NEW BOSTON LANDFILL
BOWIE COUNTY, TEXAS
TCEQ PERMIT APPLICATION NO. MSW 576C

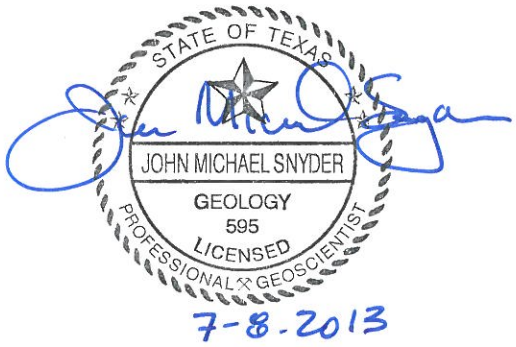
PERMIT AMENDMENT APPLICATION

PART III – SITE DEVELOPMENT PLAN
ATTACHMENT F
GROUNDWATER CHARACTERIZATION REPORT

Prepared for

Waste Management of Texas, Inc.

July 2013



Prepared by

BIGGS & MATHEWS ENVIRONMENTAL
1700 Robert Road, Suite 100 • Mansfield, Texas 76063 • 817-563-1144

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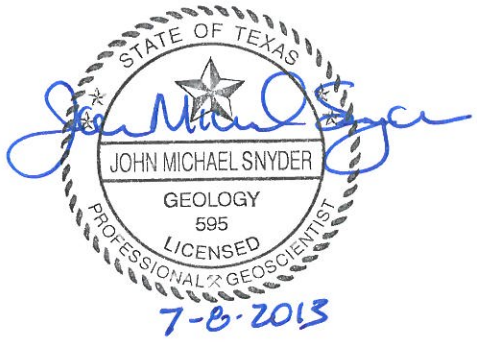
TEXAS BOARD OF PROFESSIONAL GEOSCIENTISTS
FIRM REGISTRATION NO. 50222



CONTENTS

GROUNDWATER MONITORING SYSTEM DESIGN CERTIFICATION

General Site Information

Site: New Boston Landfill

Site Location: Bowie County, Texas

MSW Permit Application No.: 576C

Qualified Groundwater Scientist Statement

I, Michael Snyder, am a licensed professional geoscientist in the State of Texas and a qualified groundwater scientist as defined in §330.3. I have reviewed the groundwater monitoring system and supporting data contained herein. In my professional opinion, the groundwater monitoring system is in compliance with the groundwater monitoring requirements specified in 30 TAC §330.401 through §330.421. This system has been designed for specific application to the New Boston Landfill (Permit Application No. MSW 576C). The only warranty made by me in connection with this document is that I have used that degree of care and skill ordinarily exercised under similar conditions by reputable members of my profession, practicing in the same or similar locality. No other warranty, expressed or implied, is intended.

Firm/Address: Biggs and Mathews Environmental, Inc.
1700 Robert Road, Suite 100
Mansfield, Texas 76063

Signature: _____

Michael Snyder, P.G. No. 595 - Texas

STATE OF TEXAS
JOHN MICHAEL SNYDER
GEOLOGY
595
LICENSED
PROFESSIONAL GEOSCIENTIST

Date: 7-8-2013

1 SITE HYDROGEOLOGY

1.1 Hydrogeologic Units

Site stratigraphy is discussed in detail in Section 4.3 of Attachment E. The hydrogeologic interpretation of the site is discussed in Section 5.6 of Attachment E and is summarized below. The geologic cross sections and maps, Figures E3-1 through E3-14 of Attachment E, depict the stratigraphy of the site.

Layer IA – Groundwater Zone

The Layer IA sands/silts are present as a significant, correlatable unit only on the northwestern perimeter of the West Disposal Area. Layer IA is not present on the North and South Disposal Areas. Based on the results from borings drilled north and west of the site, a sand channel exists north and northwest of the West Disposal Area that is oriented north/south to northeast/southwest. The northwestern perimeter of the West Disposal Area appears to be on the southern or southeastern edge of the channel. Based on previous borings, very little Layer IA sand existed within the footprint of the waste excavation at the West Disposal Area. What little sand may have existed has been removed by the excavation, leaving only a narrow area in the buffer zone of the West Disposal Area. The limited presence of the sand occurrence is shown in the geologic cross sections presented in Figures E3-1 through E3-11. Groundwater flow directions determined from potentiometric surface maps consistently showed groundwater flow from north to south from areas north of the site toward the north and northwest part of the site and areas west of the site.

Groundwater is contained in the Layer IA sands and silty clay. Because of the lack of areal extent, recharge to this sandy unit is limited to infiltration of precipitation from the surface primarily through the Layer I clays. Groundwater movement in Layer IA is limited to the areas where the sand is present. Because the isolated Layer IA sand and silty clay is contained within the Layer I clays, the Layer IA sands/silty clays are directly underlain by the Layer I clay. The Layer I clays thus serve as the lower confining unit to the Layer IA sand and silty clays.

Layer IA was previously monitored by only monitoring well MW-2R as part of the Subtitle D monitoring system. However, due to the limited occurrence of the Layer IA sands and the results of numerous studies discussed in Section 1.3.1 of this attachment, the TCEQ agreed as part of the Subchapter J permit modification (approved 2/22/2011) process that MW-2R should be removed from the groundwater monitoring system but remain in place as an observation well.

Layer I – Confining Unit

Layer I is a surface clay unit that ranges from about 20 to more than 70 feet thick and consists predominantly of brown and/or red clay with some sandy and silty clay lenses. The average thickness of this surface clay unit below the lowest landfill base grade elevation is approximately 15 feet across the site. Within Layer I are silts and sand lenses that are clayey, and have been identified as Layer IA only on the West Disposal Area.

Layer II – Uppermost Aquifer

Layer II sand directly overlying the Layer III clay unit is approximately 30 to 75 feet bgs and consists of light gray to pale olive, wet, dense, clayey and silty sands. The thickness of this unit in the site borings ranges from 8 to 28 feet. Occasional discontinuous clay lenses occur within this sandy layer. Where they occur, they are identified as Layer IIA. The areal distribution and geometry of Layer II can be seen on an isopach contour map of the thickness of Layer II (Figure E3-13) and a structural contour map of the base of the sand (Figure E3-14). The Layer II sand isopach and structure maps indicate two generally north-south trending sand deposits that are separated near the middle of the West Disposal Area by clay. The Layer II sand is continuous and correlatable across the North and South Disposal Area.

Consistent with the regional geology of the Midway group, there are two generally north-south trending sand deposits that are separated near the middle of the West Disposal Area by clay. In addition, there is a clay interval on the east side of the West Disposal Area where the Layer II sand is absent. These clay deposits are likely overbank/levee deposits that were deposited following channel flooding during storm events. Groundwater enters Layer II sands northwest and north of the site (upgradient). Layer II groundwater flows within the channels, to the southwest in the channel on the western portion of the West Disposal Area and to the south-southeast in the channel on the eastern portion of the West Disposal Area. The Layer II sand is continuous and correlatable across the North and South Disposal Areas.

Groundwater flows generally to the southwest on the western portion of the North and South Disposal Areas and to the east, southeast, and northeast on the eastern portion of the North and South Disposal Areas.

The groundwater flow velocity is estimated to be 65.6 feet per year. Flow velocity calculations and parameters are included in Attachment E, Appendix E6 as Figure E6-15.

A total of 29 Subtitle D, point of compliance (POC) groundwater monitoring wells are proposed for this zone.

Layer IIA

Layer IIA are clay lenses that are laterally discontinuous and uncorrelatable across the site. These clay lenses are found within the Layer II sand. The Layer IIA clays were only observed in a few borings. Where present this unit ranges from five to eight feet in thickness.

Layer III – Confining Unit

Layer III represents the basal aquiclude (lower confining unit) and consists of a dark gray, hard clay that was encountered at depths from 47 to 80 feet. The uppermost one to three feet of this unit is locally mottled, somewhat sandy, and generally moist because it is in contact with the saturated portion of the overlying Layer II sand unit. The unit has occasional slickensides. This clay unit is continuous across the site to the maximum depth of the borings (150 feet). Borings that did not penetrate below about 310 feet msl on the West Disposal Area did not reach this unit. However, all borings drilled as part of the current investigation (BME-1 through BME-25) reached Layer III and penetrated this unit a minimum of 10 feet. Layer II sand channels eroded the surface of the Layer III clays. The Layer III clay is the lower confining unit to the Layer II sands.

The top of the Nacatoch Sand of the Navarro Group is at least 400 feet below the site (McGowen and Lopez, 1983; Ashworth, 1988). The sands of Layer II are separated from the uppermost regional aquifer (Nacatoch) by several hundred feet of clay and therefore are not hydraulically connected to any other deeper aquifers.

There are no other known aquifers beneath the site (Ashworth and Hopkins, 1995). The Carrizo/Wilcox Aquifer crops out several miles south of the site and dips to the south and southeast, away from the site (Baker, 1963; Barnes, 1966; and Ashworth and Hopkins, 1995). The Layer II sands beneath the site are underlain by at least 90 feet of Layer III clay (see Figure E3-2 of Attachment E). This clay has laboratory permeability tests in the range of 1×10^{-8} cm/sec. Therefore, any deeper sands would not be hydraulically connected.

1.2 Aquifer Characteristics

Slug tests were performed in selected groundwater monitoring wells in Layer II. Rising and falling head tests were conducted in the monitoring wells. Data were collected by pressure transducer and electronic data logger. The raw data were analyzed by EMCON using Bouwer and Rice (1976) and the Cooper, Bredehoeft, and Papadopulos (1967) models. The test results are summarized in Table F-1. Hydraulic conductivity values ranged from 6.8×10^{-3} to 6.1×10^{-5} cm/sec. Field permeability tests were also conducted in FP-1 and FP-3 within the Layer 1 clay.

Slug tests were generally conducted by measuring the rising head or falling head of water levels with time following removal of a water column using a bailer or addition of a slug displacing a water volume. At each piezometer, a depth to static water level was measured to the nearest 0.01-foot prior to testing. A pressure transducer probe was placed near the base of the well to record initial water column heights and changes in water column heights as water levels fell or rose to static water levels.

Table F-1
New Boston Landfill
Hydraulic Conductivity Values

Well No.	Screen Interval ft/msl	Lithology at Screen Interval	Layer	Hydraulic Conductivity (cm/sec)	
				Falling Head	Rising Head
MW-01[1]	320 – 305	Clay & Sand	I & II	3.0×10^{-4}	7.0×10^{-4}
MW-02[1,4]	329 – 304	Clay & Sand	I & II	4.6×10^{-3}	6.8×10^{-3}
MW-03[2]	329 – 309	Clay & Sand	II	6.1×10^{-5}	1.0×10^{-4}
MW-04[2,3,4]	330 – 305	Clay & Sand	I & II	1.0×10^{-4}	1.0×10^{-4}
MW-05[2]	321 – 306	Sand	II	1.8×10^{-4}	1.9×10^{-4}
MW-06[1,3]	318 – 308	Sand	II	4.4×10^{-3}	4.7×10^{-3}
FP-1[4]	328 – 339	Clay	I		8.38×10^{-6}
FP-3[4]	336 – 334	Clay	I		8.58×10^{-7}
Arithmetic Mean				1.33×10^{-3}	

[1] Cooper et al. (1967) model used
[2] Bouwer and Rice (1976) model used
[3] Results are an average of two tests
[4] Only Layer II values were used to calculate arithmetic mean.

1.2.1 Groundwater Flow Direction and Rate

The groundwater flow regimes for the site are discussed in Section 5.6 of Attachment E. Groundwater flow in Layer II (which is the uppermost aquifer for groundwater monitoring purposes) is generally to the southwest in the sand channel on the western portion of the West Disposal Area, and to the south and southeast in the sand channel on the eastern portion of the West Disposal Area (Figure F1-1). Groundwater flows generally to the southwest on the western portion of the North and South Disposal Areas and to the east, southeast, and northeast on the eastern portion of the North and South Disposal Areas. Multiple potentiometric surface maps were previously constructed for a period from 1996 – 2007 for the West Disposal Area, while potentiometric surface maps that include the piezometers for the North and South Disposal Area were constructed from September 2011 through August 2012 (Attachment E, Appendix E6, Figures E6-1 through E6-14), to account for possible seasonal and temporal affects to groundwater flow direction and gradient position. The estimated flow velocity for the site is 65.6 feet per year (Attachment E, Appendix E6, Figures E6-1 through E6-15).

1.3 Groundwater Quality

Groundwater quality has been monitored at the site as a part of a permitted monitoring network since the early 1990s. Groundwater conditions in the vicinity of the facility are currently monitored by twelve (12) groundwater monitoring wells, including upgradient monitoring well MW-01 and downgradient wells MW-03R through MW-13 (screened primarily in the Layer II sand). The original MW-03 was damaged and approved for replacement in December 2008. The installation report for MW-03R was approved on June 23, 2009. A permit modification for replacement of MW-06 was approved in September 2004 due to approved construction activities. MW-06R was installed in 2004 and assumed

the assessment monitoring status of its predecessor. Four additional wells (MW-10, MW-11, MW-12, and MW-13) were installed in April 2011 as a result of a permit modification approved in November 2010 to address the well spacing requirements established by Subchapter J in the March 2006 rule revision.

Subtitle D background sampling was conducted for the site monitoring wells in accordance with the facility Groundwater Sampling and Analysis Plan (GWSAP) between October 1995 and October 1997. The initial detection monitoring event for the site under permit number 576-A was conducted in May 1998. Additional data for selected analytes is available for monitoring wells MW-01 through MW-07 that began analysis for heavy metals between February 1991 and October 1992, depending on the well installation date, as required by the previous operational permit. Background data collection began in June 2011 for the four wells installed in 2011. Historical analytical data for the facility monitoring wells is provided in Appendix E7 – Historical Groundwater Analytical Data (including Appendix II constituents).

Since the initiation of groundwater monitoring at the facility, inorganic and organic constituents listed in 40 Code of Federal Regulations Part 258, Appendix I, and §330.419 have been detected in groundwater samples. The concentration detections greater than the practical quantitation limit (PQL) are provided in a historical data tabulation in Appendix E7. Table F-2 – Historical Appendix I MCL Exceedances provides a summary of the constituents that have a U.S. EPA established MCL that have been detected at facility wells.

Table F-2
New Boston Landfill
Historical Appendix I MCL Exceedances
2005 - 2012

Sample Date	Well	Constituent	Result (µg/L)	MCL (µg/L)
5/24/2005	MW-02R	Barium	3300	2000
11/11/2005	MW-02R	Barium	3600	2000
5/23/2006	MW-02R	Barium	3300	2000
11/28/2006	MW-02R	Barium	3400	2000
5/17/2007	MW-02R	Barium	3300	2000
8/22/2007	MW-02R	Barium	2900	2000
11/7/2007	MW-02R	Barium	3400	2000
5/13/2008	MW-02R	Barium	3300	2000
11/19/2008	MW-02R	Barium	3200	2000
5/29/2009	MW-02R	Barium	3100	2000
6/12/2009	MW-03R	Arsenic	14	10
8/28/2009	MW-03R	Arsenic	30	10
11/4/2009	MW-02R	Barium	3200	2000
	MW-03R	Arsenic	33	10
2/25/2010	MW-03R	Arsenic	24	10
5/12/2010	MW-01	Barium*	2200	2000
	MW-02R	Barium	3100	2000
	MW-03R	Arsenic	23	10
8/19/2010	MW-03R	Arsenic	22	10
12/14/2010	MW-02R	Barium	3500	2000
	MW-03R	Arsenic	18	10
2/23/2011	MW-03R	Arsenic	15	10
6/30/2011	MW-02R	Barium	3200	2000
	MW-03R	Arsenic	15	10
11/8/2012	MW-4	Bis(2-theylhexyl)phthalate*	29	6

**unverified detection*

In summary, barium represents the only Appendix I constituent that has been consistently detected in site monitoring wells in concentrations equal to or greater than its MCL. As a result of the detection of barium at concentrations greater than the calculated statistical limit for that well (either the CUSUM value or the prediction limit), an assessment monitoring program was implemented at wells MW-02R, MW-04, MW-06 (MW-06R), MW-07, and MW-09 at the second semi-annual monitoring event in 2001. When MW-06R replaced MW-06 in 2004, it assumed its predecessors assessment monitoring status. MW-08 was included in the assessment monitoring program starting with the first semi-annual event of 2003 also due to exceedances of barium. Compliance response actions included sampling each well for those constituents listed in Appendix II of 40 CFR Part 258 (assessment monitoring constituents). In each case, no Appendix II constituent detection was verified in concentrations greater than the respective PQL (see Appendix E7).

There have been statistical exceedances of other inorganic constituents that are no longer required to be subjected to statistical evaluation in the site's monitoring history. Table F-3 – Statistical Analysis Summary Table provides a summary of each exceedance as originally reported in the groundwater monitoring report and statistical evaluation report for each sampling event.

Table F-3
New Boston Landfill
Statistical Analysis Summary Table – 2000 through First Quarter 2013

Groundwater Monitoring Event/Report Type	Well	Constituent	Type	Result (mg/L)	Intrawell Upper Prediction Limit (mg/L)	MCL (mg/L)	Action Taken[1]
Second Semi-Annual 2000	MW-02R	Tetrachloroethene	Initial Detection	0.43	--	0.005	Verification monitoring - not verified.
	MW-04	Selenium	Unverified	0.03	0.03	0.05	CUSUM exceedance only. Verification monitoring.
	MW-05	Sodium	Unverified	427.00	494.47		
	MW-06	Barium	Verified	0.99	1.18	2	
	MW-06	Iron	Unverified	0.20	0.05		Verification monitoring.
First Semi-Annual 2001	MW-04	Selenium	Verified	0.03	0.03	0.05	Verified - CUSUM exceedance only. Assessment initiated.
	MW-05	Iron	Unverified	0.31	0.22		Verification monitoring.
	MW-05	Sodium	Verified	425.00	494.47		CUSUM exceedance only. Verification monitoring.
	MW-08	Chloride	Unverified	429.00	507.04		
	MW-08	Magnesium	Unverified	50.50	60.36		
	MW-08	TDS	Unverified	1310.00	1418.21		
Second Semi-Annual 2001	MW-05	Iron	Unverified	0.14	0.22		
	MW-05	Sodium	Verified	426.00	494.47		
	MW-08	Barium	Unverified	0.51	0.54	2	
	MW-08	Chloride	Unverified	448.00	507.04		
	MW-08	Iron	Unverified	0.06	0.04		Verification monitoring.
	MW-08	Magnesium	Unverified	53.50	60.36		CUSUM exceedance only. Verification monitoring.
	MW-08	TDS	Unverified	1330.00	1418.21		
	Assessment monitoring began at MW-02R, MW-04, MW-06, MW-07 & MW-09. Barium at MW-02R exceeds consistently above MCL.						
First Semi-Annual 2002	MW-05	Iron	Verified	0.27	0.22		Confirmed. ASD submitted 7/02 - approved 4/03.
	MW-05	Sodium	Verified	430.00	494.47		
	MW-08	Barium	Unverified	0.46v	0.54	2	CUSUM exceedance only. Verification monitoring.
	MW-08	Chloride	Verified	446.00	507.04		
	MW-08	Magnesium	Verified	55.10	60.36		
	MW-08	TDS	Verified	1230.00	1418.21		
	Assessment monitoring at MW-02R, MW-04, MW-06, MW-07 & MW-09. Barium at MW-02R exceeds consistently above MCL.						

Table F-3
New Boston Landfill
Statistical Analysis Summary Table – 2000 through First Quarter 2013 (Continued)

Groundwater Monitoring Event/Report Type	Well	Constituent	Type	Result (mg/L)	Intrawell Upper Prediction Limit (mg/L)	MCL (mg/L)	Action Taken[1]
Second Semi-Annual 2002	MW-05	Iron	Verified	0.13	0.22		Confirmed - CUSUM exceedance only. ASD submitted 7/02 - approved 4/03.
	MW-05	Sodium	Verified	430.00	494.47		
	MW-08	Barium	Verified	0.48	0.54	2	CUSUM exceedance only. Verification monitoring.
	MW-08	Calcium	Unverified	130.00	139.05		
	MW-08	Chloride	Verified	460.00	507.04		
	MW-08	Magnesium	Verified	58.00	60.36		
	MW-08	Sodium	Unverified	340.00	368.32		
	MW-08	TDS	Verified	1300.00	1418.21		
	Assessment monitoring at MW-02R, MW-04, MW-06, MW-07 & MW-09. Barium at MW-02R exceeds consistently above MCL.						
First Semi-Annual 2003	MW-05	Iron	Verified	0.40	0.22		Confirmed. ASD submitted 7/02 - approved 4/03.
	MW-05	Sodium	Verified	410.00	494.47		
	MW-08	Barium	Verified	0.51	0.54	2	Verified. Assessment initiated.
	MW-08	Chloride	Verified	490.00	507.04		
	MW-08	Magnesium	Verified	61.00	60.36		
	MW-08	TDS	Verified	1400.00	1418.21		
	Assessment monitoring at MW-02R, MW-04, MW-06, MW-07 & MW-09. Barium at MW-02R exceeds consistently above MCL.						
Second Semi-Annual 2003	MW-05	Iron	Verified	0.30	0.22		Confirmed. ASD submitted 7/02 - approved 4/03.
	MW-05	Sodium	Verified	450.00	494.50		Confirmed - CUSUM exceedance only. ASD submitted 7/02 - approved 4/03.
	Assessment monitoring at MW-02R, MW-04, MW-06, MW-07, MW-08, & MW-09. Barium at MW-02R exceeds consistently above MCL.						
First Semi-Annual 2004	MW-03	Iron	Unverified	0.05	0.03		Verification monitoring.
	MW-05	Iron	Verified	0.52	0.22		Confirmed. ASD submitted 7/02 - approved 4/03.
	MW-05	Sodium	Verified	410.00	494.50		Confirmed - CUSUM exceedance only. ASD submitted 7/02 - approved 4/03.
	Assessment monitoring at MW-02R, MW-04, MW-06, MW-07, MW-08, & MW-09. Barium at MW-02R exceeds consistently above MCL.						
Second Semi-Annual 2004	MW-03	Iron	Unverified	0.06	0.03		Verification monitoring.
	MW-05	Iron	Verified	0.28	0.22		Confirmed. ASD submitted 12/04 - approved 1/05. Re-evaluation of ASD requested in TCEQ letter of 9/28/04.
	MW-05	Sodium	Verified	450.00	494.50		
	MW-06R	Chloroform	Initial Detection	0.01	--		Verification monitoring - Not verified.
	Assessment monitoring at MW-02R, MW-04, MW-07, MW-08, & MW-09 (MW-06 plugged/abandoned and MW-06R was installed). Barium at MW-02R exceeds consistently above MCL.						

Table F-3
New Boston Landfill
Statistical Analysis Summary Table – 2000 through First Quarter 2013 (Continued)

Groundwater Monitoring Event/Report Type	Well	Constituent	Type	Result (mg/L)	Intrawell Upper Prediction Limit (mg/L)	MCL (mg/L)	Action Taken[1]
First Semi-Annual 2005	MW-03	Iron	Verified	0.05	0.03		Verification monitoring.
	MW-05	Iron	Verified	0.43	0.22		Confirmed. ASD submitted 12/04 - approved 1/05. Re-evaluation of ASD requested in TCEQ letter of 9/28/04. Re-approved 8/18/2008.
	MW-09	Carbon Disulfide	Initial Detection	0.01	--		Verification monitoring - Not verified.
	Assessment monitoring at MW-02R, MW-04, MW-07, MW-08, & MW-09. Barium at MW-02R exceeds consistently above MCL.						
Second Semi-Annual 2005	MW-05	Iron	Verified	0.85	0.22		Confirmed. ASD submitted 12/04 - approved 1/05. Re-evaluation of ASD requested in TCEQ letter of 9/28/04. Re-approved 8/18/2008.
	Assessment monitoring at MW-02R, MW-04, MW-07, MW-08, & MW-09. Barium at MW-02R exceeds consistently above MCL.						
First Semi-Annual 2006	MW-05	Iron	Verified	0.15	0.22		Confirmed. ASD submitted 12/04 - approved 1/05. Re-evaluation of ASD requested in TCEQ letter of 9/28/04.
	MW-05	Sodium	Unverified	460.00	544.00		
	Assessment monitoring at MW-02R, MW-04, MW-07, MW-08, & MW-09. Barium at MW-02R exceeds consistently above MCL.						
Second Semi-Annual 2006	MW-05	Iron	Verified	0.15	0.22		Confirmed. ASD submitted 12/04 - approved 1/05. Re-evaluation of ASD requested in TCEQ letter of 9/28/04 and is linked to workplan in 2005. Re-approved 8/18/2008.
	MW-05	Sodium	Unverified	460.00	544.00		
	Assessment monitoring at MW-02R, MW-04, MW-06R, MW-07, MW-08, & MW-09. Barium at MW-02R exceeds consistently above MCL.						
First Semi-Annual 2007	MW-05	Iron	Verified	0.31	0.22		Confirmed. ASD submitted 12/04 - approved 1/05. Re-evaluation of ASD requested by TCEQ on 9/28/04 and is linked to workplan in 2005. Re-approved 8/18/2008.
	MW-05	Sodium	Verified	470.00	494.50		
	Assessment monitoring at MW-02R, MW-04, MW-06R, MW-07, MW-08, & MW-09. Barium at MW-02R exceeds consistently above MCL. A workplan for the occurrence of barium at MW-02R was submitted on 8/31/07.						
Second Semi-Annual 2007	MW-03	Iron	Unverified	0.03	0.03		Verification monitoring.
	MW-05	Iron	Unverified	0.42	0.22		Confirmed. ASD submitted 12/04 - approved 1/05. Re-evaluation of ASD requested by TCEQ on 9/28/04 and is linked to workplan in 2005. Re-approved 8/18/2008.
	MW-05	Sodium	Verified	430.00	494.00		
	Assessment monitoring at MW-02R, MW-04, MW-06R, MW-07, MW-08, & MW-09. Request submitted to return MW-06R to assessment. Barium at MW-02R exceeds consistently above MCL. A revised workplan for the occurrence of barium at MW-02R was submitted on 12/6/07, and an ASD for the occurrence of barium in MW-02R was submitted on 12/19/08.						
First Semi-Annual 2008	MW-03	Ammonia	Unverified	0.17	0.10		Verification monitoring.
	MW-03	Barium	Unverified	0.62	0.69	2	CUSUM exceedance only. Verification monitoring.
	MW-05	Iron	Verified	0.22	0.22		Confirmed. ASD submitted 12/04 - approved 1/05. Re-evaluation of ASD requested by TCEQ on 9/28/04 and is linked to workplan in 2005. Re-approved 8/18/2008.
	MW-05	Sodium	Verified	430.00	514.00		

Table F-3
New Boston Landfill
Statistical Analysis Summary Table – 2000 through First Quarter 2013 (Continued)

Groundwater Monitoring Event/Report Type	Well	Constituent	Type	Result (mg/L)	Intrawell Upper Prediction Limit (mg/L)	MCL (mg/L)	Action Taken[1]
	Assessment monitoring at MW-02R, MW-04, MW-06R, MW-07, MW-08, & MW-09. Barium at MW-02R exceeds consistently above MCL. A revised workplan for the occurrence of barium at MW-02R was submitted on 12/6/07.						
Second Semi-Annual 2008	MW-03	Barium	Unverified	0.29	0.69	2	Determined that the integrity of the well had been compromised. Permit mod to plug/abandon and replace with MW-03R submitted in 11/08 (approved 12/08).
	MW-03	Iron	Unverified	0.03	0.03		
	MW-05	Iron	Verified	0.81	0.22		Confirmed. ASD submitted 12/04 - approved 1/05. Re-evaluation of ASD requested in TCEQ letter of 9/28/04 and is linked to workplan in 2005. Re-approved 8/18/2008.
	MW-08	Bis(2-ethylhexyl)phthalate	Initial Detection	0.03	--	0.006	Verification monitoring on 1/2/09 - not verified.
	MW-09	Bis(2-ethylhexyl)phthalate	Initial Detection	0.02	--	0.006	
	Assessment monitoring at MW-02R, MW-04, MW-06R, MW-07, MW-08, & MW-09. Barium at MW-02R exceeds consistently above MCL. A revised workplan for the occurrence of barium at MW-02R was submitted on 12/6/07. An ASD for the occurrence of barium in MW-02R was submitted on 12/19/08 and approved 2/22/11.						
First Semi-Annual 2009	Assessment monitoring at MW-02R, MW-04, MW-07, MW-08, & MW-09. Barium at MW-02R exceeds consistently above MCL. Subchapter J permit modification approved on March 17, 2009, requiring statistics to only be completed on Appendix I total metals and VOCs. No statistical exceedances of evaluated constituents.						
Second Semi-Annual 2009	Assessment monitoring at MW-02R, MW-04, MW-07, MW-08, & MW-09. Barium at MW-02R exceeds consistently above MCL. No statistical exceedances of evaluated constituents.						
First Semi-Annual 2010	Assessment monitoring at MW-02R, MW-04, MW-07, MW-08, & MW-09. Barium at MW-02R exceeds consistently above MCL. No statistical exceedances of evaluated constituents.						
Second Semi-Annual 2010	Assessment monitoring at MW-02R, MW-04, MW-07, MW-08, & MW-09. Barium at MW-02R exceeds consistently above MCL. No statistical exceedances of evaluated constituents. An ASD for the occurrence of barium in MW-02R was submitted on 12/19/08 and approved 2/22/11.						

Table F-3
New Boston Landfill
Statistical Analysis Summary Table – 2000 through First Quarter 2013 (Continued)

Groundwater Monitoring Event/Report Type	Well	Constituent	Type	Result (mg/L)	Intrawell Upper Prediction Limit (mg/L)	MCL (mg/L)	Action Taken[1]
First Quarter 2011	MW-04	Bis(2-ethylhexyl)phthalate	Initial Detection	0.053	--	0.006	Verification monitoring. Not verified.
Second Quarter 2011	MW-10	Chloroform	Initial Detection	0.0034	--		Verification monitoring. Redevelopment needed.
	MW-11	Chloroform	Initial Detection	0.0062	--		
	MW-11	Dichlorobromomethane	Initial Detection	0.0024	--	0.08	
	MW-11	Methyl Ethyl Ketone	Initial Detection	0.02	--		
	MW-12	Chloroform	Initial Detection	0.008	--		
	MW-12	Dichlorobromomethane	Initial Detection	0.0025	--	0.08	
	MW-12	Methyl Ethyl Ketone	Initial Detection	0.0071	--		
	Assessment monitoring at MW-04, MW-06R, MW-07, MW-08, & MW-09. MW-02R was removed from the groundwater monitoring system as part of the Subchapter J permit modification that was approved 2/22/11. ASDs for barium in MW-02R and iron and sodium in MW-05 were also approved by the 2/22/11 modification.						
Third Quarter 2011	MW-10	Chloroform	Unverified	0.0023	--		Verification monitoring. Further redevelopment needed.
	MW-11	Chloroform	Unverified	0.0017	--		
	MW-12	Chloroform	Unverified	0.0038	--		
Fourth Quarter 2011	MW-10	Chloroform	Unverified	0.0011	--		
	Assessment monitoring at MW-04, MW-06R, MW-07, MW-08, & MW-09.						
Second Quarter 2012	MW-03R	Barium	Unverified	1.8	0.159	2	Verification monitoring on 7/2/12 – Verified.
	Assessment monitoring at MW-04, MW-06R, MW-07, MW-08, & MW-09.						

Table F-3
New Boston Landfill
Statistical Analysis Summary Table – 2000 through First Quarter 2013 (Continued)

Groundwater Monitoring Event/Report Type	Well	Constituent	Type	Result (mg/L)	Intrawell Upper Prediction Limit (mg/L)	MCL (mg/L)	Action Taken[1]
Third Quarter 2012	MW-03R	Barium	Verified	1.7	0.159	2	Modified Appendix II monitoring conducted. ASD submitted 11/12/12 – approved 12/7/12.
Fourth Quarter 2012	MW-03R	Barium	Verified	.85	0.159	2	Confirmed; 11/12 ASD still applied.
	MW-4	Bis(2-ethylhexyl)phthalate	Unverified	0.029	--	0.006	Verification monitoring on 2/1/13. Not verified.
	MW-5	Barium	Unverified	0.65	0.2	2	Verification monitoring on 1/18/13. Verified.
	MW-5	Benzene	Initial Detection	0.001	--	0.005	Verification monitoring on 1/18/13. Verified.
	MW-5	1,1-Dichloroethane	Initial Detection	0.001	--		Verification monitoring on 1/18/13. Verified.
	Assessment monitoring at MW-04, MW-06R, MW-07, MW-08, & MW-09.						
First Quarter 2013	MW-5	Barium	Verified	0.61	0.2	2	Assessment monitoring initiated on 1/29/13.
	MW-5	Benzene	Verified	0.0018	--	0.005	Assessment monitoring initiated on 1/29/13.
	MW-5	1,1-Dichloroethane	Verified	0.002	--		Assessment monitoring initiated on 1/29/13.
	MW-5	Benzene	Verified	0.0018	--	0.005	Assessment monitoring initiated on 1/29/13.
	MW-5	1,1-Dichloroethane	Verified	0.002	--		Assessment monitoring initiated on 1/29/13.
	Assessment monitoring at MW-04, MW-06R, MW-07, MW-08, & MW-09.						

[1]The TNRCC guidance document (MSW Monitoring Procedures, 1998) did not require assessment monitoring or additional action unless two or more non-30 TAC §330.241 Table 1 constituents had verified statistical exceedances.

1.3.1 Assessment Monitoring

In accordance with §330.409, statistically significant increases (SSI) in the groundwater triggering assessment under §330.407(b) have been addressed in accordance with TCEQ regulations and will be addressed in accordance with §330.409 for any future SSIs. Due to previous SSI events triggering assessment monitoring, the following wells are currently monitored for assessment constituents at the facility:

MW-04, MW-05, MW-06R, MW-07, MW-08 and MW-09

The concentration limit for each constituent is the maximum contaminant limit (MCL) established by the Environmental Protection Agency in 40 CFR Part 141, National Primary Drinking Water Regulations if an MCL has been established. If no MCL has been established facility background concentration levels are used to determine the groundwater protection concentration limit by statistical analysis methods. The statistical analysis methods for the Type I facility wells are discussed in Appendix F2 – Groundwater Sampling and Analysis Plan. In accordance with TCEQ rules, previous assessment of corrective measure activities at the facility included the following related to MW-2R:

In January 2003, a report titled *"Alternate Source Demonstration, Nature and Extent and Assessment of Corrective Measures, Monitoring Well MW-02R"* was submitted to TCEQ. The report included the location of old waste pit areas, the extent of stratigraphic Layer IA, demonstration of the limited areal extent, confirmation that the occurrence of barium above the MCL occurs only in Layer IA, and data to support that no hydraulic connection was observed between the two groundwater zones.

Subsequently, another study titled *"Evaluation of Barium Occurrence and Alternate Source Demonstration Addendum"* was submitted to TCEQ in December 2005. The conclusion of that study was that barium is naturally occurring. The TCEQ subsequently requested additional nature and extent plans to further characterize potential offsite occurrence of the Layer IA sands. That plan was submitted to TCEQ in August 2007. The results of the implemented workplan were submitted to TCEQ in February 2010. On September 28, 2010, a meeting was held between TCEQ, WMTX, and its consultants. The result of that meeting was an agreement that WMTX will conduct a Texas Risk Reduction Program (TRRP) analysis regarding the occurrence of barium in shallow Layer IA.

The TRRP analysis consisted of an Affected Property Assessment Report that was submitted to the TCEQ on October 6, 2011 to address the elevated levels of barium in the Layer IA groundwater. The report concluded that the facility was not the source of the high barium concentrations in Layer IA groundwater, and concluded further that the high concentrations do not represent contamination but rather natural background concentrations. According to a TCEQ letter dated December 29, 2011, the agency accepts that the facility is not the source of the high barium concentrations in Layer IA, based solely on the portion of the investigation that indicated groundwater elevations in Layer IA are higher north of the site, and that barium concentrations are also high in Layer IA north of the site, indicating that the source of the barium is upgradient from the site. As a result no further action was required.

1.3.2 Corrective Action

It has been successfully demonstrated that the facility is not the source of the detections of barium above the MCL in Layer IA groundwater at the facility and no further action in that regard is required. However, in accordance with §§330.411 through 330.415, should future detections of hazardous constituents exceed the groundwater protection standard defined under §330.409(h), (i), or (j), a corrective measures assessment shall be initiated in accordance with §330.411, a remedy selected, and a corrective action program implemented as required by §§330.413 and 330.415, respectively.

2 GROUNDWATER MONITORING SYSTEM

2.1 Existing Groundwater Monitoring System

This site has an existing Subtitle D groundwater monitoring system that was certified by a qualified groundwater scientist (defined in 30 TAC §330.3) as being in compliance with 30 TAC §§330.401 through 330.421.

The existing groundwater monitoring system consists of a total of twelve (12) wells screened primarily in Layer II (MW-01, MW-03R, MW-04, MW-05, MW-06R, MW-07, MW-08, MW-09, MW-10, MW-11, MW-12, and MW-13), which is the uppermost aquifer beneath the site. The groundwater monitoring system design certification was most recently accepted by the TCEQ on February 24, 2011 with a permit modification for the installation of monitoring well MW-06R. Based on recent groundwater contours, one of the wells screened in Layer II is upgradient (MW-01) and the remaining eleven are downgradient. The POC is shown on Figure F1-1. The groundwater monitoring system at New Boston Landfill is designed to monitor Layer II, the uppermost aquifer.

Layer IA was previously monitored by MW-2R as part of the Subtitle D monitoring system. However, due to the limited occurrence of the Layer IA sands and the results of numerous studies discussed in Section 1.3.1 of this attachment, the TCEQ agreed as part of the Subchapter J permit modification process that MW-2R should be removed from the groundwater monitoring system but remain in place as an observation well.

The approved, existing monitoring wells consist of 4-inch diameter, flush-threaded PVC casing (Schedule 40) with 0.01-inch slotted PVC screens. Filter-pack sand exists from total well depth up to approximately three to eight feet above the top of the screen. A three-foot-thick bentonite seal was placed above the filter sand. The remainder of the well boring was pressure-grouted with cement/bentonite grout to the surface. Surface completions are 4-foot by 4-foot by 6-inch thick concrete pads with locking steel housings. The wells were installed in accordance with §330.421 and other applicable rules of the TCEQ.

2.2 Operational Considerations for Groundwater System Design

2.2.1 Relationship of Excavation Bottom to Uppermost Aquifer

The excavation of the New Boston Landfill is designed to remain in Layer I. Layer I is a surface clay unit that ranges from about 20 to more than 70 feet thick and consists predominantly of brown and/or red clay with some sandy and silty clay lenses. The minimum thickness of this clay unit below the lowest landfill base grade elevation is approximately nine feet, except in one area (BME-5) on the North Disposal Area where the excavation bottom will be approximately three feet from the top of the Layer II sand. Layer

II sand is approximately 30 to 75 feet bgs and consists of light gray to pale olive, wet, dense, clayey and silty sands. The aerial distribution and geometry of Layer II can be seen on a contour map of the thickness of Layer II (Figure E3-13) and a structural contour map of the base of the sand (Figure E3-14).

The Layer II sand occurs at the base of Layer I. Where no Layer II sand is present on the West Disposal Area, the contact between Layer I and Layer III is transitional. Layer I clay is generally lighter colored (brown, reddish or yellow-brown), whereas Layer III is a darker gray color. When no Layer II sand exists, Layer I is shown to be in contact with Layer III (Figure E3-2, E3-3, and E3-4).

The saturated thickness of the Layer II sand unit occurs below the excavation and sumps. As such, the excavation has no effect on the groundwater table and groundwater continues to flow beneath the site in its natural pattern. The Layer II sand unit and the relationship between the excavation and the groundwater are depicted on geologic cross sections, Figures E3-1 through E3-11.

2.2.2 Leachate Sump Design and Location

The New Boston Landfill containment system and excavation are designed to accommodate a Subtitle D leachate collection system (LCS). The excavation bottom over most of the West Disposal Area is now lined with a composite liner and is sloped to direct leachate flow to the lowest areas where sumps are designed to collect the leachate. A small area in the West Disposal Area was pre-subtitled D and was clay lined but also contains a leachate collection system which is sloped to direct leachate to the sumps. Leachate is then pumped out of the sumps. Monitoring wells along the south boundary of the West Disposal Area are downgradient of these sumps. While leachate will not remain for lengthy periods of time nor at significant depths, the sump locations are the lowest areas of the excavation. While a leak from a Subtitle D cell is unlikely, if one were to occur it would be more likely to be at the lowest leachate collection points in the sumps. For that reason, sump locations on the downgradient side of the site are considered in the design of the groundwater monitoring system. Sump locations at the New Boston Landfill are shown on Figure F1-1. Monitoring wells along the south boundary of the West Disposal Area are downgradient of all sumps.

The southernmost cells on the West Disposal Area are pre-Subtitle D lined where an LCS does not exist over the entire area. However, several cells in the southeastern portion of that area had cells constructed with leachate sumps, as shown on Figure F1-1.

The North Disposal Area will be permitted to accept Type I and Type IV waste and will have standard Subtitle D liners, leachate collection, and cover systems for Type I waste. Leachate sumps are located along the northern perimeter of the North Disposal Area, and as such monitoring wells have been placed along the downgradient portion of this perimeter. The South Disposal Area will be permitted to accept only Type IV solid waste and therefore no leachate sumps are included in the design.

2.2.3 Critical Receptors

Critical receptors to groundwater flow downgradient of a landfill could include public drinking water supply wells, individual drinking water or livestock wells, and surface water bodies used for drinking water supply. A comprehensive water well search was conducted as part of this permit amendment. That study identified a total of nine individual industrial or domestic wells within the one-mile radius and two wells just outside the one-mile radius. Two wells are located approximately 2,500 and 3,200 feet south-southwest of the site (well nos. 103 and 1E on Figure E1-5). These wells appear to be completed in the Nacatoch Sand at depths of 650 and 366 feet bgs. Neither of these wells are completed in the uppermost aquifer, the Layer II sand. Based on the potentiometric surface map of the Nacatoch shown in Attachment E, Figure E1-4, they are not located downgradient of the site. The other wells appear to be located in either an upgradient position relevant to the site or their groundwater elevation is hydraulically higher than the groundwater at the site (well nos. 1, 1J, 202, 2B, 2C, 6, and 2A of Figure E1-5). T and P Lake, the nearest surface water body to the facility, is approximately 150 feet south of the site and is not a known drinking water supply lake. Area water wells are shown in Attachment E, Figure E1-5 and are included on Table E-3 of Attachment E.

2.3 Proposed Monitoring System

2.3.1 Design Criteria

The existing Subtitle D groundwater monitoring system for the New Boston Landfill was designed and certified by a qualified groundwater scientist, was approved by the TCEQ, and is operated in accordance with rules currently in effect. The waste fill excavation is founded in the Layer I surface clay. The minimum thickness of this surface clay unit below the lowest landfill base grade elevation is approximately nine feet in most places. The groundwater monitoring system is designed to monitor Layer II, which is the uppermost aquifer. The Layer II sand unit is approximately 30 to 75 feet bgs and consists of clayey and silty sand. The thickness of this unit in the site borings ranges from 8 to 28 feet. The proposed groundwater monitoring system is designed in accordance with §330.403(a) and (e) and has also been designed so that the monitoring well spacing does not exceed 600 feet. The distance between all wells is less than 600 feet. A clay deposit exists over most of the distance on the West Disposal Area between MW-08 and MW-06R making that area inappropriate for groundwater monitoring wells. The Layer II sands are continuous and correlatable across the entire North and South Disposal Areas. In order to achieve a groundwater monitoring system designed to comply with §330.403, the following criteria listed in Table F-4 were followed. The table lists the location of the appropriate section where the required information is located in this application.

Table F-4
Groundwater Monitoring System
Design Criteria

Criterion	Location of Information in this Report
Identify and Characterize the Uppermost Aquifer	Section 1 – Site Hydrogeology
Establish Groundwater Flow Direction and Rate	Section 1.2.1 – Groundwater Flow Direction and Rate
Evaluate Potential Impacts of Operational Attributes of the Facility on Groundwater Flow	Section 2.2.1 – Relationship of Excavation Bottom to Uppermost Aquifer Section 2.2.2 – Leachate Sump Design and Location
Determine Impacts to Critical Receptors	Section 2.2.3 – Critical Receptors
Determine the Appropriate Locations and Screened Intervals of Groundwater Monitoring Wells	Section 2.1 – Existing Groundwater Monitoring System Section 2.3.3 – Monitoring Well Locations Figure F1-2 – Monitoring Well Detail

2.3.2 Contaminant Pathway Analysis

In the unlikely event of a leachate release (i.e., failure of multiple, redundant engineered containment systems such as composite liners and an LCS) contaminants would attempt to move downward through the Layer I clay to the Layer II sand. Laboratory analysis yields hydraulic conductivity values in the order of 10^{-7} cm/sec for the clays in Layer I.

If the leachate were to reach the groundwater, the miscible contaminants would be diluted by the groundwater and would move laterally, downgradient in the Layer II sand unit. Due to the relative difference in hydraulic conductivity, leachate migration in the lower clay confining layer is very unlikely.

2.3.3 Monitoring Well Locations

The uppermost aquifer beneath the New Boston Landfill has been identified as Layer II. Layer II at the site consists of clayey and silty sands. Layer II is present and correlatable across the site (Attachment E, Appendix E3, Figures E3-1 through E3-11).

The proposed groundwater monitoring system will consist of a total of 29 monitoring wells, one upgradient monitoring well (MW-01) and 28 downgradient monitoring wells (Figure F1-1). The Type I West Disposal Area will have 11 POC monitoring wells (MW-03R, MW-04, MW-05, MW-06R, MW-07, MW-08, MW-09, MW-10, MW-11, MW-12, and MW-13). The North Disposal Area (Type I) will have 11 POC monitoring wells (MW-15 through MW-24). The South Disposal Area (Type IV) will have five point of compliance monitoring wells (MW-25 through MW-30). Monitoring wells along the south boundary of the West Disposal Area are downgradient of all sumps and at less than the required 600 feet spacing. Along the southern perimeter of the West Disposal Area wells are spaced between 293 and 507 feet apart and with an average spacing of 401 feet. Monitoring wells have been placed downgradient from the sumps located along the north perimeter of the North Disposal Area and are spaced less than 600 feet apart. The monitoring wells have been placed approximately 550 feet apart along the downgradient perimeters of the South

Disposal Area (Type IV). In some locations, monitoring wells are spaced less than 600 feet apart along the POC when measured between lines perpendicular to flow lines. Monitoring well installation on the North and South Disposal Area will proceed in a phased approach consistent with sector phasing as shown in Part II, Appendix IIA. Monitoring wells MW-14 through MW-17 will be installed prior to waste being accepted in Sector 1. Monitoring wells MW-23 and MW-24 will be installed prior to waste being placed in Sector 2. The remaining North Disposal Area monitoring wells MW-18 through MW-22 will be installed prior to the waste being placed in Sector 4. All proposed monitoring wells will be installed in the South Disposal Area prior to any waste acceptance.

The proposed monitoring system is shown on Figure F1-1. The Layer II monitoring system will ultimately consist of 29 wells, of which one is an upgradient well and 28 are downgradient wells.

2.3.4 Monitoring Well Construction

In accordance with §330.421 Monitor Well Construction Specifications, a licensed Texas driller will install monitoring wells. Wells will be drilled by a method that will not introduce contaminants into the borehole or casing. A licensed professional geoscientist or engineer who is familiar with the geology of the area will supervise monitoring well installation and development and will provide a log of the boring. Equivalent alternatives to commission rules may be used if prior written approval is obtained from the executive director. Monitoring well construction details, including the protective collar and protective barrier, are shown on Figure F1-2.

If any fluid is required in the drilling of monitoring wells, clean, treated city water shall be used and a chemical analysis provided to the executive director. No glue or solvents will be used in monitoring well construction.

After installation, monitoring wells will be developed to remove drilling artifacts and open the water-bearing zone for maximum flow until all water used or affected during drilling activities is removed and field measurements of pH, specific conductance, and temperature are stabilized.

A registered professional land surveyor will survey the well location and elevation.

Within 30 days of completion of a monitoring well or any other part of a monitoring system, an installation report will be submitted. The report will include construction and installation details for each well on forms available from the commission, a site map drawn to scale showing the location of all monitoring wells and the relevant point(s) of compliance, well elevations to the nearest 0.01 foot above msl (with year of datum shown), latitude and longitude or landfill grid location of each well, copies of detailed geologic logs including soil sample data, and copies of driller's reports required by other agencies.

Damaged monitoring wells that are no longer usable will be reported to the executive director for a determination whether to replace or repair the well. In accordance with 30 TAC §305.70, if a compromised well requires replacement a permit modification request will be submitted within 45 days of the discovery.

Plugging and abandonment of monitoring wells will be performed in accordance with 16 TAC §76.702 and §76.1004. No abandonment will be performed without prior written authorization.

All parts of the groundwater monitoring system will be operated and maintained so that they perform at least to design specifications throughout the life of the groundwater monitoring program.

The facility must notify the executive director if changes in site construction or operation or changes in adjacent property affect or are likely to affect the direction and rate of groundwater flow and the potential for detecting groundwater contamination from the facility.

2.4 Groundwater Sampling and Analysis Plan

Groundwater sampling and analytical testing will be performed in accordance with Appendix F2 – Groundwater Sampling and Analysis Plan (GWSAP) for the Type I West Disposal Area and North Disposal Area, and Appendix F3 – Groundwater Sampling and Analysis Plan for the Type IV South Disposal Area.