ATTACHMENT 5

GROUNDWATER CHARACTERIZATION REPORT

BROWNWOOD REGIONAL MUNICIPAL SOLID WASTE DISPOSAL FACILITY
MSW Permit No. 1562A

Brown County
RN100216498/CN600128664

Revised December 16, 2009
Revision 2 of March 28, 2008
September 8, 2009 – Revision 1 of March 28, 2008
Supersedes January 2001

Prepared by:

Enprotec / Hibbs & Todd

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Luci A English

Luci A. English, P.E.

12-16-2009

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GROUNDWATER CHARACTERIZATION REPORT

5.1 INTRODUCTION

The City of Brownwood (City) is conducting a groundwater sampling and analysis program at the facility to protect human health and the environment. The Groundwater Characterization Report is required by the Texas Commission on Environmental Quality (TCEQ) Municipal Solid Waste Management regulations romulgated in 30 Texas Administrative Code (TAC) Subchapter J and 30 TAC §330.63(f). The Groundwater Characterization Report summarizes the groundwater characteristics at the site and analytical results at the time of this permit modification; and identifies the upper-most aquifer(s) and most-likely pollutant migration pathway.

5.1.A Summary of Groundwater Characterization Investigations & Current Groundwater Monitoring System

An initial groundwater characterization investigation was conducted at the City of Brownwood municipal landfill in July 1991. Five borings (B-4A, B-6A, B-7A, B-14A, and B-16) were drilled and converted to piezometers to replace and supplement the four monitor wells (B-1, B-3, B-6, and B-14) which were constructed in 1982. The borings were drilled using air-rotary and hollow-stem auger procedures in order to detect the uppermost saturated zone. The replacement of the original piezometers was requested by the Texas Water Commission (TWC) in March 1991 because of concerns that the original piezometers were not constructed in accordance with the TWC requirements and because the majority of them were dry.

In 1994, 23 borings (B-1 through B-23) were drilled using air rotary coring equipment and procedures. Six of the borings were converted to piezometers.

After receiving approval from the Texas Natural Resource Conservation Commission (TNRCC), nine groundwater monitoring wells were constructed at the site in January 1996. The wells were drilled using air rotary drilling procedures. During the time of these activities, the remaining monitor wells from 1982 and the piezometers constructed in 1991 were plugged and abandoned due to concern over their construction design and integrity. The piezometers were constructed with the filter pack and/or screen extending to within 5 to 10 feet below land surface and allowed infiltrating water from precipitation to accumulate in the borehole, screen, and casing. This often resulted in water levels that were not representative of subsurface conditions.

In October and November 1996, 14 borings (B-24 through B-37) were drilled at the facility. With the available information on depth to groundwater, and with the concurrence of the TNRCC, the borings were drilled using wet-rotary procedures to expedite the drilling and provide more competent core samples. Eight of the borings were converted to piezometers. A ninth piezometer was constructed in a borehole that was air-rotary drilled (not cored) adjacent to one of the new piezometers. All piezomenters at the site were plugged in 2003.

The current groundwater monitoring system consists of fourteen wells. Three of the six wells installed in January 1996 were plugged in 2003. Three replacement wells and five new wells were installed in May 2003.

The following modifications to the groundwater monitoring system were implemented at the site in May 2003:

- A new well (MW-1S) was constructed adjacent to well MW-1 screening the shallow, saturated materials;
- A new well (MW-3S) was constructed adjacent to well MW-3 screening the shallow, saturated materials;
- Replacement wells MW-4R, MW-5R, and MW-6R were installed outside the landfill footprint and were screened to the base of the adjacent excavation or through any sandstone above that elevation;
- Using test boreholes, the integrity of wells MW-7 and MW-8 was evaluated and both were determined to be sound;
- MW-10 was installed at the southwest corner of the landfill footprint (near B-26), screening the Pennsylvanian Sandstone;
- MW-11 was installed south of the landfill (south of B-8), screening the Quaternary Alluvium; and
- MW-12 was installed at the northeastern tip of the landfill footprint, screening any sandstone lenses above the base of the excavation.

Table 5-1 presents the relevant information on the construction of these wells and the screened and/or water-bearing sediments. The wells locations are shown in Figure 5-1. A schematic of a typical monitor well construction is shown in Figure 5-2.

During the 2003 well construction, the integrity of both MW-7 and MW-8 was assessed. In the 2001 version of this document, the integrity of monitor wells MW-7 and MW-8 was questioned since both wells, thought to be screened primarily in Pennsylvanian Shale, recurrently produced groundwater. Other monitor wells screened in similar material (as described in detail in Section 4.7.2 of the Attachment 4, Geology report dated February 1998) historically have been dry. In March 2003, the integrity was assessed by drilling test bore holes adjacent to each well. Groundwater was observed in both test bore holes (TW-7 and TW-8). Based on drilling logs and field observation, the groundwater appeared to be located in a thin silty shale layer. The silty shale layer was observed in both test bore holes and is noted on the drilling logs of both MW-7 and MW-8. Even though MW-8 is screened beneath the silty shale layer, it is likely the groundwater is traveling vertically through fractures within the shale. Additionally, the drilling log for MW-7 indicates that thin stringers of sandstone are interbedded within the silty shale and could be providing limited horizontal pathways. Although this silty shale layer is thin, MW-7 and MW-8 continue to produce groundwater during quarterly and semi-annual sampling events. Based on the test well boring logs and the presence of groundwater in both test bore holes, the integrity of both MW-7 and MW-8 is sound.

5.1.B Uppermost Aquifers [30 TAC §330.403(a)(1) and §330.3]

Two general types of geologic materials which comprise the uppermost aquifers have been identified in the subsurface of the site. These materials are (1) Pennsylvanian deposits of the Strawn, (2) and Quaternary Alluvium. Within the Pennsylvanian deposits, the water-bearing soils are primarily silty shale. The weathered shale, which is the predominant subsurface material at the elevation beneath the landfill excavation and extending vertically downward, is generally not water-bearing.

The term "aquifer" is defined in §330.403(8) as a geologic formation, group of formations, or portion of a formation capable of yielding significant quantities of groundwater to wells or springs. The term also implies that the aquifer is continuous and hydraulically connected with all other portions of the same geologic formation. At this site, the traditional concept of an aquifer may not always be representative of the site conditions, since the water-bearing soils occur in thin, discontinuous lenses and cell construction may disrupt the flow in continuous lenses, if present. The hydrogeologic conditions are described in more detail below.

Three of the monitor wells (MW), MW-7, MW-8, and MW-5R, were completed in a silty shale formation. These wells have proven to be the best producing wells. Gradient maps, Figure 5-4 and Figure 5-5, were prepared using these three wells which show that the groundwater tends to flow to the northeast. It should be noted that because of the landfill construction, MW-8 is not hydraulically connected to the other two wells.

The majority of the wells completed in the Pennsylvanian strata are screened in weathered shale. These wells are MW-1, MW-2, MW-3, MW-4R, MW-9, and MW-12. MW-3, MW-4R, and MW-9 produce water sporadically. One gradient map, Figure 5-6, was completed using these wells confirming the hydraulic gradient to the northeast. MW-1 and MW-2 are historically dry. MW-10 is completed in Pennsylvania Sandstone and has been historically dry.

Three wells located at the southern portion of the landfill, MW-1S, MW-3S, and MW-11, were completed in Quaternary Alluvium. MW-11 has continuously produced groundwater, whereas MW-1S and MW-3S are sporadically dry. A groundwater gradient map calculated from these three wells shows a groundwater flow to the northeast. See Figure 5-4. However, MW-11 is installed in several feet of fill and it is difficult to calculate true groundwater elevations to compare to MW-1S and MW-3S levels.

5.1.C Pollution Migration Pathway [30 TAC §330.63(f)(3)]

The Quaternary alluvium materials in the southeast corner and along the eastern edge of the proposed landfill provide the most probable migration pathway, should the primary liner system be penetrated. These materials generally represent the most permeable subsurface deposits on site. The groundwater in the Quaternary sediments discharges to the creek located to the east of the landfill. The hydraulic gradient between PZ-1 and PZ-2 (the only points on site for which as legitimate gradient can be determined) was 0.023 foot/foot in February 1997. With a hydraulic conductivity of $5x10^{-4}$ cm/sec and an assumed porosity of 20 percent, a flow rate of 0.16 foot per day is calculated from piezometers PZ-1 to PZ-2. Both of these piezometers were plugged in 2003.

Three groundwater gradient maps representing the three producing strata during different times of the year have been completed and are shown in Figures 5-4, 5-5, and 5-6. The remaining historical events have been summarized in the Table 5-2. Based on the elevations from all historical events, it is clear that groundwater at the site flows to the northeast. The shallow groundwater in the different water bearing zones appears to be mirroring the topographic surface elevations.

The impact of landfill construction on the water-bearing formations is anticipated as follows. The water-bearing formation, as stated previously, are primarily silty shale, Quaternary Alluvium, and sporadically in weathered shale. The elevations of the water-bearing formations on the southwest side of the landfill tend to be above future landfill excavations. Therefore, any connective sediment pathways in the direction of groundwater flow will eventually be removed during construction. The landfill liner system will prevent the groundwater to flow in the northeasterly direction. A gradient control system is being constructed to channel the groundwater way from the liner. As groundwater is encountered during cell construction, the gradient control system is being designed and installed in accordance with the Site Development Plan. As landfill

construction proceeds and the connective water-bearing sediments are removed, less groundwater may be observed in wells along the east and northeast portion of the landfill.

5.2 GROUNDWATER MONITORING SYSTEM [30 TAC §330.63(f)(5)(a), §330.63(f)(6)(D), and §330.403(a)]

5.2.A Background Monitor Wells [30 TAC §330.63(f)(5)(B) and §330.403(a)(1)]

The direction of groundwater flow at the site is northeast. Therefore, MW-2, MW-7, MW-8, MW-9, MW-10 and MW-11 are the upgradient wells at the landfill. These six wells provide sufficient data for determining the quality of background groundwater that has not been affected by leakage from a unit. MW-7 and MW-8 are screened in water-bearing silty shale. MW-7 and MW-8 produce groundwater during each sampling event. MW-11 is screened in the water-bearing Quaternary alluvium and produces groundwater during each sampling event. MW-2 and MW-9 are screened in weathered shale. MW-9 produces water occasionally, and MW-2 has been dry every sampling event.

5.2.B Point of Compliance Monitor Wells and Well Spacing [30 TAC §330.63(f)(5)(C), §330.403(a)(2), and §330.403(e)(1)]

The maximum monitor well spacing for point of compliance wells under the 2006 MSW Revisions, 30 TAC §330.403(a)(2), is 600 feet, unless an applicable site-specific technical demonstration is provided. The well spacing described and proposed below meets the sited regulation in for each set of point of compliance wells, except in one case (between MW-4R and MW-5R). The site-specific technical information, per 30 TAC §330.403(a)(2), to justify the alternate well spacing in this one case is described, below.

5.2.B.i East Side and North Edge - Downgradient

Since the groundwater flow is northeasterly, MW-1, MW-1S, MW3, MW-3S, MW-4, MW-5, MW-6R, and MW-12 are located on the downgradient areas of landfill. These wells are the point of compliance wells.

MW-1 and MW-1S are located approximately 250 feet from the south edge of the landfill. The south edge of the landfill is considered as upgradient; therefore, this southern edge of the landfill defines one point of compliance. MW-1 is screened in the weathered shale below the adjacent cell 9 maximum waste fill depth and has been historically dry. MW-1S is screened in the Quaternary alluvial material and has produced groundwater each quarter. The spacing of these two adjacent wells in relation to an upgradient side of the landfill is sufficient to ensure detection of groundwater contamination in the upper-most aquifer and meets the well spacing regulatory requirement of 600 feet.

The spacing between MW-1/MW-1S and MW-3/MW-3S is approximately 750 feet. An additional point of compliance well, MW-13, is proposed to be installed equidistant between these sets of wells, adjacent to Gas Well (GW)-10, since this area has the most likely potential for pollutant migration. MW-3 and MW-3S are screened similarly to MW-1 and MW-1S in that MW-3 is screened in the weathered shale below the adjacent cell 4 maximum waste fill depth and MW-3S is screened in the Quaternary alluvial material. MW-3 and MW-3S are both in assessment monitoring. New well, MW-13, is proposed to be screened in the Quaternary sediments which represent the upper-most aquifer on the southeast side of the landfill.

The spacing between MW-3/MW-3S and MW-4R is approximately 1,000 feet. An additional point of compliance well, MW-14, is proposed to be located equidistant between MW-4R and MW-3S, along the east side of the landfill. MW-4R is screened in the weathered shale to a depth of 1395 feet MSL

which is 5 feet below the adjacent cell 10 maximum waste fill depth and has been historically dry, except for the first three quarters of 2005. The groundwater was most-likely due to construction activities in Cell 10. New well, MW-14 is proposed to be screened in the Quaternary sediment, if present, which represent the upper-most aquifer/water-bearing sediments anticipated on the southeast side of the landfill.

The spacing between MW-4R and MW-5R is 650 feet. MW-5R is screened in the silty shale to a depth of 1430 feet MSL which is 5 feet below the adjacent cell 11 maximum waste fill depth. MW-5R produces water quarterly, as the soil in the boring log was water bearing at a shallow depth, contained a layer of clay and a layer of clay with gravel below the groundwater depth, and was moist through the screened interval. The gravel-clay layer and the clay layer were located between 12 feet and 16 feet below ground surface (1451 – 1447 feet MSL) with shale above and below these water-bearing layers. Little other silty shale has been encountered in gas well or groundwater well boring logs. In addition, the connective silty shale sediments between this well and upgradient wells MW-8 has already been removed during landdfill construction. Remaining connective silty shale sediments are anticipated to be removed between upgradient MW-7 and MW-5R during future cell construction. Since the connective sediments between MW-8 and MW-5R are no longer in-place, a multi-dimensional fate and transport numerical flow model is not applicable. These models assume that the groundwater is currently hydraulically connected, which is not the case for these wells. Since the water-bearing silty shale in this northeastern portion of the landfill is limited, the spacing of these two wells at 650 feet is sufficient to ensure detection of groundwater contamination in the upper-most aquifer/water-bearing sediments.

The well spacings between MW-5R and MW-6R and between MW-6R and MW-12 are both approximately 600 feet. Since the regulatory minimum spacing is met between these wells, no additional groundwater wells are required to be installed between these wells. MW-12 is located approximately 1,000 feet from upgradient well, MW-7. MW-12 is screened in the weathered shale below the adjacent cell 14 maximum waste fill depth and has been historically dry. MW-7 is screened in the water-bearing silty shale. MW-7 produces water each quarter in sufficient quantity to sample; however, the well is dry after purging and also after sampling. An additional point of compliance well, MW-15, is proposed to be installed between MW-7 and MW-12 near the northern tip of the landfill, northeast of MW-7 and north of GW-6. The direction of groundwater flow in this area is northeast.. With MW-15 proposed to be located northeast of MW-7, MW-15 is a point of compliance well. MW-15 is proposed to be installed a minimum of two years prior to cell 14 construction to allow background groundwater data to be -collected. New well MW-15 is proposed to be screened in the silty shale, if present, and include weathered shale to an elevation of 1415 feet MSL, which is 5 feet below the adjacent cell 14 maximum waste fill depth. The screened interval is proposed to be 47 feet.

The locations of these wells are shown on Figure 5--1. The point of compliance is also shown on this figure. Table 5--1 lists the anticipated construction design of the wells. A schematic of a typical monitor well construction is shown in Figure 5--2.

Table 5-1
Proposed Groundwater Monitoring System

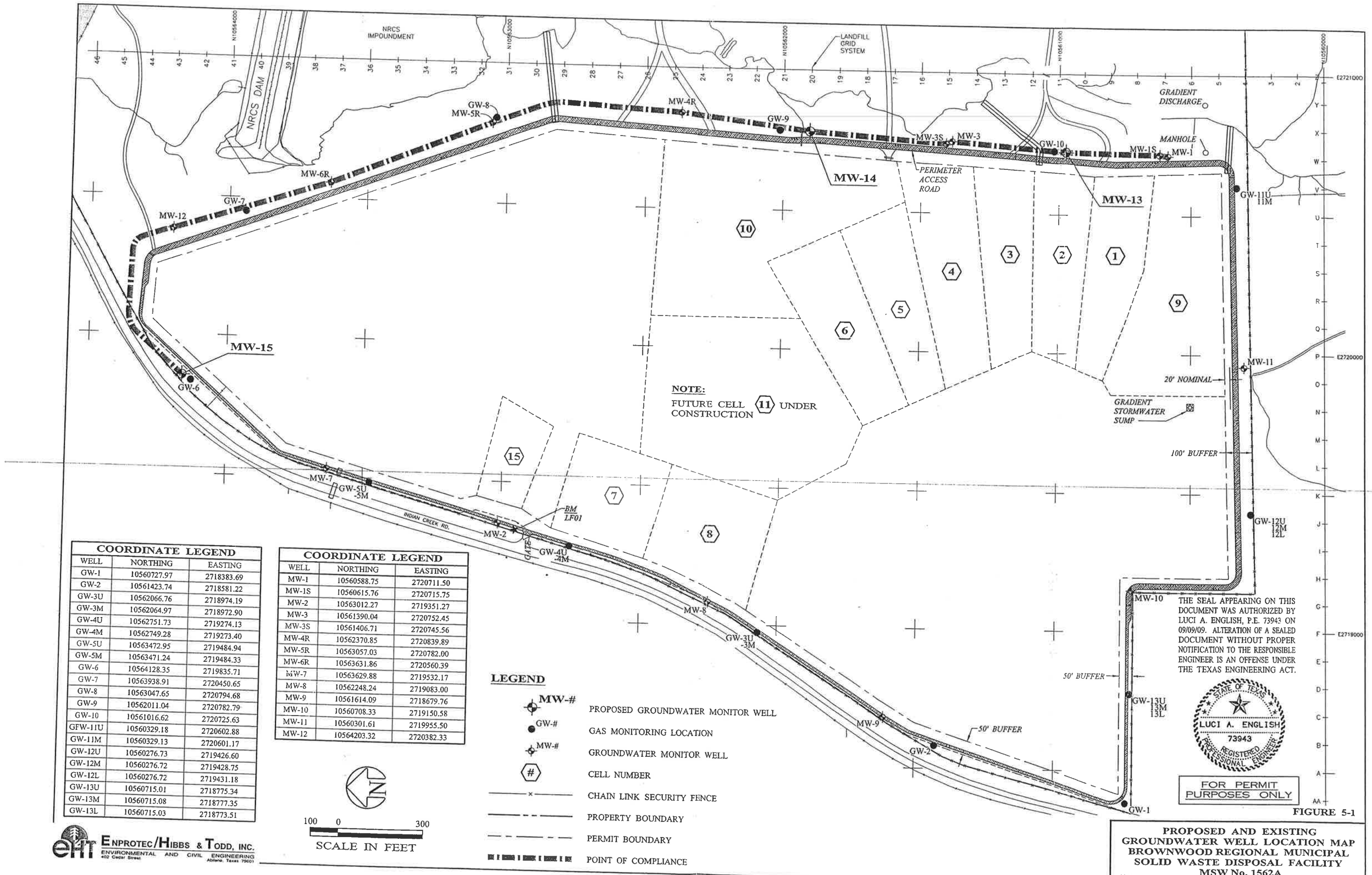
MONITOR WELL	TOP OF CASING ELEVATION	SURFACE ELEVATION	DEPTHS (FEET BELOW GRADE LEVEL)					ELEVATIONS (FEET ABOVE MEAN SEA LEVEL)					SCREENED SEDIMENT
			TOP OF FILTER SAND PACK	TOP OF SCREEN	BOTTOM OF SCREEN	BOTTOM OF SAND FILTER	TOTAL DEPTH OF WELL	TOP OF FILTER SAND PACK	TOP OF SCREEN	BOTTOM OF SCREEN	BOTTOM OF SAND FILTER	TOTAL DEPTH OF WELL	
MW-1	1497.68	1495.33	24.00	26.00	46.00	48.50	48.50	1471.33	1469.33	1449.33	1446.83	1446.83	Weathered Shale
MW-1S	1497.48	1494.65	4.00	6.00	16.00	17.00	17.00	1490.65	1488.65	1478.65	1477.65	1477.65	Quaternary Alluvium
MW-2	1496.38	1494.02	19.50	21.50	41.50	44.00	44.00	1474.52	1472.52	1452.52	1450.02	1450.02	Weathered Shale
MW-3	1481.19	1478.65	17.00	19.00	29.00	31.50	31.50	1461.65	1459.65	1449.65	1447.15	1447.15	Weathered Shale
MW-3S	1481.49	1478.62	2.50	4.50	14.50	15.5	15.5	1476.12	1474.12	1464.12	1463.12	1463.12	Quaternary Alluvium
MW-4R	1469.13	1466.28	58.5	60.5	70.5	71.5	71.5	1407.78	1405.78	1395.78	1394.78	1394.78	Weathered Shale
MW-5R	1466.08	1463.26	21	23	33	34	34	1442.26	1440.26	1430.26	1429.26	1429.26	Silty Shale
MW-6R	1471.83	1468.96	7	9	19	20	20	1461.96	1459.96	1449.96	1448.96	1448.96	Weathered Shale
MW-7	1480.41	1478.28	10.50	12.50	32.50	35.00	35.00	1467.78	1465.78	1445.78	1443.28	1443.28	Silty Shale
MW-8	1509.04	1506.39	20.00	22.00	42.00	44.50	44.50	1486.39	1484.39	1464.39	1461.89	1461.89	Silty Shale
MW-9	1540.40	1537.83	31.00	33.50	43.50	46.00	46.00	1506.83	1504.33	1494.33	1491.83	1491.83	Weathered Shale
MW-10	1593.13	1590.17	28.5	30.5	40.5	41.5	41.5	1561.67	1559.67	1549.67	1548.67	1548.67	Sandstone
MW-11	1544.49	1541.61	39.5	41.5	51.5	52.5	52.5	1502.11	1500.11	1490.11	1489.11	1489.11	Quaternary Alluvium
MW-12	1469.31	1466.63	40	42	52	53	53	1426.63	1424.63	1414.63	1413.63	1413.63	Weathered Shale
MW-13	1491.00	1488.00	4	6	26	27	27	1471.00	1482.00	1462.00	1461.00	1461.00	Quaternary Alluvium
MW-14	1473.00	1470.00	4	6	26	27	27	1466.00	1464.00	1444.00	1443.00	1443.00	Quaternary Alluvium
MW-15	1476.00	1474.00	10	12	59	60	60	1464.00	1462.00	1415.00	1414.00	1414.00	Silty Shale

Shading indicates proposed monitor wells.
Total depths of existing wells based on driller's logs and includes 2.5-foot-long blank sump at base of well which is not shown on formal logs.
Elevations are in feet above mean sea level.
Depths and elevations for MW-13, MW-14, and MW-15 are estimated based on nearby well or borehole data.
Well MW-15 will be drilled when landfill is expanded into this area.

Table 5-2
Historical Groundwater Elevations

Date	MW-1S	MW-3	MW-3S	MW-4R	MW-5R	MW-6R	MW-7	MW-8	MW-9	MW-11	MW-1	MW-2	MW-10	MW-12
3/3/2005	1478.06	1450.97	1476.43	1433.02	1449.88	1460.91	n/a	n/a	1530.09	1501.97				
6/20/2005	1485.86	1457.88	1473.76	1458.38	1450.28	dry	1474.16	1501.62	1514.05	1501.22	These wells have historically been dry every event.			
9/13/2005	1484.85	1453.11	n/a	1404.57	n/a	n/a	n/a	n/a	1492.99	n/a				
12/12/2005	1483.49	1449.44	1471.94	1401.75	1448.93	dry	1468.51	1493.61	1492.92	1497.08				
2/13/2006	n/a	n/a	1472.01	n/a	n/a	n/a	n/a	n/a	n/a	n/a				
3/23/2006	n/a	1464.18	1473.30	dry	n/a	dry	n/a	n/a	dry	n/a				
4/3/2006	n/a	n/a	1473.39	n/a	n/a	n/a	n/a	n/a	n/a	n/a				
6/22/2006	1482.50	1450.08	1471.37	dry	1448.82	dry	1464.05	1491.54	dry	1496.07				
9/21/2006	n/a	n/a	1466.97	1399.25	n/a	n/a	n/a	n/a	1492.88	n/a				
12/4/2006	dry	dry	1469.04	dry	1448.27	dry	1456.99	1487.10	dry	1493.00				
3/28/2007	dry	dry	1470.61	1399.22	1447.02	dry	1449.26	1486.06	dry	1493.34				
6/25/2007	1486.09	dry	1473.34	dry	1448.57	1461.43	1476.21	1492.13	dry	1500.29				
9/10/2007	1486.18	dry	1473.18	1399.45	1450.37	dry	1474.08	1495.39	1511.44	1501.43				
12/4/2007	1486.38	dry	1470.80	dry	1449.43	dry	1471.91	1494.19	1493.30	1497.75				
3/6/2008	1486.53	dry	1474.29	dry	1449.00	dry	1468.98	1492.51	dry	1495.71				
6/12/2008	1484.73	dry	1472.64	1401.63	1449.53	dry	1471.31	1492.49	dry	1495.04				
9/15/2008	1478.06	dry	1471.45	1399.13	1449.10	dry	1472.41	1490.46	1491.93	1493.46				
12/17/2008	1485.86	dry	1470.27	dry	1448.60	dry	1467.63	1488.21	dry	1493.41				
3/5/2009	1484.85	dry	1469.74	n/a	n/a	n/a	n/a	n/a	n/a	n/a				
6/17/2009	1483.49	dry	1471.29	1400.05	1447.76	dry	1472.25	1485.97	dry	1494.09				
9/17/2009	n/a	dry	1471.14	n/a	n/a	n/a	n/a	n/a	n/a	n/a				

Notes: Groundwater Elevation is prior to purge
Date listed is date of water level measurement, not sample date.



COORDINATE LEGEND		
WELL	NORTHING	EASTING
GW-1	10560727.97	2718383.69
GW-2	10561423.74	2718581.22
GW-3U	10562066.76	2718974.19
GW-3M	10562064.97	2718972.90
GW-4U	10562751.73	2719274.13
GW-4M	10562749.28	2719273.40
GW-5U	10563472.95	2719484.94
GW-5M	10563471.24	2719484.33
GW-6	10564128.35	2719835.71
GW-7	10563938.91	2720450.65
GW-8	10563047.65	2720794.68
GW-9	10562011.04	2720782.79
GW-10	10561016.62	2720725.63
GFW-11U	10560329.18	2720602.88
GW-11M	10560329.13	2720601.17
GW-12U	10560276.73	2719426.60
GW-12M	10560276.72	2719428.75
GW-12L	10560276.72	2719431.18
GW-13U	10560715.01	2718775.34
GW-13M	10560715.08	2718777.35
GW-13L	10560715.03	2718773.51

COORDINATE LEGEND		
WELL	NORTHING	EASTING
MW-1	10560588.75	2720711.50
MW-1S	10560615.76	2720715.75
MW-2	10563012.27	2719351.27
MW-3	10561390.04	2720752.45
MW-3S	10561406.71	2720745.56
MW-4R	10562370.85	2720839.89
MW-5R	10563057.03	2720782.00
MW-6R	10563631.86	2720560.39
MW-7	10563629.88	2719532.17
MW-8	10562248.24	2719083.00
MW-9	10561614.09	2718679.76
MW-10	10560708.33	2719150.58
MW-11	10560301.61	2719955.50
MW-12	10564203.32	2720382.33

LEGEND

- MW-# — PROPOSED GROUNDWATER MONITOR WELL
- GW-# — GAS MONITORING LOCATION
- MW-# — GROUNDWATER MONITOR WELL
- (#) — CELL NUMBER
- CHAIN LINK SECURITY FENCE
- PROPERTY BOUNDARY
- PERMIT BOUNDARY
- POINT OF COMPLIANCE

THE SEAL APPEARING ON THIS DOCUMENT WAS AUTHORIZED BY LUCI A. ENGLISH, P.E. 73943 ON 09/09/09. ALTERATION OF A SEALED DOCUMENT WITHOUT PROPER NOTIFICATION TO THE RESPONSIBLE ENGINEER IS AN OFFENSE UNDER THE TEXAS ENGINEERING ACT.

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LUCI A. ENGLISH
73943
REGISTERED PROFESSIONAL ENGINEER

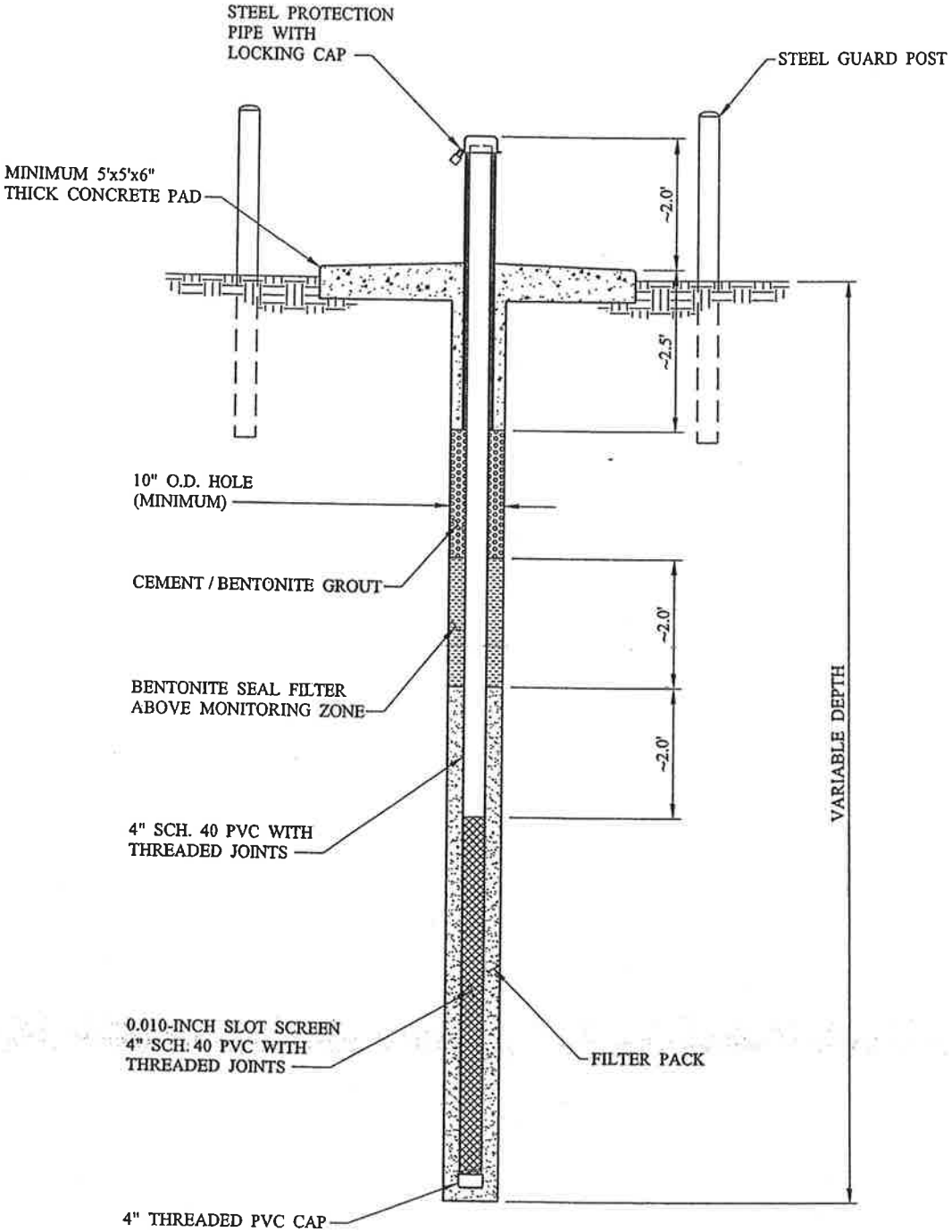
FOR PERMIT PURPOSES ONLY

ENPROTEC/HIBBS & TODD, INC.
ENVIRONMENTAL AND CIVIL ENGINEERING
402 Cedar Street Abilene, Texas 79601

FIGURE 5-1

PROPOSED AND EXISTING GROUNDWATER WELL LOCATION MAP BROWNWOOD REGIONAL MUNICIPAL SOLID WASTE DISPOSAL FACILITY MSW No. 1562A

06-3844 09/09/2009



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REVISION 2: 09/08/2009
REVISION 1: 04/01/2008
SUPERSEDES: 03/18/1997

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FIGURE 5-2

TYPICAL MONITOR WELL CONSTRUCTION DIAGRAM

BROWNWOOD REGIONAL MUNICIPAL SOLID WASTE DISPOSAL FACILITY
MSW NO. 1562A

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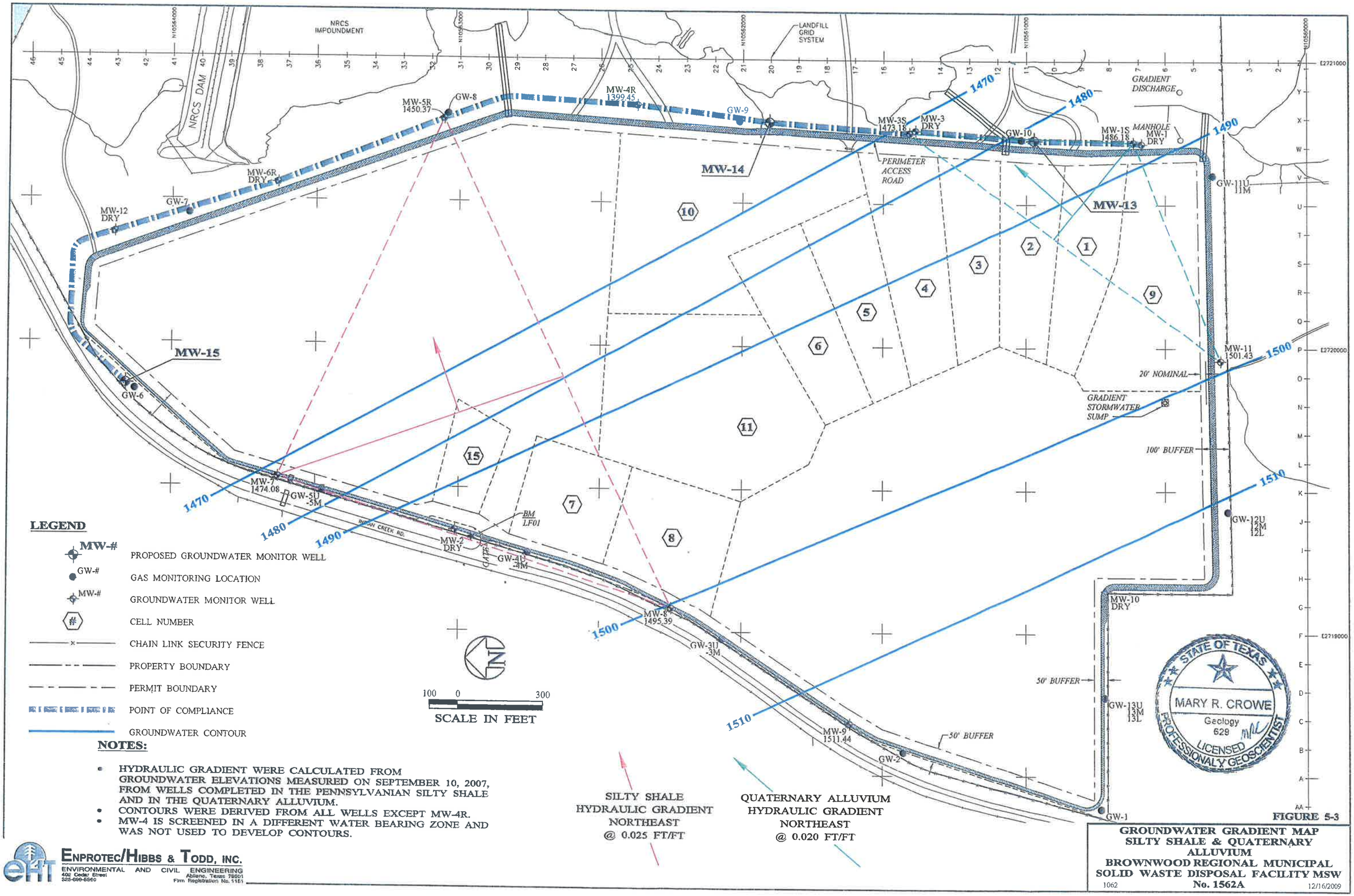

LEGEND

- MW-# — PROPOSED GROUNDWATER MONITOR WELL
- GW-# — GAS MONITORING LOCATION
- MW-# — GROUNDWATER MONITOR WELL
- (#) — CELL NUMBER
- CHAIN LINK SECURITY FENCE
- PROPERTY BOUNDARY
- PERMIT BOUNDARY
- POINT OF COMPLIANCE
- GROUNDWATER CONTOUR

NOTES:

- HYDRAULIC GRADIENT WERE CALCULATED FROM GROUNDWATER ELEVATIONS MEASURED ON SEPTEMBER 10, 2007, FROM WELLS COMPLETED IN THE PENNSYLVANIAN SILTY SHALE AND IN THE QUATERNARY ALLUVIUM.
- CONTOURS WERE DERIVED FROM ALL WELLS EXCEPT MW-4R.
- MW-4 IS SCREENED IN A DIFFERENT WATER BEARING ZONE AND WAS NOT USED TO DEVELOP CONTOURS.

SILTY SHALE HYDRAULIC GRADIENT NORTHEAST @ 0.025 FT/FT

QUATERNARY ALLUVIUM HYDRAULIC GRADIENT NORTHEAST @ 0.020 FT/FT

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FIGURE 5-3

GROUNDWATER GRADIENT MAP SILTY SHALE & QUATERNARY ALLUVIUM BROWNWOOD REGIONAL MUNICIPAL SOLID WASTE DISPOSAL FACILITY MSW

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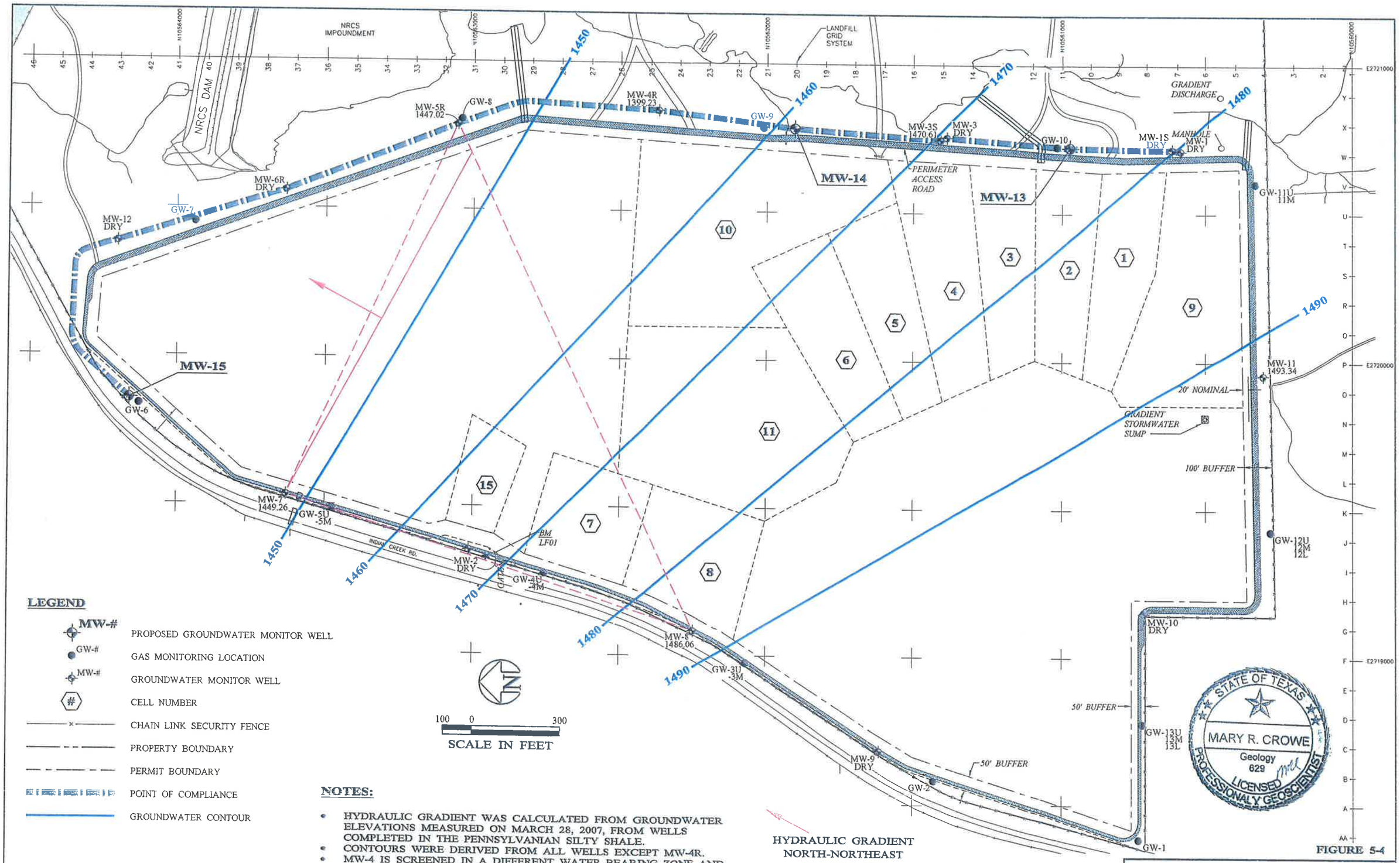

LEGEND

- MW-# — PROPOSED GROUNDWATER MONITOR WELL
- GW-# — GAS MONITORING LOCATION
- MW-# — GROUNDWATER MONITOR WELL
- # — CELL NUMBER
- CHAIN LINK SECURITY FENCE
- PROPERTY BOUNDARY
- PERMIT BOUNDARY
- POINT OF COMPLIANCE
- GROUNDWATER CONTOUR

100 0 300

SCALE IN FEET

NOTES:

- HYDRAULIC GRADIENT WAS CALCULATED FROM GROUNDWATER ELEVATIONS MEASURED ON MARCH 28, 2007, FROM WELLS COMPLETED IN THE PENNSYLVANIAN SILTY SHALE.
- CONTOURS WERE DERIVED FROM ALL WELLS EXCEPT MW-4R.
- MW-4 IS SCREENED IN A DIFFERENT WATER BEARING ZONE AND WAS NOT USED TO DEVELOP CONTOURS.

HYDRAULIC GRADIENT
NORTH-NORTHEAST
@ 0.022 FT/FT

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FIGURE 5-4

GROUNDWATER GRADIENT MAP
SILTY SHALE
BROWNWOOD REGIONAL MUNICIPAL SOLID WASTE DISPOSAL FACILITY
MSW No. 1562A

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NRCS IMPOUNDMENT

NRCS DAM

LANDFILL GRID SYSTEM

GRADIENT DISCHARGE

MANHOLE MW-1 DRY

PERIMETER ACCESS ROAD

MW-4R 1433.02

MW-5R 1449.88

GW-8

GW-9

MW-3S 1476.43

MW-3 1450.97

GW-10

MW-1S 1478.06

MW-6R 1460.91

GW-7

MW-12 DRY

MW-14

MW-13

GW-11U 11M

MW-15

GW-6

MW-11 1501.97

20' NOMINAL

GRADIENT STORMWATER SUMP

100' BUFFER

MW-7 NS

GW-5U -5M

INDIAN CREEK RD.

BM LF01

MW-2 DRY

GATE

GW-4U -4M

GW-12U 12M 12L

MW-8 NS

GW-3U -3M

MW-10 DRY

50' BUFFER

GW-13U 13M 13L

MW-9 1530.09

GW-2

50' BUFFER

GW-1

HYDRAULIC GRADIENT NORTHEAST @ 0.06 FT/FT

100 0 300

SCALE IN FEET

LEGEND

MW-#	PROPOSED GROUNDWATER MONITOR WELL
GW-#	GAS MONITORING LOCATION
MW-#	GROUNDWATER MONITOR WELL
#	CELL NUMBER
NS	NOT SAMPLED
——×——	CHAIN LINK SECURITY FENCE
—— — ——	PROPERTY BOUNDARY
— — — — —	PERMIT BOUNDARY
	POINT OF COMPLIANCE

NOTES:

- HYDRAULIC GRADIENT WAS CALCULATED FROM GROUNDWATER ELEVATIONS MEASURED ON MARCH 3, 2005, FROM WELLS COMPLETED IN THE PENNSYLVANIAN SHALE.
- GROUNDWATER CONTOURS WERE NOT CREATED FOR THIS MAP DUE TO THE LACK OF DATA FOR MONITOR WELLS MW-7 AND MW-8 AND TO THE DIFFERENCE OF WELL DEPTHS AND SCREEN INTERVALS BETWEEN THE MONITOR WELLS ON THE WEST SIDE OF THE LANDFILL.

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FIGURE 5-5

GROUNDWATER GRADIENT MAP
WEATHERED SHALE
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