City of Amarillo Landfill
Potter County, Texas
TCEQ Permit No. MSW-73A

Permit Modification

Compliance with New SubChapter J Requirements

Prepared for:

City of Amarillo, Texas

July 2009

Prepared by:

HDR Engineering, Inc.
TBPE Firm Registration No. 754
4500 West Eldorado Parkway, Suite 3500
McKinney, Texas 75070

July 17, 2009

Mr. Johnny Williams, P.G., Project Manager
MC-124
Municipal Solid Waste Permits Section
Waste Permits Division
Texas Commission on Environmental Quality
PO Box 13087
Austin, TX 78711-3087

Re: City of Amarillo Landfill – Potter County
Municipal Solid Waste (MSW) - Permit No. 73A
Permit Modification – Compliance with New Subchapter J Requirements
Response to Comments Dated April 28, 2009
Tracking No. 12644612; RN100237551 / CN600130942

Dear Mr. Williamson:

We have reviewed your comments dated April 28, 2009 regarding the proposed municipal solid waste permit modification to maintain compliance with recent changes to Title 30 Texas Administrative Code (30 TAC) Chapter 330, Subchapter J concerning the facility Groundwater Sampling and Analysis Plan (GWSAP) and the spacing of monitor wells along the facility point of compliance.

Below are your specific comments followed by our response:

1. In order to draft the permit modification sheet should your application be found satisfactory, you provided in your response a revised table containing a listing, description, and location of all changes to the facility permit (cover pages, tables of content, figures, text pages, appendices, etc.) that are proposed in your application. Please be sure that all revisions made to your application to address these comments are reflected in the above table as well.

   Response: *The table has been revised and is attached.*

2. Since your application lays out the specific details of your facility's groundwater monitoring plan in the GWSAP versus citing Chapter 330 of Title 30 Texas Administrative Code as a whole, strict consistency with the wording of these rules is imperative. Therefore, please revise the GWSAP to include the entirety of the following requirements:
   a) 30 TAC Section 330.407(b)(1);
   b) 30 TAC Section 330.407(b)(3);
   c) 30 TAC Section 330.407(b)(4);
   d) 30 TAC Section 330.407(c)(3);
   e) 30 TAC Section 330.407(c)(4);
   f) 30 TAC Section 330.407(d); and
   g) 30 TAC Section 330.409(d);

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Response: *The GWSAP has been revised as requested. In particular Section 3.0 and 4.0. The entire Attachment 11 is being re-submitted.*

3. Your response states that "...it is well documented that the entire Ogallala Aquifer is thinning due to withdrawal rates, due mainly to agricultural irrigation demands. The permitted site is experiencing the same trend. Therefore, replacing the existing monitoring wells allows for adjustment of the screened intervals within the saturated zone." Yet your proposed permit modification application does not address how the above trend could similarly impact existing piezometers B-203 and B-204 in the future. Please review the installation design of the two piezometers, and consider replacing them as well to maintain consistency with the well design proposed for the new groundwater monitoring system to be installed at your facility.

   Response: *Piezometer B-203 and B-204 were installed in 2005 and will be used to measure depth to water only. No revisions are necessary.*

4. In Comment 4 of our February 26, 2009 NOD letter, we had asked you to provide a detailed explanation for installing at least four (4) monitor wells upgradient of the site, as opposed to installing 2 to 3 of these wells along the western boundary of the facility where little historical groundwater data has been obtained to postulate a long-term groundwater flow direction in this area. Your response states that "...ongoing water level data will better define and update the flow gradients to determine the need for additional monitoring devices along the western boundary." It goes on to say that "(d)ue to the continued decrease in groundwater elevation within the Ogallala, this ongoing evaluation will be useful since it appears that the western portion of the site may be experiencing a slight shift in groundwater flow direction (more southerly without the easterly component). Until this groundwater trend is more accurately measured with additional data from the new monitoring well network presented on Plate 1, Appendix 5B is proposed."

   In considering your proposed groundwater monitoring system, we have carefully analyzed the groundwater potentiometric surface contour maps (Plates 6B.1 through 6.15) included with your application. The main problem seen in your proposed system is that its design is based on an inadequate amount of date to confidently limit the facility's point of compliance to only the southern and eastern boundaries of the site, with no compliance monitoring along the western boundary. Until the March 18, 2008 sampling event, no groundwater level data was available west of monitor wells MW-1, MW-7, MW-9, and MW-6 to better define the direction and historical fluctuation of groundwater movement in the area. Your response indicates a similar opinion, as quoted in the first paragraphs of this comment. Looking at the above plates, groundwater flow in the western half of the facility is depicted to move in a southerly to south-southwesterly direction from November 1994 through the October 2007 sampling event, using the limited data available at the time Since the stated plates contain a large majority of information pointing toward the need for groundwater monitoring along the western boundary of the permitted waste footprint, please revise your proposed monitoring system to incorporate monitor wells along this side of the facility. By moving the proposed locations of monitor wells 814, 815, 816, 817, and 818, you can position one of these five wells as a background monitor well, leaving the remainder plus an additional few wells to extend the facility's designated point of compliance to the upper northwest corner of the site. Groundwater data obtained over time in the western portion of the site could then potentially be used in the future to provide hard evidence for revising the design of the facility groundwater monitoring system should you desire to do so.

Response: *Please see revised Part III, Attachment 5 and Part III, Attachment 5 Appendix 5B.*

5. Your response to Comment 8 of our October 20, 2008 NOD letter resulted in a increase of the maintenance portion of the facility post-closure care estimate from $25,000 for 13 wells to $34,750 from 22 wells. A cost item for the plugging and abandonment of all of the proposed groundwater monitoring wells was not found in your estimates. Please add this cost to Table III.8.2, Post-Closure Care Costs.

   Response: *The Closure Cost estimate Table III.12.1 and Table III.8.1 have been revised to include the plugging and abandonment to the proposed groundwater monitoring wells and piezometers. This seemed a better location for that effort and therefore required a change to Part III, Attachment 12. Revised portions of Part III, Attachments 8 and 12 are enclosed.*

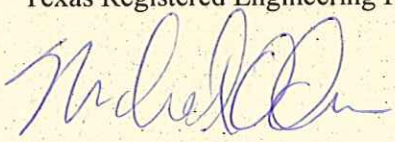
   We have adjusted the time required for installation of the monitor wells to 18-months. As discussed, the following activities must take place for this project:

   - Survey approved well locations
   - Develop plans and specifications for access roads for well installation and sampling
   - Advertise and bid road work
   - Obtain council approval for road work
   - Contract for Technical Services relates to well installation and development
   - Develop plans and specification for well installation
   - Advertise and bid well installation work
   - Obtain Council approval for well installation
   - Drill and develop 19 new wells and 5 new piezometers (for the initial phase) requiring approximately 5,100 linear feet drilling

With the enormous size of this effort, we believe an 18-month time frame is more than justified.

Attached are revised documents incorporating the changes described above. New versions are included for Part III, Attachment 5; Part III, Attachment 5, Appendix 5B; and Part III, Attachment 8 and Part III, Attachment 11. Revised Table III.12.1 (page 6) is being submitted to update the closure cost estimate in Part III, Attachment 12. One original and one unmarked copy is included along with one version in redline/strikeout format to facilitate your review of the changes. An additional unmarked copy is being sent to the Texas Commission on Environmental Quality Region 1, (Attention of Mr. Eddy Vance, Waste Program Manager, 3918 Canyon Drive, Amarillo, Texas 79109-4933). Also, included is an original certification statement.

Sincerely,
HDR Engineering, Inc.
Texas Registered Engineering Firm F-754



Michael W. Oden, P.E.
Project Manager

Attachments

cc: Mr. Michael Rice, P.E. - City of Amarillo
Mr. Eddy Vance, TCEQ Region Office, MC R-1
Mr. Michael Shiflett, P.E. - Kleinfelder
Mr. Louis Fleischhauer, P.G. - Kleinfelder

Certification Statement

List of Revisions

Signature Page

I, MICHAEL RICE (Operator), Director of Public Works (Title),

certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Signature: Michael Rice Date: July 15, 2009

TO BE COMPLETED BY THE OPERATOR IF THE APPLICATION IS SIGNED BY AN AUTHORIZED REPRESENTATIVE FOR THE OPERATOR

I, _____ (Print or Type Operator Name), hereby designate _____ (Print or Type Representative Name)

as my representative and hereby authorize said representative to sign any application, submit additional information as may be requested by the Commission; and/or appear for me at any hearing or before the Texas Commission on Environmental Quality in conjunction with this request for a Texas Water Code or Texas Solid Waste Disposal Act permit. I further understand that I am responsible for the contents of this application, for oral statements given by my authorized representative in support of the application, and for compliance with the terms and conditions of any permit which might be issued based upon this application.

_____
Printed or Typed Name of Operator or Principal Executive Officer

_____
Signature

SUBSCRIBED AND SWORN to before me by the said Michael Rice

On this 15th day of July, 2009

My commission expires on the 29th day of April, 2013

JAN WILLIAMS
NOTARY PUBLIC,
STATE OF TEXAS
My Commission Expires 04-29-2013

Jan Williams
Notary Public in and for
Potter County, Texas

(Note: Application Must Bear Signature & Seal of Notary Public)

Site Development Plan – Permit Modification
SubChapter F and J

Section	Replacement and/or Additional Pages
Part III Attachment 5: Groundwater Characterization Report	Updated/revised cover page, table of contents (TOC), pgs. 1-15 (re-submitted entire Attachment)
Part III Attachment 5: Appendix 5B	Re-submitted entire Appendix 5B
Part III Attachment 8: Closure and Post-Closure Care Estimates	Updated/revised cover page, TOC, pages 1-3 (re-submitted entire Attachment)
Part III Attachment 11: Groundwater Sampling and Analysis Plan	Updated/revised cover page, TOC, pages i-38 (re-submitted entire Attachment including appendices)
Part III Attachment 12: Final Closure Plan	Updated/revised cover page, TOC, page 11
Part III Attachment 13: Post-Closure Care Plan	Updated/revised cover page, TOC, pages 1-7 (re-submitted entire Attachment)

As of July 2009 submittal

Modified Text and Drawings

Part III

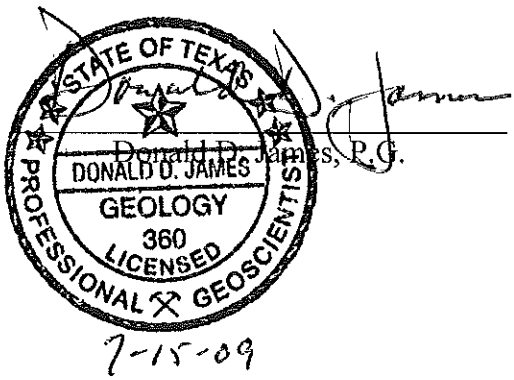
Attachment 5

Groundwater Characterization Report

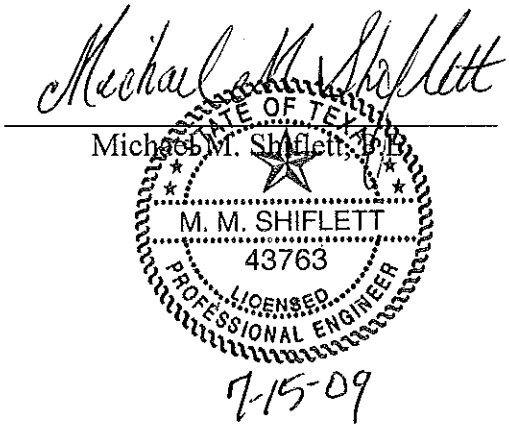
Permit - MSW No. 73A
Issued August 22, 2007

City of Amarillo,
Potter County, Texas

Revised July 2009



Donald D. James, P.G.



Michael M. Shiflett, P.E.

City of Amarillo Landfill
Part III, Attachment 5

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Appendix 5B – Updated Hydrogeologic Information (continued)

- Groundwater Contour Map, October 14, 1998
- Groundwater Contour Map, April 17, 2000
- Groundwater Contour Map, October 16, 2001
- Groundwater Contour Map, April 14, 2003
- Groundwater Contour Map, October 18, 2004
- Groundwater Contour Map, October 17, 2005
- Groundwater Contour Map, April 18, 2006
- Groundwater Contour Map, April 18, 2007
- Groundwater Contour Map, October 15, 2007
- Groundwater Contour Map, March 18, 2008
- Groundwater Contour Map, August 14, 2008
- Groundwater Contour Map, November 19, 2008
- Groundwater Contour Map, January 12, 2009
- Groundwater Contour Map, April 13, 2009
- Structural Surface Contour Map of the Triassic Dockum Formation
- Kleinfelder Logs of Borings 203 and 204 with Piezometer Construction Detail
- Monitoring Well Data Sheet and Logs

OVERVIEW OF ATTACHMENT 5 INFORMATION

The City of Amarillo plans to vertically expand its landfill. The waste footprint of the proposed landfill will be identical to the footprint that the TNRCC (now TCEQ) originally approved in 1975 and reviewed again as part of the Alternate Liner Demonstration (ALD) submitted in compliance with the requirements of the RCRA Subtitle D upgrades. The ALD provided for utilizing a flexible membrane liner including a geosynthetic clay liner (FML/GCL). Additionally, the original permit (granted July 2, 1975) had no provision for limiting the depth of excavation. The 1994 Subtitle D upgrade prepared by HDR provided excavation grades for a portion of Cell 4, with the other cells indicating excavation depths. To comply with TCEQ rule changes made March 2006, this permit has been modified.

For this permit modification the hydrogeologic information that is contained in the 1994 Alternate Liner Demonstration (see Appendix 5B) and contained in the 2005 permit amendment has been reviewed. The 1994 Alternate Liner Demonstration interprets the field permeability tests, water level measurements, hydrogeologic units, potentiometric surface, recharge/discharge mechanisms, and groundwater flow regime (including groundwater flow and velocity) of the regional and site geology and the site subsurface data. The information contained in the 1994 report remains applicable to this permit amendment.

Groundwater flow direction and gradients from 2008 data are similar to those interpreted from the 1994 and 2005 data. The recent groundwater measurements indicates the Ogallala aquifer has lowered as much as 1 foot from the 2005 measurements and from 4 to 6 feet lower in elevation than measured in 1994, over the southern half of the site. Six groundwater-monitoring wells have been used for compliance monitoring.

As a portion of the 2005 permit amendment, four additional geotechnical borings were drilled. Borings 201 and 202 were drilled June 7 and 8, 2005 in the northeastern portion of the permitted area. The purpose of these borings was to retrieve soil samples and to review stratigraphic information with existing subsurface information (see Attachment 4 for discussion). Recovered

soil samples were used for further analysis regarding landfill foundation settlement as presented in Attachment 4, 2005 permit document. Borings 203 and 204 were drilled on September 7 and 8, 2005 in the western portion of the permitted area in order to install piezometers, and to gather additional groundwater information.

The groundwater characterization information from the 1994 permit documents is attached and incorporated in its entirety as Appendix 5A to this updated 2005 report. Appendix 5B to this 2008 report contains an updated site plan with monitoring well locations including twenty two new monitoring wells, the revised monitoring well network details, updated groundwater elevations, potentiometric surface map, and updated monitoring well data.

Attachment 5 Appendices

Appendix 5A – Limited Groundwater Characterization Investigation (1994 permit documents)

- 1994 Limited Groundwater Characterization Investigation with attachments

Appendix 5B – Updated Hydrogeologic Information

- Existing and Proposed Monitoring Well Locations
- Typical Monitoring Well Detail
- Proposed Monitoring Well Network
- Groundwater Elevation Summary, September 1994 to April 13, 2009
- Groundwater Contour Map with Directional Flow and Point of Compliance
- Groundwater Contour Map, November 9, 1994
- Groundwater Contour Map, April 14, 1995
- Groundwater Contour Map, October 16, 1995
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- Groundwater Contour Map, April 17, 2000
- Groundwater Contour Map, October 16, 2001
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Appendix 5B – Updated Hydrogeologic Information (2008) (continued)

- Groundwater Contour Map, October 18, 2004
- Groundwater Contour Map, October 17, 2005
- Groundwater Contour Map, April 18, 2006
- Groundwater Contour Map, April 18, 2007
- Groundwater Contour Map, October 15, 2007
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1.0 GROUNDWATER MONITORING SYSTEM

The groundwater monitoring system plan currently in place at the site was approved by TNRCC (TCEQ) in a letter dated March 28, 1995. Subsequent approval was made by the TCEQ for the December 2005 permit amendment for the groundwater monitoring system additions. The entire records of monitoring well installations are on file with the TCEQ. The current monitoring well network consists of six locations labeled MW-1 through MW-6. Piezometers labeled PZ-1, PZ-2, and PZ-3 (drilled July through August 1994) were converted to Monitoring Wells 7, 8, and 9 respectively, and are located interior of the landfill boundary. Monitoring Wells 10, 11, 12, and 13 (drilled October through November 1999) were subsequently constructed south of Monitoring Wells 7 and 8, but north of the southern landfill boundary. Since Monitoring Wells 7 through 13 are interior of the site, but outside the current fill areas, these wells are not the monitoring wells of record, but have been used for recording groundwater data.

For this permit modification and in compliance with the March 2006 TCEQ rule changes, the current monitoring well network is proposed to be replaced with a new network of twenty two (22) new monitoring wells. To spare confusion with previously documented borings and wells the new monitoring wells are to be numbered in an "800" series to relate to this 2008/2009 modification. Plate 1 of Appendix 5B presents the existing and proposed monitoring well locations.

An updated construction detail and table for the updated, proposed monitoring well network is included in Appendix 5B, Plates 2 and 3. The table presented on Plate 3, Appendix 5B, presents monitoring well designations and elevations for screened interval, filter pack, bentonite seal, and bottom of well for the proposed new monitoring well network. A discussion regarding Plate 3, Proposed Monitoring Well Network Screen Interval Elevations, is presented in Section 4.0. A plan to add seven additional proposed monitoring wells (MW-14 through MW-20) was proposed for the 2005 permit amendment but is superseded through this permit modification.

The existing monitoring wells are currently being sampled semi-annually according to the Groundwater Sampling and Analysis Plan (GWSAP). Each monitoring well has been verified by visual observations for the 2005 Amendment as to general location. The surface completions including caps, pads, and guard posts are in acceptable condition. The monitoring well sampling events continue to document that each well is functioning as intended.

The depths to groundwater within the monitoring wells are measured for each sampling event. The elevation of the groundwater as determined from these measurements is summarized in tabular form presented on Plates 4 and 5, Appendix 5B.

The trend in the saturated thickness of each existing monitoring location is a thinning of the saturated zone.. The trend is due to increased groundwater usage throughout the region (i.e., not associated with Amarillo Landfill) resulting in a general decline in the groundwater elevations and differing recharge rates to the aquifer from localized percolation and permeability. The soils overlying the saturated zone of the Ogallala provide an unsaturated layer above the water table. No shallow perched water tables within the unsaturated zone have been encountered beneath the landfill. The presence of the unsaturated zone is consistent with regional hydrogeology information.

Each of the six existing network monitoring wells continues to provide samples from screened well sections within the saturated zone of the Ogallala. The depths of sampling within the wells will continue to be monitored at each sampling event. The current monitoring well network continues to function effectively, but will be replaced as discussed in the following sections.

2.0 POTENTIOMETRIC SURFACE

The existing monitoring wells indicate similar trends of increasing and decreasing groundwater elevations among all well locations for each sampling event. As interpreted from the groundwater measurements, the potentiometric surface continues to generally descend from the north to the south. Consistent with 1994, the 2008/2009 groundwater gradient is approximately twice as steep in the northeastern one-third of the site as compared to the southwestern two-thirds of the site. Additionally, a south-southwesterly trending hydraulic ridge is interpreted in the northeastern portion of the site locally forming radial flow to the southwest and southeast.

The 2008/2009 groundwater elevation trends indicate a continued decrease (lower) in the potentiometric surfaces since 2005. Decreases range from one foot along the northern perimeter of the site to ½-foot along the southern perimeter of the site. Saturated thicknesses of the Ogallala Aquifer estimated from the potentiometric surfaces down to the top of the Triassic Dockum formation (Plate 25, Appendix 5B) show thicknesses to be less than 2 feet along the northern perimeter and from approximately 47 to 55 feet along the southern perimeter. A chronology of groundwater elevation data for this site indicates a trend of thinning saturated thickness of the Ogallala aquifer. Regional and national data show this to be the trend for the entire Ogallala aquifer.

Two additional deep borings were drilled during the 2005 Permit Amendment and converted to standpipe piezometers. The borings/piezometers have been designated as B-203 and B-204 and are located along the western side of the permitted landfill. Including the groundwater elevation data from 203 and 204 along with the other monitoring locations, the potentiometric surface has been updated and presented as groundwater contour maps as presented on Plates 18 through 24, Appendix 5B. These groundwater maps provide the more recent historic data from the site. Groundwater contour maps presented upon Plates 7 through 17 provide the older historic data for comparison. Groundwater flow paths for 2008/2009 are similar to those estimated for 2005 and continue to generally indicate the northern and the northern two-thirds of the western boundaries of the landfill are upgradient for the permitted site. These supplemental groundwater elevation

points indicate the equipotential lines within the western quarter of the site bend slightly toward the southeast along the northern two-thirds of the western boundary, and flow direction approximately parallel to the site boundary within the southern one-third of the western boundary. The eastern boundary of the landfill area has maintained a relatively consistent potentiometric surface since 1994. The eastern boundary of the landfill continues to show a slight southeastern groundwater vector, which places the eastern boundary as downgradient to the permitted site, although groundwater flow encountering the eastern boundary has a narrow site entry area east of existing Monitoring Well 5.

The groundwater elevation trends indicate that a slight decrease (lower) in the potentiometric surfaces since 1994, especially in the southern half of the site. This is consistent with the regional groundwater information published by the High Plains Underground Water Conservation District No. 1. The groundwater measuring locations (monitoring wells) confirm groundwater elevation trends and flow directions similar to those measured in 1994 and also measured within the monitoring wells during sampling events since 1994.

3.0 MONITORING WELL LOCATIONS

The existing monitoring well locations were verified in the field. The groundwater data trends indicate that variations in the groundwater elevations within the monitoring wells are similar across the network. This indicates that groundwater flow directions and gradients continue to descend southward. Therefore, the existing monitoring well network continues to monitor both upgradient and downgradient locations as intended. However, a review of well configurations and the thinning of the aquifer saturated thickness has lead the City to desire to upgrade the entire monitoring well network for the site as a part of this modification.

Boring logs for the wells and the on-going groundwater measurements confirm the presence of groundwater within a single hydrogeologic unit (Ogallala) as interpreted by the 1994 permit document. There are no interpreted shallow, perched water pockets above the saturated zone of the Ogallala within the permitted area.

Subchapter J of the TAC Title 30 2006 revisions require that a facility have a point of compliance monitoring network with well spacing not to exceed 600 feet and for the detection of groundwater contamination in the uppermost aquifer at the point of compliance (vertical surface located no more than 500 feet from the hydraulically downgradient waste management boundary). The point of compliance is designated along the southern, eastern, and southern one-third of the western permit boundaries as depicted on Plates 1 and 6, App. 5B, and is the first time the point of compliance has been designated for this landfill site. Groundwater measurements from 2005 to 2009 consistently indicate inward gradients along the entire northern and northern two-thirds of the western side of the site. The southern one-third of the western perimeter of the site has pressure gradients approximately orthogonal, that is, groundwater flow direction parallel to the site boundary. Based on the flow paths, the entire eastern and southern boundaries of the site are indicated to be within outward gradients from the site. Since there are no perched water tables at the site, the monitoring wells are each deep wells placed completely into the groundwater zone depicted by the potentiometric surface. On this premise 20 new monitoring wells will be spaced along the site perimeter at the point of compliance. Two

additional upgradient wells (818, 819) will be installed as well as three upgradient piezometers (PZ-823, 206, and 207). The locations of the monitoring wells and piezometers are presented on Plates 1 and 6, Appendix 5B.

Plate 6, Appendix 5B has been included to show the groundwater contour elevations, selected flow paths and locations for the proposed monitoring wells and piezometers. This plate is intended to help the reader visualize the proposed monitoring well and piezometer network as it relates to the potentiometric surface.

Based on the six existing on site monitoring wells and two off site State registered water wells, a structural map of the top of the Dockum formation has been prepared and is presented as Plate 25, in Appendix 5B of this permit modification. The screened intervals for the new monitoring well network will fully penetrate the Ogallala aquifer and terminate on top of the Triassic Dockum geologic formation. Plate 3, Appendix 5B summarizes the proposed monitoring well network configurations including anticipated screening intervals.

The 6 existing monitoring wells in the currently approved groundwater monitoring system will be left in place until the regulatory background sampling period for the new wells is satisfied, at which time the existing monitoring well network MW-1 through MW-4, and MW-6 will be decommissioned. Monitoring Well 5 will be evaluated in comparison with PZ-823 to determine if MW-5 should be decommissioned or if it should remain within the monitoring well network. As previously mentioned, it is well documented that the entire Ogallala Aquifer is thinning due to withdrawal rates, due mainly to agricultural irrigation demands. The permitted site is experiencing the same trend. Therefore, replacing the existing monitoring wells allows for adjustment of the screened intervals within the saturated zone.

Therefore, the groundwater monitoring system for the site will consist of Upgradient Monitoring Wells 818, and 819 along with MW-5 and, Downgradient Monitoring Wells 801, 802, 803, 804, 805, 806, 807, 808, 809. 810, 811, 812, 813, 814, 815, 816, and 817. Downgradient Monitoring

Wells 820, 821 and 822 will be installed once Cell 12 is developed, but prior to waste placement within this cell.

As mentioned, the groundwater level beneath the landfill continues to decrease, which is a regional trend. The groundwater flow gradients along the western side of the landfill will probably continue to shift if this groundwater lowering trend continues. Therefore in addition to the existing piezometers PZ-203 and PZ-204, piezometers PZ-206, PZ-207, PZ-821, and PZ-822.will be installed along the western side of the site and groundwater measurements will be made in these piezometers when measurements and sampling occurs within the monitoring well network. Also, in order to further confirm groundwater levels being measured in MW-5, piezometer PZ-823 will be installed near MW-5 and groundwater levels measured during normal sampling events. After each sampling event, a groundwater contour map will be produced and the trend of the pressure gradients and flow directions, particularly along the western side of the site, will be analyzed. If gradients shift, the point of compliance may be altered and the monitoring well network updated to adequately monitor the groundwater flow.

A groundwater contour map will be produced for each monitoring well sampling event and submitted as part of the groundwater monitoring report. Due to the continued decrease in groundwater elevation within the Ogallala, this ongoing evaluation will be useful since it appears that the western portion of the site may be experiencing a slight shift in groundwater flow direction (more southerly without the easterly component). By observing groundwater flow lines as presented on Plate 6, it can be seen that the proposed monitoring well network installed at upgradient locations will intercept groundwater flow, as well as intercepting downgradient flow along the southern and eastern boundaries. As can be observed, the southern boundary of the landfill intercepts most of the groundwater flow entering the site from the north and west.

Following acceptable background monitoring by TCEQ, existing Monitoring Wells 1 through 4 and 6 will be decommissioned, with MW-5 evaluated at that time.

4.0 MONITORING WELL SCREENED INTERVALS

As discussed, it is well documented that the overall trend of the Ogallala formation that lies beneath the central section of the United States is decreasing in top surface elevation due to withdrawal. While it is the intent of the monitoring well system at the landfill to monitor the saturated zone, it is also necessary to maintain the bentonite seal above the screened interval below the water level for hydration purposes. With the current thinning of the saturated section, the placement of the screen and bentonite seal becomes important.

The groundwater levels at the landfill have been plotted and observed for trends. Although the groundwater level beneath the landfill is decreasing in elevation across the entire site, not every monitoring location presents identical rates of decrease. By observing the trends, an annual decrease of 0.2 feet per year has been approximated. When selecting a life expectancy of a monitoring well of at least 15 years, the elevation of top of seal can be calculated. Plate 3_Appendix 5B presents the calculated screen length for each planned monitoring location. Due to the relatively thin aquifer saturated thickness at locations MW-815, 816, and 817, and also at PZ-823, this projected decrease does not produce a saturated thickness suitable for monitoring.

At each proposed monitoring location, the initial pilot boring will determine saturated thickness at the time of drilling. For the thin sections mentioned above, the field geologist on site will communicate with the permitting engineer to determine the appropriate length of screen and depth of bentonite seal to be installed. The top of seal may be altered from the elevations presented in this document depending upon the actual observations at time of drilling.

4.1 POTENTIAL FLOW PATHWAYS

In the event that the primary composite liner system is compromised and a release occurs, the anticipated primary pathway of contaminant transport would be vertically and to a lesser extent horizontal through the unsaturated materials. The majority of the subsurface materials consist of

sand and clayey sand in the unsaturated zone, and then sand in the saturated zone of the Ogallala Formation. Caliche layers are also present in the upper portion of the unsaturated zone that would have some affect on vertical migration. Some horizontal migration would be expected as a result of the caliche and finer grained material in the unsaturated zone. Because of the relative thickness of the unsaturated zone and the finer grained nature of the unsaturated zone materials, any release of contaminants could likely become entrapped in the soil and slowly released over time. Infiltration of surface water is generally minimal in this area, and therefore it is not expected that percolation of surface water into the subsurface would aid in the leaching of any contaminant that may have been released due to a breach in the liner system.

In the event a contaminant reaches the saturated zone, the primary mechanisms controlling the distribution of chemical transport would be advection and dispersion through the aquifer materials in the direction of groundwater flow as shown on Plate 6, Appendix 5B. The predominant downgradient groundwater-monitoring boundary for the landfill site is the southern boundary. The flow direction and gradient has been consistent at the site since monitoring was initiated during the 1994 permitting process. As previously discussed above, given the consistent nature of the groundwater flow and gradient at the site, the proposed monitoring network is anticipated to be adequate to monitor groundwater conditions at the site.

4.2 GROUNDWATER MONITORING SYSTEM INSTALLATION

Upon approval of the proposed groundwater monitoring system, the City of Amarillo will begin the process of replacing the existing system with the upgraded and approved monitoring well network. The approved network will be installed, and background data developed prior to terminating groundwater testing within the existing monitoring well network. Once background analytical data has been established, the existing monitoring well network will be decommissioned and formally documented. At the time of submission of this permit modification, it is anticipated that 18 months will be required once the system has been formally approved to fully complete the extensive replacement of the existing monitoring well network.

During this time interval, dual sampling events will be occurring and will continue until the upgraded network is fully installed and appropriate background data established.

Notification of the Texas Commission on Environmental Quality (TCEQ) MSW Permits Section will be given at least 45 days prior to initiating any proposed plugging and abandonment procedures.

5.0 EXISTING GROUNDWATER ANALYTICAL DATA

The general water quality of the Ogallala is acceptable for numerous applications. The concentrations of Total Dissolved Solids (TDS) and Chloride increase from north to south. TDS concentrations in the Amarillo area have been reported (Nativ 1988; Knowles and others 1984) to be approximately 400 milligrams per liter (mg/l). Samples obtained in 1980 and in 1988 from water wells near the Amarillo landfill show similar TDS levels and levels of chloride in the range of 4 to 7 mg/l. Groundwater samples have been taken from monitoring wells at the landfill since 1995. These samples indicate that TDS levels range from 300 to 600 mg/l. Chloride levels range from 4 to almost 200 mg/l, with the higher results occurring in upgradient monitoring well, MW-5. Nitrate levels at the landfill historically range from 1 to 20 mg/l; sulfate levels from 10 to 33 mg/l; again the higher concentrations occurring in upgradient monitoring well, MW-5. The water is considered "hard" by the High Plains Underground Water Conservation District.

Some metals have been detected in small concentrations during monitoring events. The most prevalent metal that has been detected is Barium with levels ranging from 180 to about 550 micrograms per liter (µg/l). The higher concentrations of barium occur in upgradient monitoring wells, MW-5 and MW-6.

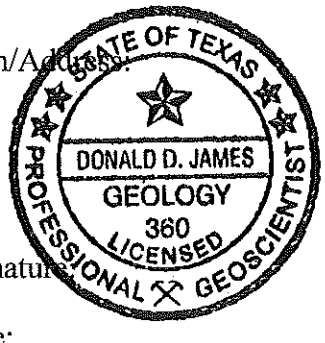
6.0 GROUNDWATER MONITORING SYSTEM CERTIFICATION

General Site Information

Site:	City of Amarillo Landfill
Site Location:	Amarillo, Potter County, Texas
Permit No:	73A
Date Permit Issued:	1974

Qualified Groundwater Scientist Statement

I, Donald D. James, P.G., have reviewed the groundwater monitoring system and supporting data. In my professional opinion, the existing groundwater monitoring system and the proposed additional monitoring wells is in compliance with the groundwater monitoring requirements specified in 30 TAC §330.230 through §330.235. The monitoring well system is currently operative at the site, but will be replaced. The proposed groundwater monitoring system will consists of: upgradient wells MW-5, MW-818 and MW-819; downgradient wells MW-801, MW-802, MW-803, MW-804, MW-805, MW-806, MW-807, MW-808, MW-809, MW-810, MW-811, MW-812, MW-813, MW-814, MW-815, MW-816, and MW-817. Groundwater monitoring wells MW-820, MW-821, MW-822 will be installed once Cell 12 is developed, but prior to waste placement. This system has been designed for the exclusive use of the City of Amarillo, Texas for specific application to the Amarillo Landfill (TCEQ Permit No. 73). I am a qualified groundwater scientist as defined by 30 TAC §330.2. The only warranty made by us in connection with this document and specifically with the monitoring well network is that we have used that degree of care and skill ordinarily exercised under similar conditions by reputable members of our profession, practicing in the same or similar locality when designing or reviewing monitoring well systems. No other warranty, expressed or implied, is made or intended.



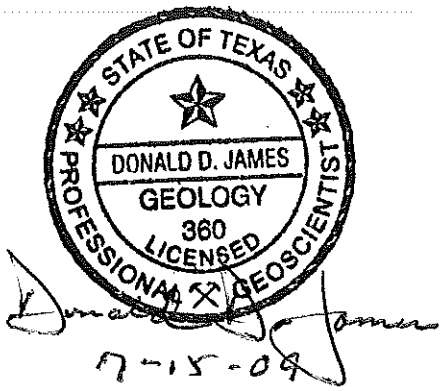
Firm/Address: Kleinfelder

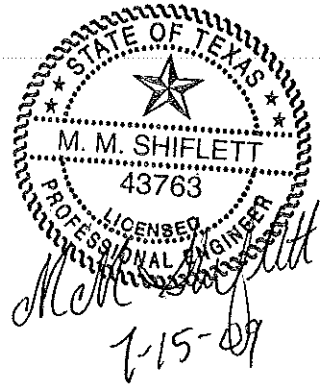
6850 Manhattan Boulevard, Suite 300

Fort Worth, Texas 76120

Signature: Donald D. James

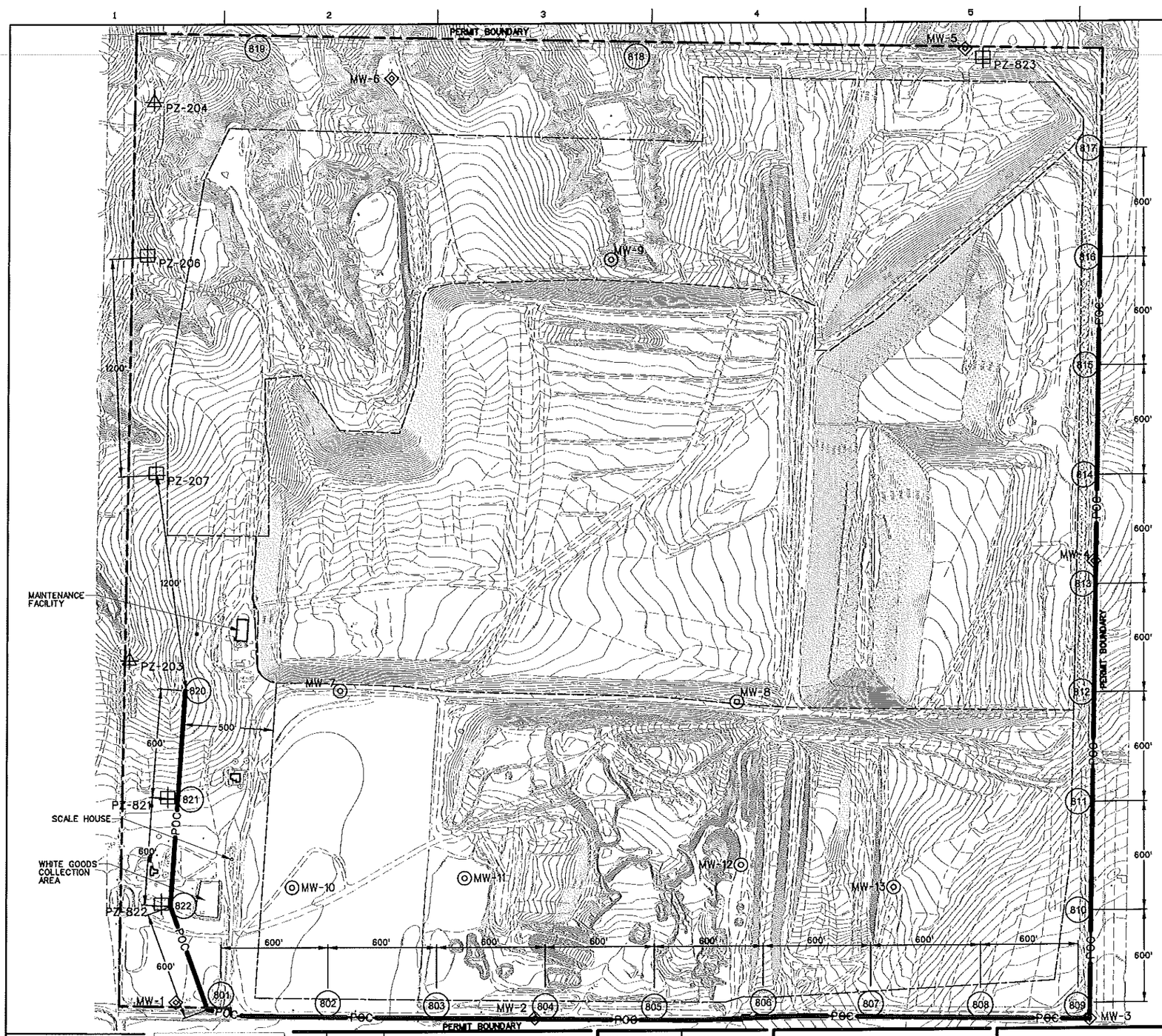
Date: 7-15-09





APPENDIX 5B

Existing and Proposed Monitoring Well Locations
Typical Monitoring Well Detail
Proposed Monitoring Well Network
Groundwater Elevation Summary, September 1994 to April 13, 2009
Groundwater Contour Map with Directional Groundwater Flow and Point of Compliance
Groundwater Contour Map, November 9, 1994
Groundwater Contour Map, April 14, 1995
Groundwater Contour Map, October 16, 1995
Groundwater Contour Map, April 15, 1997
Groundwater Contour Map, October 14, 1998
Groundwater Contour Map, April 17, 2000
Groundwater Contour Map, October 16, 2001
Groundwater Contour Map, April 14, 2003
Groundwater Contour Map, October 18, 2004
Groundwater Contour Map, October 17, 2005
Groundwater Contour Map, April 18, 2006
Groundwater Contour Map, April 18, 2007
Groundwater Contour Map, October 15, 2007
Groundwater Contour Map, March 18, 2008
Groundwater Contour Map, August 14, 2008
Groundwater Contour Map, November 19, 2008
Groundwater Contour Map, January 12, 2009
Groundwater Contour Map, April 13, 2009
Structural Surface Contour Map of the Triassic Dockum Formation
Kleinfelder Logs of Borings 203 and 204 with Piezometer Construction Detail
Monitoring Well Data Sheets and Logs



N

0 300 600

SCALE IN FEET

LEGEND

- PERMIT BOUNDARY
- EXISTING CONTOURS, IN FEET, MSL
- LANDFILL FOOTPRINT
- MW-4 — EXISTING MONITORING WELL LOCATIONS TO BE PLUGGED AND ABANDONED UPON COMPLETION OF BACKGROUND MONITORING OF THE ADDITIONAL WELLS
- MW-7 — EXISTING MONITORING WELL LOCATIONS TO BE PLUGGED AND ABANDONED AS CONSTRUCTION ACTIVITY DICTATES.
- PZ-203 — EXISTING PIEZOMETERS
- 822 — ADDITIONAL MONITORING WELL LOCATIONS
- POC — POINT OF COMPLIANCE
- LIMITS OF WASTE (2009)
- PZ-204 — PROPOSED PIEZOMETER (4")

STATE OF TEXAS
DONALD D. JAMES
GEOLOGY
360
LICENSED
PROFESSIONAL GEOSCIENTIST

STATE OF TEXAS
M. M. SHIFLETT
43763
LICENSED
PROFESSIONAL ENGINEER
7-15-09

Signed for Monitoring Wells

NOTES

1. FOR TOPOGRAPHIC INFO SEE SHEET III.1.1.
2. TOPOGRAPHIC MAP WAS COMPILED BY PHOTOGRAMMETRIC METHODS BY STEWART GEO TECHNOLOGIES, SAN ANTONIO, TEXAS FROM AERIAL PHOTOGRAPHY DATED APRIL 7, 2005. VERTICAL DATUM BASED ON NGVD 29. MAPPING GROUND CONTROL PROVIDED BY THE CITY OF AMARILLO, COMPLETED IN ACCORDANCE WITH NATIONAL MAP ACCURACY STANDARDS.
3. POINT OF COMPLIANCE FOR GROUNDWATER MONITORING IS SHOWN ON APP.5B PLATE 8.
4. THE GROUNDWATER MONITORING SYSTEM WILL CONSIST OF UPGRADIENT WELLS 818, 819 AND MW-5 DOWNGRADIENT WELLS 801 - 817
5. WELLS 820, 821 AND 822 TO BE INSTALLED ONCE CELL 12 IS DEVELOPED (PRIOR TO WASTE PLACEMENT). INSTALL PZ-821 AND PZ-822 ALONG WITH WELLS 801 - 819.

CITY OF AMARILLO TEXAS

HDR

HDR ENGINEERING, INC.
4500 W. Eldorado Pkwy.
Suite 3500
McKinney, Texas 75070

TEXAS P.E. FIRM REGISTRATION NO. F-754

ISSUE	DATE	DESCRIPTION
4	7/2009	REVISED MONITOR WELL LOCATIONS
3	3/2009	REVISED MONITOR WELL LOCATIONS
2	1/2009	ADD POC/DISTANCE/WASTE
1	8/2008	REVISED MONITOR WELL NETWORK

PROJECT MANAGER	M. ODEN
CIVIL ENGINEER	M. ODEN
CHECKED BY	M. ODEN
DESIGNED	
DRAWN BY	
QA/QC	M. ODEN
PROJECT NUMBER	82070

CITY OF AMARILLO LANDFILL
MSW PERMIT NO. 73A
POTTER COUNTY, TEXAS

EXISTING AND PROPOSED MONITORING WELL LOCATIONS

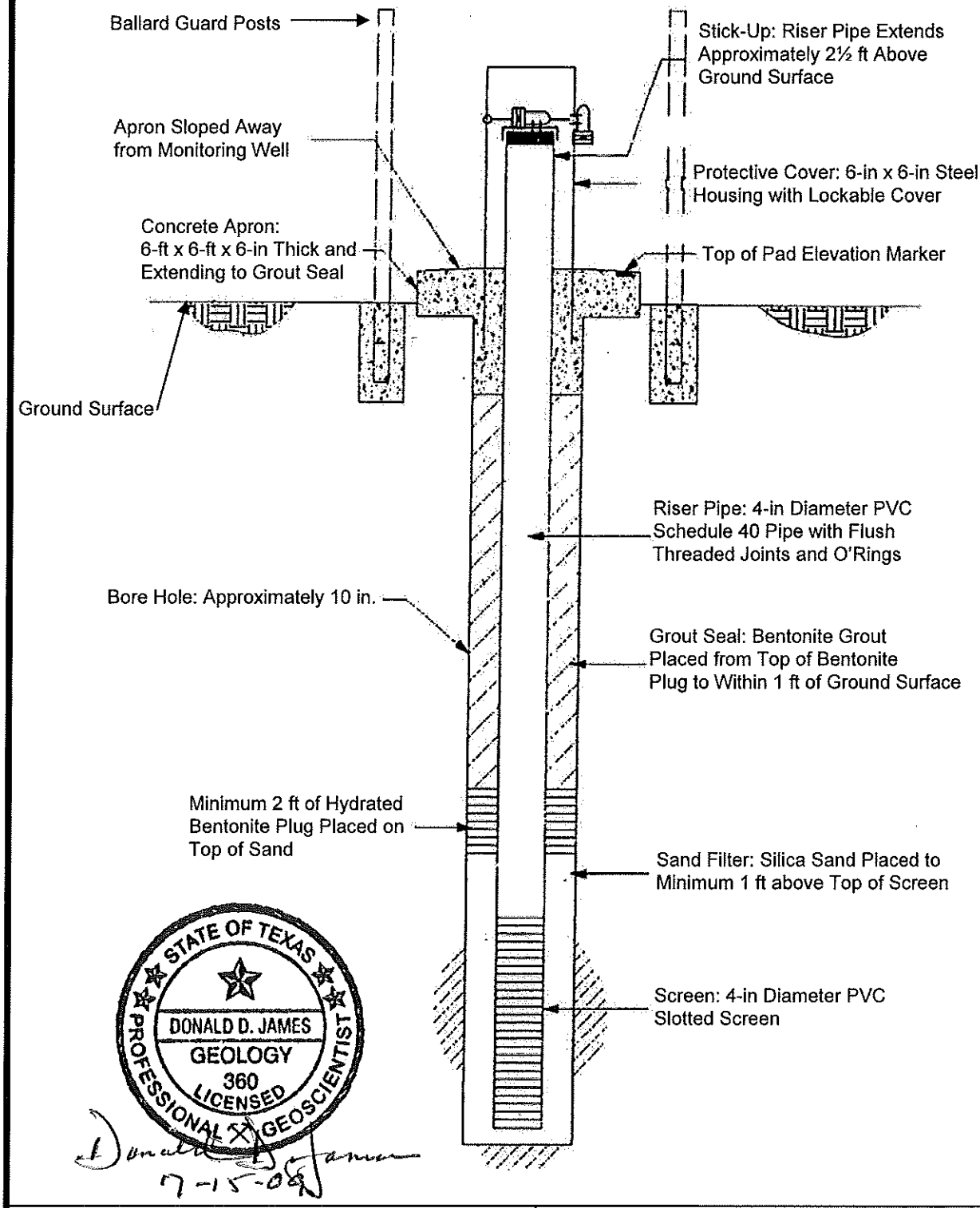
0 1" 2"

FILENAME

SCALE

SHEET
Plate 1
App. 5B

USER: RCOX
FILE: ...\DMS15902\AM11105.PLATE1A.DGN
DATE: 7/15/2009
TIME: 7:46:27 AM



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7-15-09

KLEINFELDER
Bright People. Right Solutions.

TYPICAL MONITORING WELL DETAIL
City of Amarillo Landfill
Potter County, Texas

KLEINFELDER
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7-15-09

Proposed Monitoring Well Network
Screened Interval Elevations
City of Amarillo Landfill
Potter County, Texas

Well No.	Well Location	Ground Surface Elevation	Top of Triassic Elevation, Bottom Elevation	Groundwater Elevation (April 2009)	Groundwater Thickness (ft.) (April 2009)	Groundwater Elevation (projected for 15 yrs. at current trend of 0.2 ft/yr drop)	15 yr. Projected Groundwater Thickness (ft.)	Top of Filter Pack Elevation (Groundwater Elevation-3ft.)	Submerged Top of Bentonite Seal Elevation (projected for 15 yr.)	Screened Interval, Top Elevation	Screened Interval, Bottom Elevation	Screen Length (ft.)
MW-801	Downgradient	3814.00	3532	3586.2	54.2	3583.2	51.2	3580.2	3582.2	3579.2	3532	47.2
MW-082	Downgradient	3811.11	3532	3585.0	53.0	3582.0	50.0	3579.0	3581.0	3578.0	3532	46.0
MW-803	Downgradient	3809.90	3535	3584.6	49.6	3581.6	46.6	3578.6	3580.6	3577.6	3535	42.6
MW-804	Downgradient	3806.66	3535	3583.4	48.4	3580.4	45.4	3577.4	3579.4	3576.4	3535	41.4
MW-805	Downgradient	3805.91	3534	3583.4	49.4	3580.4	46.4	3577.4	3579.4	3576.4	3534	42.4
MW-806	Downgradient	3796.77	3532	3583.4	51.4	3580.4	48.4	3577.4	3579.4	3576.4	3532	44.4
MW-807	Downgradient	3781.07	3533	3583.4	50.4	3580.4	47.4	3577.4	3579.4	3576.4	3533	43.4
MW-808	Downgradient	3789.70	3529	3583.3	54.3	3580.3	51.3	3577.3	3579.3	3576.3	3529	47.3
MW-809	Downgradient	3792.10	3526	3583.1	57.1	3580.1	54.1	3577.1	3579.1	3576.1	3526	50.1
MW-810	Downgradient	3784.08	3538	3584.5	46.5	3581.5	43.5	3578.5	3580.5	3577.5	3538	39.5
MW-811	Downgradient	3768.29	3549	3586.2	37.2	3583.2	34.2	3580.2	3582.2	3579.2	3549	30.2
MW-812	Downgradient	3743.14	3560	3587.8	27.8	3584.8	24.8	3581.8	3583.8	3580.8	3560	20.8
MW-813	Downgradient	3745.44	3571	3589.4	18.4	3586.4	15.4	3583.4	3585.4	3582.4	3571	11.4
MW-814	Downgradient	3745.83	3582	3593.3	11.3	3590.3	8.3	3587.3	3589.3	3586.3	3582	<5.0
MW-815	Downgradient	3746.92	3591	3598.0	7.0	3595.0	<5.0	3592.0	3594.0	3591.0	3591	<5.0
MW-816	Downgradient	3757.68	3600	3602.5	2.5	3599.5	<5.0	3596.5	3598.5	3595.5	3600	<5.0
MW-817	Downgradient	3746.21	3607	3607.5	0.5	3604.5	<5.0	3601.5	3603.5	3600.5	3607	<5.0
MW-818	Upgradient	3702.56	3594	3604.5	10.5	3601.5	7.5	3598.5	3600.5	3597.5	3594	<5.0
MW-819	Upgradient	3688.61	3560	3596.5	36.5	3593.5	33.5	3590.5	3592.5	3589.5	3560	29.5
MW-820	Downgradient	3784.80	3550	3590.5	40.5	3587.5	37.5	3584.5	3586.5	3583.5	3550	33.5
MW-821	Downgradient	3810.00	3543	3589.1	46.1	3586.1	43.1	3583.1	3585.1	3582.1	3543	39.1
MW-822	Downgradient	3815.82	3537	3587.5	50.5	3584.5	47.5	3581.5	3583.5	3580.5	3537	43.5
PZ-823	Upgradient	3738.35	3612	3613.3	1.3	3610.3	<5.0	3607.3	3609.3	3606.3	3612	<5.0
PZ-206	Upgradient	3704.72	3555	3594.8	39.8	3591.8	36.8	3588.8	3590.8	3587.8	3555	32.8
PZ-207	Upgradient	3764.98	3551	3592.7	41.7	3589.7	38.7	3586.7	3588.7	3585.7	3551	34.7
PZ-821	Downgradient	3810.00	3543	3589.1	46.1	3586.1	43.1	3583.1	3585.1	3582.1	3543	39.1
PZ-822	Downgradient	3815.82	3537	3587.5	50.5	3584.5	47.5	3581.5	3583.5	3580.5	3537	43.5

Note: For locations where 15 year project groundwater thickness is less than 5 feet, well screen length and top of bentonite seal will be finalized at the time of well installation, depending upon actual saturated thickness measured in the field.

CITY OF AMARILLO MUNICIPAL SOLID WASTE LANDFILL

PERMIT NO. 73A

Groundwater Elevation Summary

1994-2009

DATE	MW 1	MW 2	MW 3	MW 4	MW 5	MW 6	MW 7	MW 8	MW 9	MW 10	MW 11	MW 12	MW 13	B203	B204
9/20/1994	3590.24	3590.44	3588.90	3596.26	3613.78	3601.55	3595.12	3594.75	3599.57	N/A	N/A	N/A	N/A	N/A	N/A
9/28/1994	3588.65	3587.34	3588.98	3595.69	3613.03	3601.06	3594.51	3594.11	3599.24	N/A	N/A	N/A	N/A	N/A	N/A
10/5/1994	3590.32	3590.44	3590.12	3596.51	3613.84	3601.55	3595.20	3594.80	3597.59	N/A	N/A	N/A	N/A	N/A	N/A
10/12/1994	3590.27	3590.44	3590.07	3596.56	3613.89	3601.55	3595.01	3594.75	3597.54	N/A	N/A	N/A	N/A	N/A	N/A
10/19/1994	3590.32	3590.44	3590.12	3596.51	3613.84	3601.55	3595.11	3594.75	3599.59	N/A	N/A	N/A	N/A	N/A	N/A
10/26/1994	3590.27	3590.44	3590.12	3596.66	3613.94	3601.50	3595.16	3594.80	3599.54	N/A	N/A	N/A	N/A	N/A	N/A
10/31/1994	3590.22	3590.39	3589.97	3596.66	3613.99	3601.50	3594.96	3594.65	3599.44	N/A	N/A	N/A	N/A	N/A	N/A
11/9/1994	3590.17	3590.39	3589.97	3596.76	3614.09	3601.50	3595.01	3594.65	3599.44	N/A	N/A	N/A	N/A	N/A	N/A
11/16/1994	3590.22	3590.39	3590.02	3596.81	3614.24	3601.45	3595.06	3594.75	3599.44	N/A	N/A	N/A	N/A	N/A	N/A
11/23/1994	3590.22	3590.34	3590.02	3596.91	3614.34	3601.45	3595.11	3594.75	3599.49	N/A	N/A	N/A	N/A	N/A	N/A
11/30/1994	3590.92	3590.34	3590.02	3597.06	3614.39	3601.45	3595.01	3594.75	3599.44	N/A	N/A	N/A	N/A	N/A	N/A
12/7/1994	3590.12	3590.24	3590.02	3597.06	3614.39	3601.40	3594.65	3594.65	3599.39	N/A	N/A	N/A	N/A	N/A	N/A
12/14/1994	3589.87	3590.34	3590.02	3597.11	3614.39	3601.40	3595.01	3594.75	3599.44	N/A	N/A	N/A	N/A	N/A	N/A
2/20/1995	3590.65	3590.25	3589.00	3596.65	3614.10	3601.40	3595.02	3594.65	3599.34	N/A	N/A	N/A	N/A	N/A	N/A
3/14/1995	3590.22	3590.74	3588.87	3595.86	3614.16	3601.45	3595.21	3595.00	3598.64	N/A	N/A	N/A	N/A	N/A	N/A
4/14/1995	3589.82	3590.69	3589.82	3596.56	3614.19	3601.55	3595.11	3594.85	3599.64	N/A	N/A	N/A	N/A	N/A	N/A
5/14/1995	3589.77	3590.64	3590.64	3596.36	3614.09	3601.55	3594.61	3594.85	3599.59	N/A	N/A	N/A	N/A	N/A	N/A
6/14/1995	3589.82	3590.29	3590.29	3597.01	3614.39	3601.45	3595.11	3594.70	3599.54	N/A	N/A	N/A	N/A	N/A	N/A
7/14/1995	3589.82	3590.69	3590.69	3596.46	3614.09	3601.50	3595.11	3594.90	3599.59	N/A	N/A	N/A	N/A	N/A	N/A
8/14/1995	3589.67	3590.49	3589.77	3596.31	3614.19	3601.45	3595.06	3594.80	3599.54	N/A	N/A	N/A	N/A	N/A	N/A
9/14/1995	3589.67	3590.54	3589.72	3597.46	3614.69	3601.40	3594.91	3594.80	3599.64	N/A	N/A	N/A	N/A	N/A	N/A
10/16/1995	3589.65	3589.85	3588.70	3597.25	3614.30	3602.10	3594.67	3594.15	3599.14	N/A	N/A	N/A	N/A	N/A	N/A
11/16/1995	3589.55	3589.75	3588.70	3597.40	3614.35	3600.95	3594.52	3594.55	3599.14	N/A	N/A	N/A	N/A	N/A	N/A
12/14/1995	3589.65	3589.75	3588.75	3597.40	3614.30	3601.10	3594.57	3594.65	3599.14	N/A	N/A	N/A	N/A	N/A	N/A
1/15/1996	3589.70	3589.85	3588.80	3597.45	3614.30	3601.15	3594.62	3594.70	3599.14	N/A	N/A	N/A	N/A	N/A	N/A
2/15/1996	3589.45	3589.55	3588.65	3597.10	3614.10	3600.90	3594.42	3594.45	3599.04	N/A	N/A	N/A	N/A	N/A	N/A
4/16/1996	3589.35	3589.74	3588.67	3596.63	3613.94	3600.94	3594.60	3594.65	3599.14	N/A	N/A	N/A	N/A	N/A	N/A
5/15/1996	3588.45	3589.55	3588.80	3596.30	3613.80	3600.85	3594.32	3594.40	3599.04	N/A	N/A	N/A	N/A	N/A	N/A
6/15/1996	3588.36	3589.60	3588.52	3596.15	3613.78	3600.75	3594.80	3594.38	3599.04	N/A	N/A	N/A	N/A	N/A	N/A
7/16/1996	3588.10	3589.55	3588.50	3595.95	3613.94	3600.67	3594.72	3594.35	3598.94	N/A	N/A	N/A	N/A	N/A	N/A
8/15/1996	3588.00	3589.43	3588.38	3596.10	3613.70	3600.73	3594.47	3594.30	3598.89	N/A	N/A	N/A	N/A	N/A	N/A
9/15/1996	3587.88	3589.12	3588.30	3596.05	3613.30	3600.62	3594.17	3594.40	3598.84	N/A	N/A	N/A	N/A	N/A	N/A
10/16/1996	3587.78	3588.85	3588.26	3596.00	3614.89	3600.40	3593.97	3594.21	3598.83	N/A	N/A	N/A	N/A	N/A	N/A
11/20/1996	3586.92	3588.99	3588.35	3596.13	3614.20	3600.80	3594.07	3594.37	3598.89	N/A	N/A	N/A	N/A	N/A	N/A
12/20/1996	3587.45	3589.10	3588.10	3595.75	3614.65	3600.80	3593.87	3594.42	3599.04	N/A	N/A	N/A	N/A	N/A	N/A
1/15/1997	3588.18	3588.30	3587.22	3595.21	3614.06	3600.24	3593.51	3594.16	3598.49	N/A	N/A	N/A	N/A	N/A	N/A
2/15/1997	3588.31	3588.28	3587.20	3595.14	3613.86	3600.21	3593.54	3594.21	3598.43	N/A	N/A	N/A	N/A	N/A	N/A
3/15/1997	3588.32	3588.24	3587.18	3595.08	3613.72	3600.15	3593.52	3594.15	3598.38	N/A	N/A	N/A	N/A	N/A	N/A
4/15/1997	3588.28	3588.20	3587.13	3595.00	3613.62	3600.15	3593.56	3594.18	3598.36	N/A	N/A	N/A	N/A	N/A	N/A
5/16/1997	3588.28	3588.14	3587.10	3594.90	3613.52	3600.24	3593.49	3594.05	3598.75	N/A	N/A	N/A	N/A	N/A	N/A
6/18/1997	3588.27	3588.11	3587.07	3594.85	3613.43	3600.50	3593.46	3594.00	3599.22	N/A	N/A	N/A	N/A	N/A	N/A

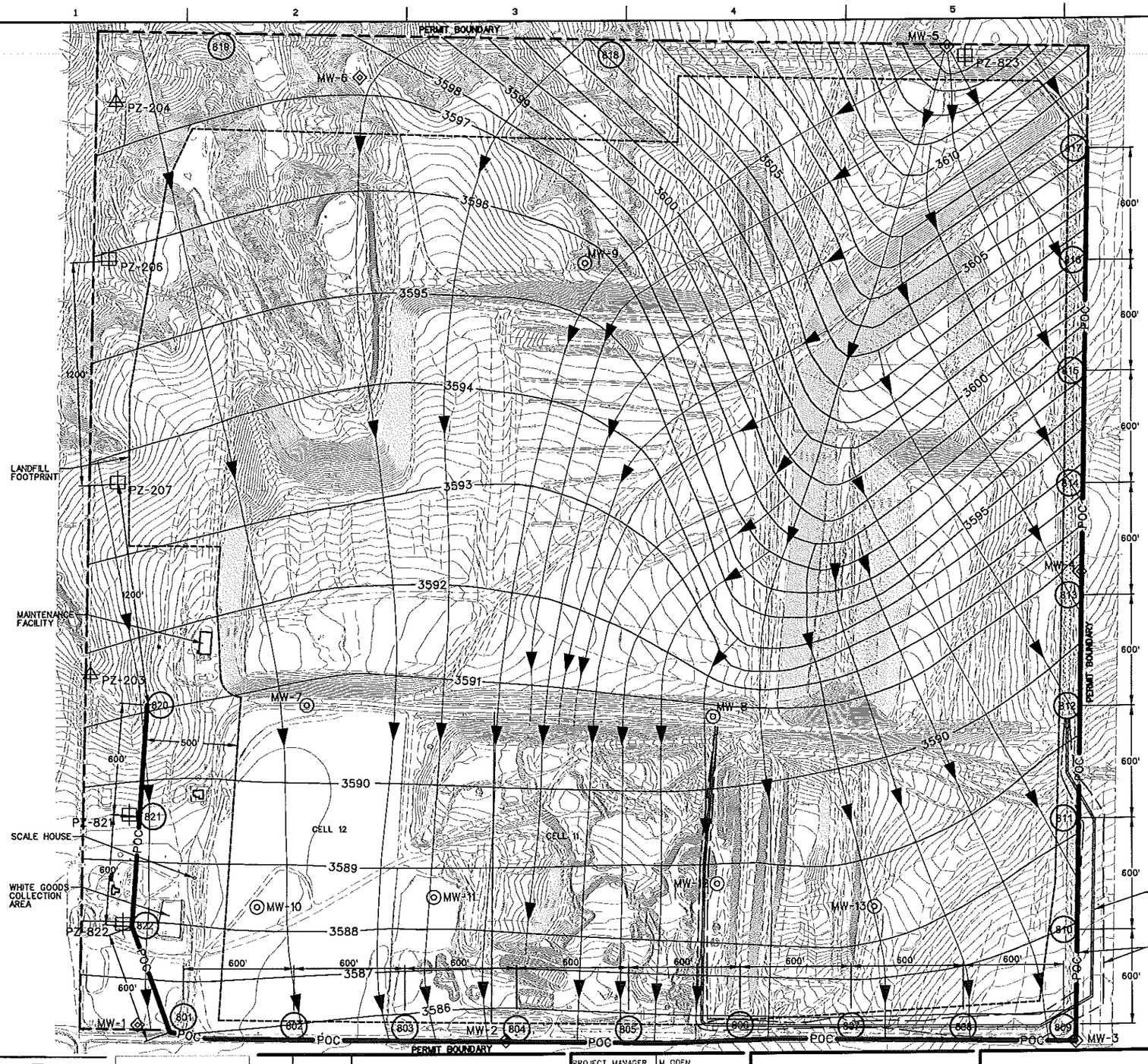
CITY OF AMARILLO MUNICIPAL SOLID WASTE LANDFILL

PERMIT NO. 73A

Groundwater Elevation Summary

1994-2009

DATE	MW 1	MW 2	MW 3	MW 4	MW 5	MW 6	MW 7	MW 8	MW 9	MW 10	MW 11	MW 12	MW 13	B203	B204
10/14/1997	3587.45	3587.90	3586.89	3594.55	3614.12	3600.40	3593.31	3593.80	3598.79	N/A	N/A	N/A	N/A	N/A	N/A
11/20/1997	3588.18	3587.86	3586.84	3594.45	3614.00	3600.21	3593.23	3593.75	3598.56	N/A	N/A	N/A	N/A	N/A	N/A
4/14/1998	3588.30	3587.72	3586.76	3594.23	3613.43	3599.95	3593.21	3593.51	3598.18	N/A	N/A	N/A	N/A	N/A	N/A
10/14/1998	3587.29	3587.64	3586.45	3593.77	3613.40	3599.69	3593.09	3593.28	3597.87	N/A	N/A	N/A	N/A	N/A	N/A
4/19/1999	3587.68	3587.33	3586.19	3593.41	3613.94	3599.48	3592.57	3592.90	3597.65	N/A	N/A	N/A	N/A	N/A	N/A
10/11/1999	3588.02	3587.23	3585.95	3593.26	3614.53	3599.50	3592.63	3592.68	3597.74	N/A	N/A	N/A	N/A	N/A	N/A
4/17/2000	3587.91	3587.09	3585.76	3593.00	3613.45	3599.19	3592.53	3592.56	3597.34	3590.68	3590.70	3590.74	3590.76	N/A	N/A
10/16/2000	3587.57	3586.95	3585.51	3592.71	3613.25	3598.93	3592.30	3592.40	3596.99	3590.35	3590.47	3590.50	3590.48	N/A	N/A
4/16/2001	3587.21	3586.74	3585.26	3592.41	3613.12	3598.66	3592.10	3592.02	3596.69	3590.41	3590.27	3590.32	3590.20	N/A	N/A
10/16/2001	3586.37	3586.62	3585.09	3592.29	3613.25	3598.49	3591.78	3591.93	3596.49	3589.52	3590.02	3590.16	3590.06	N/A	N/A
4/15/2002	3587.22	3586.50	3584.88	3591.95	3613.07	3598.20	3591.70	3591.71	3596.19	3589.89	3589.98	3590.00	3589.86	N/A	N/A
10/14/2002	3587.32	3586.41	3584.73	3591.63	3613.12	3598.02	3591.54	3591.53	3596.09	3589.79	3589.83	3589.88	3589.67	N/A	N/A
4/14/2003	3587.85	3586.16	3584.44	3591.30	3613.08	3597.75	3591.32	3591.19	3595.73	3589.72	3589.10	3589.54	3589.43	N/A	N/A
10/14/2003	3586.75	3586.04	3584.24	3591.08	3609.34	3597.53	3591.10	3591.02	3595.46	3589.40	3589.45	3589.43	3589.28	N/A	N/A
4/14/2004	3586.77	3585.91	3584.08	3590.82	3613.25	3597.34	3591.01	3590.88	3595.23	3589.31	3589.30	3589.21	3589.07	N/A	N/A
10/18/2004	3586.76	3585.63	3583.77	3590.59	3613.99	3597.30	3590.75	3590.57	3595.61	3589.16	3589.04	3588.90	3588.92	N/A	N/A
10/18/2004	3586.77	3585.63	3583.77	3590.59	3613.99	3597.30	3590.75	3590.57	3595.61	3589.16	3589.04	3588.90	3588.92	N/A	N/A
4/19/2005	3586.28	3585.59	3583.69	3590.55	3614.31	3597.51	3590.67	3590.61	3595.76	3588.88	3589.00	3588.98	3588.92	N/A	N/A
9/16/2005	3586.17	3585.59	3583.63	3590.47	3614.77	3597.38	3590.58	3590.45	3595.56	3588.86	3588.90	3588.86	3588.80	3592.11	3597.41
10/17/2005	3586.09	3585.52	3583.53	3590.41	3614.58	3597.20	3590.51	3590.40	3595.34	3588.69	3588.84	3588.79	3588.68	N/A	N/A
11/18/2005	3586.23	3585.48	3585.49	3590.34	3614.36	3597.11	3590.44	3590.31	3595.19	3588.76	3588.79	3588.73	3588.68	3591.91	3597.22
11/29/2005	3586.37	3585.43	3583.44	3590.33	3614.25	3597.10	3590.39	3590.31	3595.12	3588.76	3588.72	3588.64	3588.90	3591.89	3597.22
4/18/2006	3586.19	3585.51	3583.39	3590.31	3613.73	3596.95	3590.46	3590.17	3594.91	3588.72	3588.78	3588.68	3588.50	N/A	N/A
10/24/2006	3578.75	3585.32	3583.53	3590.05	3616.41	3597.24	3590.25	3590.12	3595.51	3588.52	3588.59	3588.50	3589.50	N/A	N/A
4/18/2007	3586.46	3585.35	3583.29	3590.01	3615.12	3596.85	3590.27	3589.94	3594.74	3588.76	3588.67	3588.55	3588.60	N/A	N/A
10/16/2007	3586.09	3585.28	3583.45	3590.30	3615.26	3596.83	3590.12	3590.07	3595.06	3588.53	3588.52	3588.65	3589.24	N/A	N/A
1/14/2008	3586.35	3585.33	3583.33	3590.44	3615.26	3596.67	3590.07	3589.87	3594.76	3588.54	3588.52	3588.79	3588.93	3591.52	3596.42
2/14/2008	3586.27	3585.51	3583.33	3590.14	3615.26	3596.67	3590.07	3589.87	3594.76	3588.54	3588.52	3588.79	3588.93	3591.57	3596.60
3/18/2008	3586.41	3585.27	3583.19	3590.14	3614.19	3596.67	3590.07	3589.87	3594.63	3588.72	3588.52	3588.79	3588.93	3591.64	3596.60
4/17/2008	3586.41	3585.27	3583.19	3590.14	3614.19	3596.67	3590.07	3589.87	3594.63	3588.72	3588.52	3588.79	3588.93	3591.64	3596.60
5/16/2008	3585.35	3585.19	3583.19	3589.92	3613.88	3596.67	3589.96	3589.87	3594.63	3588.08	3588.52	3588.79	3588.35	3591.64	3596.49
6/18/2008	3585.35	3585.19	3583.19	3590.00	3613.88	3596.42	3589.96	3589.87	3594.50	3588.08	3588.45	3588.79	3588.35	3591.34	3596.51
8/14/2008	3585.15	3585.12	3583.00	3589.00	3613.65	3596.31	3589.80	3589.82	3594.39	3587.93	3588.32	3588.33	N/A	3591.19	3596.44
9/17/2008	3585.44	3585.12	3583.00	3589.90	3613.65	3596.23	3589.80	3589.82	3594.39	3588.04	3588.30	3588.29	N/A	3591.19	3596.41
10/20/2008	3585.44	3584.94	3583.00	3589.34	3613.49	3596.17	3589.61	3589.65	3594.24	3587.91	3588.14	3588.16	N/A	3591.19	3596.41
11/19/2008	3585.63	3584.45	3582.95	3589.45	3613.58	3596.10	3589.68	3589.55	3594.14	3588.16	3588.16	3588.04	N/A	3591.17	3596.19
12/17/2008	3585.85	3584.85	3582.95	3589.65	3613.60	3596.10	3590.02	3589.62	3594.14	3588.27	3588.16	3588.19	N/A	3591.28	3596.22
1/12/2009	3585.88	3585.01	3582.94	3589.79	3613.58	3596.12	3590.17	3589.69	3594.19	3588.29	3588.26	3588.22	3588.50	3591.33	3596.25
2/18/2009	3585.88	3585.01	3582.94	3589.79	3613.58	3596.12	3590.17	3589.69	3594.19	3588.29	3588.26	3588.22	3588.50	3591.33	3596.25
3/19/2009	3585.73	3584.88	3582.80	3589.64	3613.58	3595.95	3589.67	3589.51	3594.19	3588.29	3588.26	3588.05	3588.35	3591.17	3596.19
4/13/2009	3585.77	3583.05	3582.79	3589.64	3613.58	3595.85	3589.68	3589.55	3594.03	3588.16	3588.16	3588.04	3587.41	3591.17	3596.19



N

0 300 600

SCALE IN FEET

LEGEND

- PERMIT BOUNDARY
- EXISTING CONTOURS
- LANDFILL FOOTPRINT
- 3605 — GROUNDWATER CONTOURS
- MW-4 — EXISTING MONITORING WELL LOCATIONS TO BE PLUGGED AND ABANDONED UPON COMPLETION OF BACKGROUND MONITORING OF THE ADDITIONAL WELLS
- MW-7 — EXISTING MONITORING WELL LOCATIONS TO BE PLUGGED AND ABANDONED AS CONSTRUCTION ACTIVITY DICTATES.
- PZ-203 — EXISTING PIEZOMETERS
- 822 — ADDITIONAL MONITORING WELL LOCATIONS
- GROUNDWATER FLOW
- POC — POINT OF COMPLIANCE
- PROPOSED PIEZOMETER (4")

STATE OF TEXAS
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43763
LICENSED
PROFESSIONAL ENGINEER

NOTES

1. FOR TOPOGRAPHIC INFO SEE FIGURE III.1.1.
2. TOPOGRAPHIC MAP WAS COMPILED BY PHOTOGRAMMETRIC METHODS BY STEWART GEO TECHNOLOGIES, SAN ANTONIO, TEXAS FROM AERIAL PHOTOGRAPHY DATED APRIL 7, 2005. VERTICAL DATUM BASED ON NGVD 29. MAPPING GROUND CONTROL PROVIDED BY THE CITY OF AMARILLO, COMPLETED IN ACCORDANCE WITH NATIONAL MAP ACCURACY STANDARDS.
3. FLOWLINES SHOWN AS INDICATORS OF GROUNDWATER FLOW DIRECTION. DRAWING NOT INTENDED TO REPRESENT A COMPLETE FLOWNET.
4. GROUNDWATER ELEVATIONS OBTAINED IN 2008 REMAIN CONSISTENT WITH THE NOVEMBER 2005 ELEVATIONS.
5. WELLS 820, 821 AND 822 TO BE INSTALLED ONCE CELL 12 IS DEVELOPED (PRIOR TO WASTE PLACEMENT). INSTALL PZ-821 AND PZ-822 ALONG WITH WELLS 801 - 819.

CITY OF AMARILLO TEXAS

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TEXAS P.E. FIRM REGISTRATION NO. F-754

ISSUE	DATE	DESCRIPTION
3	7/2009	REVISED MONITOR WELL LOCATIONS
2	3/2009	REVISED MONITOR WELL LOCATIONS
1	8/2008	REVISED MONITOR WELL NETWORK

PROJECT MANAGER	M. ODEN
CIVIL ENGINEER	M. ODEN
CHECKED BY	M. ODEN
DESIGNED	
DRAWN BY	
QA/QC	M. ODEN
PROJECT NUMBER	82070

CITY OF AMARILLO LANDFILL
MSW PERMIT NO. 73A
POTTER COUNTY, TEXAS

GROUNDWATER CONTOUR MAP WITH DIRECTIONAL GROUNDWATER FLOW AND POINT OF COMPLIANCE AUGUST, 2008

0 1" 2"

FILENAME

SCALE

SHEET
Plate 6
App. 5B

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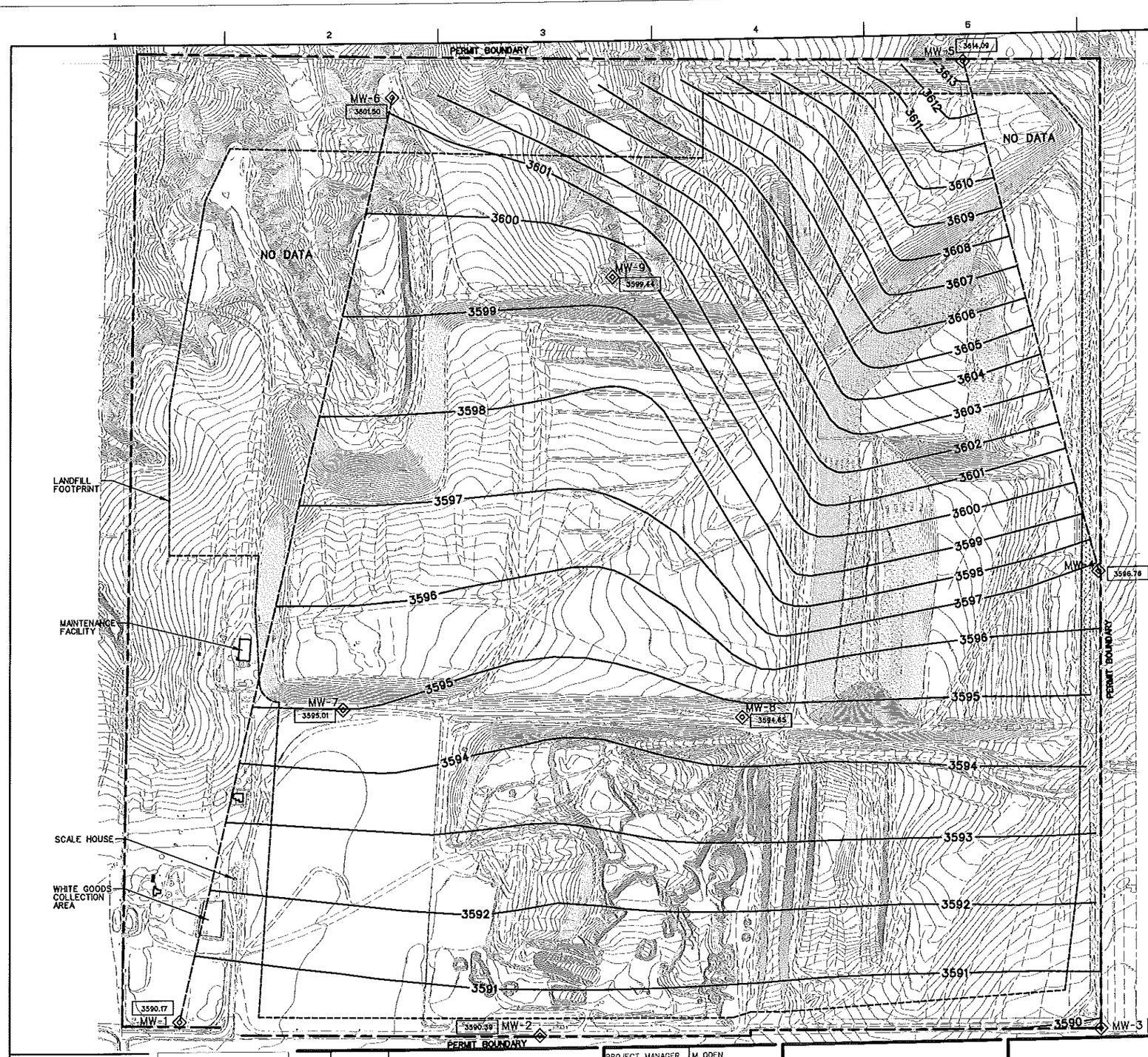

LEGEND

- PERMIT BOUNDARY
- EXISTING CONTOURS
- LANDFILL FOOTPRINT
- 3605 — GROUNDWATER CONTOURS
- MW-4 3615.28 — EXISTING MONITORING WELL LOCATIONS AND ELEVATIONS

NOTES

1. FOR TOPOGRAPHIC INFO SEE FIGURE III.1.1.
2. TOPOGRAPHIC MAP WAS COMPILED BY PHOTOGRAMMETRIC METHODS BY STEWART GEO TECHNOLOGIES, SAN ANTONIO, TEXAS FROM AERIAL PHOTOGRAPHY DATED APRIL 7, 2005. VERTICAL DATUM BASED ON NGVD 29. MAPPING GROUND CONTROL PROVIDED BY THE CITY OF AMARILLO, COMPLETED IN ACCORDANCE WITH NATIONAL MAP ACCURACY STANDARDS.

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LICENSED
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CITY OF AMARILLO
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TEXAS P.E. FIRM
REGISTRATION NO. F-754

ISSUE	DATE	DESCRIPTION
3	7/2009	REVISED MONITOR WELL LOCATIONS
2	3/2009	REVISED CONTOURS
1	1/2009	ISSUED FOR TCEQ REVIEW

PROJECT MANAGER	M. ODEN
CIVIL ENGINEER	M. ODEN
CHECKED BY	M. ODEN
DESIGNED	
DRAWN BY	
QA/QC	M. ODEN
PROJECT NUMBER	82070

CITY OF AMARILLO LANDFILL
MSW PERMIT NO. 73A
POTTER COUNTY, TEXAS

GROUNDWATER CONTOUR MAP
NOVEMBER 9, 1994

FILENAME
SCALE

SHEET
Plate 7
App. 5B

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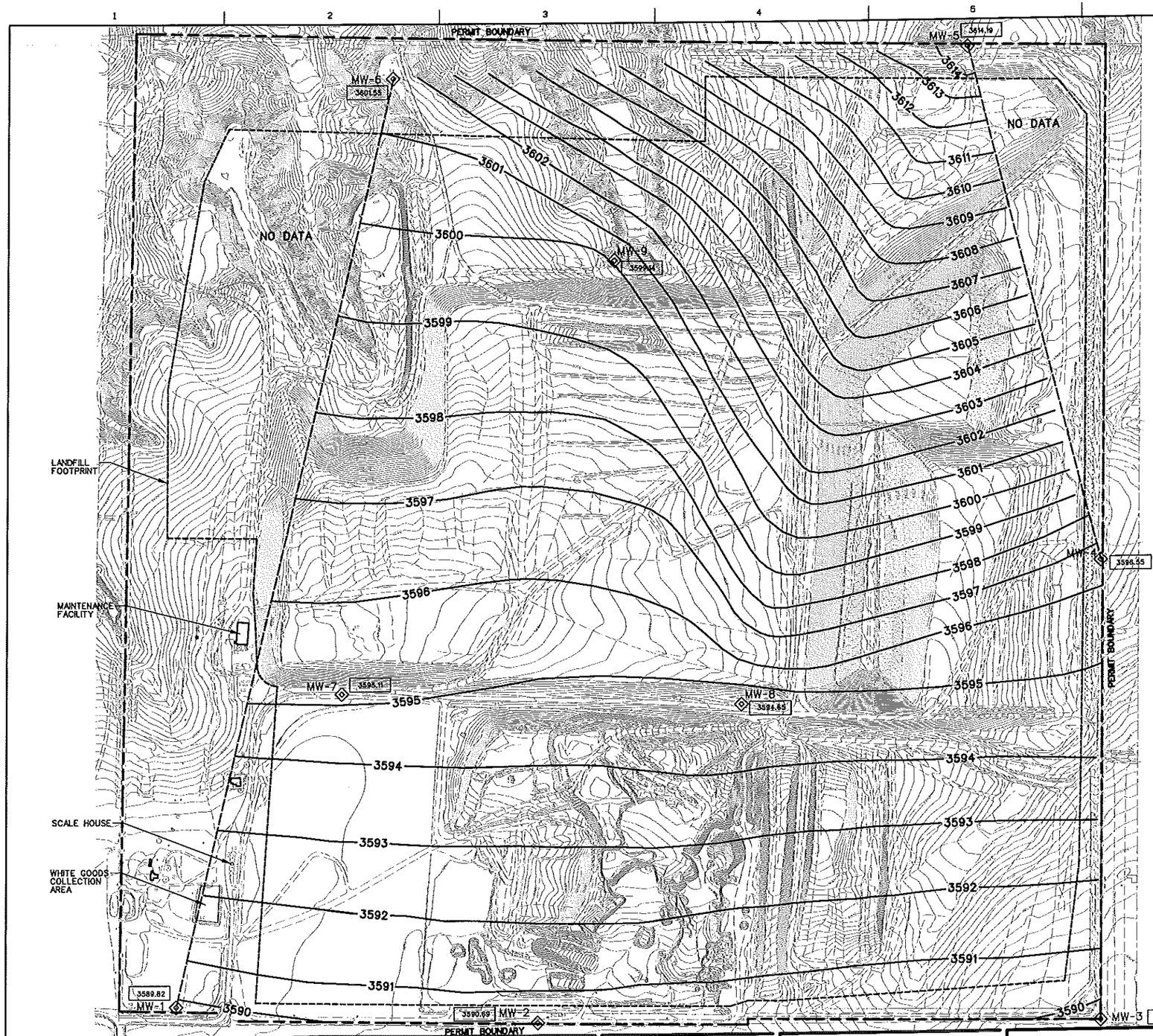

N

0 300 600

SCALE IN FEET

LEGEND

- PERMIT BOUNDARY
- 300 EXISTING CONTOURS
- LANDFILL FOOTPRINT
- 3605 GROUNDWATER CONTOURS
- MW-4 3615.28 EXISTING MONITORING WELL LOCATIONS AND ELEVATIONS

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43763
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PROFESSIONAL ENGINEER

7-15-09

NOTES

1. FOR TOPOGRAPHIC INFO SEE FIGURE III.1.1.
2. TOPOGRAPHIC MAP WAS COMPILED BY PHOTOGRAMMETRIC METHODS BY STEWART GEO TECHNOLOGIES, SAN ANTONIO, TEXAS FROM AERIAL PHOTOGRAPHY DATED APRIL 7, 2005. VERTICAL DATUM BASED ON NGVD 29. MAPPING GROUND CONTROL PROVIDED BY THE CITY OF AMARILLO, COMPLETED IN ACCORDANCE WITH NATIONAL MAP ACCURACY STANDARDS.

CITY OF AMARILLO
TEXAS

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TEXAS P.E. FIRM
REGISTRATION NO. F-754

ISSUE	DATE	DESCRIPTION
3	7/2009	REVISED MONITOR WELL LOCATIONS
2	3/2009	REVISED CONTOURS
1	1/2009	ISSUED FOR TCEQ REVIEW

PROJECT MANAGER	M. ODEN
CIVIL ENGINEER	M. ODEN
CHECKED BY	M. ODEN
DESIGNED	
DRAWN BY	
QA/QC	M. ODEN
PROJECT NUMBER	82070

CITY OF AMARILLO LANDFILL
MSW PERMIT NO. 73A
POTTER COUNTY, TEXAS

GROUNDWATER CONTOUR MAP
APRIL 14, 1995

FILENAME

SCALE

SHEET
Plate 8
App. 5B

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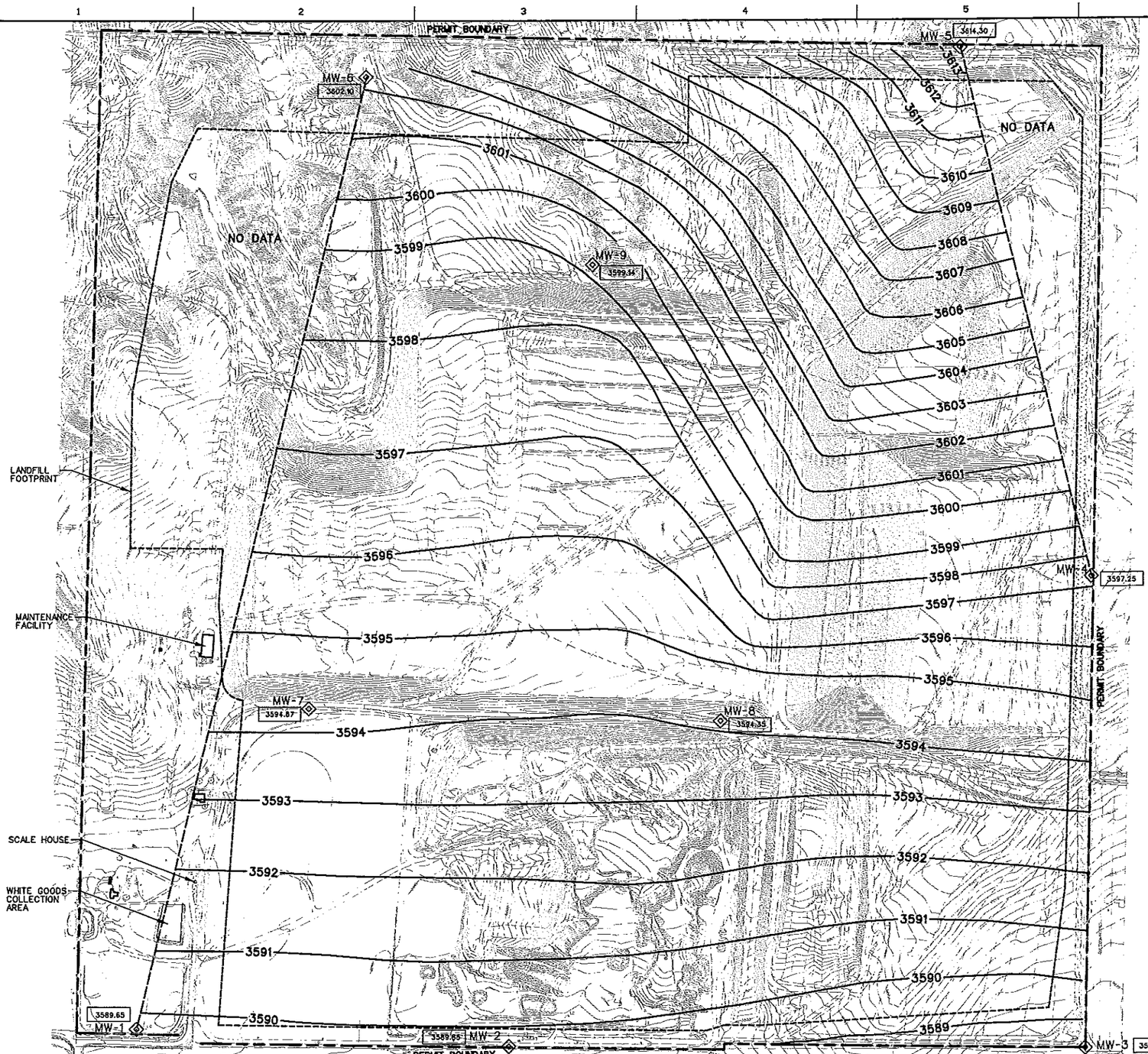

N

0 300 600

SCALE IN FEET

LEGEND

- PERMIT BOUNDARY
- 500 EXISTING CONTOURS
- LANDFILL FOOTPRINT
- 3605 GROUNDWATER CONTOURS
- MW-4 3615.28 EXISTING MONITORING WELL LOCATIONS AND ELEVATIONS

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43763
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PROFESSIONAL ENGINEER

7-15-09

NOTES

1. FOR TOPOGRAPHIC INFO SEE FIGURE III.1.1.
2. TOPOGRAPHIC MAP WAS COMPILED BY PHOTOGRAMMETRIC METHODS BY STEWART GEO TECHNOLOGIES, SAN ANTONIO, TEXAS FROM AERIAL PHOTOGRAPHY DATED APRIL 7, 2005. VERTICAL DATUM BASED ON NGVD 29. MAPPING GROUND CONTROL PROVIDED BY THE CITY OF AMARILLO, COMPLETED IN ACCORDANCE WITH NATIONAL MAP ACCURACY STANDARDS.

CITY OF AMARILLO LANDFILL
MSW PERMIT NO. 73A
POTTER COUNTY, TEXAS

GROUNDWATER CONTOUR MAP
OCTOBER 16, 1995

HDR ENGINEERING, INC.
4500 W. Eldorado Pkwy.
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McKinney, Texas 75070

TEXAS P.E. FIRM REGISTRATION NO. F-754

ISSUE	DATE	DESCRIPTION
3	7/2009	REVISED MONITOR WELL LOCATIONS
2	3/2009	REVISED CONTOURS
1	1/2009	ISSUED FOR TCEQ REVIEW

PROJECT MANAGER	M. ODEN
CIVIL ENGINEER	M. ODEN
CHECKED BY	M. ODEN
DESIGNED	
DRAWN BY	
QA/QC	M. ODEN
PROJECT NUMBER	82070

FILENAME
SCALE

SHEET
Plate 9
App. 5B

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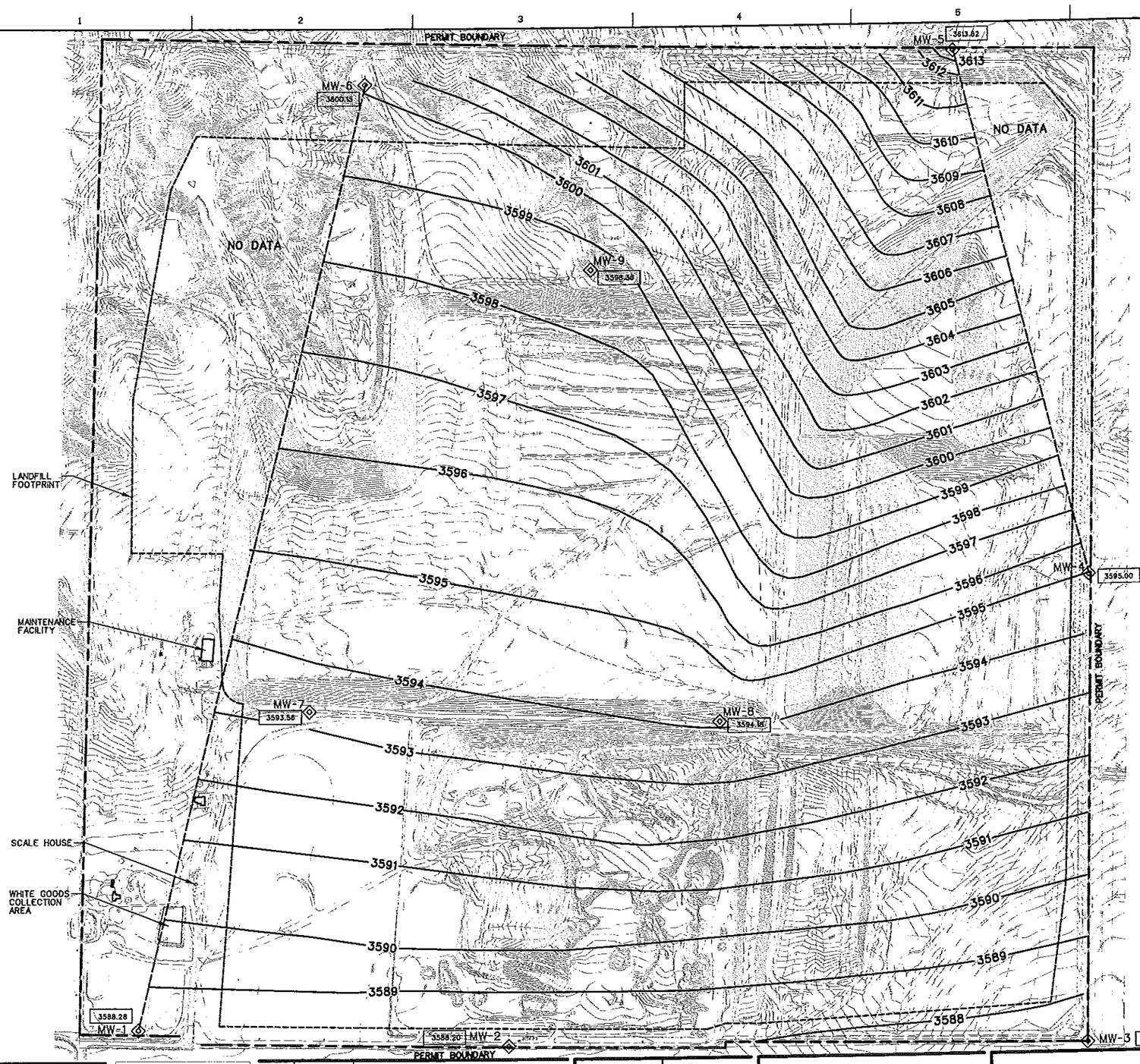

N

0 300 600

SCALE IN FEET

LEGEND

- PERMIT BOUNDARY
- 3602 EXISTING CONTOURS
- LANDFILL FOOTPRINT
- 3605 GROUNDWATER CONTOURS
- MW-4 3615.26 EXISTING MONITORING WELL LOCATIONS AND ELEVATIONS

NOTES

1. FOR TOPOGRAPHIC INFO SEE FIGURE III.1.1.
2. TOPOGRAPHIC MAP WAS COMPILED BY PHOTOGRAMMETRIC METHODS BY STEWART GEO TECHNOLOGIES, SAN ANTONIO, TEXAS FROM AERIAL PHOTOGRAPHY DATED APRIL 7, 2005. VERTICAL DATUM BASED ON NGVD 29. MAPPING GROUND CONTROL PROVIDED BY THE CITY OF AMARILLO, COMPLETED IN ACCORDANCE WITH NATIONAL MAP ACCURACY STANDARDS.

STATE OF TEXAS
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7-15-09

CITY OF AMARILLO
TEXAS

HDR

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4500 W. Eldorado Pkwy.
Suite 3500
McKinney, Texas 75070

TEXAS P.E. FIRM
REGISTRATION NO. F-754

ISSUE	DATE	DESCRIPTION
3	7/2009	REVISED MONITOR WELL LOCATIONS
2	3/2009	REVISED CONTOURS
1	1/2009	ISSUED FOR TCEQ REVIEW

PROJECT MANAGER	M. ODEN
CIVIL ENGINEER	M. ODEN
CHECKED BY	M. ODEN
DESIGNED	
DRAWN BY	
QA/QC	M. ODEN
PROJECT NUMBER	82070

CITY OF AMARILLO LANDFILL
MSW PERMIT NO. 73A
POTTER COUNTY, TEXAS

GROUNDWATER CONTOUR MAP
APRIL 15, 1997

FILENAME
SCALE

SHEET
Plate 10
App. 5B

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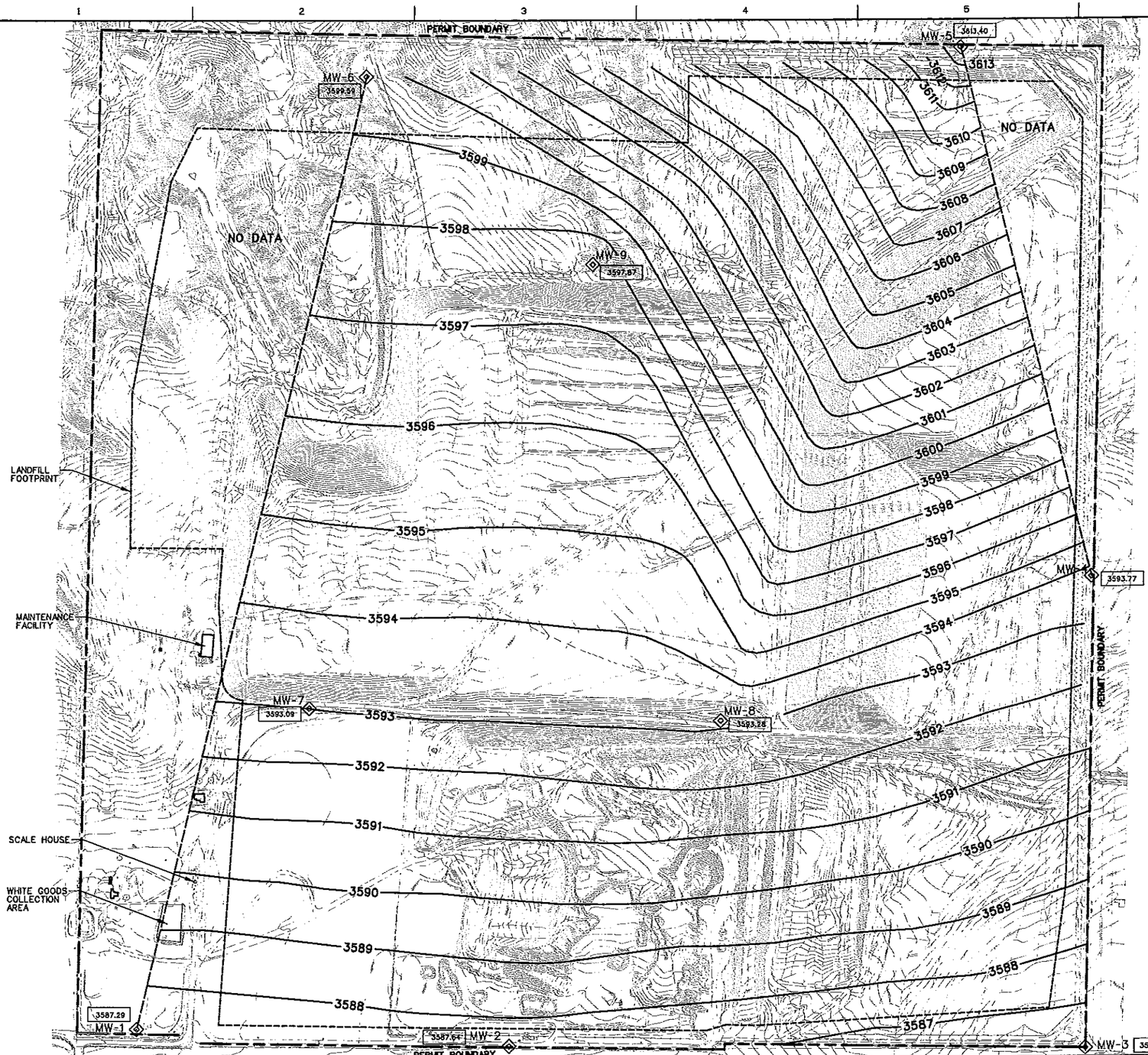

N

0 300 600

SCALE IN FEET

LEGEND

- PERMIT BOUNDARY
- 339 EXISTING CONTOURS
- LANDFILL FOOTPRINT
- 3605 GROUNDWATER CONTOURS
- MW-4 3515.26 EXISTING MONITORING WELL LOCATIONS AND ELEVATIONS

NOTES

1. FOR TOPOGRAPHIC INFO SEE FIGURE III.1.1.
2. TOPOGRAPHIC MAP WAS COMPILED BY PHOTOGRAMMETRIC METHODS BY STEWART GEO TECHNOLOGIES, SAN ANTONIO, TEXAS FROM AERIAL PHOTOGRAPHY DATED APRIL 7, 2005. VERTICAL DATUM BASED ON NGVD 29. MAPPING GROUND CONTROL PROVIDED BY THE CITY OF AMARILLO, COMPLETED IN ACCORDANCE WITH NATIONAL MAP ACCURACY STANDARDS.

STATE OF TEXAS
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7-15-09

STATE OF TEXAS
M. M. SHIFLETT
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PROFESSIONAL ENGINEER

7-15-09

CITY OF AMARILLO TEXAS

HDR

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Suite 3500
McKinney, Texas 75070

TEXAS P.E. FIRM
REGISTRATION NO. F-754

ISSUE	DATE	DESCRIPTION
3	7/2009	REVISED MONITOR WELL LOCATIONS
2	3/2009	REVISED CONTOURS
1	1/2009	ISSUED FOR TCEQ REVIEW

PROJECT MANAGER	M. ODEN
CIVIL ENGINEER	M. ODEN
CHECKED BY	M. ODEN
DESIGNED	
DRAWN BY	
QA/QC	M. ODEN
PROJECT NUMBER	82070

CITY OF AMARILLO LANDFILL
MSW PERMIT NO. 73A
POTTER COUNTY, TEXAS

GROUNDWATER CONTOUR MAP
OCTOBER 14, 1998

FILENAME

SCALE

SHEET
Plate 11
App. 5B

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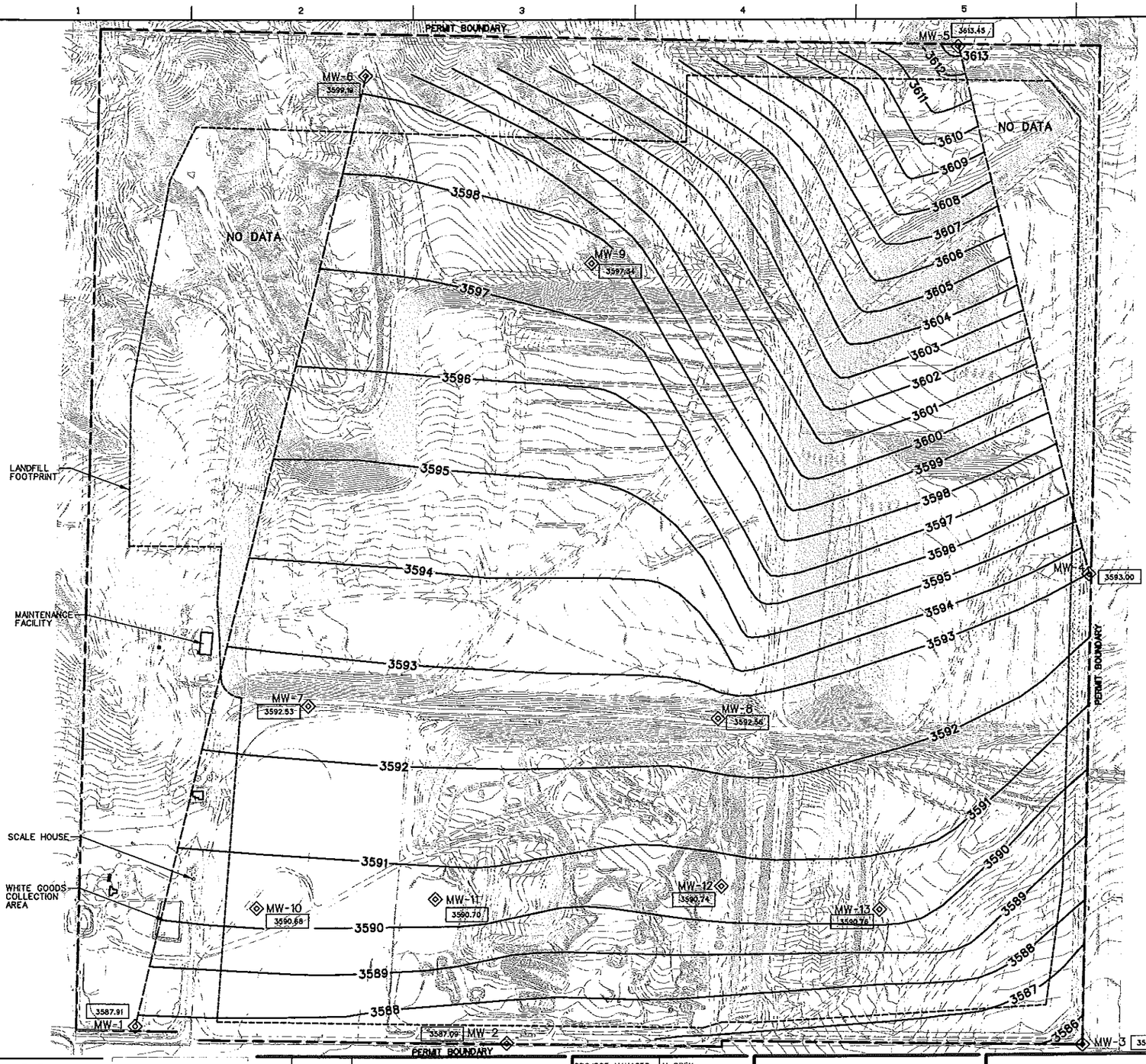

LEGEND

- PERMIT BOUNDARY
- 350 EXISTING CONTOURS
- LANDFILL FOOTPRINT
- 3605 GROUNDWATER CONTOURS
- MW-4 (3615.26) EXISTING MONITORING WELL LOCATIONS AND ELEVATIONS

NOTES

1. FOR TOPOGRAPHIC INFO SEE FIGURE III.1.1.
2. TOPOGRAPHIC MAP WAS COMPILED BY PHOTOGRAMMETRIC METHODS BY STEWART GEO TECHNOLOGIES, SAN ANTONIO, TEXAS FROM AERIAL PHOTOGRAPHY DATED APRIL 7, 2005. VERTICAL DATUM BASED ON NGVD 29. MAPPING GROUND CONTROL PROVIDED BY THE CITY OF AMARILLO, COMPLETED IN ACCORDANCE WITH NATIONAL MAP ACCURACY STANDARDS.

STATE OF TEXAS
DONALD D. JAMES
GEOLOGY
360
LICENSED
PROFESSIONAL GEOSCIENTIST

7-15-09

STATE OF TEXAS
M. M. SHIFLETT
43763
LICENSED
PROFESSIONAL ENGINEER

7-15-09

CITY OF AMARILLO
TEXAS

HDR

HDR ENGINEERING, INC.
4500 W. Eldorado Pkwy.
Suite 3500
McKinney, Texas 75070

TEXAS P.E. FIRM REGISTRATION NO. F-754

ISSUE	DATE	DESCRIPTION
3	7/2009	REVISED MONITOR WELL LOCATIONS
2	3/2009	REVISED CONTOURS
1	1/2009	ISSUED FOR TCEQ REVIEW

PROJECT MANAGER	M. ODEN
CIVIL ENGINEER	M. ODEN
CHECKED BY	M. ODEN
DESIGNED	
DRAWN BY	
QA/QC	M. ODEN
PROJECT NUMBER	82070

CITY OF AMARILLO LANDFILL
MSW PERMIT NO. 73A
POTTER COUNTY, TEXAS

GROUNDWATER CONTOUR MAP
APRIL 17, 2000

FILENAME
SCALE

SHEET
Plate 12
App. 5B

USER: RCOX
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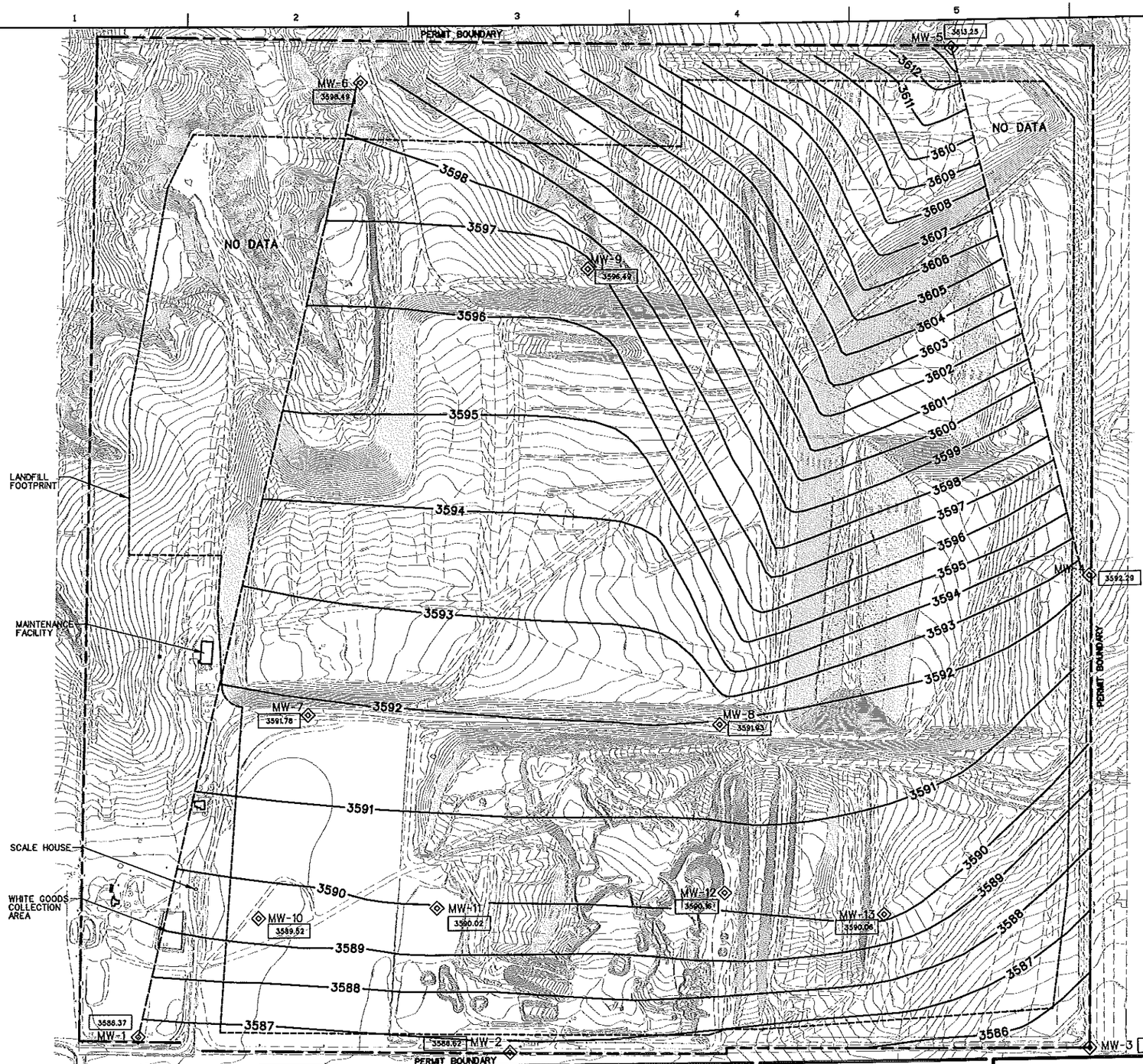

N

0 300 600

SCALE IN FEET

LEGEND

- PERMIT BOUNDARY
- EXISTING CONTOURS
- LANDFILL FOOTPRINT
- 3605 GROUNDWATER CONTOURS
- MW-4 3615.28 EXISTING MONITORING WELL LOCATIONS AND ELEVATIONS

NOTES

1. FOR TOPOGRAPHIC INFO SEE FIGURE III.1.1.
2. TOPOGRAPHIC MAP WAS COMPILED BY PHOTOGRAMMETRIC METHODS BY STEWART GEO TECHNOLOGIES, SAN ANTONIO, TEXAS FROM AERIAL PHOTOGRAPHY DATED APRIL 7, 2005. VERTICAL DATUM BASED ON NGVD 29. MAPPING GROUND CONTROL PROVIDED BY THE CITY OF AMARILLO, COMPLETED IN ACCORDANCE WITH NATIONAL MAP ACCURACY STANDARDS.

STATE OF TEXAS
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TEXAS P.E. FIRM
REGISTRATION NO. F-754

ISSUE	DATE	DESCRIPTION
3	7/2009	REVISED MONITOR WELL LOCATIONS
2	3/2009	REVISED CONTOURS
1	1/2009	ISSUED FOR TCEQ REVIEW

PROJECT MANAGER	M. ODEN
CIVIL ENGINEER	M. ODEN
CHECKED BY	M. ODEN
DESIGNED	
DRAWN BY	
QA/QC	M. ODEN
PROJECT NUMBER	82070

CITY OF AMARILLO LANDFILL
MSW PERMIT NO. 73A
POTTER COUNTY, TEXAS

GROUNDWATER CONTOUR MAP
OCTOBER 16, 2001

FILENAME
SCALE

SHEET
Plate 13
App. 5B

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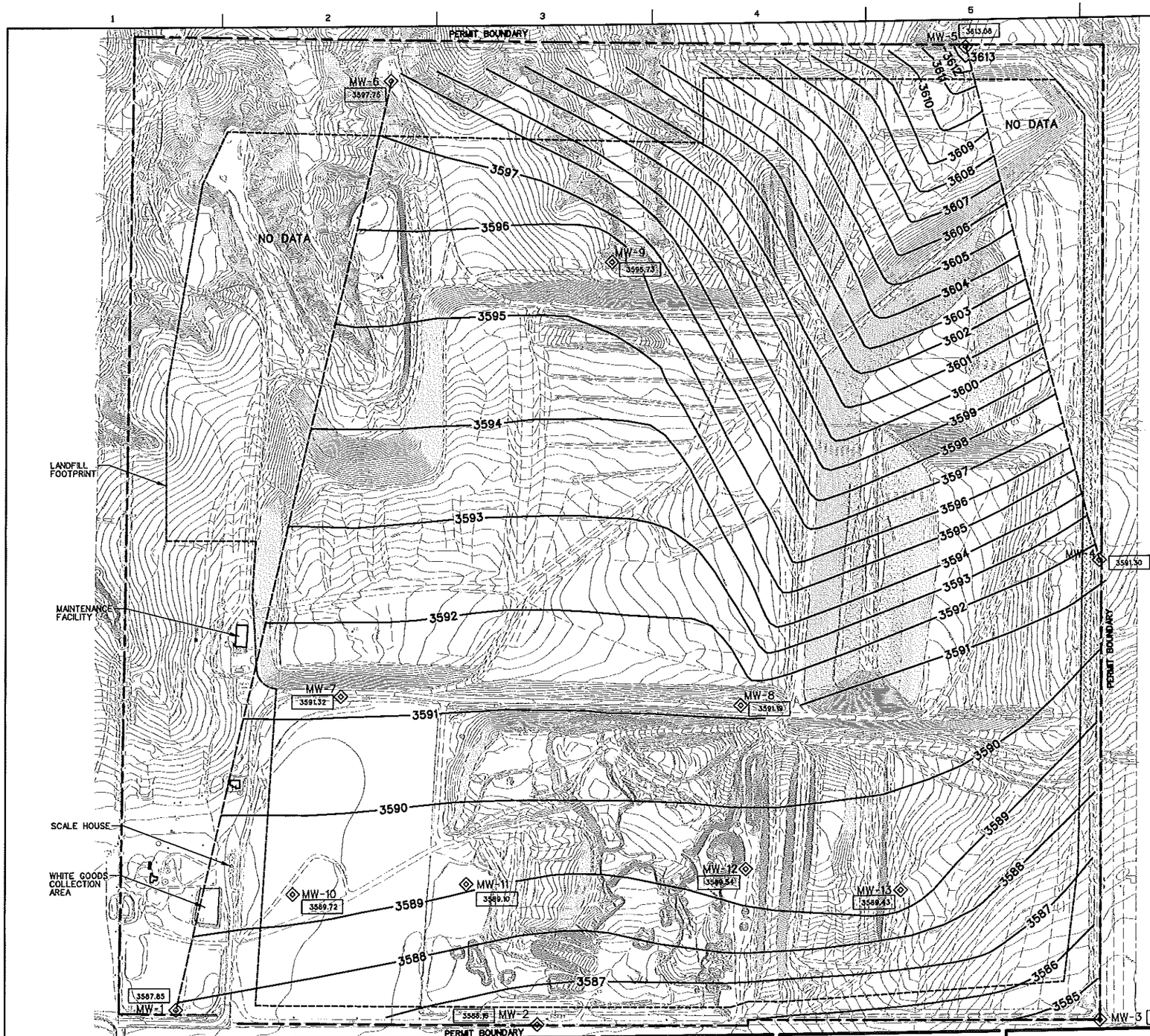

N

0 300 600

SCALE IN FEET

LEGEND

- PERMIT BOUNDARY
- 390 EXISTING CONTOURS
- LANDFILL FOOTPRINT
- 3605 GROUNDWATER CONTOURS
- MW-4 3615.28 EXISTING MONITORING WELL LOCATIONS AND ELEVATIONS

NOTES

1. FOR TOPOGRAPHIC INFO SEE FIGURE III.1.1.
2. TOPOGRAPHIC MAP WAS COMPILED BY PHOTOGRAMMETRIC METHODS BY STEWART GEO TECHNOLOGIES, SAN ANTONIO, TEXAS FROM AERIAL PHOTOGRAPHY DATED APRIL 7, 2005. VERTICAL DATUM BASED ON NGVD 29. MAPPING GROUND CONTROL PROVIDED BY THE CITY OF AMARILLO, COMPLETED IN ACCORDANCE WITH NATIONAL MAP ACCURACY STANDARDS.

STATE OF TEXAS
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7-15-09

STATE OF TEXAS
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43763
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7-15-09

CITY OF AMARILLO TEXAS

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TEXAS P.E. FIRM REGISTRATION NO. F-754

ISSUE	DATE	DESCRIPTION
3	7/2009	REVISED MONITOR WELL LOCATIONS
2	3/2009	REVISED CONTOURS
1	1/2009	ISSUED FOR TCEQ REVIEW

PROJECT MANAGER	M. ODEN
CIVIL ENGINEER	M. ODEN
CHECKED BY	M. ODEN
DESIGNED	
DRAWN BY	
QA/QC	M. ODEN
PROJECT NUMBER	82070

CITY OF AMARILLO LANDFILL
MSW PERMIT NO. 73A
POTTER COUNTY, TEXAS

GROUNDWATER CONTOUR MAP APRIL 14, 2003

FILENAME

SCALE

SHEET
Plate 14
App. 5B

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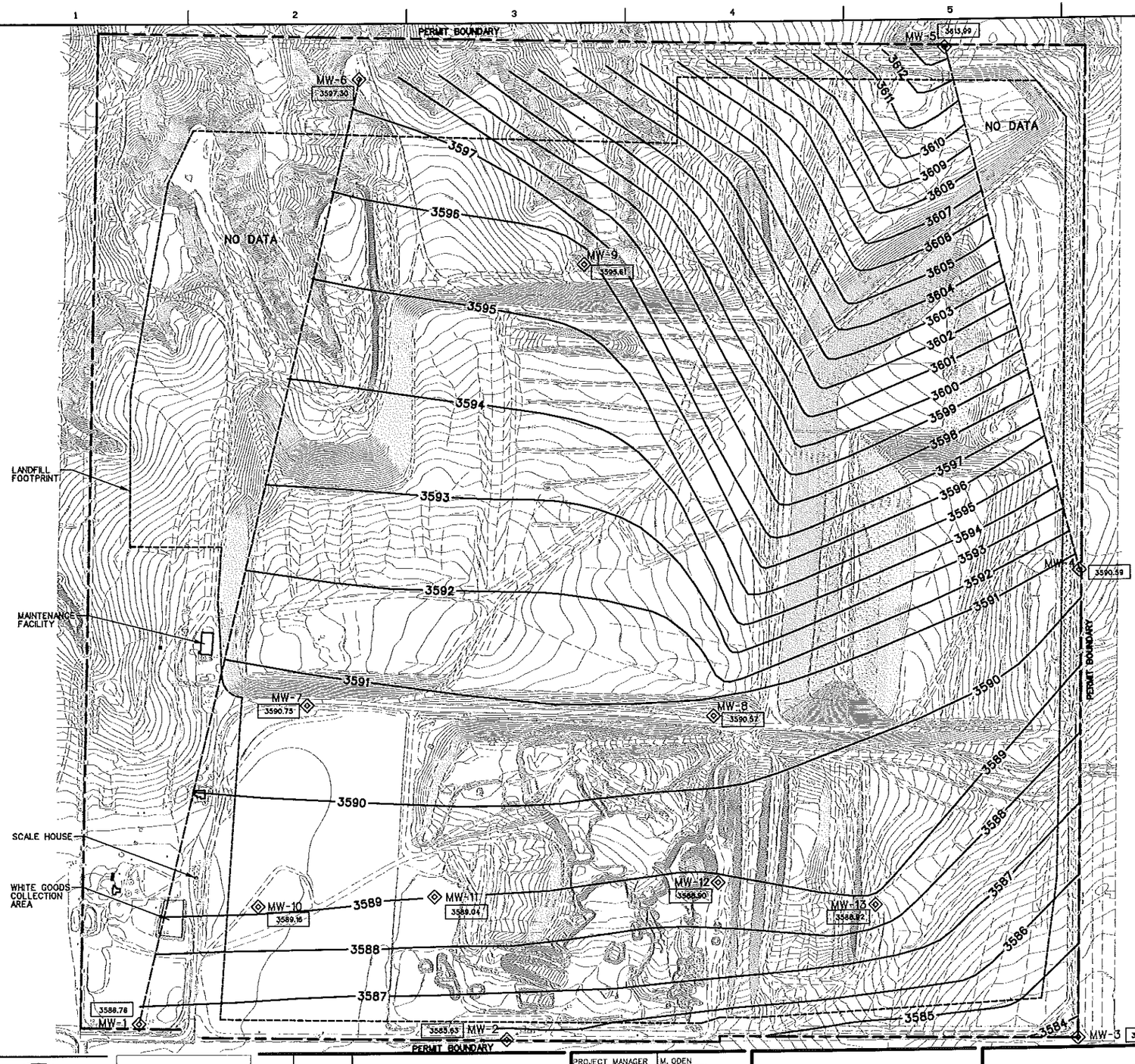

N

0 300 600

SCALE IN FEET

LEGEND

- PERMIT BOUNDARY
- 500 EXISTING CONTOURS
- LANDFILL FOOTPRINT
- 3605 GROUNDWATER CONTOURS
- MW-4 3615.28 EXISTING MONITORING WELL LOCATIONS AND ELEVATIONS

NOTES

1. FOR TOPOGRAPHIC INFO SEE FIGURE II.1.1.
2. TOPOGRAPHIC MAP WAS COMPILED BY PHOTOGRAMMETRIC METHODS BY STEWART GEO TECHNOLOGIES, SAN ANTONIO, TEXAS FROM AERIAL PHOTOGRAPHY DATED APRIL 7, 2005. VERTICAL DATUM BASED ON NGVD 29. MAPPING GROUND CONTROL PROVIDED BY THE CITY OF AMARILLO, COMPLETED IN ACCORDANCE WITH NATIONAL MAP ACCURACY STANDARDS.

STATE OF TEXAS
DONALD D. JAMES
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7-15-09

STATE OF TEXAS
M. M. SHIFLETT
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LICENSED
PROFESSIONAL ENGINEER
7-15-09

CITY OF AMARILLO TEXAS

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Suite 3500
McKinney, Texas 75070

TEXAS P.E. FIRM REGISTRATION NO. F-754

ISSUE	DATE	DESCRIPTION
3	7/2009	REVISED MONITOR WELL LOCATIONS
2	3/2009	REVISED CONTOURS
1	1/2009	ISSUED FOR TCEQ REVIEW

PROJECT MANAGER	M. ODEN
CIVIL ENGINEER	M. ODEN
CHECKED BY	M. ODEN
DESIGNED	
DRAWN BY	
QA/QC	M. ODEN
PROJECT NUMBER	82070

CITY OF AMARILLO LANDFILL
MSW PERMIT NO. 73A
POTTER COUNTY, TEXAS

GROUNDWATER CONTOUR MAP
OCTOBER 18, 2004

FILENAME

SCALE

SHEET
Plate 15
App. 5B

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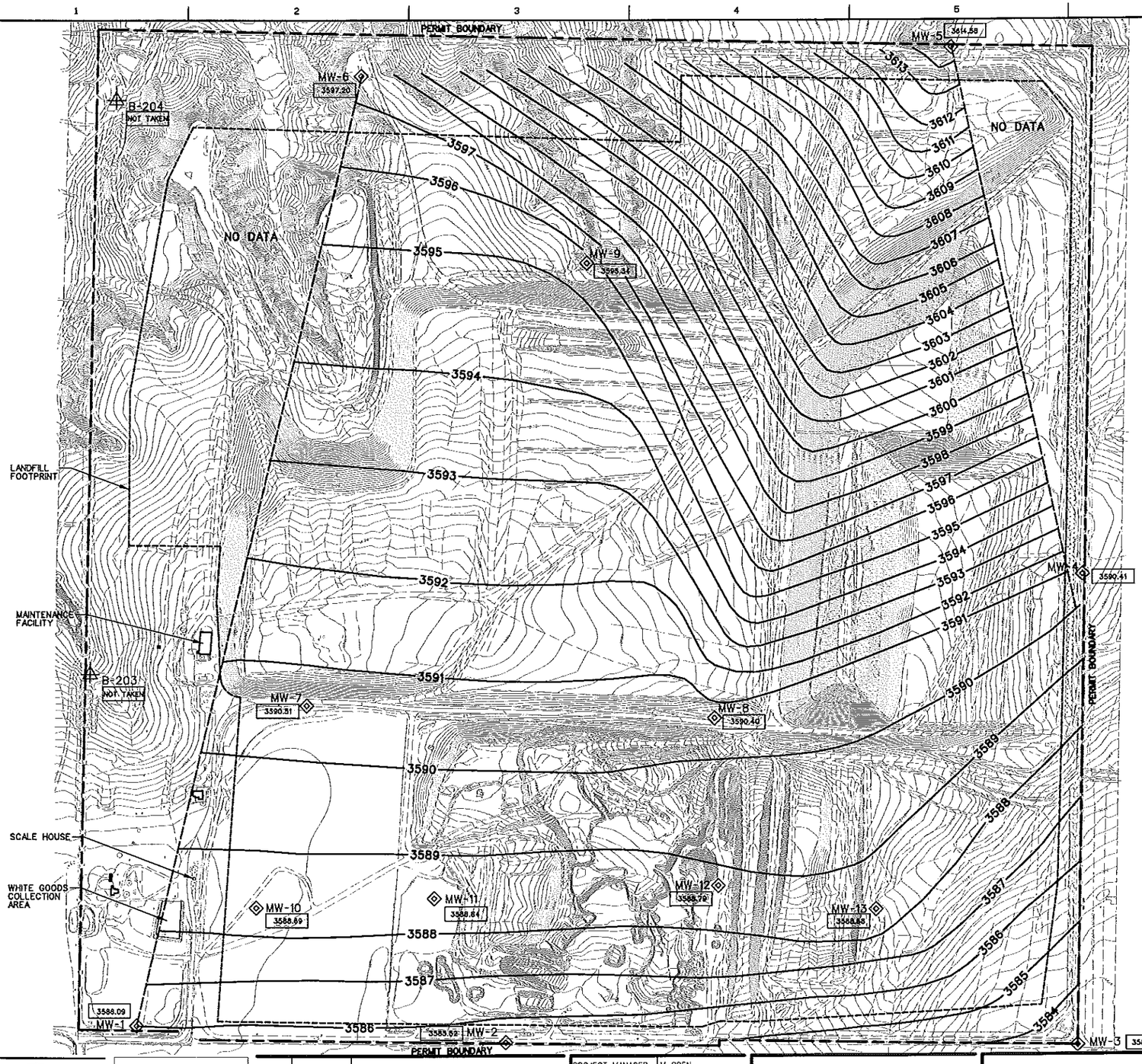

N

0 300 600

SCALE IN FEET

LEGEND

- PERMIT BOUNDARY
- 330 EXISTING CONTOURS
- LANDFILL FOOTPRINT
- 3605 GROUNDWATER CONTOURS
- MW-4 3615.28 EXISTING MONITORING WELL LOCATIONS AND ELEVATIONS
- B-204 3615.28 2005 BORING LOCATIONS WITH PIEZOMETER AND ELEVATIONS

STATE OF TEXAS
DONALD D. JAMES
GEOLOGY
360
LICENSED
PROFESSIONAL GEOSCIENTIST

1-15-09

STATE OF TEXAS
M. M. SHIFLETT
43763
LICENSED
PROFESSIONAL ENGINEER

1-15-09

NOTES

1. FOR TOPOGRAPHIC INFO SEE FIGURE III.1.1.
2. TOPOGRAPHIC MAP WAS COMPILED BY PHOTOGRAMMETRIC METHODS BY STEWART GEO TECHNOLOGIES, SAN ANTONIO, TEXAS FROM AERIAL PHOTOGRAPHY DATED APRIL 7, 2005. VERTICAL DATUM BASED ON NGVD 29. MAPPING GROUND CONTROL PROVIDED BY THE CITY OF AMARILLO, COMPLETED IN ACCORDANCE WITH NATIONAL MAP ACCURACY STANDARDS.

CITY OF AMARILLO TEXAS

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ISSUE	DATE	DESCRIPTION
3	7/2009	REVISED MONITOR WELL LOCATIONS
2	3/2009	REVISED CONTOURS
1	1/2009	ISSUED FOR TCEQ REVIEW

PROJECT MANAGER	M. ODEN
CIVIL ENGINEER	M. ODEN
CHECKED BY	M. ODEN
DESIGNED	
DRAWN BY	
QA/QC	M. ODEN
PROJECT NUMBER	82070

CITY OF AMARILLO LANDFILL
MSW PERMIT NO. 73A
POTTER COUNTY, TEXAS

GROUNDWATER CONTOUR MAP
OCTOBER 17, 2005

FILENAME
SCALE

SHEET
Plate 16
App. 5B

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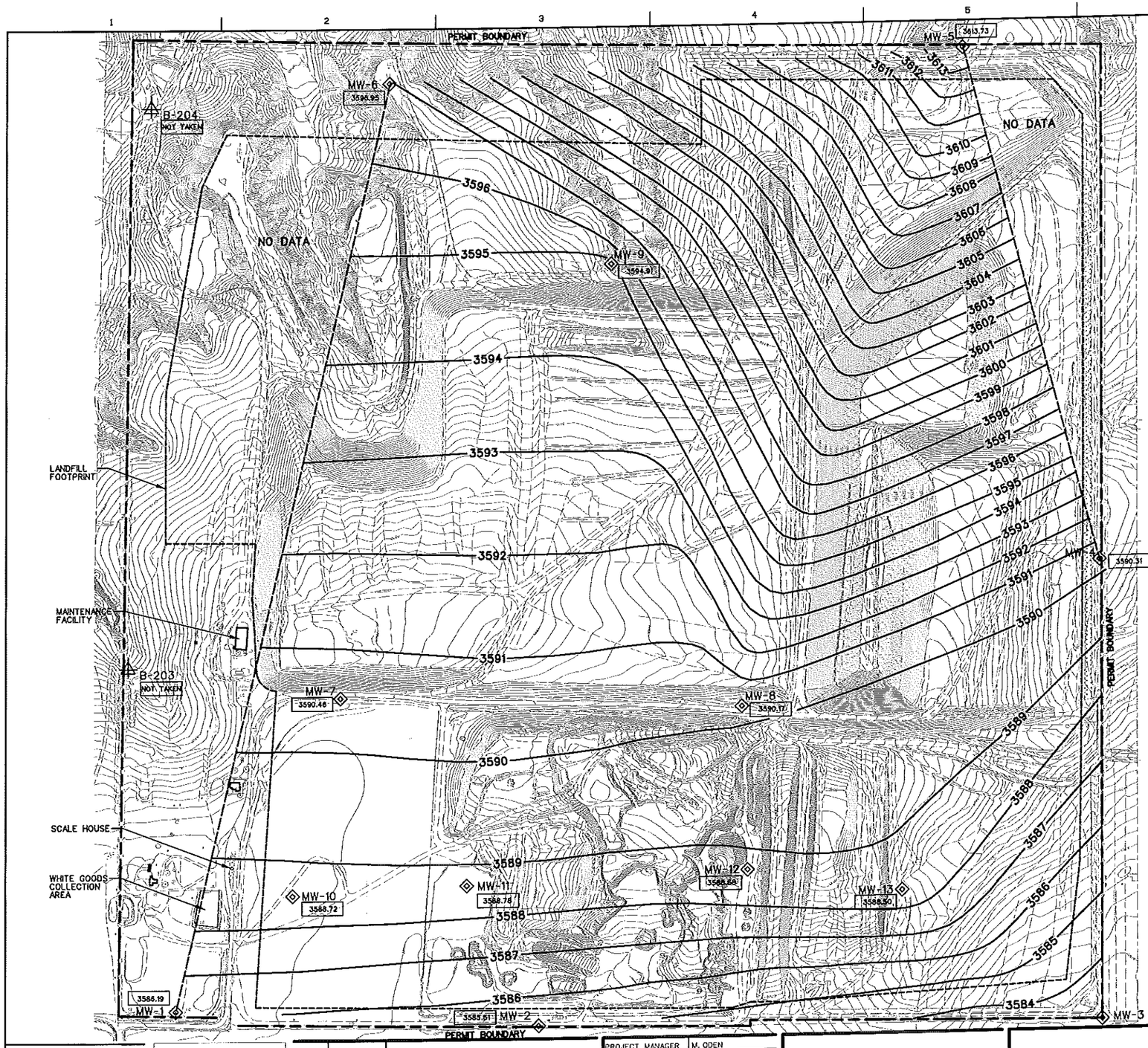

N

0 300 600

SCALE IN FEET

LEGEND

- PERMIT BOUNDARY
- EXISTING CONTOURS
- LANDFILL FOOTPRINT
- 3605 GROUNDWATER CONTOURS
- MW-4 3615.28 EXISTING MONITORING WELL LOCATIONS AND ELEVATIONS
- B-204 3615.28 2005 BORING LOCATIONS WITH PIEZOMETER AND ELEVATIONS

NOTES

1. FOR TOPOGRAPHIC INFO SEE FIGURE III.1.1.
2. TOPOGRAPHIC MAP WAS COMPILED BY PHOTOGRAMMETRIC METHODS BY STEWART GEO TECHNOLOGIES, SAN ANTONIO, TEXAS FROM AERIAL PHOTOGRAPHY DATED APRIL 7, 2005. VERTICAL DATUM BASED ON NGVD 29. MAPPING GROUND CONTROL PROVIDED BY THE CITY OF AMARILLO, COMPLETED IN ACCORDANCE WITH NATIONAL MAP ACCURACY STANDARDS.

STATE OF TEXAS
DONALD D. JAMES
GEOLOGY
360
LICENSED
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7-15-09

STATE OF TEXAS
M. M. SHIFLETT
43763
LICENSED
PROFESSIONAL ENGINEER

7-15-09

CITY OF AMARILLO TEXAS

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Site 3500
McKinney, Texas 75070

TEXAS P.E. FIRM REGISTRATION No. F-754

ISSUE	DATE	DESCRIPTION
3	7/2009	REVISED MONITOR WELL LOCATIONS
2	3/2009	REVISED CONTOURS
1	1/2009	ISSUED FOR TCEQ REVIEW

PROJECT MANAGER	M. ODEN
CIVIL ENGINEER	M. ODEN
CHECKED BY	M. ODEN
DESIGNED	
DRAWN BY	
QA/QC	M. ODEN
PROJECT NUMBER	82070

CITY OF AMARILLO LANDFILL
MSW PERMIT NO. 73A
POTTER COUNTY, TEXAS

GROUNDWATER CONTOUR MAP
APRIL 18, 2006

FILENAME

SCALE

SHEET
Plate 17
App. 5B

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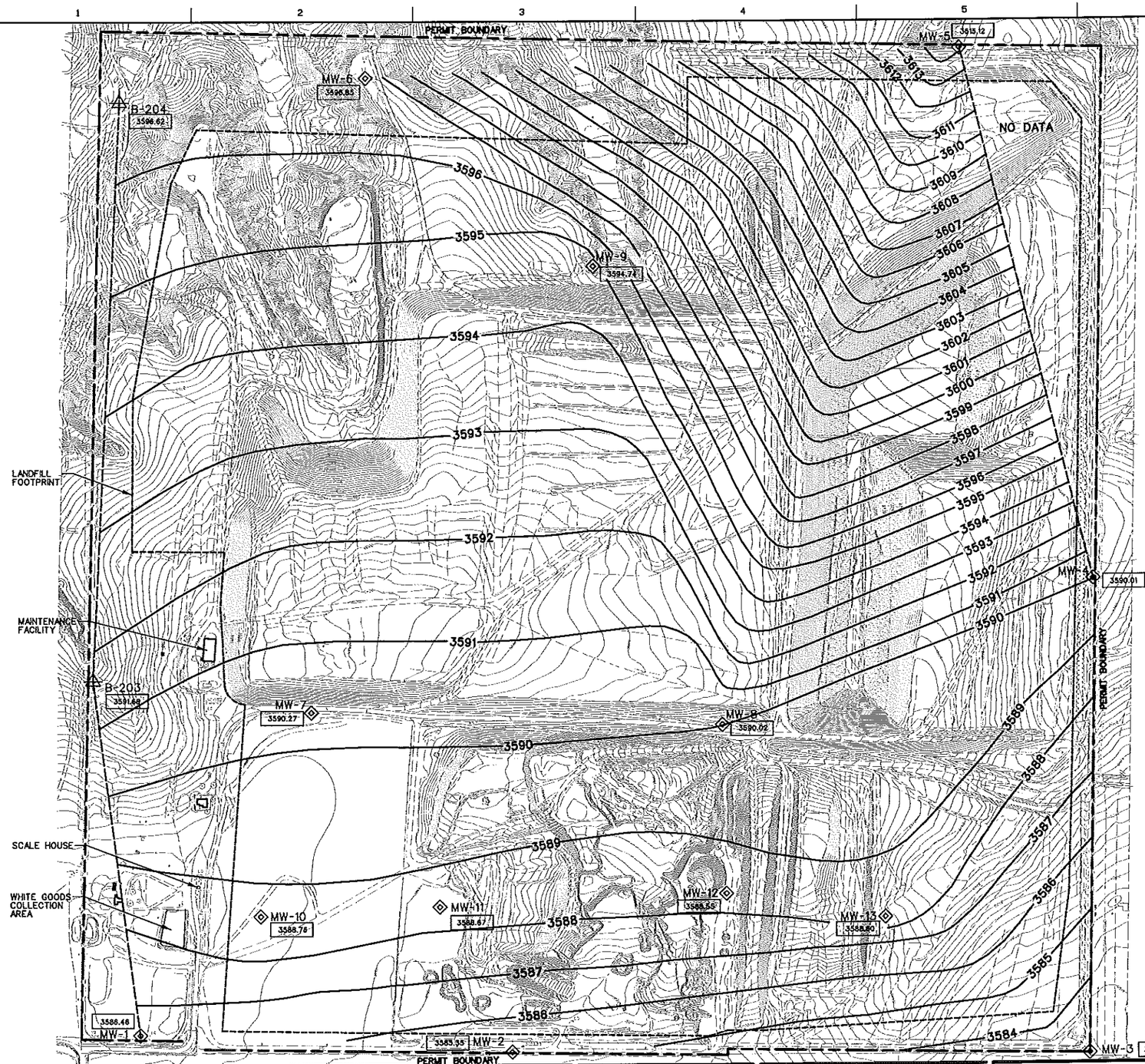

N

0 300 600

SCALE IN FEET

LEGEND

- PERMIT BOUNDARY
- 329 EXISTING CONTOURS
- LANDFILL FOOTPRINT
- 3605 GROUNDWATER CONTOURS
- MW-4 3615.28 EXISTING MONITORING WELL LOCATIONS AND ELEVATIONS
- B-204 3615.28 2005 BORING LOCATIONS WITH PIEZOMETER AND ELEVATIONS

STATE OF TEXAS
DONALD D. JAMES
GEOLOGY
360
LICENSED
PROFESSIONAL GEOSCIENTIST

7-15-09

STATE OF TEXAS
M. M. SHIFLETT
43763
LICENSED
PROFESSIONAL ENGINEER

7-15-09

NOTES

1. FOR TOPOGRAPHIC INFO SEE FIGURE III.1.1.
2. TOPOGRAPHIC MAP WAS COMPILED BY PHOTOGRAMMETRIC METHODS BY STEWART GEO TECHNOLOGIES, SAN ANTONIO, TEXAS FROM AERIAL PHOTOGRAPHY DATED APRIL 7, 2005. VERTICAL DATUM BASED ON NGVD 29. MAPPING GROUND CONTROL PROVIDED BY THE CITY OF AMARILLO, COMPLETED IN ACCORDANCE WITH NATIONAL MAP ACCURACY STANDARDS.

CITY OF AMARILLO TEXAS

HDR

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4500 W. Eldorado Pkwy.
Suite 3500
McKinney, Texas 75070

TEXAS P.E. FIRM
REGISTRATION NO. F-754

ISSUE	DATE	DESCRIPTION
3	7/2009	REVISED MONITOR WELL LOCATIONS
2	3/2009	REVISED CONTOURS
1	1/2009	ISSUED FOR TCEQ REVIEW

PROJECT MANAGER	M. ODEN
CIVIL ENGINEER	M. ODEN
CHECKED BY	M. ODEN
DESIGNED	
DRAWN BY	
QA/QC	M. ODEN
PROJECT NUMBER	82070

CITY OF AMARILLO LANDFILL
MSW PERMIT NO. 73A
POTTER COUNTY, TEXAS

GROUNDWATER CONTOUR MAP
APRIL 18, 2007

FILENAME
SCALE

SHEET
Plate 18
App. 5B

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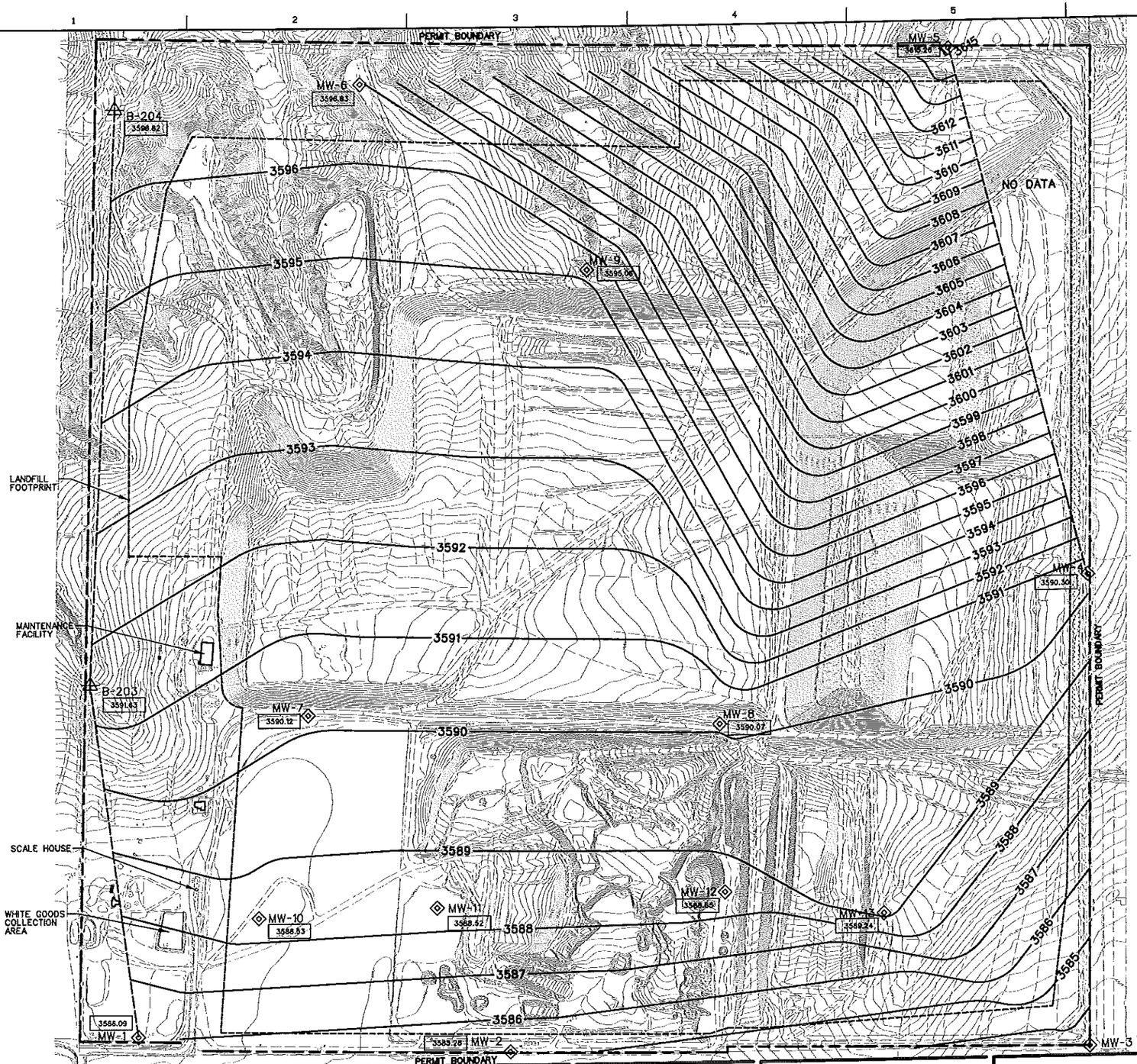

N

0 300 600

SCALE IN FEET

LEGEND

- PERMIT BOUNDARY
- EXISTING CONTOURS
- LANDFILL FOOTPRINT
- 3605 GROUNDWATER CONTOURS
- MW-4 3615.28 EXISTING MONITORING WELL LOCATIONS AND ELEVATIONS
- B-204 3615.28 2005 BORING LOCATIONS WITH PIEZOMETER AND ELEVATIONS

STATE OF TEXAS
DONALD D. JAMES
GEOLOGY
360
LICENSED
PROFESSIONAL GEOSCIENTIST

7-15-09

STATE OF TEXAS
M. M. SHIFLETT
43763
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PROFESSIONAL ENGINEER

7-15-09

NOTES
1. FOR TOPOGRAPHIC INFO SEE FIGURE III.1.1.
2. TOPOGRAPHIC MAP WAS COMPILED BY PHOTOGRAMMETRIC METHODS BY STEWART GEO TECHNOLOGIES, SAN ANTONIO, TEXAS FROM AERIAL PHOTOGRAPHY DATED APRIL 7, 2005. VERTICAL DATUM BASED ON NGVD 29. MAPPING GROUND CONTROL PROVIDED BY THE CITY OF AMARILLO, COMPLETED IN ACCORDANCE WITH NATIONAL MAP ACCURACY STANDARDS.

CITY OF AMARILLO TEXAS

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TEXAS P.E. FIRM
REGISTRATION NO. F-754

ISSUE	DATE	DESCRIPTION
3	7/2009	REVISED MONITOR WELL LOCATIONS
2	3/2009	REVISED CONTOURS
1	1/2009	ISSUED FOR TCEQ REVIEW

PROJECT MANAGER	M. ODEN
CIVIL ENGINEER	M. ODEN
CHECKED BY	M. ODEN
DESIGNED	
DRAWN BY	
QA/QC	M. ODEN
PROJECT NUMBER	82070

CITY OF AMARILLO LANDFILL
MSW PERMIT NO. 73A
POTTER COUNTY, TEXAS

GROUNDWATER CONTOUR MAP
OCTOBER 15, 2007

FILENAME
SCALE

SHEET
Plate 19
App. 5B

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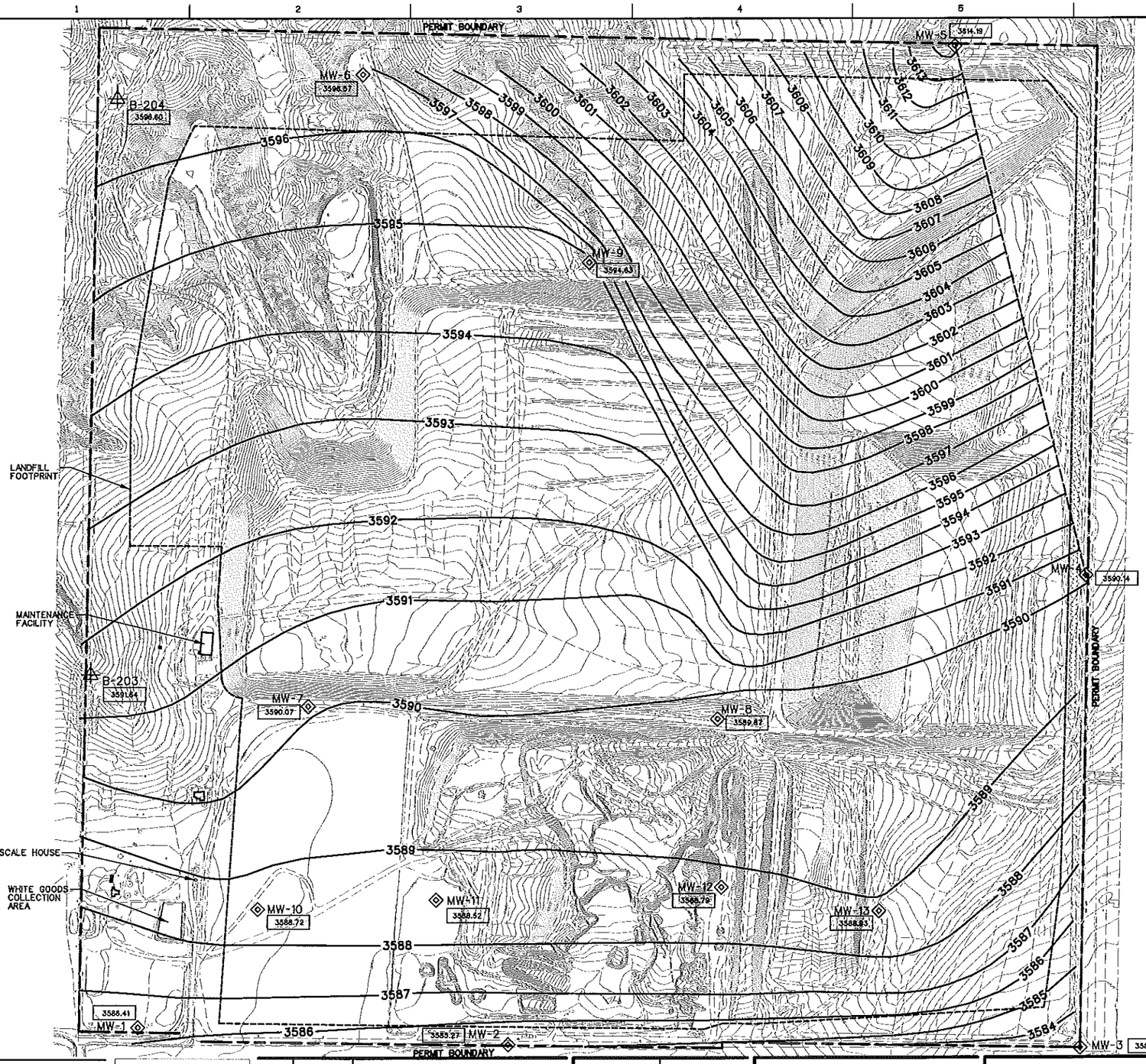

STATE OF TEXAS
DONALD D. JAMES
GEOLOGY
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PROFESSIONAL GEOSCIENTIST
7-15-09

STATE OF TEXAS
M. M. SHIFLETT
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LICENSED
PROFESSIONAL ENGINEER
7-15-09

NOTES
1. FOR TOPOGRAPHIC INFO SEE FIGURE III.1.1.
2. TOPOGRAPHIC MAP WAS COMPILED BY PHOTOGRAMMETRIC METHODS BY STEWART GEO TECHNOLOGIES, SAN ANTONIO, TEXAS FROM AERIAL PHOTOGRAPHY DATED APRIL 7, 2005. VERTICAL DATUM BASED ON NGVD 29. MAPPING GROUND CONTROL PROVIDED BY THE CITY OF AMARILLO, COMPLETED IN ACCORDANCE WITH NATIONAL MAP ACCURACY STANDARDS.

CITY OF AMARILLO TEXAS

HDR

HDR ENGINEERING, INC.
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Suite 3900
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TEXAS P.E. FIRM REGISTRATION NO. F-754

ISSUE	DATE	DESCRIPTION
3	7/2009	REVISED MONITOR WELL LOCATIONS
2	3/2009	REVISED CONTOURS
1	1/2009	ISSUED FOR TCEQ REVIEW

PROJECT MANAGER	M. ODEN
CIVIL ENGINEER	M. ODEN
CHECKED BY	M. ODEN
DESIGNED	
DRAWN BY	
QA/QC	M. ODEN
PROJECT NUMBER	82070

CITY OF AMARILLO LANDFILL
MSW PERMIT NO. 73A
POTTER COUNTY, TEXAS

GROUNDWATER CONTOUR MAP
MARCH 18, 2008

FILENAME
SCALE

SHEET
Plate 20
App. 5B

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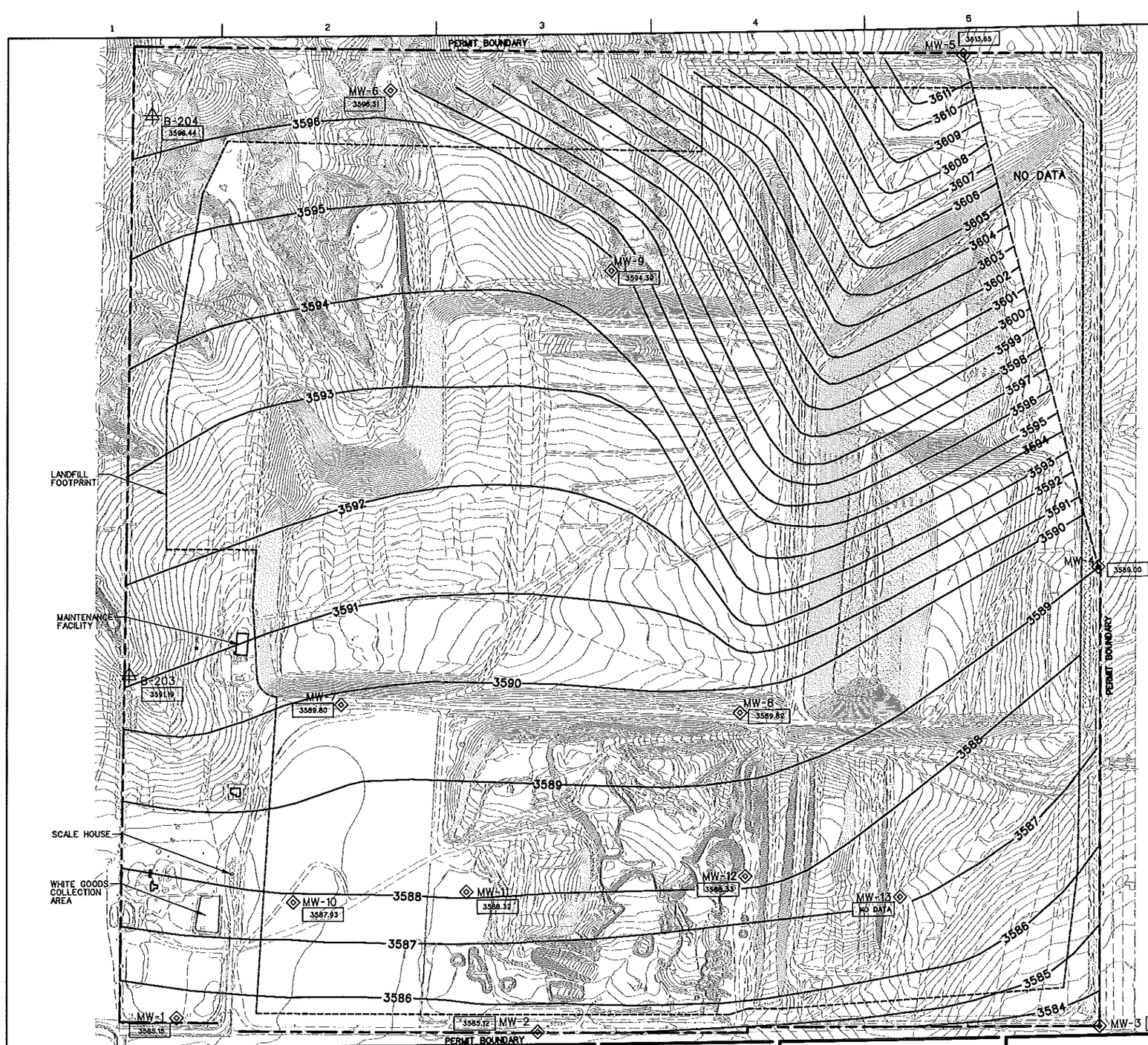

N

0 300 600

SCALE IN FEET

LEGEND

- PERMIT BOUNDARY
- EXISTING CONTOURS
- LANDFILL FOOTPRINT
- 3605 GROUNDWATER CONTOURS
- MW-4 3615.26 EXISTING MONITORING WELL LOCATIONS AND ELEVATIONS
- B-204 3615.26 2005 BORING LOCATIONS WITH PIEZOMETER AND ELEVATIONS

NOTES

1. FOR TOPOGRAPHIC INFO SEE FIGURE III.1.1.
2. TOPOGRAPHIC MAP WAS COMPILED BY PHOTOGRAMMETRIC METHODS BY STEWART GEO TECHNOLOGIES, SAN ANTONIO, TEXAS FROM AERIAL PHOTOGRAPHY DATED APRIL 7, 2005. VERTICAL DATUM BASED ON NGVD 29. MAPPING GROUND CONTROL PROVIDED BY THE CITY OF AMARILLO, COMPLETED IN ACCORDANCE WITH NATIONAL MAP ACCURACY STANDARDS.

STATE OF TEXAS
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GEOLOGY
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PROFESSIONAL GEOSCIENTIST

7-15-09

STATE OF TEXAS
M. M. SHIFLETT
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LICENSED
PROFESSIONAL ENGINEER

7-15-09

CITY OF AMARILLO
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TEXAS P.E. FIRM
REGISTRATION NO. F-754

ISSUE	DATE	DESCRIPTION
3	7/2009	REVISED MONITOR WELL LOCATIONS
2	3/2009	REVISED CONTOURS
1	1/2009	ISSUED FOR TCEQ REVIEW

PROJECT MANAGER	M. ODEN
CIVIL ENGINEER	M. ODEN
CHECKED BY	M. ODEN
DESIGNED	
DRAWN BY	
QA/QC	M. ODEN
PROJECT NUMBER	82070

CITY OF AMARILLO LANDFILL
MSW PERMIT NO. 73A
POTTER COUNTY, TEXAS

GROUNDWATER CONTOUR MAP
AUGUST 14, 2008

FILENAME
SCALE

SHEET
Plate 21
App. 5B

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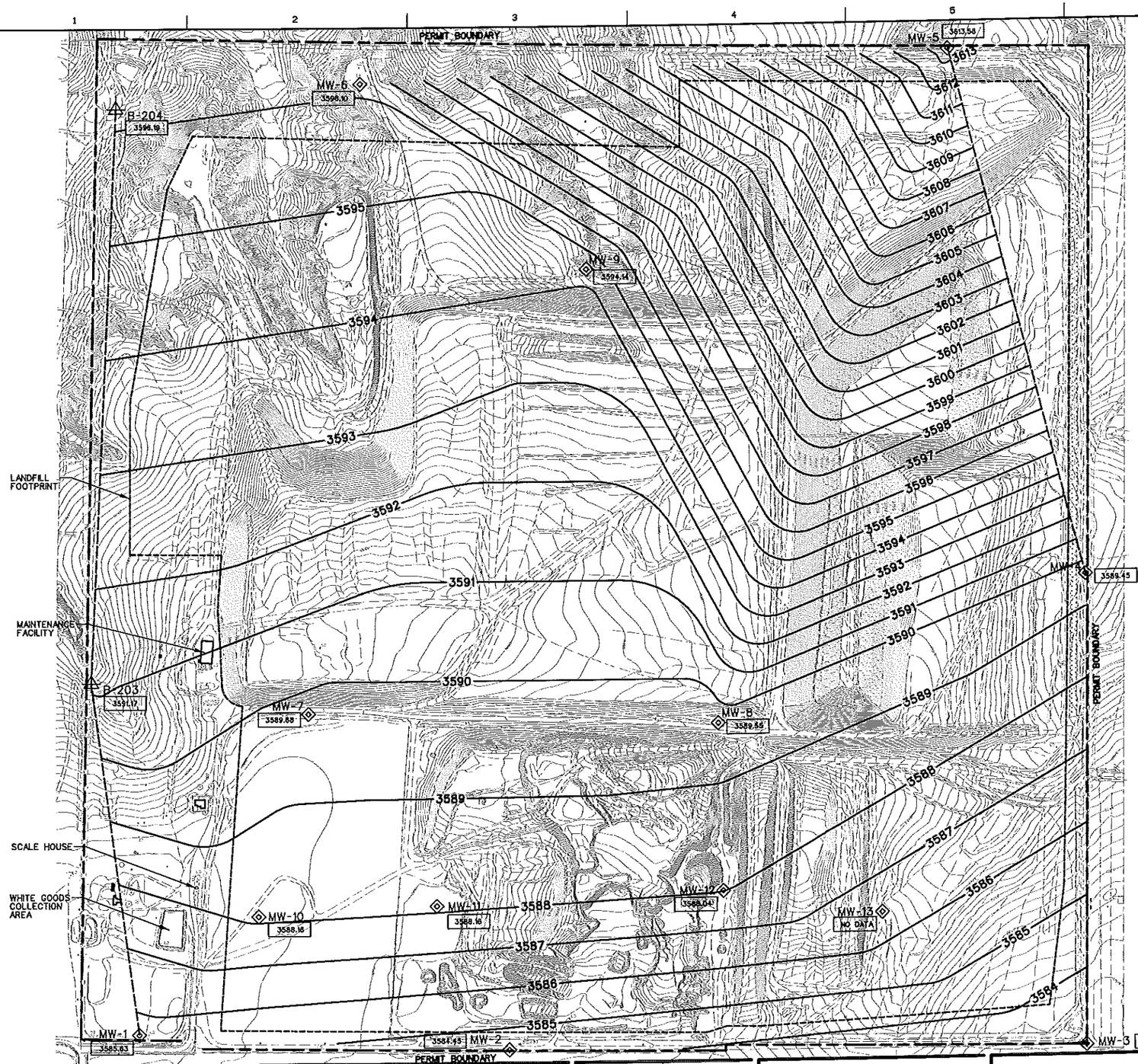

N

0 300 600

SCALE IN FEET

LEGEND

- PERMIT BOUNDARY
- 350 EXISTING CONTOURS
- LANDFILL FOOTPRINT
- 3605 GROUNDWATER CONTOURS
- MW-4 3615.26 EXISTING MONITORING WELL LOCATIONS AND ELEVATIONS
- B-204 3615.26 2005 BORING LOCATIONS WITH PIEZOMETER AND ELEVATIONS

NOTES

1. FOR TOPOGRAPHIC INFO SEE FIGURE II.1.1.
2. TOPOGRAPHIC MAP WAS COMPILED BY PHOTOGRAMMETRIC METHODS BY STEWART GEO TECHNOLOGIES, SAN ANTONIO, TEXAS FROM AERIAL PHOTOGRAPHY DATED APRIL 7, 2005. VERTICAL DATUM BASED ON NGVD 29. MAPPING GROUND CONTROL PROVIDED BY THE CITY OF AMARILLO, COMPLETED IN ACCORDANCE WITH NATIONAL MAP ACCURACY STANDARDS.

STATE OF TEXAS
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7-15-09

STATE OF TEXAS
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PROFESSIONAL ENGINEER
7-15-09

CITY OF AMARILLO
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TEXAS P.E. FIRM
REGISTRATION NO. F-754

ISSUE	DATE	DESCRIPTION
1	7/2009	ISSUED FOR TCEQ REVIEW

PROJECT MANAGER	M. ODEN
CIVIL ENGINEER	M. ODEN
CHECKED BY	M. ODEN
DESIGNED	
DRAWN BY	
QA/QC	M. ODEN
PROJECT NUMBER	82070

CITY OF AMARILLO LANDFILL
MSW PERMIT NO. 73A
POTTER COUNTY, TEXAS

GROUNDWATER CONTOUR MAP
NOVEMBER 19, 2008

FILENAME
SCALE

SHEET
Plate 22
App. 5B

USER: RCOX
FILE: ...\DMS15903\AM_GWC_11-19-08.DGN
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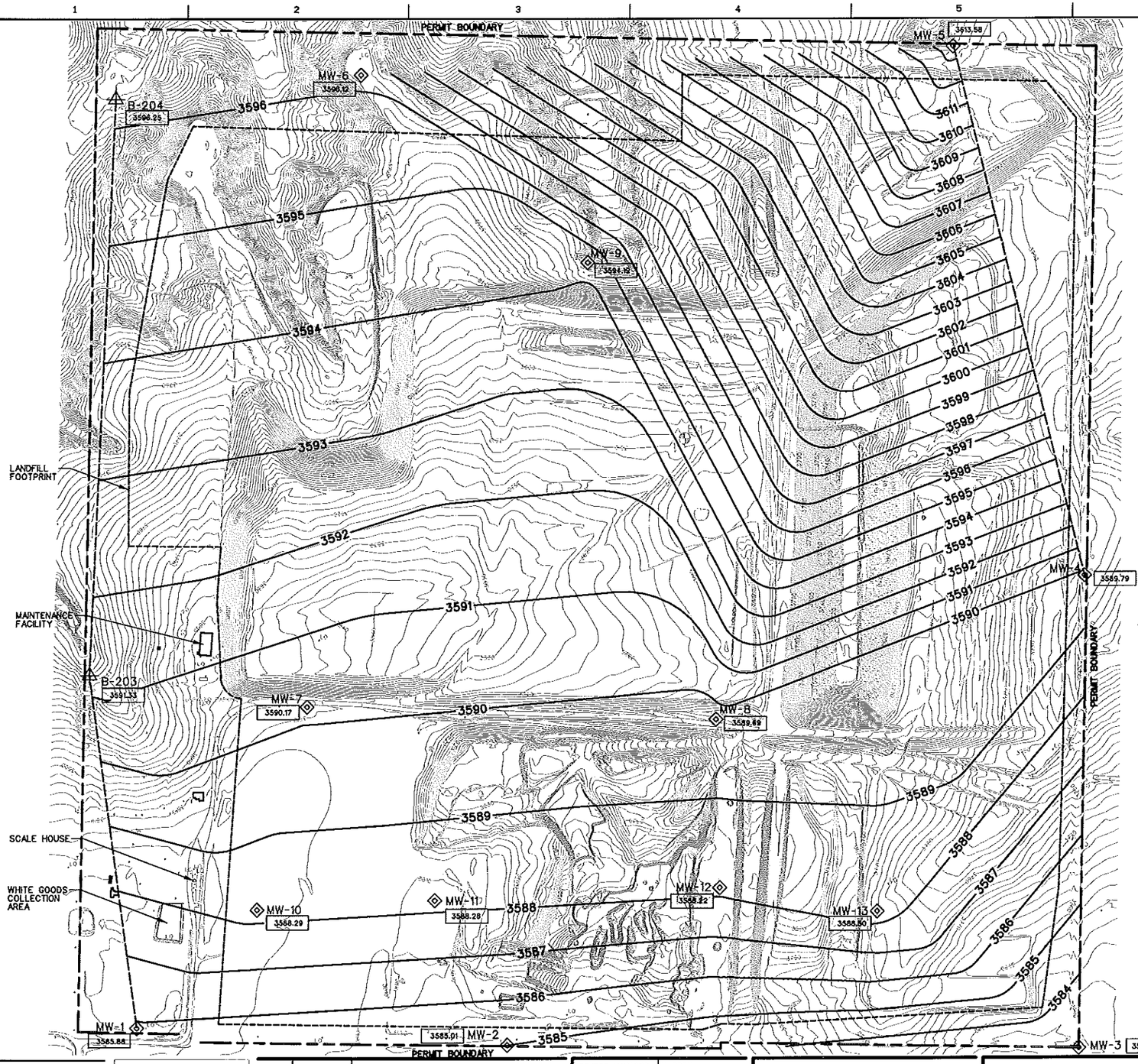

N

0 300 600

SCALE IN FEET

LEGEND

- PERMIT BOUNDARY
- EXISTING CONTOURS
- LANDFILL FOOTPRINT
- 3605 GROUNDWATER CONTOURS
- MW-4 3615.28 EXISTING MONITORING WELL LOCATIONS AND ELEVATIONS
- B-204 3615.28 2005 BORING LOCATIONS WITH PIEZOMETER AND ELEVATIONS

STATE OF TEXAS
DONALD D. JAMES
GEOLOGY
360
LICENSED
PROFESSIONAL GEOSCIENTIST
7-15-09

STATE OF TEXAS
M. M. SHIFLETT
43763
LICENSED
PROFESSIONAL ENGINEER
7-15-09

NOTES

1. FOR TOPOGRAPHIC INFO SEE FIGURE III.1.1.
2. TOPOGRAPHIC MAP WAS COMPILED BY PHOTOGRAMMETRIC METHODS BY STEWART GEO TECHNOLOGIES, SAN ANTONIO, TEXAS FROM AERIAL PHOTOGRAPHY DATED APRIL 7, 2005. VERTICAL DATUM BASED ON NGVD 29. MAPPING GROUND CONTROL PROVIDED BY THE CITY OF AMARILLO, COMPLETED IN ACCORDANCE WITH NATIONAL MAP ACCURACY STANDARDS.

CITY OF AMARILLO TEXAS

HDR

HDR ENGINEERING, INC.
4500 W. Eldorado Pkwy.
Suite 3500
McKinney, Texas 75070

TEXAS P.E. FIRM REGISTRATION NO. F-754

ISSUE	DATE	DESCRIPTION
1	7/2009	ISSUED FOR TCEQ REVIEW

PROJECT MANAGER	M. ODEN
CIVIL ENGINEER	M. ODEN
CHECKED BY	M. ODEN
DESIGNED	
DRAWN BY	
QA/QC	M. ODEN
PROJECT NUMBER	82070

CITY OF AMARILLO LANDFILL
MSW PERMIT NO. 73A
POTTER COUNTY, TEXAS

GROUNDWATER CONTOUR MAP JANUARY 12, 2009

FILENAME
SCALE

SHEET
Plate 23
App. 5B

USER: RCOX
FILE: ...\DMS15903\AM_GWC_1-12-09.DGN
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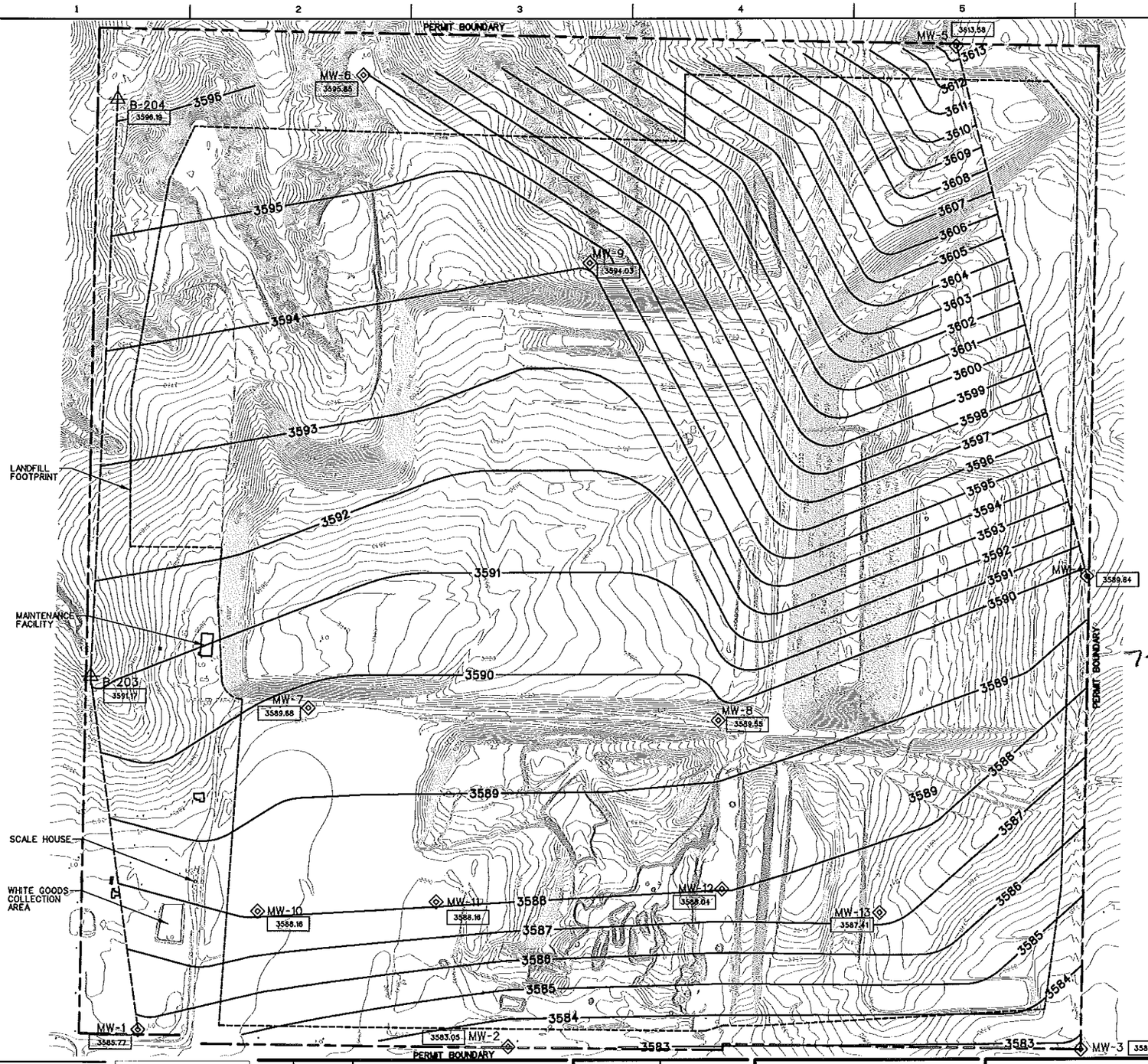

N

0 300 600

SCALE IN FEET

LEGEND

- PERMIT BOUNDARY
- EXISTING CONTOURS
- LANDFILL FOOTPRINT
- 3605 GROUNDWATER CONTOURS
- MW-4 3615.26 EXISTING MONITORING WELL LOCATIONS AND ELEVATIONS
- B-204 3615.26 2005 BORING LOCATIONS WITH PIEZOMETER AND ELEVATIONS

NOTES

1. FOR TOPOGRAPHIC INFO SEE FIGURE III.1.1.
2. TOPOGRAPHIC MAP WAS COMPILED BY PHOTOGRAMMETRIC METHODS BY STEWART GEO TECHNOLOGIES, SAN ANTONIO, TEXAS FROM AERIAL PHOTOGRAPHY DATED APRIL 7, 2005. VERTICAL DATUM BASED ON NGVD 29. MAPPING GROUND CONTROL PROVIDED BY THE CITY OF AMARILLO, COMPLETED IN ACCORDANCE WITH NATIONAL MAP ACCURACY STANDARDS.

STATE OF TEXAS
DONALD D. JAMES
GEOLOGY
360
LICENSED
PROFESSIONAL GEOSCIENTIST

7-15-09

STATE OF TEXAS
M. M. SHIFLETT
43763
LICENSED
PROFESSIONAL ENGINEER

7-15-09

CITY OF AMARILLO TEXAS

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Suite 3500
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TEXAS P.E. FIRM
REGISTRATION NO. F-754

ISSUE	DATE	DESCRIPTION
1	7/2009	ISSUED FOR TCEQ REVIEW

PROJECT MANAGER	M. ODEN
CIVIL ENGINEER	M. ODEN
CHECKED BY	M. ODEN
DESIGNED	
DRAWN BY	
QA/QC	M. ODEN
PROJECT NUMBER	82070

CITY OF AMARILLO LANDFILL
MSW PERMIT NO. 73A
POTTER COUNTY, TEXAS

GROUNDWATER CONTOUR MAP
APRIL 13, 2009

FILENAME

SCALE

SHEET
Plate 24
App. 5B

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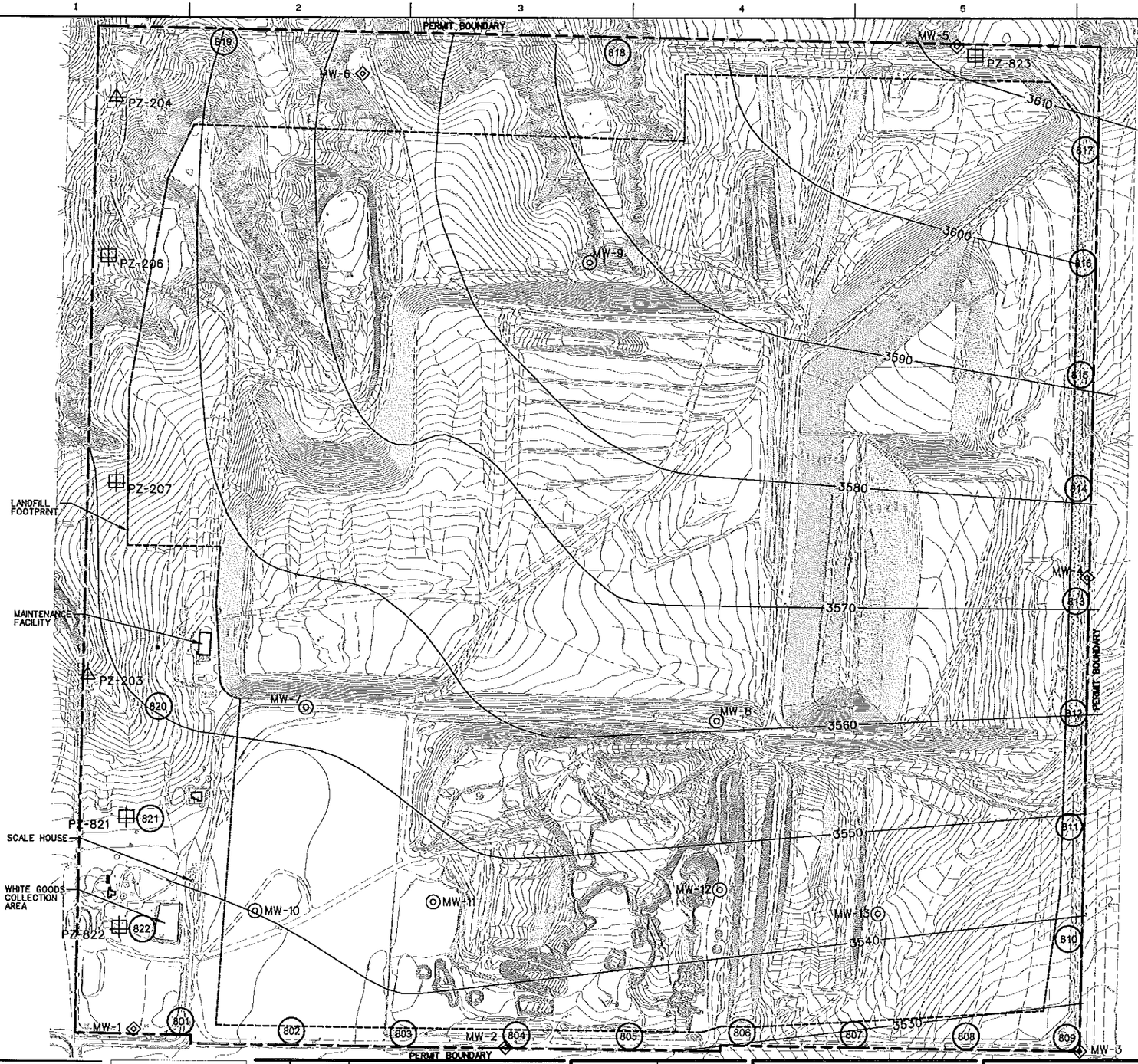


N

0 300 600

SCALE IN FEET

LEGEND

- PERMIT BOUNDARY
- EXISTING CONTOURS
- LANDFILL FOOTPRINT
- 3605 — STRUCTURAL CONTOURS
- MW-4 — EXISTING MONITORING WELL LOCATIONS TO BE PLUGGED AND ABANDONED UPON COMPLETION OF BACKGROUND MONITORING OF THE ADDITIONAL WELLS
- MW-7 — EXISTING MONITORING WELL LOCATIONS TO BE PLUGGED AND ABANDONED AS CONSTRUCTION ACTIVITY DICTATES.
- PZ-203 — EXISTING PIEZOMETERS
- 822 — ADDITIONAL MONITORING WELL LOCATIONS
- PZ-204 — PROPOSED PIEZOMETER (4")

STATE OF TEXAS
DONALD D. JAMES
GEOLOGY
360
LICENSED
PROFESSIONAL GEOSCIENTIST

2-15-09

STATE OF TEXAS
M. M. SHIFLETT
43763
LICENSED
PROFESSIONAL ENGINEER

1-15-09

NOTES

1. FOR TOPOGRAPHIC INFO SEE FIGURE III.1.1.
2. TOPOGRAPHIC MAP WAS COMPILED BY PHOTOGRAMMETRIC METHODS BY STEWART GEO TECHNOLOGIES, SAN ANTONIO, TEXAS FROM AERIAL PHOTOGRAPHY DATED APRIL 7, 2005. VERTICAL DATUM BASED ON NGVD 29. MAPPING GROUND CONTROL PROVIDED BY THE CITY OF AMARILLO, COMPLETED IN ACCORDANCE WITH NATIONAL MAP ACCURACY STANDARDS.
3. TOP OF TRIASSIC DOCKUM OBTAINED FROM SIX ON SITE WELLS, PZ-204, TB-2, MW-5, PZ-203, MW-10, TB-1, AND TWO OFFSITE WATER WELLS, STATE WELL 73002 AND 89620.
4. WELLS 820, 821 AND 822 TO BE INSTALLED ONCE CELL 12 IS DEVELOPED (PRIOR TO WASTE PLACEMENT). INSTALL PZ-821 AND PZ-822 ALONG WITH WELLS 801 - 819.

CITY OF AMARILLO TEXAS

HDR

HDR ENGINEERING, INC.
4500 W. Eldorado Pkwy.
Suite 3500
McKinney, Texas 75070

TEXAS P.E. FIRM
REGISTRATION NO. F-754

ISSUE	DATE	DESCRIPTION
3	7/2009	REVISED MONITOR WELL LOCATIONS
2	3/2009	REVISED MONITOR WELL LOCATIONS
1	8/2008	REVISED MONITOR WELL NETWORK

PROJECT MANAGER	M. ODEN
CIVIL ENGINEER	M. ODEN
CHECKED BY	M. ODEN
DESIGNED	
DRAWN BY	
QA/QC	M. ODEN
PROJECT NUMBER	82070

CITY OF AMARILLO LANDFILL
MSW PERMIT NO. 73A
POTTER COUNTY, TEXAS

STRUCTURAL CONTOUR MAP
TOP OF TRIASSIC DOCKUM

0 1" 2"

FILENAME
SCALE

SHEET
Plate 25
App. 5B

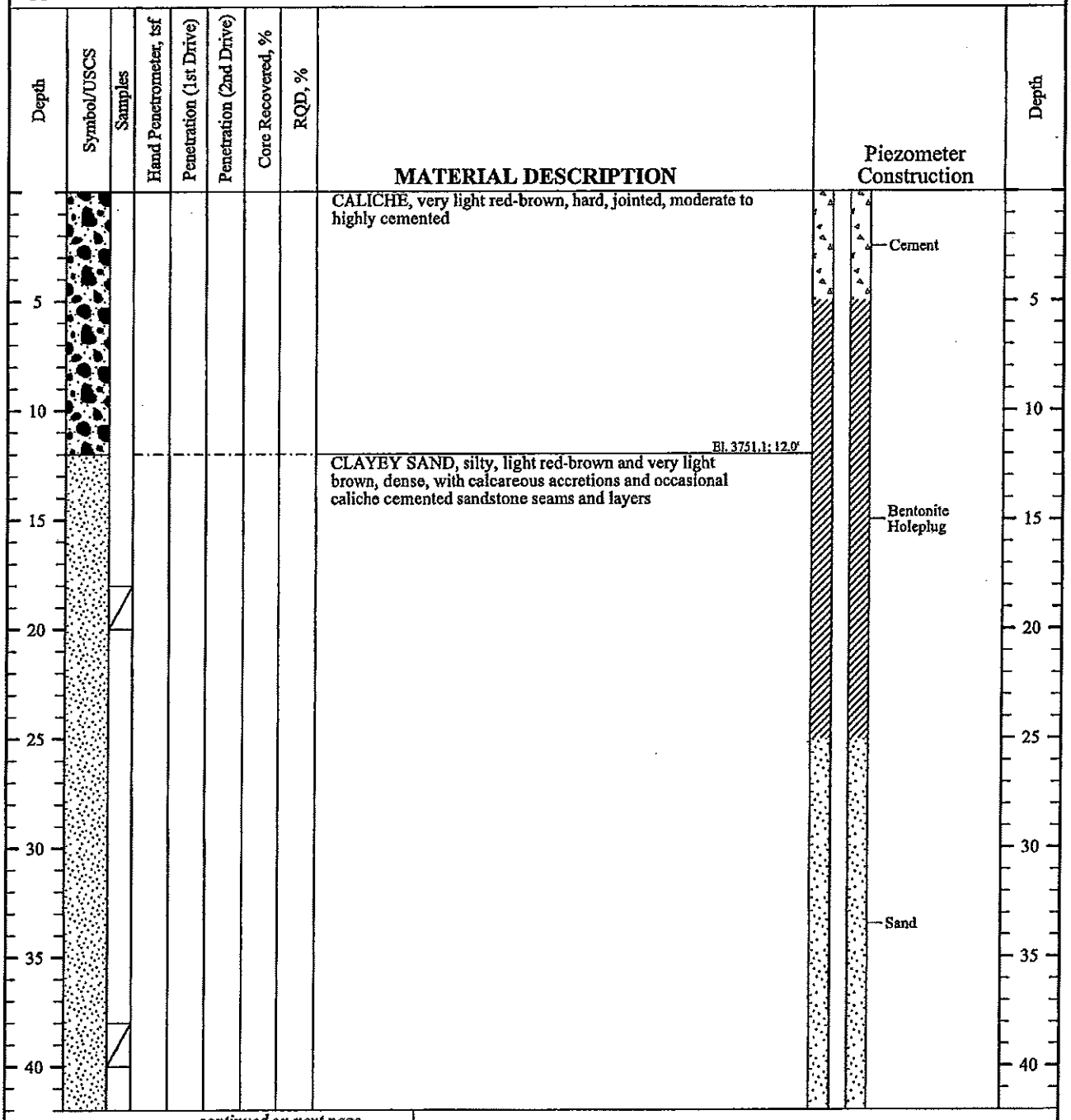
USER: RCOX
FILE: ...\DMS15903\AMIII05_PLATE6D.DGN
DATE: 7/9/2009
TIME: 4:34:41 PM

2005 Kleinfelder
Logs of Borings

B-203 and B-204

LOG OF BORING NO. B-203

Project Description: **Amarillo Municipal Landfill - Potter County, Texas**
Location: See Plan of Borings, Plate 1 Appendix 4C
Approx. Surface Elevation: 3763'



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Completion Depth: 220 ft.
Date Boring Started: 9/7/05
Date Boring Completed: 9/7/05
Logged by: D. James
Project No.: 57815

Remarks: Boring dry upon completion. Water at 169.1 feet, 20 hours after completion of drilling and sampling.

KLEINFELDER

LOG OF BORING NO. B-203 (cont'd)

Project Description: **Amarillo Municipal Landfill - Potter County, Texas**
Location: See Plan of Borings, Plate 1 Appendix 4C
Approx. Surface Elevation: 3763'

Depth	Symbol/USCS	Samples	Hand Penetrometer, tsf	Penetration (1st Drive)	Penetration (2nd Drive)	Core Recovered, %	RQD, %	MATERIAL DESCRIPTION	Piezometer Construction	Depth
45								CLAYEY SAND, silty, light red-brown and very light brown, dense, with calcareous accretions and occasional caliche cemented sandstone seams and layers		45
50										50
55									Sand	55
60										60
65										65
70										70
75										75
80									2-in PVC	80

continued on next page

Completion Depth: 220 ft.
Date Boring Started: 9/7/05
Date Boring Completed: 9/7/05
Logged by: D. James
Project No.: 57815

Remarks: Boring dry upon completion. Water at 169.1 feet, 20 hours after completion of drilling and sampling.

KLEINFELDER

LOG OF BORING NO. B-203 (cont'd)

Project Description: **Amarillo Municipal Landfill - Potter County, Texas**
Location: See Plan of Borings, Plate 1 Appendix 4C
Approx. Surface Elevation: 3763'

Depth	Symbol/USCS	Samples	Hand Penetrometer, tsf	Penetration (1st Drive)	Penetration (2nd Drive)	Core Recovered, %	RQD, %	MATERIAL DESCRIPTION	Piezometer Construction	Depth
85								CLAYEY SAND, silty, light red-brown and very light brown, dense, with calcareous accretions and occasional caliche cemented sandstone seams and layers		85
90									2-in PVC	90
95										95
100										100
105										105
110									Sand	110
115										115
120										120
125										125

continued on next page

Completion Depth: 220 ft.
Date Boring Started: 9/7/05
Date Boring Completed: 9/7/05
Logged by: D. James
Project No.: 57815

Remarks: Boring dry upon completion. Water at 169.1 feet, 20 hours after completion of drilling and sampling.

KLEINFELDER

LOG OF BORING NO. B-203 (cont'd)

Project Description: **Amarillo Municipal Landfill - Potter County, Texas**
Location: See Plan of Borings, Plate 1 Appendix 4C
Approx. Surface Elevation: 3763'

Depth	Symbol/USCS	Samples	Hand Penetrometer, tsf	Penetration (1st Drive)	Penetration (2nd Drive)	Core Recovered, %	RQD, %	MATERIAL DESCRIPTION	Piezometer Construction	Depth
130								CLAYEY SAND, silty, light red-brown and very light brown, dense, with calcareous accretions and occasional caliche cemented sandstone seams and layers		130
135										135
140									Sand	140
145										145
150										150
155								- moderate to highly cemented from 155 to 162 feet		155
160								- coarse to medium, subrounded, frosted, gap graded to well graded, yellow-brown, less cemented to non-cemented below 162 feet	Screen	160
165										165

continued on next page

Completion Depth: 220 ft.
Date Boring Started: 9/7/05
Date Boring Completed: 9/7/05
Logged by: D. James
Project No.: 57815

Remarks: Boring dry upon completion. Water at 169.1 feet, 20 hours after completion of drilling and sampling.

KLEINFELDER

LOG OF BORING NO. B-203 (cont'd)

Project Description: **Amarillo Municipal Landfill - Potter County, Texas**
Location: See Plan of Borings, Plate 1 Appendix 4C
Approx. Surface Elevation: 3763'

Depth	Symbol/USCS	Samples	Hand Penetrometer, tsf	Penetration (1st Drive)	Penetration (2nd Drive)	Core Recovered, %	RQD, %	MATERIAL DESCRIPTION	Piezometer Construction	Depth
170								CLAYEY SAND, silty, light red-brown and very light brown, dense, with calcareous accretions and occasional caliche cemented sandstone seams and layers		170
175										175
180										180
185										185
190									Screen	190
195										195
200										200
205										205
210								- with occasional fine rounded gravel below 212 feet		210

continued on next page

Completion Depth: 220 ft.
Date Boring Started: 9/7/05
Date Boring Completed: 9/7/05
Logged by: D. James
Project No.: 57815

Remarks: Boring dry upon completion. Water at 169.1 feet, 20 hours after completion of drilling and sampling.

KLEINFELDER

LOG OF BORING NO. B-203 (cont'd)

Project Description: **Amarillo Municipal Landfill - Potter County, Texas**
Location: See Plan of Borings, Plate 1 Appendix 4C
Approx. Surface Elevation: 3763'

Depth	Symbol/USCS	Samples	Hand Penetrometer, tsf	Penetration (1st Drive)	Penetration (2nd Drive)	Core Recovered, %	RQD, %	MATERIAL DESCRIPTION	Piezometer Construction	Depth
								CLAYEY SAND, silty, light red-brown and very light brown, dense, with calcareous accretions and occasional caliche cemented sandstone seams and layers		
								El. 3549.1; 214.0'		
215								SHALE, red-brown and light green-gray, very stiff to hard, weathered	Screen	215
								El. 3543.1; 220.0'		
220										220

Completion Depth: 220 ft.
Date Boring Started: 9/7/05
Date Boring Completed: 9/7/05
Logged by: D. James
Project No.: 57815

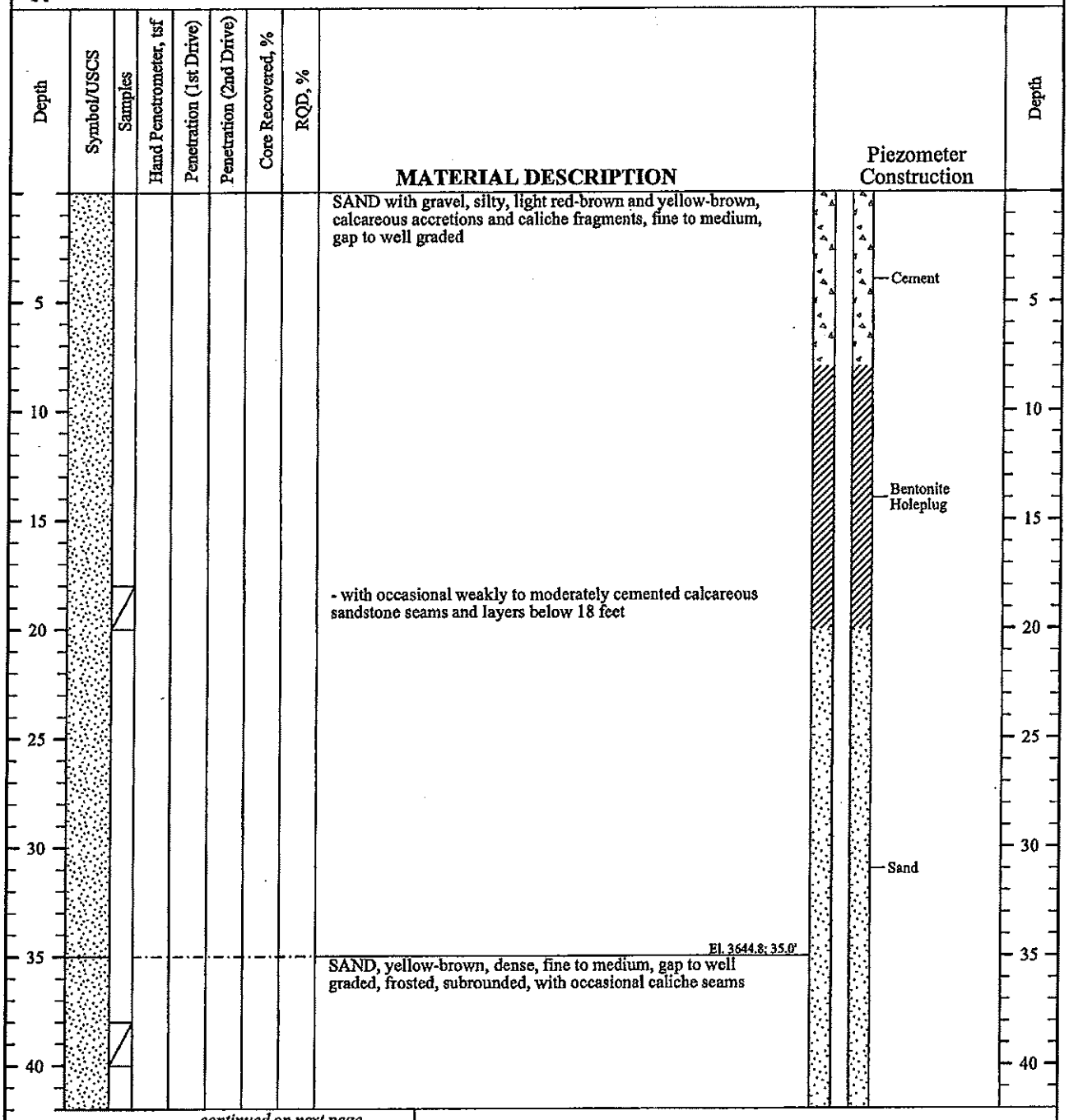
Remarks: Boring dry upon completion. Water at 169.1 feet, 20 hours after completion of drilling and sampling.

KLEINFELDER

Stratification lines represent approximate strata boundaries, as in-situ the transitions may be gradual. This Log of Boring is not intended for bidding or estimating purposes. Boring log(s) should not be reproduced separately from the engineering report unless said report is specifically included by reference.

LOG OF BORING NO. B-204

Project Description: **Amarillo Municipal Landfill - Potter County, Texas**
Location: See Plan of Borings, Plate 1 Appendix 4C
Approx. Surface Elevation: 3680'



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Completion Depth: 135 ft.
Date Boring Started: 9/8/05
Date Boring Completed: 9/8/05
Logged by: D. James
Project No.: 57815

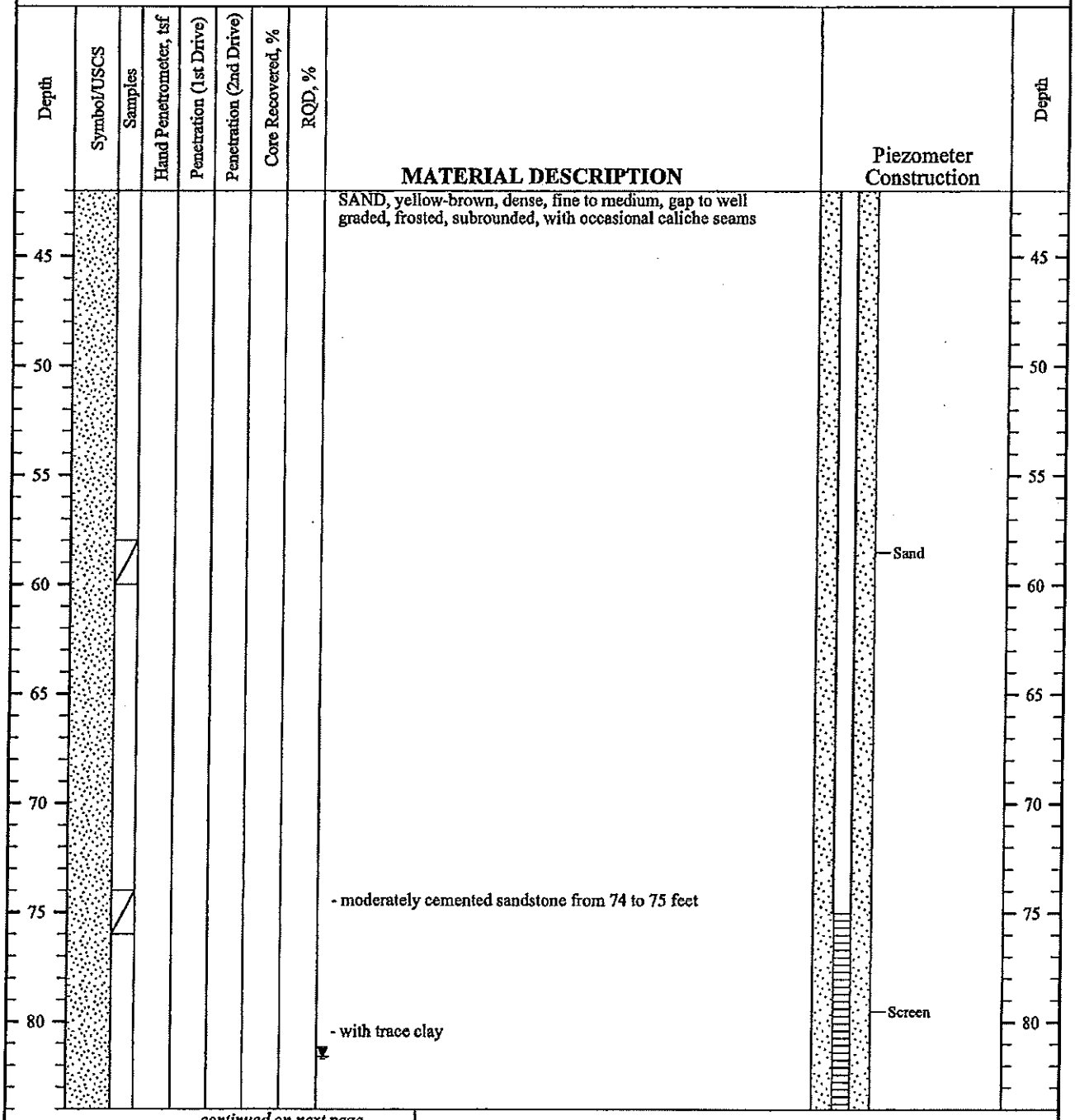
Remarks: Boring dry upon completion. Water at 81.6 feet, 1 hour after completion of drilling and sampling.

KLEINFELDER

Stratification lines represent approximate strata boundaries, as in-situ the transitions may be gradual. This Log of Boring is not intended for bidding or estimating purposes. Boring log(s) should not be reproduced separately from the engineering report unless said report is specifically included by reference.

LOG OF BORING NO. B-204 (cont'd)

Project Description: **Amarillo Municipal Landfill - Potter County, Texas**
Location: See Plan of Borings, Plate 1 Appendix 4C
Approx. Surface Elevation: 3680'



continued on next page

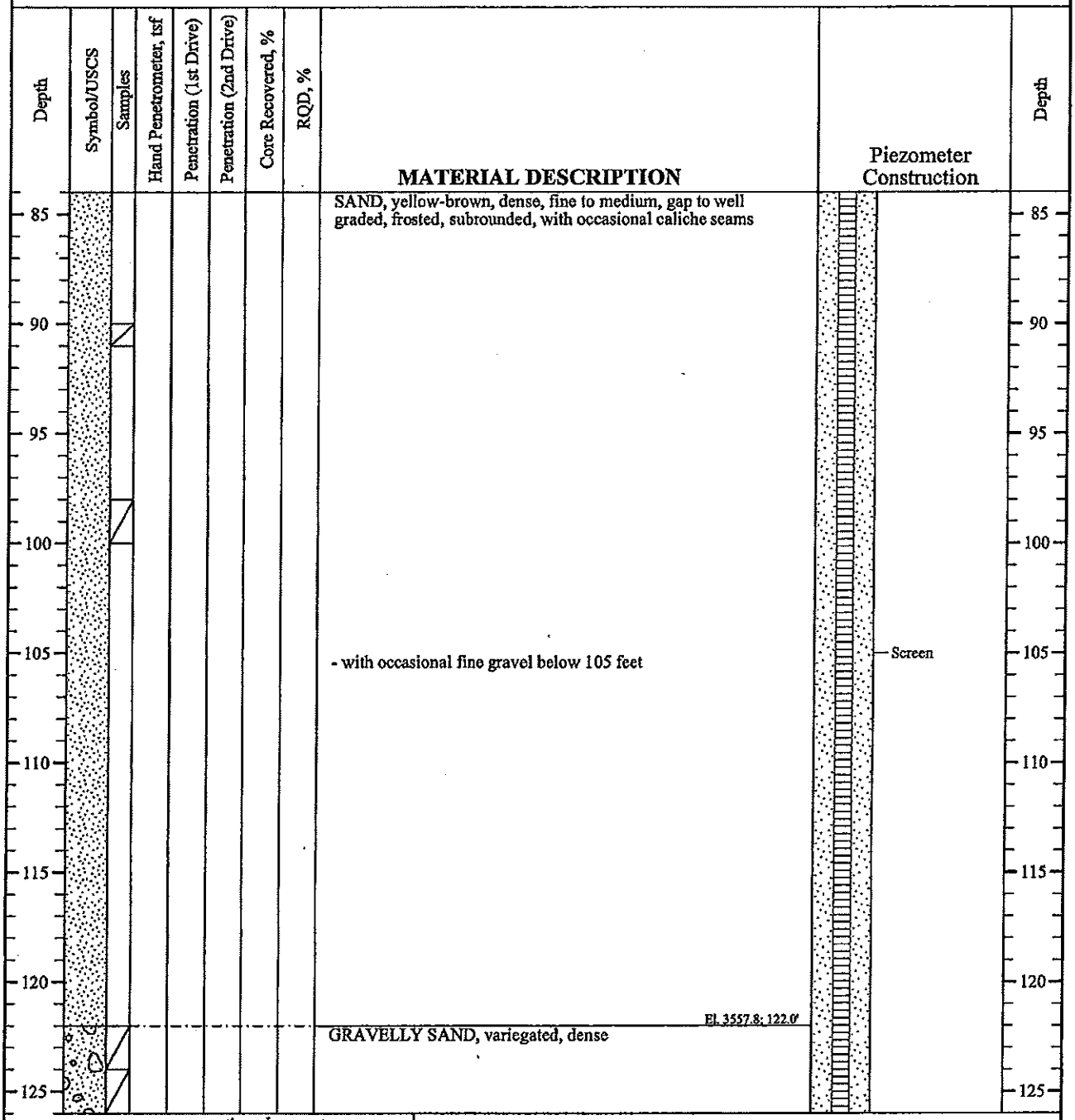
Completion Depth: 135 ft.
Date Boring Started: 9/8/05
Date Boring Completed: 9/8/05
Logged by: D. James
Project No.: 57815

Remarks: Boring dry upon completion. Water at 81.6 feet, 1 hour after completion of drilling and sampling.

KLEINFELDER

LOG OF BORING NO. B-204 (cont'd)

Project Description: **Amarillo Municipal Landfill - Potter County, Texas**
Location: See Plan of Borings, Plate 1 Appendix 4C
Approx. Surface Elevation: 3680'



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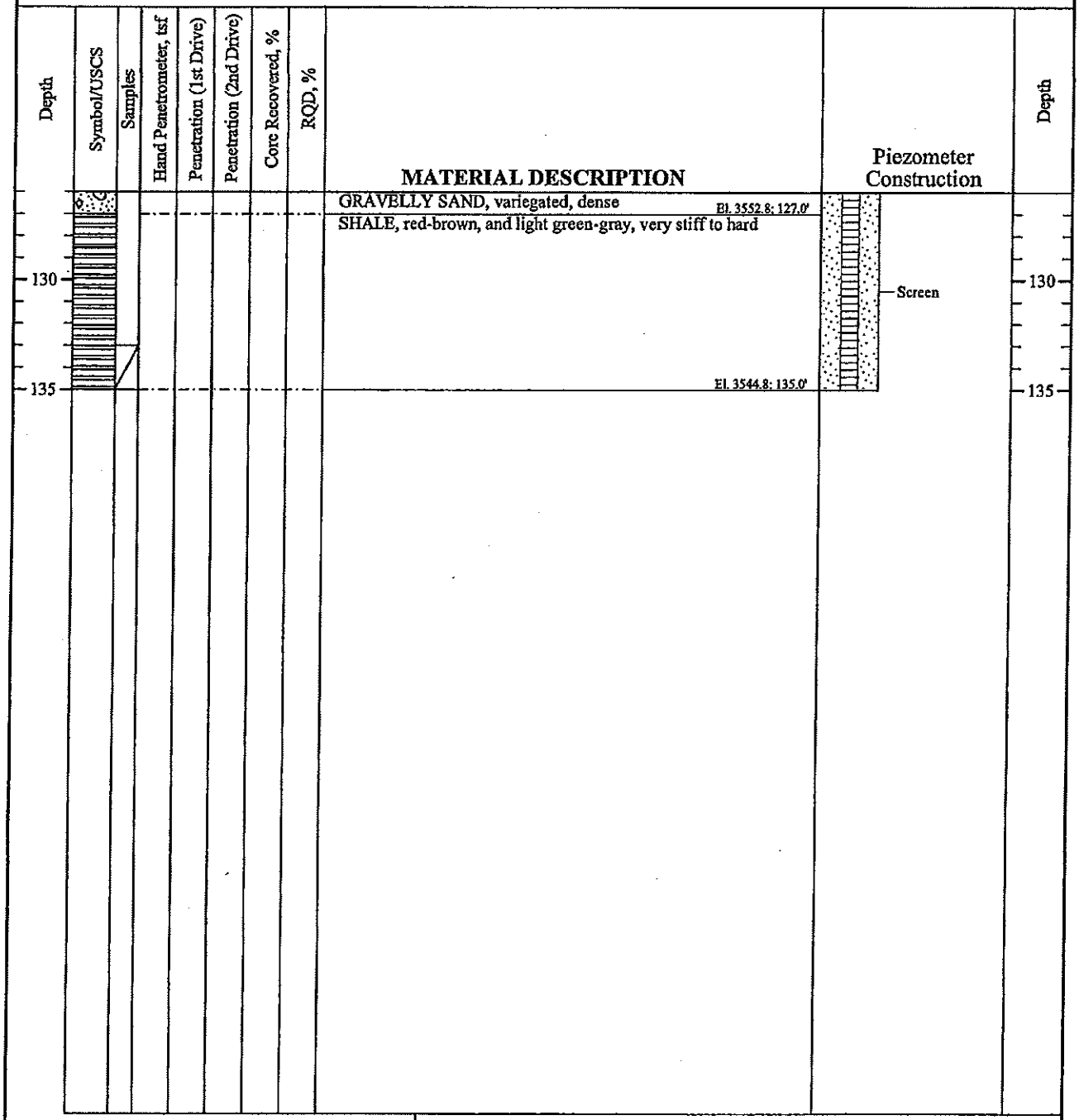
Completion Depth: 135 ft.
Date Boring Started: 9/8/05
Date Boring Completed: 9/8/05
Logged by: D. James
Project No.: 57815

Remarks: Boring dry upon completion. Water at 81.6 feet, 1 hour after completion of drilling and sampling.

KLEINFELDER

LOG OF BORING NO. B-204 (cont'd)

Project Description: **Amarillo Municipal Landfill - Potter County, Texas**
Location: See Plan of Borings, Plate 1 Appendix 4C
Approx. Surface Elevation: 3680'



Completion Depth:	135 ft.
Date Boring Started:	9/8/05
Date Boring Completed:	9/8/05
Logged by:	D. James
Project No.:	57815

Remarks: Boring dry upon completion. Water at 81.6 feet, 1 hour after completion of drilling and sampling.

KLEINFELDER

Stratification lines represent approximate strata boundaries, as in-situ the transitions may be gradual. This Log of Boring is not intended for bidding or estimating purposes. Boring log(s) should not be reproduced separately from the engineering report unless said report is specifically included by reference.

1994 – Dyess - Peterson Testing Laboratory, Inc.
Log of Boring

MW-1

A. Monitor Well Data Sheet

Texas Water Commission
Municipal Solid Waste Division
SE 67

Permittee or Site Name: City of Amarillo MSWLF

County: Potter

Date of Monitor Well Installation: 8-9-94

Monitor Well: Latitude: N35° 13'16" Longitude: W102° 01'35"

Monitor Well Groundwater Gradient: Upgradient ___ Downgradient XX

TDH Permit No.: 73

Monitor Well I.D. No.: MW-1

Date of Monitor Well Development: 8-10-94

Monitor Well Driller Name: Lee Peterson

License No.: 3045M

NOTE:

(A) The information shown in the sketch below should be considered the minimum required for an installed ground-water monitor well.
(B) Report All Depths from Surface Elevation and all Elevations relative to Mean Sea Level.
(C) The minimun distance between the inside wall of the Bore Hole and the outside of the Well Casing shall be 3".
(D) Use Flush Screw Joint Casing only, 2" diameter or larger. Recommend 4" diameter minimum & Teflon Taping Casing Joints.
(E) Well development should continue until water is clear, and pH and conductivity are stable.

Geologist, Hydrologist or Engineer Supervising Well Installation: Ray Hamby

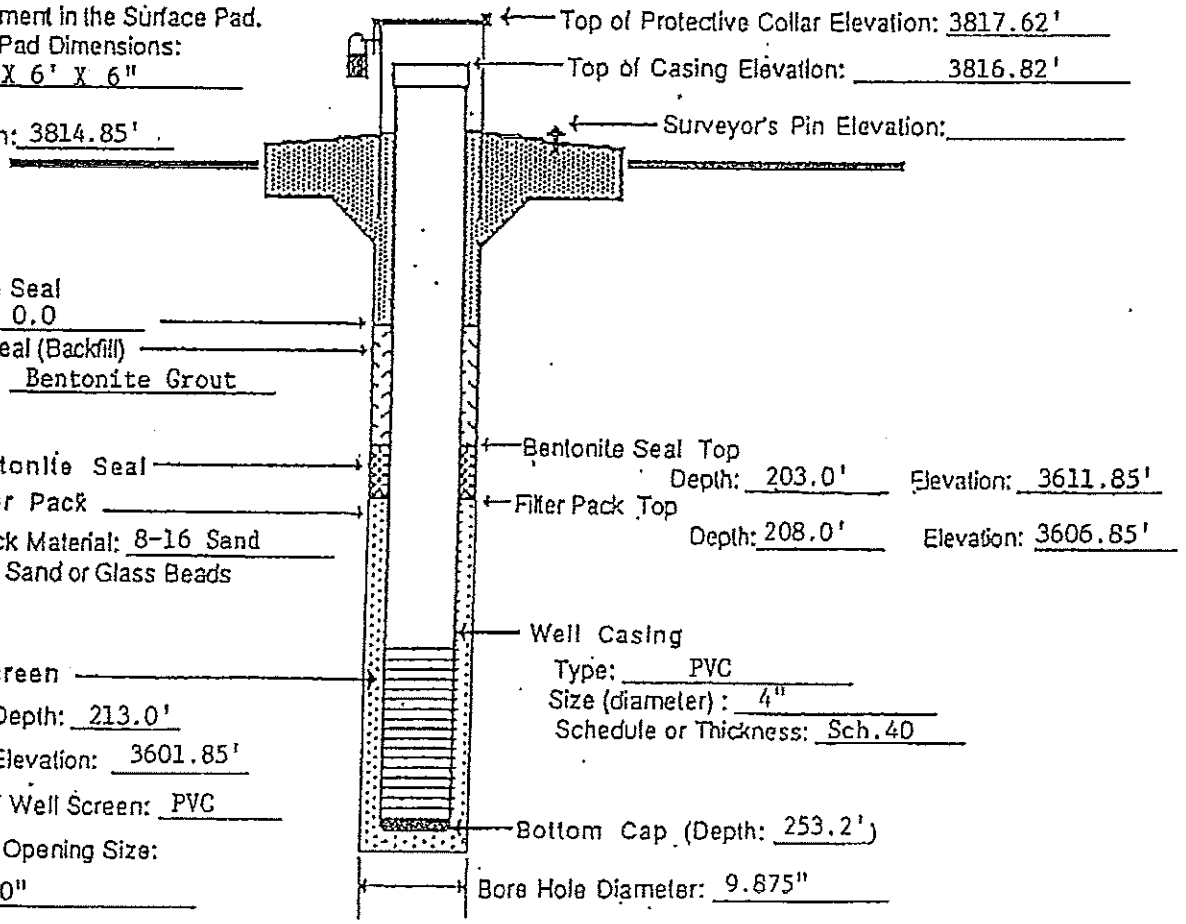
Static Water Level Elevation (with respect to MSL) after Well Development: 3588.30'

Name of Geologic Formation(s) in which Well is completed: Ogallala

Type of Locking Device: Padlock

Type of Casing Protection: Upright Well Protector

Concrete Surface Pad - Recommend steel reinforcement in the Surface Pad.
Surface Pad Dimensions: 6' X 6' X 6"
Surface Elevation: 3814.85'



Top of Protective Collar Elevation: 3817.62'

Top of Casing Elevation: 3816.82'

Surveyor's Pin Elevation: ___

Concrete Seal
Depth: 0.0
Casing Seal (Backfill)
Material: Bentonite Grout

Bentonite Seal

Bentonite Seal Top
Depth: 203.0' Elevation: 3611.85'

Filter Pack

Filter Pack Top
Depth: 208.0' Elevation: 3606.85'

Filter Pack Material: 8-16 Sand
Sterilized Sand or Glass Beads

Well Casing
Type: PVC
Size (diameter): 4"
Schedule or Thickness: Sch.40

Well Screen
Top Depth: 213.0'
Top Elevation: 3601.85'
Type of Well Screen: PVC
Screen Opening Size: 0.020"

Bottom Cap (Depth: 253.2')

Bore Hole Diameter: 9.875"

LOG OF BORING

PROJECT: Amarillo MSWLF
CLIENT: City of Amarillo

BORING NO.: MW-1
LOCATION: Amarillo, Texas

Date: 8-4-94 thru 8-9-94

Ground Elevation: 3814.85'

DRILLING METHOD: Air/Mud Rotary

GROUNDWATER INFORMATION: Air drilled to 125' Groundwater encountered at 225'

DEPTH, FEET	SYMBOL	SAMPLE	DESCRIPTION OF STRATUM	SPT BLOWS / FT PENETROMETER TSF	MOISTURE CONTENT, %	DRY DENSITY, PCF	LIQUID LIMIT, LL	PLASTIC LIMIT, PL	PLASTICITY INDEX, PI	UNCONFINED COMPRESSIVE STRENGTH, TSF	% PASSING NO. 200 SIEVE
0			Sandy Clay: Dark Brown, Stiff, Dry (CL)		13.1		34	13	21		94.1
5		X	Sandy Clay: Reddish Tan w/Calcareous Nodules (8%) Stiff, Dry (CL)	4-6"	9.9		26	15	11		84.6
				14-12"							
				38-18"							
10		X		7.6"	8.8		29	13	16		90.7
				16-12"							
				27-18"							
15		X		18-6"	10.1		34	13	21		88.9
				41-12"							
				50-13"							
20		X		23-6"	9.9		35	20	15		87.7
				50-12"							
25		X	Sandy Clay: Reddish Tan w/Calcareous Nodules (8%) Stiff, Dry (CL)	15-6"	9.6		26	15	11		92.1
				35-12"							
				50-16"							
30		X	Continued on Page 2								

LOG OF BORING

PROJECT: Amarillo MSWLF
CLIENT: City of Amarillo

BORING NO.: MW-1
LOCATION: Amarillo, Texas

Date: 8-4-94 thru 8-9-94

Ground Elevation: 3814.85'

DRILLING METHOD: Air/Mud Rotary

GROUNDWATER INFORMATION: Air drilled to 125' Groundwater encountered at 225'

DEPTH, FEET	SYMBOL	SAMPLE	DESCRIPTION OF STRATUM	SPT BLOWS / FT PENETROMETER TSF	MOISTURE CONTENT, %	DRY DENSITY, PCF	LIQUID LIMIT, LL	PLASTIC LIMIT, PL	PLASTICITY INDEX, PI	UNCONFINED COMPRESSIVE STRENGTH, TSF	% PASSING NO. 200 SIEVE
30		X		16-6"	8.3		32	22	10		80.6
				36-12"							
				50-17"							
35		X		15-6"	9.1		33	24	9		81.4
				33-12"							
				50-15.5"							
40		X		12-6"	8.7		32	20	12		77.9
				30-12"							
				50-17"							
45		X		21-6"	7.1		33	21	12		76.1
				50-11.5"							
50		X		15-6"	8.4		34	23	11		77.8
				36-12"							
				50-15"							
55		X		18-6"	8.7		26	17	9		66.8
				45-12"							
				50-13"							
60		X									

Continued on Page 3

LOG OF BORING

PROJECT: Amarillo MSWLF
CLIENT: City of Amarillo
BORING NO.: MW-1
LOCATION: Amarillo, Texas
Date: 8-4-94 thru 8-9-94
Ground Elevation: 3814.85'

DRILLING METHOD: Air/Mud Rotary
GROUNDWATER INFORMATION: Air drilled to 125' Groundwater encountered at 225'

DEPTH, FEET	SYMBOL	SAMPLE	DESCRIPTION OF STRATUM	SPT BLOWS/FT PENETROMETER TSF	MOISTURE CONTENT, %	DRY DENSITY, PCF	LIQUID LIMIT, LL	PLASTIC LIMIT, PL	PLASTICITY INDEX, PI	UNCONFINED COMPRESSIVE STRENGTH, TSF	% PASSING NO. 200 SIEVE
60				50-2"	7.4		19	14	5		21.5
65			Sandy Clay: Light Tan, Caliche, Stiff, Dry (CL)	40-6"	6.8		21	15	6		55.1
				50-7.5"							
70			Caliche: Light Tan, Limestone, Fractures, Hard (CL)	29-6"	5.1		23	18	5		50.9
75				28-6"	4.5		19	16	3		20.9
				50-10.5"							
80			Sandy Clay: Light Tan, Caliche (CL)	33-6"	3.7		21	17	4		41.1
				50-7"							
85				50-3"	3.2		21	17	4		29.1
90			Continued on Page 4								

LOG OF BORING

PROJECT: Amarillo MSWLF
CLIENT: City of Amarillo
BORING NO.: MW-1
LOCATION: Amarillo, Texas

Date: 8-4-94 thru 8-9-94
Ground Elevation: 3814.85'

DRILLING METHOD: Air/Mud Rotary

GROUNDWATER INFORMATION: Air drilled to 125' Groundwater encountered at 225'

DEPTH, FEET	SYMBOL	SAMPLE	DESCRIPTION OF STRATUM	SPT BLOWS / FT PENETROMETER TSF	MOISTURE CONTENT, %	DRY DENSITY, PCF	LIQUID LIMIT, LL	PLASTIC LIMIT, PL	PLASTICITY INDEX, PI	UNCONFINED COMPRESSIVE STRENGTH, TSF	% PASSING NO. 200 SIEVE
90				40-6"	3.6		23	20	3		27.4
				50-7"							
95		X		36-6"	3.7		17	13	4		26.9
				50-8.5"							
100		X		50-5"	3.6		19	16	3		15.3
105		X	Clayey Sand: Reddish Tan, w/Calcareous Nodules (10%) Stiff, Dry (SC)								
110		X		26-6"	2.7		15	10	5		12.1
				50-12"							
115											
120		X									

Continued on Page 5

LOG OF BORING

PROJECT: Amarillo MSWLF
CLIENT: City of Amarillo
BORING NO.: MW-1
LOCATION: Amarillo, Texas
Date: 8-4-94 thru 8-9-94
Ground Elevation: 3814.85'

DRILLING METHOD: Air/Mud Rotary
GROUNDWATER INFORMATION: Air drilled to 125' Groundwater encountered at 225'

DEPTH, FEET	SYMBOL	SAMPLE	DESCRIPTION OF STRATUM	SPT BLOWS / FT PENETROMETER TSF	MOISTURE CONTENT, %	DRY DENSITY, PCF	LIQUID LIMIT, LL	PLASTIC LIMIT, PL	PLASTICITY INDEX, PI	UNCONFINED COMPRESSIVE STRENGTH, TSF	% PASSING NO. 200 SIEVE
120				24.6"	1.7		16	12	4		14.9
				50-10"							
125											
130				50-4"							
135			Lost Circulation Not Able to Sample from 130' to 190'								
140											
145											
150			Continued on Page 6								

LOG OF BORING

PROJECT: Amarillo MSWLF
CLIENT: City of Amarillo

BORING NO.: MW-1
LOCATION: Amarillo, Texas

Date: 8-4-94 thru 8-9-94

Ground Elevation: 3814.85'

DRILLING METHOD: Air/Mud Rotary

GROUNDWATER INFORMATION: Air Drilled to 125' Groundwater encountered at 225'

DEPTH, FEET	SYMBOL	SAMPLE	DESCRIPTION OF STRATUM	SPT BLOWS / FT PENETROMETER TSF	MOISTURE CONTENT, %	DRY DENSITY, PCF	LIQUID LIMIT, LL	PLASTIC LIMIT, PL	PLASTICITY INDEX, PI	UNCONFINED COMPRESSIVE STRENGTH, TSF	% PASSING NO. 200 SIEVE
150											
155											
160											
165											
170											
175											
180			Continued on Page 7								

LOG OF BORING

PROJECT: Amarillo MSWLF
CLIENT: City of Amarillo

BORING NO.: MW-1
LOCATION: Amarillo, Texas

Date: 8-4-94 thru 8-9-94

Ground Elevation: 3814.85'

DRILLING METHOD: Air/Mud Rotary

GROUNDWATER INFORMATION: Air drilled to 125' Groundwater encountered at 225'

DEPTH, FEET	SYMBOL	SAMPLE	DESCRIPTION OF STRATUM	SPT BLOWS/FT, PENETROMETER TSF	MOISTURE CONTENT, %	DRY DENSITY, PCF	LIQUID LIMIT, LL	PLASTIC LIMIT, PL	PLASTICITY INDEX, PI	UNCONFINED COMPRESSIVE STRENGTH, TSF	% PASSING NO. 200 SIEVE
180											
185											
190											
195			Regained Circulation								
200			Clayey Sand: Reddish Tan, w/Calcareous Nodules (10%) Stiff, Dry (SC)	50-5"	MD		20	16	4		14.1
205			Lost Circulation Not Able to Sample from 205' to 253'								
210			Continued on Page 8								

LOG OF BORING

PROJECT: Amarillo MSWLF
CLIENT: City of Amarillo

BORING NO.: MW-1
LOCATION: Amarillo, Texas

Date: 8-4-94 thru 8-9-94

Ground Elevation: 3814.85'

DRILLING METHOD: Air/Mud Rotary

GROUNDWATER INFORMATION: Air drilled to 125' Groundwater encountered at 225'

DEPTH, FEET	SYMBOL	SAMPLE	DESCRIPTION OF STRATUM	SPT BLOWS / FT PENETROMETER TSF	MOISTURE CONTENT, %	DRY DENSITY, PCF	LIQUID LIMIT, LL	PLASTIC LIMIT, PL	PLASTICITY INDEX, PI	UNCONFINED COMPRESSIVE STRENGTH, TSF	% PASSING NO. 200 SIEVE
210											
215											
220											
225											
230											
235											
240			Continued on Page 9								

LOG OF BORING

PROJECT: Amarillo MSWLF
CLIENT: City of Amarillo
BORING NO.: MW-1
LOCATION: Amarillo, Texas

Date: 8-4-94 thru 8-9-94
Ground Elevation: 3814.85'

DRILLING METHOD: Air/Mud Rotary

GROUNDWATER INFORMATION: Air drilled to 125' Groundwater encountered at 225'

DEPTH, FEET	SYMBOL	SAMPLE	DESCRIPTION OF STRATUM	SPT BLOWS / FT. PENETROMETER TSF	MOISTURE CONTENT, %	DRY DENSITY, PCF	LIQUID LIMIT, LL	PLASTIC LIMIT, PL	PLASTICITY INDEX, PI	UNCONFINED COMPRESSIVE STRENGTH, TSF	% PASSING NO. 200 SIEVE
240'											
245											
250											
			* T.D. - 253' *								
255											

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Log of Boring

MW-2

A. Monitor Well Data Sheet

Texas Water Commission
Municipal Solid Waste Division
SE-67

)rmittee or Site Name: City of Amarillo MSWLF
County: Potter
Date of Monitor Well Installation: 7-20-94
Monitor Well: Latitude: N35° 13'15" Longitude: W102° 01'12"
Monitor Well Groundwater
Gradient: Upgradient ___ Downgradient X

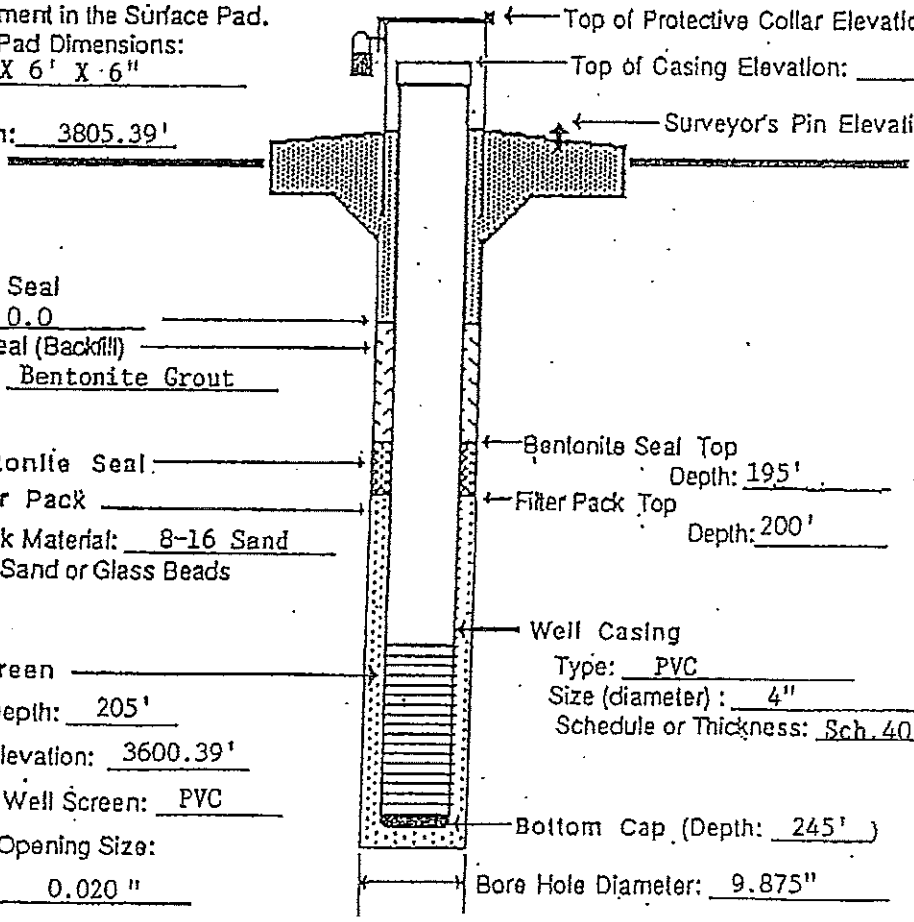
TDH Permit No.: 73
Monitor Well I.D. No.: MW-2
Date of Monitor Well
Development: 7-21-94
Monitor Well Driller
Name: Lee Peterson
License No.: 3045M

NOTE:
(A)The information shown in the sketch below should be considered the minimum required for an installed ground-water monitor well.
(B) Report All Depths from Surface Elevation and all Elevations relative to Mean Sea Level.
(C) The minimun distance between the inside wall of the Bore Hole and the outside of the Well Casing shall be 3".
(D) Use Flush Screw Joint Casing only, 2" diameter or larger. Recommend 4" diameter minimum & Teflon Taping Casing Joints.
(E) Well development should continue until water is clear, and pH and conductivity are stable.

Geologist, Hydrologist or Engineer Supervising Well Installation: Ray Hamby
Static Water Level Elevation (with respect to MSL) after Well Development: 3586.29'
Name of Geologic Formation(s) in which Well is completed: Ogallala

Type of Locking Device: Padlock.
Type of Casing Protection: Upright Well Protector

Concrete Surface Pad - Recommend steel reinforcement in the Surface Pad.
Surface Pad Dimensions: 6' X 6' X 6"
)ace
Elevation: 3805.39'



← Top of Protective Collar Elevation: 3809.89'
← Top of Casing Elevation: 3809.54'
← Surveyor's Pin Elevation: ___

Concrete Seal
Depth: 0.0
Casing Seal (Backfill)
Material: Bentonite Grout

Bentonite Seal
Filter Pack
Filter Pack Material: 8-16 Sand
Sterilized Sand or Glass Beads

← Bentonite Seal Top
Depth: 195' Elevation: 3610.39'
← Filter Pack Top
Depth: 200' Elevation: 3605.39'

← Well Casing
Type: PVC
Size (diameter): 4"
Schedule or Thickness: Sch.40

Well Screen
Top Depth: 205'
Top Elevation: 3600.39'
Type of Well Screen: PVC
)reen Opening Size:
0.020"

← Bottom Cap (Depth: 245')

← Bore Hole Diameter: 9.875"

LOG OF BORING

PROJECT: Amarillo MSWLF
CLIENT: City of Amarillo
BORING NO.: MW-2
LOCATION: Amarillo, Texas
Date: 7-15-94 thru 7-20-94
Ground Elevation: 3805.39'

DRILLING METHOD: Air/Mud Rotary
GROUNDWATER INFORMATION: Auger drilled to 74' Groundwater encountered at 215'

DEPTH, FEET	SYMBOL	SAMPLE	DESCRIPTION OF STRATUM	SPT BLOWS / FT PENETROMETER TSF	MOISTURE CONTENT, %	DRY DENSITY, PCF	LIQUID LIMIT, LL	PLASTIC LIMIT, PL	PLASTICITY INDEX, PI	UNCONFINED COMPRESSIVE STRENGTH, TSF	% PASSING NO. 200 SIEVE
0		X	Sandy Clay: Dark Brown, Stiff Dry (CL) $K = 4.5 \times 10^{-8}$ cm/sec	13-6"	9.5		38	18	20	1.5	94.5
				18-12"							
			Sandy Clay: Reddish Tan w/Calcareous Nodules(8%) Stiff, Dry (CL)								
5		X		50-5"	8.5		36	15	21	3.5	92.1
10		X		50-4"	6.2		29	18	11	3.0	91.7
15		X		50-5"	8.6		32	13	19	3.25	85.4
20		X		50-4"	9.7		35	15	20		91.4
25		X		50-5"	9.3		38	23	15	3.5	91.8
30											

Continued on Page 2

LOG OF BORING

PROJECT: Amarillo MSWLF
CLIENT: City of Amarillo

BORING NO.: MW-2
LOCATION: Amarillo, Texas

Date: 7-15-94 thru 7-20-94

Ground Elevation: 3805.39'

DRILLING METHOD: Air/Mud Rotary

GROUNDWATER INFORMATION: Auger Drilled to 74' Groundwater encountered at 215'

DEPTH, FEET	SYMBOL	SAMPLE	DESCRIPTION OF STRATUM	SPT BLOWS / FT PENETROMETER TSF	MOISTURE CONTENT, %	DRY DENSITY, PCF	LIQUID LIMIT, LL	PLASTIC LIMIT, PL	PLASTICITY INDEX, PI	UNCONFINED COMPRESSIVE STRENGTH, TSF	% PASSING NO. 200 SIEVE
30		X		50-3"	5.8		32	21	11	4.0+	81.1
35		X	Caliche: Light Tan, Limestone, Fractures, Hard (CL)	50-3"	11.9		29	20	9	4.0+	79.2
40		X	Sandy Clay: Reddish Tan w/Calcareous Nodules(10%) Stiff, Dry (CL)	50-4"	11.5		32	19	13	3.25	74.4
45		X		50-4"	10.5		31	18	13	3.50	73.0
50		X		50-5"	7.7		37	15	22	2.50	73.9
55		X		50-4"	5.5		34	22	12	2.0	82.6
60											

Continued on Page 3

LOG OF BORING

PROJECT: Amarillo MSWLF
CLIENT: City of Amarillo

BORING NO.: MW-2
LOCATION: Amarillo, Texas

Date: 7-15-94 thru 7-20-94

Ground Elevation: 3805.39'

DRILLING METHOD: Air/Mud Rotary

GROUNDWATER INFORMATION: Auger drilled to 74' Groundwater encountered at 215'

DEPTH, FEET	SYMBOL	SAMPLE	DESCRIPTION OF STRATUM	SPT BLOWS / FT PENETROMETER TSF	MOISTURE CONTENT, %	DRY DENSITY, PCF	LIQUID LIMIT, LL	PLASTIC LIMIT, PL	PLASTICITY INDEX, PI	UNCONFINED COMPRESSIVE STRENGTH, TSF	% PASSING NO 200 SIEVE
60		X		50-4"	4.2		31	15	16	2.5	62.2
65											
70											
75		X	Caliche: Light Tan Limestone Layers, Fractures, Hard (CL)	50-3"	MD		31	17	14	3.5	45.9
80		X		50-5"	MD		28	18	10		40.8
85		X		22-6"	MD		23	18	5	1.5	30.7
				50-11.5"							
90			Continued on Page 4								

LOG OF BORING

PROJECT: Amarillo MSWLF
CLIENT: City of Amarillo

BORING NO.: MW-2
LOCATION: Amarillo, Texas

Date: 7-15-94 thru 7-20-94

Ground Elevation: 3805.39'

DRILLING METHOD: Air/Mud Rotary

GROUNDWATER INFORMATION: Auger drilled to 74' Groundwater encountered at 215'

DEPTH, FEET	SYMBOL	SAMPLE	DESCRIPTION OF STRATUM	SPT BLOWS / FT PENETROMETER TSF	MOISTURE CONTENT, %	DRY DENSITY, PCF	LIQUID LIMIT, LL	PLASTIC LIMIT, PL	PLASTICITY INDEX, PI	UNCONFINED COMPRESSIVE STRENGTH, TSF	% PASSING NO. 200 SIEVE
90				24-6"	MD		27	20	7	1.0	33.4
				50-12"							
95				50-6"	MD		34	20	14	2.5	31.0
100				25-6"	MD		21	17	4	1.25	17.4
105			Clayey Sand: Reddish Tan w/Calcareous Nodules(10%) Stiff Dry (SC)	50-5"	MD		25	21	4	3.0	30.1
110				50-5"	MD		22	19	3		27.8
115											
120			Continued on Page 5								

LOG OF BORING

PROJECT: Amarillo MSWLF
CLIENT: City of Amarillo
BORING NO.: MW-2
LOCATION: Amarillo, Texas
Date: 7-15-94 thru 7-20-94
Ground Elevation: 3805.39'

DRILLING METHOD: Air/Mud Rotary
GROUNDWATER INFORMATION: Auger drilled to 74' Groundwater encountered at 215'

DEPTH, FEET	SYMBOL	SAMPLE	DESCRIPTION OF STRATUM	SPT BLOWS / FT. PENETROMETER TSF	MOISTURE CONTENT, %	DRY DENSITY, PCF	LIQUID LIMIT, LL	PLASTIC LIMIT, PL	PLASTICITY INDEX, PI	UNCONFINED COMPRESSIVE STRENGTH, TSF	% PASSING NO. 200 SIEVE
120		X		36-6"	MD		21	18	3		22.4
				50-8"							
125											
130		X	Clayey Sand:Reddish Tan, w/Calcareous Nodules(10%) Stiff, Dry (SC)	33-6"	MD		25	21	4	1.75	23.1
				50-8"							
135											
140		X		50-5"	MD		24	20	4	3.0	17.9
145											
150											

Continued on Page 6

LOG OF BORING

PROJECT: Amarillo MSWLF
CLIENT: City of Amarillo
BORING NO.: MW-2
LOCATION: Amarillo, Texas
Date: 7-15-94 thru 7-20-94
Ground Elevation: 3805.39'

DRILLING METHOD: Air/Mud Rotary
GROUNDWATER INFORMATION: Auger drilled to 74' Groundwater encountered at 215'

DEPTH, FEET	SYMBOL	SAMPLE	DESCRIPTION OF STRATUM	SPT BLOWS / FT. PENETROMETER TSF	MOISTURE CONTENT, %	DRY DENSITY, PCF	LIQUID LIMIT, LL	PLASTIC LIMIT, PL	PLASTICITY INDEX, PI	UNCONFINED COMPRESSIVE STRENGTH, TSF	% PASSING NO. 200 SIEVE
150		X		40-6"	MD				NP		16.0
				50-7.5"							
155											
160		X		39-6"	MD				NP		22
				50-8"							
165											
170		X	Clayey Sand: Reddish Tan, w/Calcareous Nodules(15%) Stiff, Dry (SC)	50-5"	MD				NP	3.0	20.7
			Organic Carbon Content (*) *237.1 MG/KG								
175											
180			Continued on Page 7								

LOG OF BORING

PROJECT: Amarillo MSWLF
CLIENT: City of Amarillo
BORING NO.: MW-2
LOCATION: Amarillo, Texas
Date: 7-15-94 thru 7-20-94
Ground Elevation: 3805.39'

DRILLING METHOD: Air/Mud Rotary
GROUNDWATER INFORMATION: Auger drilled to 74' Groundwater encountered at 215'

DEPTH, FEET	SYMBOL	SAMPLE	DESCRIPTION OF STRATUM	SPT BLOWS / FT. PENETROMETER TSF	MOISTURE CONTENT, %	DRY DENSITY, PCF	LIQUID LIMIT, LL	PLASTIC LIMIT, PL	PLASTICITY INDEX, PI	UNCONFINED COMPRESSIVE STRENGTH, TSF	% PASSING NO. 200 SIEVE
180		X	Clayey Sand: Reddish Tan, w/Calcareous Nodules (15%) (SC)	50-3.5"	MD				NP		
185											
190		X	Sand: Tan, Well sorted, Fine Grain (SC) *444.12 MG/KG	50-4"	MD				NP		
195											
200		X		50-3.5'	MD				NP		
205			Sand: Tan, Fine Grain w/Small Pea Gravel (30%) (GW)								
210			Continued on Page 8								

LOG OF BORING

PROJECT: Amarillo MSWLF
CLIENT: City of Amarillo
BORING NO.: MW-2
LOCATION: Amarillo, Texas

Date: 7-15-94 thru 7-20-94
Ground Elevation: 3805.39'

DRILLING METHOD: Air/Mud Rotary

GROUNDWATER INFORMATION: Auger drilled to 74' Groundwater encountered at 215'

DEPTH, FEET	SYMBOL	SAMPLE	DESCRIPTION OF STRATUM	SPT BLOWS / FT PENETROMETER TSF	MOISTURE CONTENT, %	DRY DENSITY, PCF	LIQUID LIMIT, LL	PLASTIC LIMIT, PL	PLASTICITY INDEX, PI	UNCONFINED COMPRESSIVE STRENGTH, TSF	% PASSING NO. 200 SIEVE
210			*482.80 MG/KG Sand: Tan, Well Sorted, Fine Grain (SC)	50.4"	MD				NP		
215											
220				50-1"	MD						
225											
230			Sand: Tan, Coarse Grain w/Small Pea Gravel (30%) (SC) *336.34 MG/KG	50-1"	MD						
235											
240			Continued on Page 9								

LOG OF BORING

PROJECT: Amarillo MSWLF
CLIENT: City of Amarillo
BORING NO.: MW-2
LOCATION: Amarillo, Texas
Date: 7-15-94 thru 7-20-94
Ground Elevation: 3805.39'

DRILLING METHOD: Air/Mud Rotary
GROUNDWATER INFORMATION: Auger Drilled to 74' Groundwater encountered at 215'

DEPTH, FEET	SYMBOL	SAMPLE	DESCRIPTION OF STRATUM	SPT BLOWS/FT PENETROMETER TSF	MOISTURE CONTENT, %	DRY DENSITY, PCF	LIQUID LIMIT, LL	PLASTIC LIMIT, PL	PLASTICITY INDEX, PI	UNCONFINED COMPRESSIVE STRENGTH, TSF	% PASSING NO. 200 SIEVE
240		X	Sand: Tan, Coarse Grain w/Small Pea Gravel (SC) *529.70 MG/KG	50-3"	MD				NP		2.0
245		X		50-2.5"	MD						
			* T.D. - 245' *								

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Log of Boring

MW-3

A. Monitor Well Data Sheet

Texas Water Commission
Municipal Solid Waste Division
SE 67

)rmittee or Site Name: City of Amarillo MSWLF
County: Potter
Date of Monitor Well Installation: 7-20-94
Monitor Well: Latitude: N35° 13'16" Longitude: W102° 00'35"
Monitor Well Groundwater
Gradient: Upgradient ___ Downgradient XX

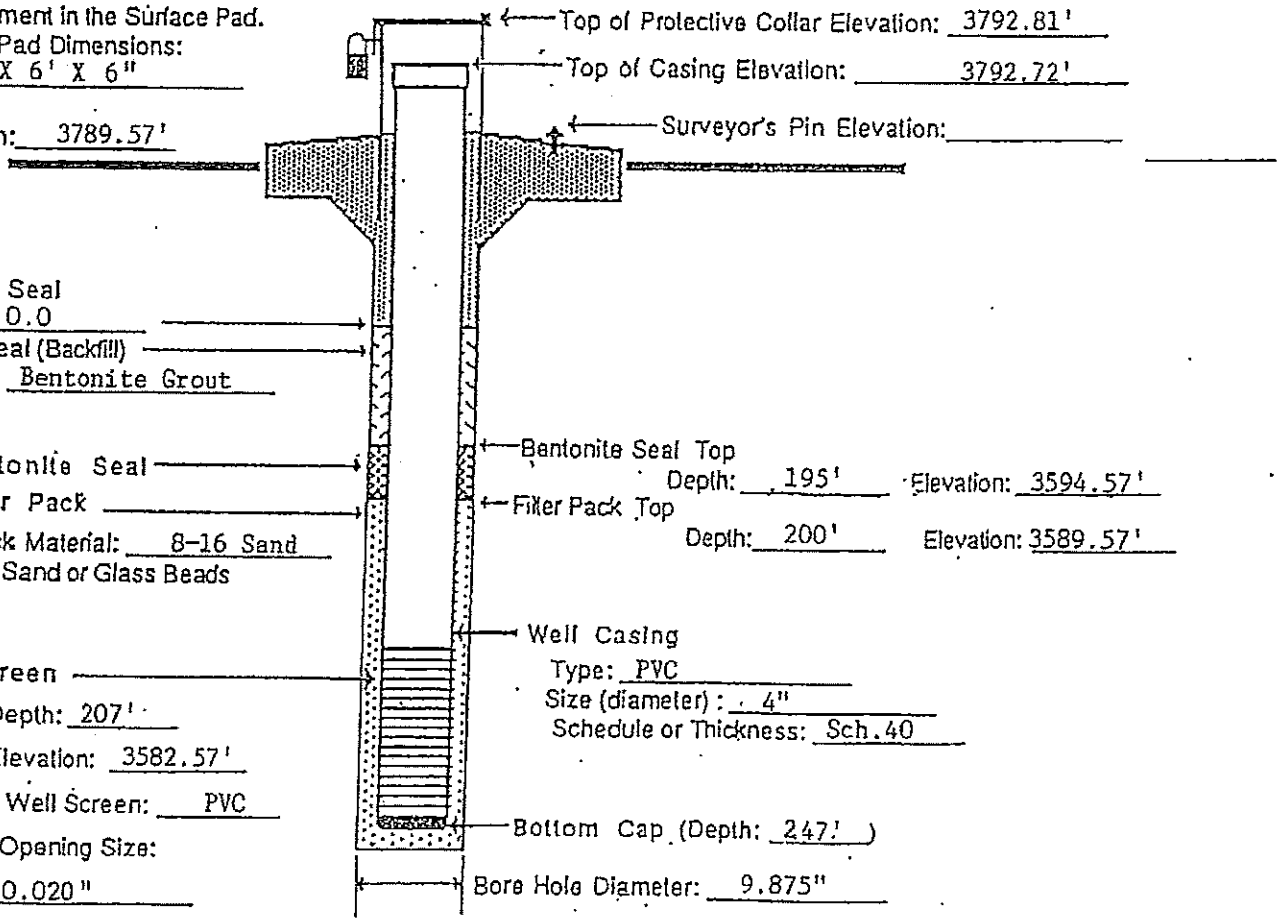
TDH Permit No.: 73
Monitor Well I.D. No.: MW-3
Date of Monitor Well
Development: 7-23-94
Monitor Well Driller
Name: Lee Peterson
License No.: 3045M

NOTE:
(A)The information shown in the sketch below should be considered the minimum required for an installed ground-water monitor well.
(B) Report All Depths from Surface Elevation and all Elevations relative to Mean Sea Level.
(C) The minimun distance between the inside wall of the Bore Hole and the outside of the Well Casing shall be 3".
(D) Use Flush Screw Joint Casing only, 2" diameter or larger. Recommend 4" diameter minimum & Teflon Taping Casing Joints.
(E) Well development should continue until water is clear; and pH and conductivity are stable.

Geologist, Hydrologist or Engineer Supervising Well Installation: Ray Hamby
Static Water Level Elevation (with respect to MSL) after Well Development: 3589.92'
Name of Geologic Formation(s) in which Well is completed: Ogallala

Type of Locking Device: Padlock.
Type of Casing Protection: Upright Well Protector

Concrete Surface Pad - Recommend steel reinforcement in the Surface Pad.
Surface Pad Dimensions: 6' X 6' X 6"
)ace Elevation: 3789.57'



LOG OF BORING

PROJECT: Amarillo MSWLF
CLIENT: City of Amarillo

BORING NO.: MW-3
LOCATION: Amarillo, Texas

Date: 7-19-94 thru 7-26-94

Ground Elevation: 3789.57'

DRILLING METHOD: Air/Mud Rotary

GROUNDWATER INFORMATION: (Continous Core) Auger Drilled to 70' Groundwater encountered at 200'

DEPTH, FEET	SYMBOL	SAMPLE	DESCRIPTION OF STRATUM	SPT BLOWS / PT PENETROMETER TSF	MOISTURE CONTENT, %	DRY DENSITY, PCF	LIQUID LIMIT, LL	PLASTIC LIMIT, PL	PLASTICITY INDEX, PI	UNCONFINED COMPRESSIVE STRENGTH, TSF	% PASSING NO. 200 SIEVE
0			Sandy Clay: Brown, Stiff, Dry(CL) (R) $\bar{K} = 2.98 \times 10^{-8}$ cm/sec		11.3		33	14	19		93.7
5			Sandy Clay: Reddish Brown with Scattered Calcareous Nodules, Stiff, Dry (CL)		10.1		32	15	17		92.6
10			Sandy Clay: Tan with a Caliche Stringer (CL)		8.2		21	8	13		63.3
15			Sandy Clay: Reddish Tan with Scattered Calcareous Nodules, Stiff, Dry (CL)		8.3		32	16	16		85.8
20					9.8		31	14	17	3.5	90.7
25			Sandy Clay: Tan with Caliche Stringers (CL)		8.7		31	16	15		90.4
30			Continued on Page 2								

LOG OF BORING

PROJECT: Amarillo MSWLF
CLIENT: City of Amarillo

BORING NO.: MW-3
LOCATION: Amarillo, Texas

Date: 7-19-94 thru 7-26-94

Ground Elevation: 3789.57'

DRILLING METHOD: Air/Mud Rotary

GROUNDWATER INFORMATION: (Continous Core) Auger Drilled to 70' Groundwater encountered at 200'

DEPTH, FEET	SYMBOL	SAMPLE	DESCRIPTION OF STRATUM	SPT BLOWS / FT PENETROMETER TSF	MOISTURE CONTENT, %	DRY DENSITY, PCF	LIQUID LIMIT, LL	PLASTIC LIMIT, PL	PLASTICITY INDEX, PI	UNCONFINED COMPRESSIVE STRENGTH, TSF	% PASSING NO. 200 SIEVE
30											
35			Sandy Clay: Reddish Tan with Scattered Calcareous Nodules Stiff, Dry (CL)		8.2		32	70	12		72.9
40											
45			K = 3.45 X 10^{-5} cm/sec (R)		7.6						
50											
55											
60			Continued on Page 3								

LOG OF BORING

PROJECT: Amarillo MSWLF
CLIENT: City of Amarillo

BORING NO.: MW-3
LOCATION: Amarillo, Texas

Date: 7-19-94 thru 7-26-94

Ground Elevation: 3789.57'

DRILLING METHOD: Air/Mud Rotary

GROUNDWATER INFORMATION: (Continous Core) Auger Drilled to 70' Groundwater encountered at 200'

DEPTH, FEET	SYMBOL	SAMPLE	DESCRIPTION OF STRATUM	SPT BLOWS / FT PENETROMETER TSF	MOISTURE CONTENT, %	DRY DENSITY, PCF	LIQUID LIMIT, LL	PLASTIC LIMIT, PL	PLASTICITY INDEX, PI	UNCONFINED COMPRESSIVE STRENGTH, TSF	% PASSING NO. 200 SIEVE
60			Clayey Sand: Reddish Tan with Scattered Calcareous Nodules Stiff, Dry (SC)		7.2		30	20	10		32.8
65					6.9		25	12	13		53.1
70					7.4		27	16	11		44.1
75		X		21-6"	MD		26	19	7		34.7
				46-12"							
				50-13"							
80		X		50-1"	MD						
85		X		50-3"	MD						
90											

Continued on Page 4

LOG OF BORING

PROJECT: Amarillo MSWLF
CLIENT: City of Amarillo

BORING NO.: MW-3
LOCATION: Amarillo, Texas

Date: 7-19-94 thru 7-26-94

Ground Elevation: 3789.57'

DRILLING METHOD: Air/Mud Rotary

GROUNDWATER INFORMATION(Continous Core) Auger Drilled to 70' Groundwater encountered at 200'

DEPTH, FEET	SYMBOL	SAMPLE	DESCRIPTION OF STRATUM	SPT BLOWS/FT PENETROMETER TSF	MOISTURE CONTENT, %	DRY DENSITY, PCF	LIQUID LIMIT, LL	PLASTIC LIMIT, PL	PLASTICITY INDEX, PI	UNCONFINED COMPRESSIVE STRENGTH, TSF	% PASSING NO. 200 SIEVE
90		X	Clayey Sand: Light Tan with Scattered Calcareous Nodules, Stiff (SC)	50-6"	MD		25	18	7		31.9
95		X		50-4"	MD		26	19	7		30.8
100		X		50-5"	MD		21	16	5		16.8
105											
110		X		34-6" / 50-8"	MD		23	19	4		28.1
115			Clayey Sand: Reddish Tan with Scattered Calcareous Nodules, Stiff (SC)								
120			Continued on Page 5								

LOG OF BORING

PROJECT: Amarillo MSWLF
CLIENT: City of Amarillo

BORING NO.: MW-3
LOCATION: Amarillo, Texas

Date: 7-19-94 thru 7-26-94

Ground Elevation: 3789.57'

DRILLING METHOD: Air/Mud Rotary

GROUNDWATER INFORMATION: (Continous Core) Auger Drilled to 70' Groundwater encountered at 200'

DEPTH, FEET	SYMBOL	SAMPLE	DESCRIPTION OF STRATUM	SPT BLOWS / FT PENETROMETER TSF	MOISTURE CONTENT, %	DRY DENSITY, PCF	LIQUID LIMIT, LL	PLASTIC LIMIT, PL	PLASTICITY INDEX, PI	UNCONFINED COMPRESSIVE STRENGTH, TSF	% PASSING NO. 200 SIEVE
120		X		38-6"	MD		19	16	3		21.8
				50-7"							
125											
130		X		38-6"	MD		22	19	3		22.6
				50-7.5"							
135			Clayey Sand: Reddish Tan with Scattered Calcareous Nodules, Stiff (SC)								
140		X		50-5"	MD		19	16	3		17.0
145											
150			Continued on Page 6								

LOG OF BORING

PROJECT: Amarillo MSWLF
CLIENT: City of Amarillo
BORING NO.: MW-3
LOCATION: Amarillo, Texas

Date: 7-19-94 thru 7-26-94
Ground Elevation: 3789.57'

DRILLING METHOD: Air/Mud Rotary
GROUNDWATER INFORMATION: (Continous Core) Auger Drilled to 70' Groundwater encountered at 200'

DEPTH, FEET	SYMBOL	SAMPLE	DESCRIPTION OF STRATUM	SPT BLOWS / FT. PENETROMETER TSF	MOISTURE CONTENT, %	DRY DENSITY, PCF	LIQUID LIMIT, LL	PLASTIC LIMIT, PL	PLASTICITY INDEX, PI	UNCONFINED COMPRESSIVE STRENGTH, TSF	% PASSING NO. 200 SIEVE
150		X		50-6"	MD		19	16	3		15.7
155											
160		X		50-4"	MD		18	16	2		21.
165			Clayey Sand: Reddish Tan with Scattered Calcareous Nodules Stiff (SC)								
170		X		50-4"	MD		19	17	2		20.1
175			Tan Sand: Well Sorted with Calcareous Nodules (SC)								
180			Continued on Page 7								

LOG OF BORING

PROJECT: Amarillo MSWLF
CLIENT: City of Amarillo

BORING NO.: MW-3
LOCATION: Amarillo, Texas

Date: 7-19-94 thru 7-26-94

Ground Elevation: 3789.57'

DRILLING METHOD: Air/Mud Rotary

GROUNDWATER INFORMATION: (Continous Core) Auger Drilled to 70' Groundwater encountered at 200'

DEPTH, FEET	SYMBOL	SAMPLE	DESCRIPTION OF STRATUM	SPT BLOWS / FT. PENETROMETER TSF	MOISTURE CONTENT, %	DRY DENSITY, PCF	LIQUID LIMIT, LL	PLASTIC LIMIT, PL	PLASTICITY INDEX, PI	UNCONFINED COMPRESSIVE STRENGTH, TSF	% PASSING NO. 200 SIEVE
180		X		50-4.5"	MD				NP		12.6
			Tan Sand: Pea Size Caliche Nodules (SC)								
185											
190		X		50-5"	MD				NP		13.0
195											
200		X		50-6"	MD				NP		14.1
205											
210			Continued on Page 8								

LOG OF BORING

PROJECT: Amarillo MSWLF
CLIENT: City of Amarillo

BORING NO.: MW-3
LOCATION: Amarillo, Texas

Date: 7-19-94 thru 7-26-94

Ground Elevation: 3789.57'

DRILLING METHOD: Air/Mud Rotary

GROUNDWATER INFORMATION: (Continous Core) Auger Drilled to 70' Groundwater encountered at 200'

DEPTH, FEET	SYMBOL	SAMPLE	DESCRIPTION OF STRATUM	SPT BLOWS / FT PENETROMETER TSF	MOISTURE CONTENT, %	DRY DENSITY, PCF	LIQUID LIMIT, LL	PLASTIC LIMIT, PL	PLASTICITY INDEX, PI	UNCONFINED COMPRESSIVE STRENGTH, TSF	% PASSING NO. 200 SIEVE
210		X		50-5"	MD				NP		14.9
215											
220		X		50-4"	MD				NP		23.7
225											
230		X		50-5.5"	MD				NP		
235			Clayey Sand: Tan with Scattered Calcareous Nodules, Stiff (SC)								
240			Continued on Page 9								

LOG OF BORING

PROJECT: Amarillo MSWLF
CLIENT: City of Amarillo

BORING NO.: MW-3
LOCATION: Amarillo, Texas

Date: 7-19-94 thru 7-26-94

Ground Elevation: 3789.57'

DRILLING METHOD: Air/Mud Rotary

GROUNDWATER INFORMATION: (Continous Core) Auger Drilled to 70' Groundwater encountered at 200'

DEPTH, FEET	SYMBOL	SAMPLE	DESCRIPTION OF STRATUM	SPT BLOWS / FT PENETROMETER TSF	MOISTURE CONTENT, %	DRY DENSITY, PCF	LIQUID LIMIT, LL	PLASTIC LIMIT, PL	PLASTICITY INDEX, PI	UNCONFINED COMPRESSIVE STRENGTH, TSF	% PASSING NO. 200 SIEVE
240											
245		X		50-2.5"	MD				NP		24.4
			* T.D. - 245' *								

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Log of Boring

MW-4

A. Monitor Well Data Sheet

Texas Water Commission
Municipal Solid Waste Division
SE 67

)rmittee or Site Name: City of Amarillo MSWLF

TDH Permit No. : 73

County: Potter

Monitor Well I.D. No.: MW-4

Date of Monitor Well Installation: 8-17-94

Date of Monitor Well Development: 8-19-94

Monitor Well: Latitude: N35° 13'41" Longitude: W102° 00'35"

Monitor Well Groundwater Gradient: Upgradient ___ Downgradient X

Monitor Well Driller Name: Lee Peterson

License No.: 3045M

NOTE:

(A)The information shown in the sketch below should be considered the minimum required for an installed ground-water monitor well.
(B) Report All Depths from Surface Elevation and all Elevations relative to Mean Sea Level.
(C) The minimun distance between the inside wall of the Bore Hole and the outside of the Well Casing shall be 3".
(D) Use Flush Screw Joint Casing only, 2" diameter or larger. Recommend 4" diameter minimum & Teflon Taping Casing Joints.
(E) Well development should continue until water is clear, and pH and conductivity are stable.

Geologist, Hydrologist or Engineer Supervising Well Installation: Ray Hamby

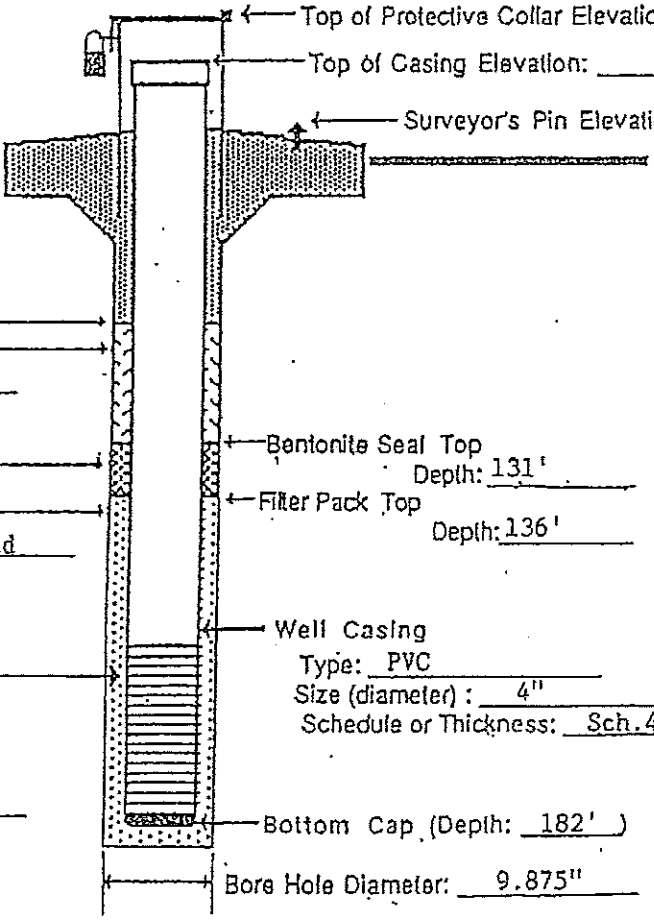
Static Water Level Elevation (with respect to MSL) after Well Development : 3593.18'

Name of Geologic Formation(s) in which Well is completed: Ogallala

Type of Locking Device: Padlock

Type of Casing Protection: Upright Well Protector

Concrete Surface Pad - Recommend steel reinforcement in the Surface Pad.
Surface Pad Dimensions: 6' X 6' X 6"
)face Elevation: 3746.88'



Top of Protective Collar Elevation: 3750.58'

Top of Casing Elevation: 3750.26'

Surveyor's Pin Elevation: ___

Concrete Seal Depth: 0.0

Casing Seal (Backfill) Material: Bentonite Grout

Bentonite Seal

Filter Pack

Filter Pack Material: 8-16 Sand
Sterilized Sand or Glass Beads

Bentonite Seal Top Depth: 131' Elevation: 3615.88'

Filter Pack Top Depth: 136' Elevation: 3610.88'

Well Screen

Top Depth: 142'

Top Elevation: 3604.88'

Type of Well Screen: PVC

)creen Opening Size: 0.020"

Well Casing
Type: PVC
Size (diameter) : 4"
Schedule or Thickness: Sch.40

Bottom Cap (Depth: 182')

Bore Hole Diameter: 9.875"

LOG OF BORING

PROJECT: Amarillo MSWLF
CLIENT: City of Amarillo
BORING NO.: MW-4
LOCATION: Amarillo, Texas

Date: 8-11-94 thru 8-17-94
Ground Elevation: 3746.88'

DRILLING METHOD: Air/Mud Rotary
GROUNDWATER INFORMATION: Air drilled to 150' Groundwater encountered at 155'

DEPTH, FEET	SYMBOL	SAMPLE	DESCRIPTION OF STRATUM	SPT BLOWS/FT, PENETROMETER TSF	MOISTURE CONTENT, %	DRY DENSITY, PCF	LIQUID LIMIT, LL	PLASTIC LIMIT, PL	PLASTICITY INDEX, PI	UNCONFINED COMPRESSIVE STRENGTH, TSF	% PASSING NO. 200 SIEVE
0			Sandy Clay: Dark Brown, Dry (CL)		9.2		34	15	19		93.8
5		X	Sandy Clay: Reddish Tan w/Scattered Calcareous Nodules (8%) Stiff, Dry (CL) $K = 2.83 \times 10^{-7}$ cm/sec	13-6"	8.5		32	15	17		89.7
				30-12"							
				47-18"							
10		X		20-6"	7.2		32	14	18	2.50	91.3
				50-12"							
15		X		20-6"	8.2		31	14	17		88.3
				50-11.5"							
20		X		42-6"	7.6					2.25	86.3
25		X		50-5.5"	6.4						85.5
30											

Continued on Page 2

LOG OF BORING

PROJECT: Amarillo MSWLF
CLIENT: City of Amarillo

BORING NO.: MW-4
LOCATION: Amarillo, Texas

Date: 8-11-94 thru 8-17-94

Ground Elevation: 3746.88'

DRILLING METHOD: Air/Mud Rotary

GROUNDWATER INFORMATION: Air drilled to 150' Groundwater encountered at 155'

DEPTH, FEET	SYMBOL	SAMPLE	DESCRIPTION OF STRATUM	SPT BLOWS / FT PENETROMETER TSF	MOISTURE CONTENT, %	DRY DENSITY, PCF	LIQUID LIMIT, LL	PLASTIC LIMIT, PL	PLASTICITY INDEX, PI	UNCONFINED COMPRESSIVE STRENGTH, TSF	% PASSING NO. 200 SIEVE
'30		X		50-6"	7.4		30	19	11		83.7
			Caliche: Light Tan, Limestone Cap, Very Hard (CL) (R)								
35											
40		X		50-1.5"	3.8						
			Clayey Sand: Reddish Tan Scattered Calcareous Nodules (10%) Stiff, Dry (SC)								
45		X		31-6"	6.9		33	17	16		44.5
				50-10"							
50		X		28-6"	6.1		28	17	11	2.25	39.1
				50-9"							
55		X		40-6"	6.9		30	17	13		37.3
				50-7.5"							
60											

Continued on Page 3

LOG OF BORING

PROJECT: Amarillo MSWLF
CLIENT: City of Amarillo

BORING NO.: MW-4
LOCATION: Amarillo, Texas

Date: 8-11-94 thru 8-17-94

Ground Elevation: 3746.88'

DRILLING METHOD: Air/Mud Rotary

GROUNDWATER INFORMATION: Air drilled to 150' Groundwater encountered at 155'

DEPTH, FEET	SYMBOL	SAMPLE	DESCRIPTION OF STRATUM	SPT BLOWS / FT PENETROMETER TSF	MOISTURE CONTENT, %	DRY DENSITY, PCF	LIQUID LIMIT, LL	PLASTIC LIMIT, PL	PLASTICITY INDEX, PI	UNCONFINED COMPRESSIVE STRENGTH, TSF	% PASSING NO. 200 SIEVE
60		X		11-16"	5.7		25	15	10		36.3
				36-12"							
				50-15"							
65		X		16-6"	6.4		25	16	9		49.4
				48-12"							
				50-12.5'							
70		X		50-1.5"							
75		X		30-6"	4.9		25	16	9		31.9
				50-8.5"							
80		X		19-6"	5.6		23	19	4		27.7
				50-10.5'							
85		X		36-6"	4.1		23	14	9		28.9
				50-8.5"							
90											

Continued on Page 4

LOG OF BORING

PROJECT: Amarillo MSWLF
CLIENT: City of Amarillo
Date: 8-11-94 thru 8-17-94

BORING NO.: MW-4
LOCATION: Amarillo, Texas
Ground Elevation: 3746.88'

DRILLING METHOD: Air/Mud Rotary
GROUNDWATER INFORMATION: Air drilled to 150' Groundwater encountered at 155'

DEPTH, FEET	SYMBOL	SAMPLE	DESCRIPTION OF STRATUM	SPT BLOWS / FT PENETROMETER TSF	MOISTURE CONTENT, %	DRY DENSITY, PCF	LIQUID LIMIT, LL	PLASTIC LIMIT, PL	PLASTICITY INDEX, PI	UNCONFINED COMPRESSIVE STRENGTH, TSF	% PASSING NO. 200 SIEVE
90		X		50-6"	3.7		24	16	8		28.1
95		X		35-6"	4.3		22	15	7		27.7
				50-6.5"							
100		X		37-6"	3.3		23	18	5		15
				50-7.5"							
			Clayey Sand: Reddish Tan w/Scattered Calcareous Nodules(10%) Stiff, Dry (SC)								
105											
110		X		50-5.5"	3.0					3.5	24.5
115											
120			Continued on Page 5								

LOG OF BORING

PROJECT: Amarillo MSWLF
CLIENT: City of Amarillo

BORING NO.: MW-4
LOCATION: Amarillo, Texas

Date: 8-11-94 thru 8-17-94

Ground Elevation: 3746.88'

DRILLING METHOD: Air/Mud Rotary

GROUNDWATER INFORMATION: Air drilled to 150' Groundwater encountered at 155'

DEPTH, FEET	SYMBOL	SAMPLE	DESCRIPTION OF STRATUM	SPT BLOWS / FT, PENETROMETER TSF	MOISTURE CONTENT, %	DRY DENSITY, PCF	LIQUID LIMIT, LL	PLASTIC LIMIT, PL	PLASTICITY INDEX, PI	UNCONFINED COMPRESSIVE STRENGTH, TSF	% PASSING NO. 200 SIEVE
120		X		50-5"	3.4					3.5	26.3
125											
130		X		50-6"	2.7		19	15	4		17.7
135											
140		X		50-5.5"	3.1				NP		19.3
145			Sand: Tan, Fine Grain w/Scattered Pea Gravel (SC)								
150			Continued on Page 6								

LOG OF BORING

PROJECT: Amarillo MSWLF
CLIENT: City of Amarillo

BORING NO.: MW-4
LOCATION: Amarillo, Texas

Date: 8-11-94 thru 8-17-94

Ground Elevation: 3746.88'

DRILLING METHOD: Air/Mud Rotary

GROUNDWATER INFORMATION: Air drilled to 150' Groundwater encountered at 155'

DEPTH, FEET	SYMBOL	SAMPLE	DESCRIPTION OF STRATUM	SPT BLOWS / FT PENETROMETER TSF	MOISTURE CONTENT, %	DRY DENSITY, PCF	LIQUID LIMIT, LL	PLASTIC LIMIT, PL	PLASTICITY INDEX, PI	UNCONFINED COMPRESSIVE STRENGTH, TSF	% PASSING NO. 200 SIEVE
150		X	K = 8.34 X 10^{-5} cm/sec	23-6"	MD						14.1
			Sand: Tan w/Pea Size Calcareous Nodules(15%) Well Sorted (SC)(R)								
155											
160		X		50-3"	MD				NP		15.
165											
170		X	Sand: Tan w/Scattered Calcareous Nodules(10%) Well Sorted (SC)	45-6"	MD						21.3
				50-6.5"							
175											
180											

Continued on Page 7

LOG OF BORING

PROJECT: Amarillo MSWLF
CLIENT: City of Amarillo

BORING NO.: MW-4
LOCATION: Amarillo, Texas

Date: 8-11-94 thru 8-17-94

Ground Elevation: 3746.88'

DRILLING METHOD: Air/Mud Rotary

GROUNDWATER INFORMATION: Air drilled to 150' Groundwater encountered at 155'

DEPTH, FEET	SYMBOL	SAMPLE	DESCRIPTION OF STRATUM	SPT BLOWS/FT PENETROMETER TSF	MOISTURE CONTENT, %	DRY DENSITY, PCF	LIQUID LIMIT, LL	PLASTIC LIMIT, PL	PLASTICITY INDEX, PI	UNCONFINED COMPRESSIVE STRENGTH, TSF	% PASSING NO. 200 SIEVE
180		X	Sand: Reddish Tan w/Scattered Calcareous Nodules (SC)	50-5"	MD		22	20	NP		13.1
			* T.D. - 180' *								

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Log of Boring

MW-5

A. Monitor Well Data Sheet

Texas Water Commission
Municipal Solid Waste Division
SE 67

Permittee or Site Name: City of Amarillo MSWLF
County: Potter
Date of Monitor Well Installation: 8-20-94
Monitor Well: Latitude: N35° 14'09" Longitude: W102° 00'44"
Monitor Well Groundwater
Gradient: Upgradient XX Downgradient __

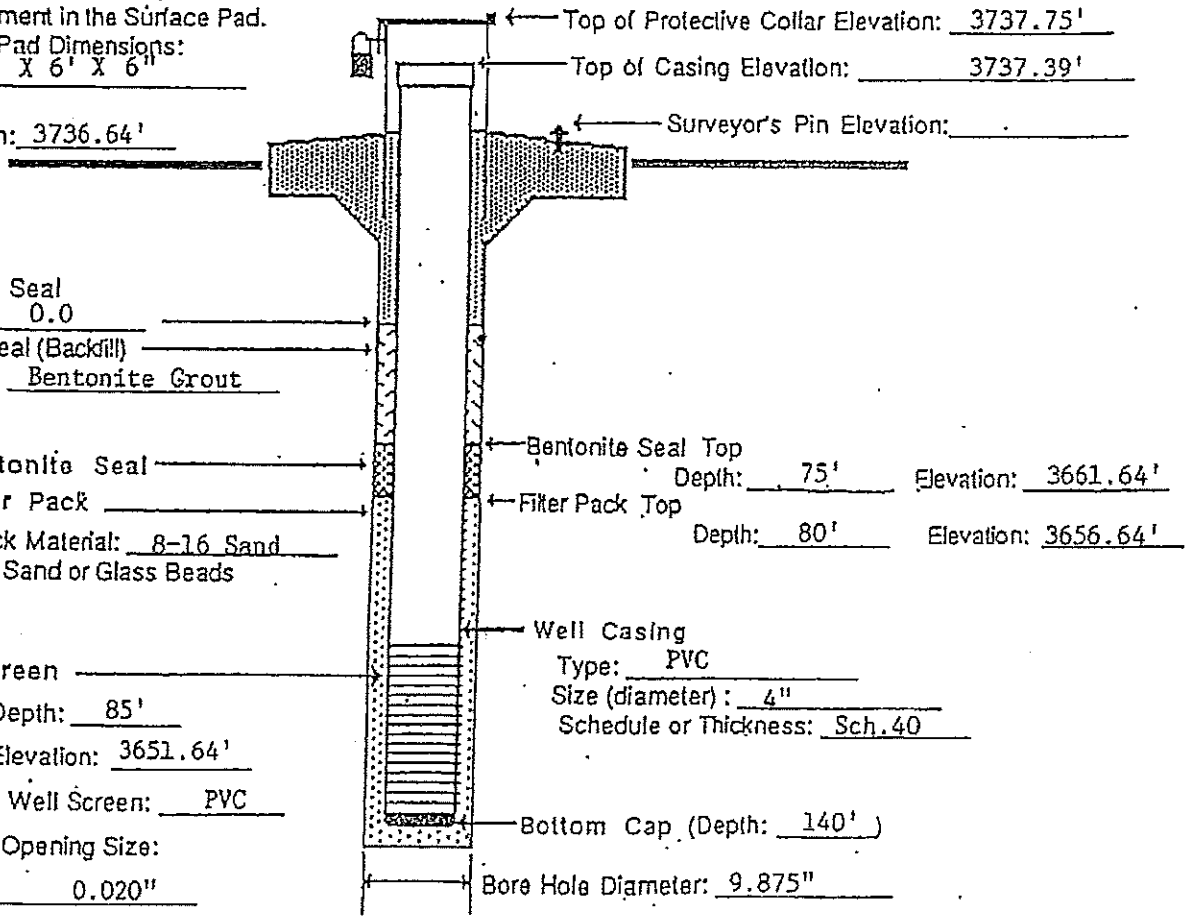
TDH Permit No.: 73
Monitor Well I.D. No.: MW-5
Date of Monitor Well Development: 8-22-94
Monitor Well Driller
Name: Lee Peterson
License No.: 3045M

NOTE:
(A) The information shown in the sketch below should be considered the minimum required for an installed ground-water monitor well.
(B) Report All Depths from Surface Elevation and all Elevations relative to Mean Sea Level.
(C) The minimun distance between the inside wall of the Bore Hole and the outside of the Well Casing shall be 3".
(D) Use Flush Screw Joint Casing only, 2" diameter or larger. Recommend 4" diameter minimum & Teflon Taping Casing Joints.
(E) Well development should continue until water is clear; and pH and conductivity are stable.

Geologist, Hydrologist or Engineer Supervising Well Installation: Ray Hamby
Static Water Level Elevation (with respect to MSL) after Well Development: 3610.14'
Name of Geologic Formation(s) in which Well is completed: Ogallala

Type of Locking Device: Padlock
Type of Casing Protection: Upright Well Protector

Concrete Surface Pad - Recommend steel reinforcement in the Surface Pad.
Surface Pad Dimensions: 6' X 6' X 6"
Surface Elevation: 3736.64'



LOG OF BORING

PROJECT: Amarillo MSWLF
CLIENT: City of Amarillo

BORING NO.: MW-5
LOCATION: Amarillo, Texas

Date: 8-19-94 thru 8-21-94

Ground Elevation: 3736.64

DRILLING METHOD: Air/Mud Rotary

GROUNDWATER INFORMATION:
Air Drilled to 115'
Mud Drilled to 140'

DEPTH, FEET	SYMBOL	SAMPLE	DESCRIPTION OF STRATUM	SPT BLOWS / FT PENETROMETER TSF	MOISTURE CONTENT, %	DRY DENSITY, PCF	LIQUID LIMIT, LL	PLASTIC LIMIT, PL	PLASTICITY INDEX, PI	UNCONFINED COMPRESSIVE STRENGTH, TSF	% PASSING NO. 200 SIEVE
0			Sandy Clay: Reddish Brown w/Calcareous Nodules, Stiff, Dry (CL)								
5		X	Caliche: Light Tan, Limestone Layers, Fractures, Hard (CL)	19-6"	7.7		28	25	3		24
				43-12"							
				50-13.5"							
10		X	Clayey Sand: Reddish Brown with Calcareous Nodules, Stiff, Dry (SC)	50-4.5"						4.0	
15		X		50-5"	6.9		25	22	3		34
			Clayey Sand: Reddish Tan with Scattered Calcareous Nodules(SC)								
20		X		50-2"							
25		X	Clayey Sand: Light Tan with Caliche(Very Hard)(SC)	50-5.5"	5.7		18	16	2		22
30			Continued on Page 2								

LOG OF BORING

PROJECT: Amarillo MSWLF
CLIENT: City of Amarillo

BORING NO.: MW-5
LOCATION: Amarillo, Texas

Date: 8-19-94 thru 8-21-94

Ground Elevation: 3736.64

DRILLING METHOD: Air/Mud Rotary

GROUNDWATER INFORMATION:
Air Drilled to 115'
Mud Drilled to 140'

DEPTH, FEET	SYMBOL	SAMPLE	DESCRIPTION OF STRATUM	SPT BLOWS / FT PENETROMETER TSF	MOISTURE CONTENT, %	DRY DENSITY, PCF	LIQUID LIMIT, LL	PLASTIC LIMIT, PL	PLASTICITY INDEX, PI	UNCONFINED COMPRESSIVE STRENGTH, TSF	% PASSING NO. 200 SIEVE
30		X	K = 7.73 X 10^{-4} cm/sec (R) Clayey Sand: Reddish Tan with Scattered Calcareous Nodules, Dry (SC)	22-6"	5.2		25	21	4		17
				50-11"							
35		X		50-3"							
40		X		24-6"	6.1		19	16	3		24
				50-11"							
45		X		27-6"	5.6				NP		11
				50-10"							
50		X		31-6"	4.8				NP		11
			Clayey Sand Reddish Brown . Stiff, Dry (SC)	50-9"							
55		X		50-6"	4.2		19	16	3		10
			Clayey Sand: Reddish Tan with Scattered Calcareous Nodules Dry (SC)								
60			Continued on Page 3								

LOG OF BORING

PROJECT: Amarillo MSWLF
CLIENT: City of Amarillo

BORING NO.: MW-5
LOCATION: Amarillo, Texas

Date: 8-19-94 thru 8-21-94

Ground Elevation: 3736.64

DRILLING METHOD: Air/Mud Rotary

GROUNDWATER INFORMATION:
Air Drilled to 115'
Mud Drilled to 140'

DEPTH, FEET	SYMBOL	SAMPLE	DESCRIPTION OF STRATUM	SPT BLOWS / FT PENETROMETER TSF	MOISTURE CONTENT, %	DRY DENSITY, PCF	LIQUID LIMIT, LL	PLASTIC LIMIT, PL	PLASTICITY INDEX, PI	UNCONFINED COMPRESSIVE STRENGTH, TSF	% PASSING NO. 200 SIEVE
60			Clayey Sand: Reddish Tan to Tan with Scattered Calcareous Nodules Dry (SC)	50-4"	3.3						
65				50-6"	4.6		25	22	3		15
70				34-6"	4.3				NP		24
				50-7"							
75				50-5.5"	3.1		28	24	4		14
80			Gravel: Medium Coarse	50-6"	1.3				NP		2
85				45-6"	1.9						3
				50-7"							
			Clayey Sand: Reddish Tan to Tan with Coarse Gravel (SC)								
90											

Continued on Page 4

LOG OF BORING

PROJECT: Amarillo MSWLF
CLIENT: City of Amarillo

BORING NO.: MW-5
LOCATION: Amarillo, Texas

Date: 8-19-94 thru 8-21-94

Ground Elevation: 3736.64

DRILLING METHOD: Air/Mud Rotary

GROUNDWATER INFORMATION:
Air Drilled to 115'
Mud Drilled to 140'

DEPTH, FEET	SYMBOL	SAMPLE	DESCRIPTION OF STRATUM	SPT BLOWS / FT, PENETROMETER TSF	MOISTURE CONTENT, %	DRY DENSITY, PCF	LIQUID LIMIT, LL	PLASTIC LIMIT, PL	PLASTICITY INDEX, PI	UNCONFINED COMPRESSIVE STRENGTH, TSF	% PASSING NO. 200 SIEVE
90		X	Clayey Sand: Reddish Tan to Tan with Coarse Gravel (SC)	31-6"	1.6						4
95											
100											
105											
110		X		16-6"	6.1				NP		85
				50-9"							
115					MD						
120			Continued on Page 5		MD						

LOG OF BORING

PROJECT: Amarillo MSWLF
CLIENT: City of Amarillo

BORING NO.: MW-5
LOCATION: Amarillo, Texas

Date: 8-19-94 thru 8-21-94

Ground Elevation: 3736.64

DRILLING METHOD: Air/Mud Rotary

GROUNDWATER INFORMATION:
Air Drilled to 115'
Mud Drilled to 140'

DEPTH, FEET	SYMBOL	SAMPLE	DESCRIPTION OF STRATUM	SPT BLOWS / FT PENETROMETER TSF	MOISTURE CONTENT, %	DRY DENSITY, PCF	LIQUID LIMIT, LL	PLASTIC LIMIT, PL	PLASTICITY INDEX, PI	UNCONFINED COMPRESSIVE STRENGTH, TSF	% PASSING NO. 200 SIEVE
120			Clayey Sand: Reddish Tan to Tan With Coarse Gravel (SC)		MD						
125			Silty Clay: Red to Deep Red, Red Bed (MH)		MD						
130					MD						
135					MD						
140					MD						
			* T.D. - 140' *								

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Log of Boring
MW-6

A. Monitor Well Data Sheet

Texas Water Commission
Municipal Solid Waste Division
SE 67

)mittee or Site Name: City of Amarillo MSWLF

County: Potter

Date of Monitor Well Installation: 8-18-94

Monitor Well: Latitude: N35° 14'07" Longitude: W102° 01'23"

Monitor Well Groundwater

Gradient: Upgradient ___ Downgradient X

TDH Permit No.: 73

Monitor Well I.D. No.: MW-6

Date of Monitor Well

Development: 8-19-94

Monitor Well Driller

Name: Lee Peterson

License No.: 3045M

NOTE:

(A)The information shown in the sketch below should be considered the minimum required for an installed ground-water monitor well.
(B) Report All Depths from Surface Elevation and all Elevations relative to Mean Sea Level.
(C) The minimun distance between the inside wall of the Bore Hole and the outside of the Well Casing shall be 3".
(D) Use Flush Screw Joint Casing only, 2" diameter or larger. Recommend 4" diameter minimum & Teflon Taping Casing Joints.
(E) Well development should continue until water is clear, and pH and conductivity are stable.

Geologist, Hydrologist or Engineer Supervising Well Installation: Ray Hamby

Static Water Level Elevation (with respect to MSL) after Well Development: 3597.53'

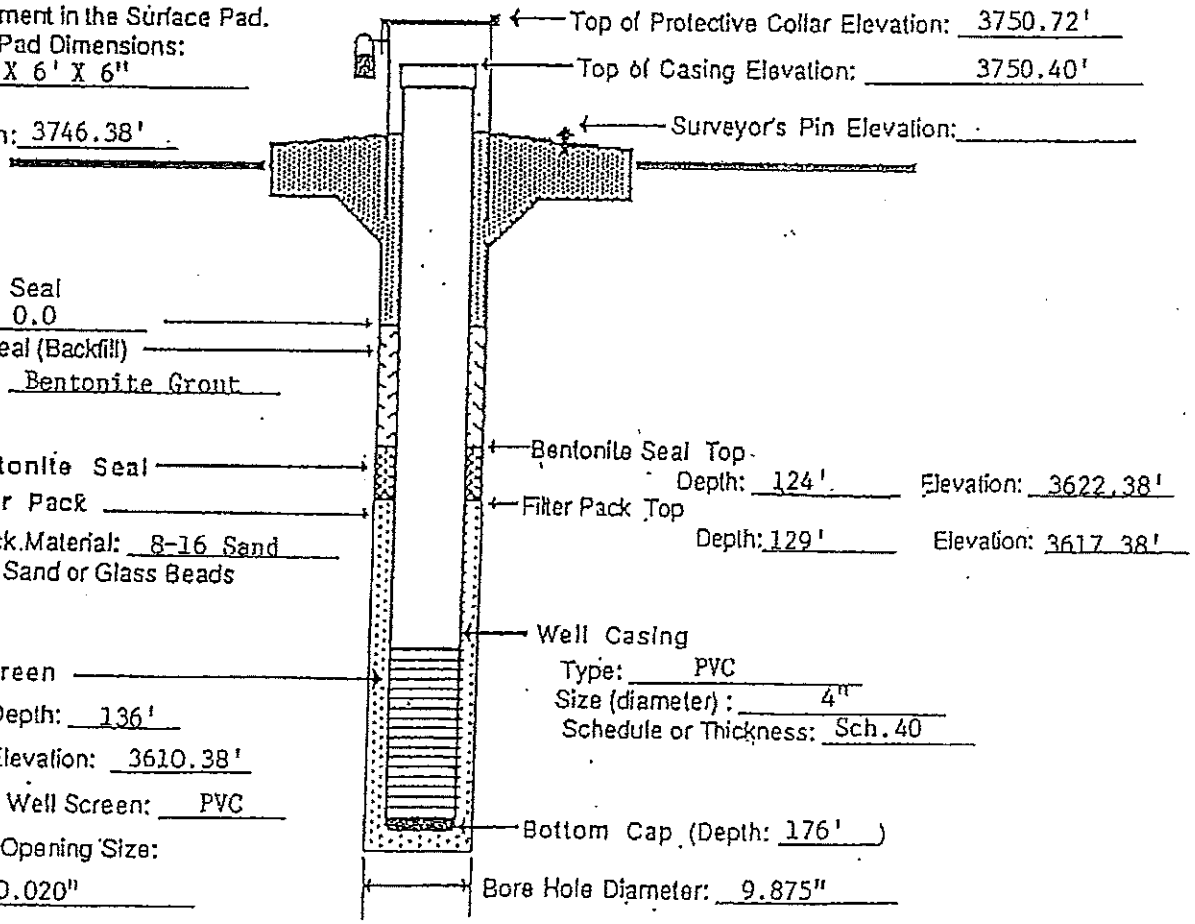
Name of Geologic Formation(s) in which Well is completed: Ogallala

Type of Locking Device: Padlock

Type of Casing Protection: Upright Well Protector

Concrete Surface Pad - Recommend steel reinforcement in the Surface Pad.
Surface Pad Dimensions: 6' X 6' X 6"

)ace
...evation: 3746.38'



LOG OF BORING

PROJECT: Amarillo MSWLF
CLIENT: City of Amarillo
Date: 7-8-94 thru 7-12-94
8-17-94 thru 8-19-94

BORING NO.: MW-6
LOCATION: Amarillo, Texas
Ground Elevation: 3746.38'

DRILLING METHOD: Air/Mud Rotary
GROUNDWATER INFORMATION:
Air Drilled to 155'
Mud Drilled to 180'

DEPTH, FEET	SYMBOL	SAMPLE	DESCRIPTION OF STRATUM	SPT BLOWS/FT, PENETROMETER TSF	MOISTURE CONTENT, %	DRY DENSITY, PCF	LIQUID LIMIT, LL	PLASTIC LIMIT, PL	PLASTICITY INDEX, PI	UNCONFINED COMPRESSIVE STRENGTH, TSF	% PASSING NO. 200 SIEVE
0			Caliche: Limestone Cap, Extremely Hard, Outcropping Existing at Surface (CL)								
5		X									
10		X	Clayey Sand: Light Tan Large Caliche Nodules (SC)	50-4"	9.7		35	28	7		23.3
15		X		20-6"	6.6		25	22	3		33.8
				50-12"							
20		X		50-6"	6.2		28	25	3		23.1
25		X	Clayey Sand: Reddish Tan with Scattered Calcareous Nodules Stiff, Dry (SC)	50-5.5"	7.2		28	22	6		30.5
30			Continued on Page 2								

Part III

Attachment 8

Closure and Post-Closure Care Cost Estimates

Permit – MSW No. 73A
Issued August 22, 2007

City of Amarillo,
Potter County, Texas

Revised July 2009

7-15-2009

This document is released for the purpose of review only under the authority of Michael W. Oden, P.E. #67165. It is not to be used for bidding or construction. Firm Registration No. F-754

For pages i thru i

City of Amarillo
Landfill Permit Amendment – Part III, Attachment 8

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7-15-2009

This document is released for the purpose of review only under the authority of Michael W. Oden, P.E. #67165. It is not to be used for bidding or construction. Firm Registration No. F-754

For pages 1 thru 3

1.0 GENERAL

This section includes the Closure Cost Estimate (Table III.8.1) and Post-Closure Cost Estimate (Table III.8.2) for the City of Amarillo Landfill.

1.1 Financial Assurance

In order to address financial assurance requirements, the City of Amarillo will submit documentation to verify its compliance with Chapter 37, Subchapter R: Financial Assurance for Municipal Solid Waste Facilities upon receipt of this amendment. The combined cost of closure and post-closure is $12,645,053. This cost estimate is based upon Year 2005 dollars (escalated by 5% per annum to 2008) and provision of service by a third party. The unit costs used are based on previous projects in the area. This estimate also assumes that the largest landfill area that would require final cover at one time is 526 acres. The City has built cells in approximately 10 acre phases. Worst case scenario is for final closure of the entire site (526 acres) with 70 feet of depth for a 10 acre phase needing filling to maintain drainage.

Post-closure care estimates include activities associated with the entire site.

Table III.8.1: Closure Costs
City of Amarillo Solid Waste Disposal Facility
MSW Permit No. 73A

Item	Quantity	Unit	Unit Cost	Total
Engineering				
Topo Survey	1	LS*	$7,500	$7,500
Boundary Survey	40	HR	$80	$3,200
Site Evaluation and Development of Plans	1	LS	$25,000	$25,000
Closure Plan	1	LS	$10,000	$10,000
Construction Observation/Testing	400	HR	$75	$30,000
Subtotal				$75,700
Contingency	20%			$15,140
Total Engineering				**$90,840**
Construction				
Plug and Abandon Wells	22	EA	$8,000	$176,000
Plug and Abandon Piezometers	5	EA	$5,000	$25,000
Fill to grade	1,129,333	CY	$2.00	$2,258,667
Infiltration Layer (12 inches)				
Placing/grading/compaction	848,013	CY	$1.50	$1,272,020
Erosion/Vegetative Layer (24 inches)	1,697,227	CY	$1.50	$2,545,840
Vegetation	526	ACRE	$1,000.00	$526,000
Backfill/grading/drainage	1	LS	$100,000.00	$100,000
Methane Gas Control Wells	10	EA	$1,000.00	$10,000
Subtotal				$6,913,526
Contingency	20%			$1,382,705
Total Construction				**$8,296,231**
Total Closure Costs (2005)				**$8,387,071**
5% increase for 2006				**$8,806,425**
5% increase for 2007				**$9,246,746**
5% increase for 2008				**$9,709,084**

* LS = Lump Sum

Table III.8.2: Post-Closure Care Costs
City of Amarillo Solid Waste Disposal Facility
MSW Permit No. 73A

Description	Quantity	Unit	Unit Costs	Total Costs
One-Time Costs				
Site Post-Closure Plan Update	1	LS*	$ 15,000	$15,000
Contingency	20%			$3,000
Subtotal				**$18,000**
Annual Costs				
Site Inspections and Report	40	HR	$ 80	$3,200
Correctional Plans & Specs	1	LS	$ 3,500	$3,500
Site Monitoring Groundwater Wells****	22	EA	$ 1,250	$27,500
Site Monitoring Gas Probes	20	EA	$ 50	$1,000
Maintenance**	1	LS	$ 34,750	$34,750
Subtotal Annual Cost				**$69,950**
Contingency	20%			$13,990
Total Annual Costs				$83,940
30-year Post-Closure Total*(2005)**				**$2,536,200**
5% increase for 2006				**$2,663,010**
5% increase for 2007				**$2,796,161**
5% increase for 2008				**$2,935,969**

* Lump Sum

** Maintenance may include leachate pumps, leachate collection system repairs, electrical, mowing, gate/fence repair, erosion and access control, surface water control, seeding, monitor well maintenance, and methane gas system repairs. See Table below.

*** 30-year Post-Closure Total includes the entire project site.

**** Site Monitoring assumed semi-annual and includes wells and probes around the entire site.

Total Estimated Closure and Post-Closure Costs $12,645,053

Itemized Maintenance Costs				
Description	**Quantity**	**Unit**	**Unit Costs**	**Total Costs**
Leachate Pumps	1	EA	$2,750	$2,750
Leachate Collection System	1	YR	$1,000	$1,000
Electrical	1	YR	$500	$500
Mowing	526	AC	$50	$26,300
Gate/fence Repair	1	YR	$500	$500
Erosion and Access Control, Surface Water Control, Seeding	1	YR	$1,000	$1,000
Monitor Well Maintenance & Pump Replacement	1	EA	$2,500	$2,500
Methane Gas System Repairs	20	EA	$10	$200
Subtotal Annual Cost				**$34,750**

Part III

Attachment 11

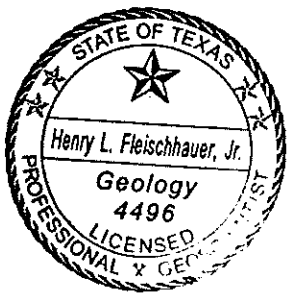
Groundwater Sampling and Analysis Plan

Permit Amendment – MSW No. 73A

City of Amarillo,
Potter County, Texas

Permit Issued
August 22, 2007

Revised July 2009



Henry L. Fleischhauer, P.G.
Hydrogeologist

July 7, 2009
Date

City of Amarillo
Landfill Permit Amendment – Part III, Attachment 11
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City of Amarillo
Landfill Permit Amendment – Part III, Attachment 11
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Appendices

1.0 INTRODUCTION

This groundwater sampling and analysis plan (GWSAP) addresses the groundwater monitoring and sampling program to be implemented at the City of Amarillo's Municipal Solid Waste Landfill (MSWLF). The GWSAP is required by the Texas Commission on Environmental Quality (TCEQ) Municipal Solid Waste Regulations and will meet the requirements of Title 30 Texas Administrative Code, Subchapter F "Analytical Quality Assurance and Quality Control" and Subchapter J "Groundwater Monitoring and Corrective Action." Once approved by the TCEQ, this GWSAP will become part of the site operating record.

2.0 BACKGROUND SAMPLING

Background groundwater quality shall be established for monitored constituents by collecting groundwater samples quarterly and analyzing the samples for the detection monitoring or assessment monitoring constituents. Background sampling for inorganic and volatile organic detection monitoring constituents shall be conducted quarterly for a two-year period [a total of eight (8) sampling events]. This will allow the collection of groundwater data over the different seasons of the year, which should demonstrate the effects that seasonal and temporal changes may have on groundwater quality.

As described in Section 4.2, background determinations will be required if Appendix II constituents are detected at quantifiable concentrations during the initial assessment monitoring event. Background sampling for assessment monitoring constituents shall be conducted quarterly for 1 to 2 years [a total of four (4) to eight (8) samples].

If additional samples are needed for the statistical analysis of either detection or assessment monitoring constituents, they will be collected no closer than 30 days apart.

At the conclusion of the background monitoring period for either detection or assessment monitoring, all the results will be thoroughly reviewed, and a statistical evaluation of the

background monitoring shall be performed as described in Section 7 to determine the background limits for each constituent.

The background concentrations of monitored constituents may be reviewed and updated every two years by applying statistical methods described in Section 7 to data collected in the period following the last update. Revision of background may be performed after receiving written permission from TCEQ.

3.0 DETECTION MONITORING

Detection monitoring is the routine, periodic sampling that is conducted for purposes of detecting a release relative to certain constituents. Regulations pertaining to Detection Monitoring are codified at 30 TAC §330.407

3.1 Constituents

The constituents to be analyzed during the detection monitoring program are listed in Table 11.1. At the request of the TCEQ (formerly the Texas Natural Resource Conservation Commission [TNRCC]) during the initial preparation of this GWSAP, total alkalinity was substituted for antimony, total dissolved solids for beryllium, dissolved iron for thallium, and dissolved manganese for vanadium. In addition, ammonia was also added to the constituents to be analyzed. The list of constituents includes 16 inorganics and 47 organics. The test methods to be used for the constituents listed are presented in Table 11.2. If at a later date, the City determines that any of these constituents are not being detected and are not expected to originate from the waste contained in the MSWLF unit, the City may request a modification to the GWSAP for the deletion, substitution, and/or addition of other constituents.

3.2 Frequency of Monitoring

Monitoring for the detection monitoring constituents will occur semiannually during the active life of the MSWLF unit and the closure and post-closure care period, unless an alternate schedule is approved by the Executive Director.

3.3 Statistically Significant Increases Above Background

The determination of and responses to Statistically Significant Increases (SSIs) shall comply with 30 TAC §407(b). A summary of this rule is follows.

Detection monitoring data shall be evaluated for indications of potential landfill releases by comparing the sampling data with background concentrations for monitored constituents within 60 days after the end of each sampling event. A statistically significant increase (SSI) occurs when the concentration of a monitored constituent is higher than its background concentration. The TCEQ and any local pollution control agencies with jurisdiction must be notified within 14 days of this initial determination.

If an SSI is identified, field and laboratory quality control data should be examined. The occurrence of the constituent in laboratory blanks or failure to meet other laboratory quality control standards may suggest that analytical conditions contributed to the SSI and that re-analysis of the sample may be required. The occurrence of a constituent in field quality control samples may suggest field cross contamination or environmental sampling conditions which may require re-sampling.

An SSI may be confirmed by collecting a verification sample from the affected well. Verification sampling may be repeated for the affected well as long as all such sampling is completed within 60 days of the initial determination.

If there is evidence that a source other than the landfill caused an SSI, or that an SSI resulted from error in sampling, analysis, statistical evaluation, or natural variation in groundwater quality, then an alternate source demonstration report providing documentation to this effect may be submitted. The Landfill shall notify the TCEQ and any local pollution agency of the intent to perform an alternate source demonstration within 14 days of identifying an SSI. The report must be prepared and certified by a qualified groundwater scientist and submitted to the TCEQ within

90 days of the initial determination of the SSI. Samples collected for the alternate source demonstration shall not be filtered.

If an SSI is confirmed, or if a satisfactory alternate source demonstration is not made, a record shall be placed in the site operating record, and Assessment Monitoring shall be initiated.

3.4 Detection Monitoring Reports

An annual report documenting detection monitoring activities shall be submitted to the TCEQ within 90 days following the last groundwater monitoring event of the calendar year.

This report shall include the following information determined since the last groundwater monitoring report.

- The results of groundwater monitoring, testing, and analysis obtained under requirements of the permit, including a summary of monitoring analyses together with graphs or drawings, as appropriate (Data may be summarized on form TCEQ-0312, Appendix 11A);
- A summary of background water quality values, presentation of statistical calculations, a statement as to whether an SSI over background occurred during the monitoring period, and the status of any related verification sampling events or alternate source demonstrations;
- A contour map of piezometric elevations in the uppermost aquifer based on concurrent measurements, together with data or documentation used to prepare the map;
- The calculated groundwater flow rate and direction using data collected during the report period, including documentation of all information used to make this calculation.
- Recommendations for changes;
- Other information requested by the TCEQ.

3.5 Program Modification

If the Landfill determines that the Detection Monitoring Program no longer satisfies the requirements of Title 30 Texas Administrative Code Section 330.407, then within 90 days of the determination, the Landfill shall submit an application for a permit amendment or modification to make appropriate changes to the program.

4.0 ASSESSMENT MONITORING

Assessment monitoring is triggered when a statistically significant increase (SSI) in one or more detection monitoring constituents has been confirmed by 1 or more verification sampling events, or cannot be rejected by an alternate source demonstration. Assessment monitoring will be conducted in accordance with 30 TAC §409.

4.1 Regulatory Summary

The requirements for Assessment Monitoring are codified at 30 TAC §330.409 as follows:

- §330.409 (a) and (b) establish the assessment program;
- §330.409 (c) specifies a basis for modifying the frequency of sampling the full set of Appendix II constituents;
- §330.409 (d) establishes a semiannual monitoring program for detected Appendix II constituents and requires determining background values and groundwater protection standards;
- §330.409 (e) establishes the basis for discontinuing assessment monitoring;
- §330.409 (f) establishes the basis for continuing assessment monitoring;
- §330.409 (g) specifies actions to be taken when the groundwater protection standard is exceeded;
- §330.409 (h), (i) and (j) specify how groundwater protection standards are determined;
- §330.409 (k) specifies the requirements for the annual assessment monitoring report.

4.2 Implementation

If an SSI has occurred, the Landfill shall immediately place a notice in the Site Operating Record. An assessment monitoring program shall be initiated within 90 days of the notifying the TCEQ that an SSI has occurred. The entire groundwater monitoring system, i.e. all monitor wells, or an approved subset of wells, shall be sampled and analyzed for all constituents listed in 40 CFR 258 Appendix II (effective July 14, 2005)[hereafter, EPA Appendix II].

After the initial sampling, the TCEQ may be petitioned to authorize a reduced subset of wells to be sampled and analyzed for EPA Appendix II constituents, and/or to authorize an alternate sampling frequency.

If EPA Appendix II constituents are detected at quantifiable concentrations in point of compliance wells at the initial sampling, then

- Implement monitoring for detected constituents on at least a semi-annual basis. These results shall be reported to TCEQ within 60 days after each sampling event.
- Establish background concentrations for the detected EPA Appendix II constituents using 4 to 8 background samples collected from the upgradient well(s), using statistical methods described in Section 7.
- Establish groundwater protection standards for each EPA Appendix II constituent detected in point of compliance wells in accordance with §409(h) or §409(i) or §409(j).

Detected EPA Appendix II constituents shall be added to the detection monitoring list and shall be sampled and analyzed on a semiannual basis. Annually, however, the wells shall be sampled for all EPA Appendix II constituents, unless the frequency is modified in accordance with §330.409 (c).

4.3 Exceeding Groundwater Protection Standard

If the groundwater protection standard is exceeded, the City of Amarillo or the landfill operator shall install additional monitor wells as necessary, including at least one additional monitor well

between the next adjacent monitor wells along the point of compliance before the next sampling event. These wells shall be sampled at the next assessment monitoring sampling event.

If contaminants have migrated offsite, the owner/operator shall notify owners and occupants of land overlying the contaminant plume.

The City of Amarillo or landfill operator shall initiate assessment of corrective measures in accordance with 30 TAC §330.411 within 90 days of notice to the TCEQ.

4.4 Assessment Monitoring Reports

Assessment monitoring results must be submitted to the TCEQ within 60 days after each sampling event.

Not later than 60 days after a sampling event, the owner/operator shall determine if any EPA Appendix II constituents were detected at concentrations above the groundwater protection standard. If so, TCEQ and appropriate local agencies must be notified within 7 days of this determination.

An annual report shall be submitted within 60 days after the second semiannual sampling event each year. This report shall contain the following elements:

- A statement whether the groundwater protection standard has been exceeded;
- Groundwater monitoring data, including laboratory analyses, water level measurements, summaries of background values and analytical data, and as appropriate, statistical calculations, graphs and drawings;
- A contour map of the piezometric water levels in the uppermost aquifer;
- The groundwater flow rate and directions;
- Recommended changes;
- Other information requested by the TCEQ.

4.5 Termination of Assessment Monitoring Program

If detected EPA Appendix II constituents are shown to be at or below background concentrations for two successive sampling events, TCEQ shall be notified with a request to resume detection monitoring.

5.0 SAMPLING PROTOCOL

5.1 Groundwater Elevation Monitoring and Well Inspection

Prior to purging and sampling, all groundwater monitor wells will be measured for depth to water and total depth. To minimize the potential effects of water level fluctuation across the site, the water levels in all the monitor wells will be measured first, then they will be purged and sampled. During water level measurement events, each well will be inspected for damage to the well casing, protective cover, lock, well cap, and concrete pad. In addition, the ground surface around the well pads will be inspected for erosion. If any problems are discovered, they will be addressed and the appropriate corrective action(s) will be rendered as soon as practicable.

Groundwater level measurements will be collected using an electric well sounder with a tape marked in 1-foot increments with intermediate intervals marked in 0.01 foot. The groundwater level measurement will be recorded to the nearest 0.01 foot from an established survey mark on top of the monitor well casing. When a measurement is collected, the electric well sounder will be raised and lowered two to three times to be sure the correct reading is read off the tape measure. Water level measurements collected for each event will be recorded on the Groundwater Sampling Report form (Form TCEQ-0312) or other form required by the TCEQ (Appendix 11A).

5.2 Quality Assurance and Quality Control of Field Measurements

During each water level measurement event, the current measurements will be compared to the readings recorded from the previous event. It is anticipated that the water levels in this area of Texas should be fairly consistent for each monitor event. If an obvious discrepancy is

encountered, the water level will be measured again to ensure the measurement was recorded correctly.

Prior to collecting water level measurements, the electric sounder will be checked for damage, including bends or kinks in the tape. To maintain consistency and precision, the same electric well sounder will be used during each measuring event.

Prior to conducting the well purging activities, the pH and conductivity meters will be calibrated. Calibration of the instruments will be in accordance with the manufacturer's procedures for the particular instrument. At a minimum, the pH meter will be calibrated using standard calibration solutions consisting of an acidic solution (pH < 7), basic solution (pH > 7), and a neutral solution (pH = 7). The conductivity meter will be calibrated using standard solutions as recommended or supplied by the manufacturer.

5.3 Groundwater Sample Collection

5.3.1 Well Purging and Decontamination Procedures

Prior to each sampling event, the groundwater level in each well and the total well depth will be measured as described in Section 5.1. The volume of water to be removed from the well will be calculated based on well casing volume. The wells will be purged of at least 3 well casing volumes before collecting a groundwater sample. During purging, temperature, conductivity, and pH will be measured in a separate glass, stainless steel container or flow cell. The parameters will continue to be recorded throughout the entire purging of the well and until the readings stabilize and/or the required well volume of water is removed. Wells that dewater prior to achieving the 3 well casing volumes will be evacuated until dry then allowed to recharge before collecting a groundwater sample. For slowly recovering wells, a sample will be collected as soon as practicable to reduce the potential of volatilization in the well casing. Monitor wells that have not sufficiently recovered after 7 days will be considered dry and not sampled. The recommended recovery is 75% of the pre-purging water level. However, the sampler(s) may collect samples from a well with less recovery provided that the water level sufficient to supply the required sample volume from the dedicated sampling system, and provided that, in their

professional judgment, the recovery represents fresh formation water as opposed to filter pack drainage. For monitor wells that recharge quickly, a sample will be collected within 24-hours following purging. The calculated and actual purge volume achieved as well as the field parameters will be recorded on the Groundwater Sampling Report form (Form TCEQ-0312, Appendix 11A), or other form acceptable to the TCEQ.

The method of well purging will consist of using dedicated submersible pumps installed in the well casings. The pump intake will be set approximately halfway into the water column in the well casing. The discharge rate on the pump will be regulated to allow no more than 1-foot of drawdown for wells that can sustain continuous pumping without dewatering. This procedure will minimize any cascading effects that may volatilize constituents in the groundwater entering the well casing and will also minimize agitating any residual sediment that is in the bottom of the well. If the pump system fails, then the monitor well will be purged with a dedicated PVC or stainless steel bailer or back up submersible pump. If a bailer is used, a development rig will be used to raise and lower the bailer. The bailer will be of sufficient size in order to efficiently purge the well. The bailer will be lowered gently into the well casing and only submerged in the upper half of the water column during purging. The bailer will not be lowered to the bottom of the well. This procedure should minimize agitating any residual sediment that has collected in the bottom of the well. In the event bailers are used, care will be taken to prevent the bailer from coming into contact with the ground or potential contaminants that could be introduced into the well. Any non-dedicated equipment used with the development rig including the cable to raise and the lower the bailer, will be decontaminated between wells to avoid potential cross contamination.

The monitor wells will be purged in order from the well with the maximum groundwater elevation to the well with the minimum groundwater elevation, unless historical analytical data indicates the presence of volatile organic constituents (VOC) to be tested. If groundwater contains VOCs, then the order of purging and sampling will proceed from the well with the minimum to maximum VOC concentrations.

Prior to beginning each sample event and between wells, all non-dedicated equipment including the electric well sounder will be decontaminated thoroughly to minimize the potential for cross contamination. For non-dedicated submersible pumps, the decontamination procedures will consist of pumping a nonphosphatic detergent or solution with potable water through the pump system. Then the pump equipment will be flushed with potable water and cleaned a second time with the decontamination solution. Following the second cleaning, the pump equipment will be rinsed with potable water and given a final rinse with deionized water. If non-dedicated bailers are used, the same decontamination procedures will be used.

During the purging operations, a record of the climatic conditions, condition of the wells and surrounding ground surface, water turbidity, color, odors, water level, depth of well and purge rate will be maintained and recorded on the Groundwater Sampling Report form (Appendix 11A), or other form acceptable to the TCEQ. Additional sheets will be attached if necessary. The information will be recorded in ink and a copy of the information will remain on site at the landfill office and will become part of the site operating record.

5.3.2 Groundwater Sample Collection and Handling Procedures

During groundwater collection, disposable latex gloves will be worn to minimize cross contamination of samples and to reduce the possibility of coming into contact with groundwater containing VOCs. Prior to collecting a groundwater sample, the monitor wells will be purged of groundwater as described in Section 5.3.1. Purge water will be handled as discussed in Section 5.6. The monitor wells will be sampled in the same order they are purged. Samples will be collected within 24-hours following purging, but typically the day of the purging activities. For slowly recharging wells, samples will be collected when sufficient water is present to fill the appropriate number of containers. If sufficient recharge does not occur within 7 days following purging, then the well will be considered dry and samples will not be collected. A notation will be recorded in the site operating plan explaining why the well(s) was not sampled. Recommended sample containers, preservation, and holding times for the analyses listed in this GWSAP are presented in Table 11.3. The sample containers will be filled in the following order:

1) VOCs,
2) semi-volatiles or other organics, if collected,
3) total metals and dissolved constituents, and
4) other inorganics.

Samples will not be filtered in the field. In the case of analysis for dissolved constituents, the sample will be filtered in the laboratory using a 0.45u membrane filter and will be preserved with an appropriate acid such as nitric acid.

The samples will either be collected off the pump discharge or decanted from the bottom of the bailers, if used. The containers for the VOCs will be tilted slightly during the filling process so that the water runs down the inside of the container. If a pump is used, the pump discharge will be regulated at the time of sampling so as to maintain a slow enough discharge rate as possible to minimize cascading and volatilization as the sample containers are being filled. Once the discharge rate is set for sampling, it will be maintained at that rate for a few minutes so that the sample collected will not be from the period of time when the pump was operating at a higher discharge rate. The sample containers will be held as close to the pump discharge as possible without touching to minimize the loss of volatiles. If bailers are used, the sample will be decanted from the bottom of the bailer using a stop-cock to regulate flow. Once the sampling program is initiated, the samples will be collected by the same method throughout the program.

Following the filling of each sample container, they will be labeled with the well number, date and time collected, preservatives used, analyses to be performed, and sampler's initials. The containers will be placed in zip-locked plastic bags. In addition, immediately after the sample is collected, the temperature, pH, and conductivity will be measured again in either a glass or stainless steel container or flow cell. The sample containers for each well will include as a minimum, two-40 milliliter VOA glass vials with Teflon® septa screw caps for volatile organic constituents (VOC), two-1 liter glass bottles for metals, and one-1 quart glass bottle with Teflon® septa screw caps for inorganic and semi-volatile constituents. Sample containers for VOCs (i.e., VOAs and quart glass bottles) will be completely filled and sealed carefully to

prevent air bubbles. To check for air bubbles, invert the sample container and lightly shake it. If an air bubble is present, then the sample will be discarded and the sample will be collected again. All other sample containers for non VOCs will be filled as completely as possible.

Once the samples have been properly sealed and labeled as described above, they will be recorded on a Chain-of-Custody (COC), signed and dated by the sampling technician(s). An example of a typical COC is presented in Appendix 11B. The COC will accompany the samples to the laboratory the same day they are collected. The readings for temperature, conductivity, and pH will be submitted to the laboratory with the samples. The samples will be placed in a plastic ice chest (similar to an igloo ice chest) with ice, and will be maintained as close as possible to 4 degrees centigrade until the analyses are performed. Precautions will be taken to secure the samples in the ice chest to prevent them from breaking during transport. The samples will be delivered to the laboratory as soon as possible, generally the same day they are collected, therefore it will not be necessary to preserve the samples in the field, except samples collected for dissolved constituent analyses. Any samples, other than the samples collected for dissolved constituent analyses, requiring overnight transport to the laboratory will be collected in pre-preserved sample bottles prepared and provided by the laboratory.

5.4 Quality Assurance and Quality Control Samples

To provide screening of field procedures, additional samples will be collected. A trip blank will be prepared by the laboratory and will also accompany the sample containers and collected samples to and from the laboratory. The trip blank will consist of filling two-40 milliliter VOA vials with appropriate liquid designated by the laboratory performing the analyses. The purpose of the trip blank is to assess whether any of the sample containers or collected samples have been impacted before or during sampling. At least one trip blank will be prepared for each shipment of sample containers. The equipment and trip blank samples will be handled in a similar fashion as the other samples and will be analyzed for VOCs. On occasion, blind duplicate samples will be collected to assess the precision of the sampling and laboratory methods. If duplicates are collected, the duplicate sample will be collected from the same bailer water as was used to fill the original sample.

Duplicate samples should not be collected off the pump discharge. If needed, additional samples can be obtained with a bailer for the purpose of collecting duplicate samples. The duplicate sample should be collected from the same bailer water used to fill the original sample containers. The blind samples will usually be collected from well(s) with the maximum concentrations of VOCs. When a blind sample is collected, it will be handled in a similar fashion as the other samples, but will be labeled in such a way that the laboratory does not know which sample is the duplicate for QA/QC purposes.

5.5 Sampling in Adverse Weather Conditions

Sampling of the monitor wells will not be permitted during inclement weather, sandstorms, or during periods when the temperature drops below freezing. Caution should be taken when the temperature exceeds 100 degrees Fahrenheit.

5.6 Purge Water Handling Procedures

Purge and decontaminated water will be collected in approved Department of Transportation (DOT) 55-gallon drums and stored onsite for subsequent disposal. The analytical data will be reviewed to determine the proper disposal procedures. If needed, the TCEQ will be consulted to assist in assessing proper disposal procedures. Purge and decontaminated water will be disposed at an approved licensed facility.

6.0 ANALYTICAL TESTING

6.1 Laboratory Performing the Analyses

Analysis of landfill samples will be performed by either a NELAC accredited environmental testing laboratory, or a non-accredited, in-house environmental testing laboratory meeting requirements of 30 TAC §25.1(9) and §25.6. Presently, samples are analyzed by an in-house laboratory, owned and operated by the City of Amarillo, which provides data only to City departments for environmental compliance and enforcement, and for permits or authorizations

issued to the City. In the event that the in-house laboratory ceases to qualify for the exception under 30 TAC §25.6, then the City will use a NELAC-accredited laboratory having fields of accreditation for the matrix, methods and analytes used for the landfill's monitoring program.

6.2 Laboratory Procedures

The laboratory will analyze samples according to methods specified in "Test Methods for Evaluating Solid Waste, Physical/Chemical Methods" (U. S. Environmental Protection Agency Publication Number SW-846), 3rd Edition, September 1986, as revised or updated, or by other equivalent or better methods accepted by the TCEQ.

The PQL is defined as the lowest concentration reliably achieved within specified limits of precision and accuracy during routine laboratory operating conditions and is analogous to the limit of quantitation definition in the most recent available National Environmental Laboratory Accreditation Conference (NELAC) Standard. The PQL is method, instrument, and analyte specific and may be updated as more data becomes available. The PQL must be below the groundwater protection standard established for that analyte as defined by 30 TAC Section 330.409(h) unless approved otherwise by the TCEQ. The precision and accuracy of the PQL shall be initially determined from the PQLs reported over the course of a minimum of eight groundwater monitoring events. The results obtained from these events shall be used to demonstrate that the PQLs meet the specified precision and accuracy as shown in the Table 11.4 below. The PQL will be supported by analysis of a PQL check sample, which is a laboratory reagent grade sample matrix spiked with chemicals of concern at concentrations equal to or less than the PQL. At a minimum, a PQL check sample will be performed quarterly during the calendar year to demonstrate that the PQL continues to meet the specified limits for precision and accuracy as defined in the table below.

For analytes that the established PQL cannot meet the precision and accuracy requirements in the table above, the owner/operator will ensure the laboratory will submit sufficient documentation and information to the TCEQ for alternate precision and accuracy limits on a case by case basis.

Non-detected results will be reported as less than the established PQL limit that meets these precision and accuracy requirements.

6.3 Data Review and Laboratory Case Narrative

All analytical data submitted under the requirements of this permit will be examined by the owner and/or operator to ensure that the data quality objectives are considered and met prior to submittal for the commission to review. The owner or operator will determine if the results represent the sample are accurate and complete. The quality control results, supporting data, and data review by the laboratory must be included when the owner/operator reviews the data. Any potential impacts will be reported such as the bias on the quality of the data, footnotes in the report, and anything of concern that was identified in the laboratory case narrative summary.

The owner or operator will ensure that the laboratory documents and reports all problems and observed anomalies associated with the analysis. If analysis of the data indicates that the data fails to meet the quality control goals for the laboratory's analytical data analysis program, the owner or operator will determine if the data is usable. If the owner and/or operator determines the analytical data may be utilized, any and all problems and corrective action that the laboratory identified during the analysis will be included in the report submitted to the TCEQ.

A Laboratory Case Narrative (LCN) report for all problems and anomalies observed must be submitted by the owner and/or operator. The LCN will report the following information:

1. The exact number of samples, testing parameters and sample matrix.
2. The name of the laboratory involved in the analysis. If more than one laboratory is used, all laboratories shall be identified in the case narrative.
3. The test objective regarding samples.
4. Explanation of each failed precision and accuracy measurement determined to be outside of the laboratory and/or method control limits.
5. Explanation if the effect of the failed precision and accuracy measurements on the results induces a positive or negative bias.

6. Identification and explanation of problems associated with the sample results, along with the limitations these problems have on data usability.

7. A statement on the estimated uncertainty of analytical results of the samples when appropriate and/or when requested.

8. A statement of compliance and/or noncompliance with the requirements and specifications. Exceedance of holding times and identification of matrix interferences must be identified. Dilutions shall be identified and if dilutions are necessary, they must be done to the smallest dilution possible to effectively minimize matrix interferences and bring the sample into control for analysis.

9. Identification of any and all applicable quality assurance and quality control samples that will require special attention by the reviewer.

10. A statement on the quality control of the analytical method of the permit and the analytical recoveries information shall be provided when appropriate and/or when requested.

In addition to the LCN, the following information must be submitted for all analytical data:

1. A table identifying the field sample name with the sample identification in the laboratory report.

2. Chain of custody.

3. An analytical report that documents the results and methods for each sample and analyte to be included for every analytical testing event. These test reports must document the reporting limit/method detection limit the laboratory used.

4. A release statement must be submitted from the laboratory. This statement must state "I am responsible for the release of this laboratory data package. This data package has been reviewed by the laboratory and is complete and technically compliant with the requirements of the methods used, except where noted by the laboratory in the attached exception reports. By my signature below, I affirm to the best of my knowledge, all problems/anomalies, observed by the laboratory as having the potential to affect the quality of the data, have been identified by the laboratory in the Laboratory Review Checklist, and no information or data have been knowingly withheld that would affect the quality of the data."

    a. If it is an in-house laboratory, it must have the following statement: "This laboratory is an in-house laboratory controlled by the person responding to rule. The official signing the cover page of the rule-required report (for example, the

APAR) in which these data are used is responsible for releasing this data package and is by signature affirming the above release statement is true."

5. If the data is from soil and/or sediment samples, it must be reported on a dry weight basis with the percent solids and the percent moisture reported so that any back calculations of the wet analysis may be preformed.

A laboratory review checklist shall be submitted with all groundwater analytical data documents. An example laboratory review checklist is presented in Appendix 11C. For every response of "No, NA, or NR" that is reported on the checklist, the permittee will ensure the laboratory provides a detailed description of the "exception report" in the summary of the LCN.

7.0 STATISTICAL METHODS

The groundwater monitoring data will be evaluated to determine statistically significant increases (SSIs) above background values for each constituent listed in Table 11.1. The statistical analyses will be performed in accordance with 31 TAC 330.407 (e) and (f), using commercially available software, such as SANITAS. The statistical method currently used following establishment of background data for the currently approved groundwater monitoring system (February 1995 through October 1996) consists of two methods. One method is a control chart (CUSUM) and the other method is intra-well parametric and non-parametric prediction limits (PL). The rationale for utilizing these methods was presented in HDR's October 9, 1997 response to comments letter to the TCEQ.

The Landfill may use statistical tests other than those approved by TCEQ in Section 330.405(e), provided that the test meets the performance standards of Section 330.405(f) and provided that a satisfactory justification has been submitted to the TCEQ.

Table 11.1: Detection Monitoring Constituents

Total Alkalinity
Arsenic
Barium
Total Dissolved Solids
Cadmium
Chromium
Cobalt
Copper
Lead
Nickel
Selenium
Sliver
Dissolved iron
Dissolved Manganese
Zinc
Ammonia

Acetone
Acrylonitrile
Benzene
Bromochloromethane
Bromodichloromethane
Bromoform
Carbon disulfide
Carbon tetrachloride
Chlorobenzene
Chloroethane
Chloroform
Dibromochloromethane
1,2-Dibromo-3-chloropropane
1,2-Dibromoethane
o-Dichlorobenzene,(1,2)
p-Dichlorobenzene (1,4)
trans- 1,4-Dichloro-2-butene
1,1-Dichloroethane
1,2-Dichloroethane
1, 1 -Dichloroethylene
cis-1,2-Dichloroethylene
trans- 1,2-Dichloroethylene
1,2-Dichloropropane
cis-1,3-Dichloropropene
trans-1,3-Dichloropropene
Ethylbenzene
2-Hexanone
Methyl bromide
Methyl chloride
Methylene bromide
Methylene chloride
Methyl ethyl ketone
Methyl iodide
4-Methyl-2-pentanone
Styrene
1,1,1,2-Tetrachloroethane
1,1,2,2-Tetrachloroethane
Tetrachloroethylene
Toluene
1,1,1-Trichloroethane
1,1,2-Trichloroethane
Trichloroethylene
Trichlorofluoromethane
1,2,3-Trichloropropane
Vinyl acetate
Vinyl chloride
Xylenes (total)

Table 11.2: Test Methods and Containers

CONSTITUENT	METHOD
Volatile Organic Constituents	8260B
Total Alkalinity	310.1, titration, sulfuric acid
Total Dissolved Solids	160.1
Arsenic	ICP 6010C, ICPMS 6020A
Barium	ICP 6010C, ICPMS 6020A
Cadmium	ICP 6010C, ICPMS 6020A
Chromium	ICP 6010C, ICPMS 6020A
Cobalt	ICP 6010C, ICPMS 6020A
Copper	ICP 6010C, ICPMS 6020A
Lead	ICP 6010C, ICPMS 6020A
Nickel	ICP 6010C, ICPMS 6020A
Selenium	ICP 6010C, ICPMS 6020A
Silver	ICP 6010C, ICPMS 6020A
Dissolved Iron	ICP 6010C, ICPMS 6020A
Dissolved Manganese	ICP 6010C, ICPMS 6020A
Zinc	ICP 6010C, ICPMS 6020A
Ammonia	350.3, ion electrode

Containers & Preservation

Volatiles - Method 8260B - 3, 40-ml VOA Vials)
Metals - Methods ICP 6010 and ICPMS 6020 - 2, 1-liter, plastic, kept cold; one preserved with HNO_3 to pH <2; one with no preservative.
Ammonia – Method 350.3 - 1, 500-ml, glass, preserved with H_2SO_4.

The above test methods are taken from EPA SW-846, Test Methods for Evaluating Solid Waste, Third Edition, Update IIIB, November 2004. All samples shall be analyzed by SW846 methods or other methods accepted by the TCEQ.

Table 11.3: Sample Containers, Preservation, and Holding Times

Parameter	Recommended Containers	Preservation	Maximum Holding Time	Minimum Volume
pH Spec. Cond. Temperature Heavy Metals (includes iron and manganese)	P,G P,G P,G P,G	None None None *Acidify w/$HN0_3$ to *pH<2, 4°C*	Analyze immediately Analyze immediately Analyze immediately 6 months except *28* days for Hg	*25* ml 100 ml 1 liter
Calcium, Magnesium, Sodium, Potassium, Fluoride, Sulfate, Chloride, and Hardness	P,G	*4°C*	*28* days	1 liter
Total Dissolved Solids (TDS) (may be included with above parameters)	P,G	*4°C*	7 days	1 liter
Nitrate	P,G	*4°C*	*48* hrs	100 ml
Ammonia	P,G	4°C; acidify*w/*H_2S0_4 to *pH<2, 4°C*	7 days; *28* days if acidified	500 ml
Alkalinity	P,G	4°C	*48* hrs	*200* ml
NPOC	G amber, T-lined caps	*4°C;* acidify *w/HC1* to *pH<2, 4°C*	*48* hrs; *28* days if acidified	100 ml/ replicate
Chemical Oxygen Demand (COD)	P,G	*4°C;* acidify w/H_2S0_4 to *pH<2, 4°C*	*48* hrs; *28* days if acidified	100 ml
Semi-volatile organic constituents (SVOC)	G, T-lined caps	*4°C*	7 days until extraction, then analyze within *40* days	1 liter
Biological Oxygen Demand (BOD)	P,G	*4°C*	*24* hrs	1 liter
Volatile Organic Constituents (VOCs)	G, T-lined septa	*4°C;* acidify *w/HC1 to pH<2, 4°C*	*14* days	*2 x 40* ml

P=Polyethylene, G=Glass, T=Teflon.
***If analyzing for dissolved metals, filter in the lab before acidifying.**

Table 11.4 QC Specification Limits for the PQL and Lower Limit of Quantitation Check Samples

COC	Precision (% RSD)	Accuracy (% Recovery)
Metals	10	70-130
Volatiles	20	50-150
Semi-volatiles	30	50-150

Appendix 11A: Groundwater Sampling Report, Form TCEQ-0312

TEXAS COMMISSION ON ENVIRONMENTAL QUALITY

Waste Permits Division, Municipal Solid Waste Permits Section
Groundwater Sampling Report

Facility name _____ **1. MSW permit no.** _____ (Essential Field)

Permittee _____ **2. Monitor well no.** _____ (Essential Field)

County _____ **3. Date of sampling** _____ (Essential Field)

Name of sampler _____ Most recent previous sampling _____

Affiliation of sampler _____ Date of water level measurements _____

If split-sampled, with whom? _____ Datum reference point _____

Integrity of well _____ Datum elevation* _____

Installation date _____ Depth to water (below datum)* _____

4. Water level elevation* _____

5. Purging/Sampling method _____ (enter Bailer or Pump)
Were low-flow methods used? [ ] yes [ ] no (check one)
If yes, what volume was purged? _____

6. Well volumes purged _____ (enter 1, 2, 2.5, 3, etc)

7. Was the well dry before purging? [ ] yes [ ] no (check one)

8. Was the well dry after purging? [ ] yes [ ] no (check one)

9. How long before sampling? _____ (enter time)

10. Unit of measure? _____ (days, hours, or mins)

11. Sample Event _____
(enter one of the selections below)
- Background
- Corrective Action
- Detection Monitoring
- Other
- Assessment

12. Sample Schedule _____
(enter one of the selections below)
- Quarterly
- Fourth Year
- Semi-Annual
- Other
- Annual

13. Sample Type _____
(enter one of the selections below)
- Regular
- Split
- Duplicate
- Other
- Resample

Field Measurements: 14. pH _____

15. Spec. cond. _____ 16. [ ] umho/cm or [ ] mmho/cm (check one)

17. Temp. _____ 18. [ ] °F or [ ] °C (check one)

Laboratory: 19. Name _____ Phone _____

Address _____

Representative _____
(name) (signature) (date)

Site operator or representative: _____
(name) (signature) (date)

***Report depth to water and elevations to nearest 0.01 foot relative to mean sea level (MSL).**

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TEXAS COMMISSION ON ENVIRONMENTAL QUALITY

Waste Permits Division, Municipal Solid Waste Permits Section
Groundwater Sampling Report

HEAVY METALS

CONSTITUENT			CONCENTRATION		REPORTING LIMITS[3]		METHOD
Antimony	T[1]	D[2]	_____	µg/l	_____	µg/l	_____
Arsenic	T	D	_____	µg/l	_____	µg/l	_____
Barium	T	D	_____	µg/l	_____	µg/l	_____
Beryllium	T	D	_____	µg/l	_____	µg/l	_____
Cadmium	T	D	_____	µg/l	_____	µg/l	_____
Chromium	T	D	_____	µg/l	_____	µg/l	_____
Cobalt	T	D	_____	µg/l	_____	µg/l	_____
Copper	T	D	_____	µg/l	_____	µg/l	_____
Lead	T	D	_____	µg/l	_____	µg/l	_____
Mercury	T	D	_____	µg/l	_____	µg/l	_____
Nickel	T	D	_____	µg/l	_____	µg/l	_____
Selenium	T	D	_____	µg/l	_____	µg/l	_____
Silver	T	D	_____	µg/l	_____	µg/l	_____
Thallium	T	D	_____	µg/l	_____	µg/l	_____
Vanadium	T	D	_____	µg/l	_____	µg/l	_____
Zinc	T	D	_____	µg/l	_____	µg/l	_____
Iron	T	D	_____	mg/l	_____	mg/l	_____
Manganese	T	D	_____	mg/l	_____	mg/l	_____

[1, 2] Indicate whether analyses for Total (T) or Dissolved (D); use two pages if both are run. If analyses for dissolved concentrations, indicate filter pore size [ ] 0.45, [ ] 1, [ ] 10, [ ] ___ micron, and whether filtered [ ] in field or [ ] in laboratory.

[3] Indicate if reporting limits are _____ PQLs or _____ MDLs.

TEXAS COMMISSION ON ENVIRONMENTAL QUALITY

Waste Permits Division, Municipal Solid Waste Permits Section
Groundwater Sampling Report

VOLATILE ORGANIC COMPOUNDS (VOCs)[1]

CONSTITUENT	CONCENTRATION (ug/L)	REPORTING LIMIT (ug/L)[2]	METHOD	CAS NO.
Acetone				67-64-1
Acrylonitrile				107-13-1
Benzene				71-43-2
Bromochloromethane				74-97-5
Bromodichloromethane				75-27-4
Bromoform				75-25-2
Carbon disulfide				75-15-0
Carbon tetrachloride				56-23-5
Chlorobenzene				108-90-7
Chloroethane				75-00-3
Chloroform				67-66-3
Dibromochloromethane				124-48-1
1,2-Dibromo-3-chloropropane				96-12-8
1,2-Dibromoethane				106-93-4
o-Dichlorobenzene (1,2)				95-50-1
p-Dichlorobenzene (1,4)				106-46-7
trans-1,4-Dichloro-2-butene				110-57-6
1,1-Dichloroethane				75-34-3
1,2-Dichloroethane				107-06-2
1,1-Dichloroethylene				75-35-4
cis-1,2-Dichloroethylene				156-59-2
trans-1,2-Dichloroethylene				156-60-5
1,2-Dichloropropane				78-87-5
cis-1,3-Dichloropropene				10061-01-5
trans-1,3-Dichloropropene				10061-02-6
Ethylbenzene				100-41-4
2-Hexanone				591-78-6
Methyl bromide				74-83-9
Methyl chloride				74-87-3
Methylene bromide				74-95-3
Methylene chloride				75-09-2
Methyl ethyl ketone				78-93-3
Methyl iodide				74-88-4
4-Methyl-2-pentanone				108-10-1
Styrene				100-42-5
1,1,1,2-Tetrachloroethane				630-20-6
1,1,2,2-Tetrachloroethane				79-34-5
Tetrachloroethylene				127-18-4
Toluene				108-88-3
1,1,1-Trichloroethane				71-55-6
1,1,2-Trichloroethane				79-00-5
Trichloroethylene				79-01-6
Trichlorofluoromethane				75-69-4
1,2,3-trichloropropane				96-18-4
Vinyl acetate				108-05-4
Vinyl chloride				75-01-4
Xylenes (total)				1330-20-7

[1] **Samples for VOCs must not be filtered.**
[2] **Indicate if reporting limits are _____ PQLs or _____ MDLs.**

TEXAS COMMISSION ON ENVIRONMENTAL QUALITY

Waste Permits Division, Municipal Solid Waste Permits Section
Groundwater Sampling Report

OTHER CONSTITUENTS

CONSTITUENT[1]	CONCENTRATION[2]	REPORTING LIMIT[2,3]	METHOD

[1] Indicate whether analyses for Total (T) or Dissolved (D) concentrations. If analyses for dissolved concentrations, indicate filter pore size [ ] 0.45, [ ] 1, [ ] 10, [ ] __ micron, and whether filtered [ ] in field or [ ] in laboratory.

[2] Indicate if reporting limits are _____ PQLs or _____ MDLs.

[3] Show units of concentration and reporting limit.

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Appendix 11B: Chain of Custody Form

CITY OF AMARILLO

MUNICIPAL SOLID WASTE LANDFILL
PERMIT NO. 73

CHAIN OF CUSTODY RECORD

Sampler:
(signature) _____

(printed) _____

Laboratory: _____

Address: _____

Sample ID No.	Sampling		Description	No. of Cont.	Remarks
	Date	Time			

Relinquished by: (signature)	Date	Time	Received by: (signature)
(printed)			(printed)

Relinquished by: (signature)	Date	Time	Received by: (signature)
(printed)			(printed)

Appendix 11C: Example Laboratory Checklist

Laboratory Data Package Cover Page

This data package consists of:

- ☐ This signature page, the laboratory review checklist, and the following reportable data:
- ☐ R1 Field chain-of-custody documentation;
- ☐ R2 Sample identification cross-reference;
- ☐ R3 Test reports (analytical data sheets) for each environmental sample that includes:
  a) Items consistent with NELAC 5.13 or ISO/IEC 17025 Section 5.10
  b) dilution factors,
  c) preparation methods,
  d) cleanup methods, and
  e) if required for the project, tentatively identified compounds (TICs).
- ☐ R4 Surrogate recovery data including:
  a) Calculated recovery (%R), and
  b) The laboratory's surrogate QC limits.
- ☐ R5 Test reports/summary forms for blank samples;
- ☐ R6 Test reports/summary forms for laboratory control samples (LCSs) including:
  a) LCS spiking amounts,
  b) Calculated %R for each analyte, and
  c) The laboratory's LCS QC limits.
- ☐ R7 Test reports for project matrix spike/matrix spike duplicates (MS/MSDs) including:
  a) Samples associated with the MS/MSD clearly identified,
  b) MS/MSD spiking amounts,
  c) Concentration of each MS/MSD analyte measured in the parent and spiked samples,
  d) Calculated %Rs and relative percent differences (RPDs), and
  e) The laboratory's MS/MSD QC limits
- ☐ R8 Laboratory analytical duplicate (if applicable) recovery and precision:
  a) the amount of analyte measured in the duplicate,
  b) the calculated RPD, and
  c) the laboratory's QC limits for analytical duplicates.
- ☐ R9 List of practical quantitation limits (PQLs) for each analyte for each method and matrix;
- ☐ R10 Other problems or anomalies.
- ☐ The Exception Report for every "No" or "Not Reviewed (NR)" item in laboratory review checklist.

Release Statement: I am responsible for the release of this laboratory data package. This data package has been reviewed by the laboratory and is complete and technically compliant with the requirements of the methods used, except where noted by the laboratory in the attached exception reports. By my signature below, I affirm to the best of my knowledge, all problems/anomalies, observed by the laboratory as having the potential to affect the quality of the data, have been identified by the laboratory in the Laboratory Review Checklist, and no information or data have been knowingly withheld that would affect the quality of the data.

Check, if applicable: ☐ This laboratory is an in-house laboratory controlled by the person responding to rule. The official signing the cover page of the rule-required report (for example, the APAR) in which these data are used is responsible for releasing this data package and is by signature affirming the above release statement is true.

Name (Printed)	Signature	Official Title (printed)	Date

Laboratory Review Checklist: Reportable Data

Laboratory Name:	LRC Date:
Project Name:	Laboratory Job Number:
Reviewer Name:	Prep Batch Number(s):

#[1]	A[2]	Description	Yes	No	NA[3]	NR[4]	ER#[5]
R1	OI	**Chain-of-custody (C-O-C)**					
		Did samples meet the laboratory's standard conditions of sample acceptability upon receipt?					
		Were all departures from standard conditions described in an exception report?					
R2	OI	**Sample and quality control (QC) identification**					
		Are all field sample ID numbers cross-referenced to the laboratory ID numbers?					
		Are all laboratory ID numbers cross-referenced to the corresponding QC data?					
R3	OI	**Test reports**					
		Were all samples prepared and analyzed within holding times?					
		Other than those results < PQL, were all other raw values bracketed by calibration standards?					
		Were calculations checked by a peer or supervisor?					
		Were all analyte identifications checked by a peer or supervisor?					
		Were sample quantitation limits reported for all analytes not detected?					
		Were all results for soil and sediment samples reported on a dry weight basis?					
		Were % moisture (or solids) reported for all soil and sediment samples?					
		If required for the project, TICs reported?					
R4	O	**Surrogate recovery data**					
		Were surrogates added prior to extraction?					
		Were surrogate percent recoveries in all samples within the laboratory QC limits?					
R5	OI	**Test reports/summary forms for blank samples**					
		Were appropriate type(s) of blanks analyzed?					
		Were blanks analyzed at the appropriate frequency?					
		Were method blanks taken through the entire analytical process, including preparation and, if applicable, cleanup procedures?					
		Were blank concentrations < PQL?					
R6	OI	**Laboratory control samples (LCS):**					
		Were all COCs included in the LCS?					
		Was each LCS taken through the entire analytical procedure, including prep and cleanup steps?					
		Were LCSs analyzed at the required frequency?					
		Were LCS (and LCSD, if applicable) %Rs within the laboratory QC limits?					
		Does the detectability data document the laboratory's capability to detect the COCs at the MDL used to calculate the SQLs?					
		Was the LCSD RPD within QC limits?					
R7	OI	**Matrix spike (MS) and matrix spike duplicate (MSD) data**					
		Were the project/method specified analytes included in the MS and MSD?					
		Were MS/MSD analyzed at the appropriate frequency?					
		Were MS (and MSD, if applicable) %Rs within the laboratory QC limits?					
		Were MS/MSD RPDs within laboratory QC limits?					
R8	OI	**Analytical duplicate data**					
		Were appropriate analytical duplicates analyzed for each matrix?					
		Were analytical duplicates analyzed at the appropriate frequency?					
		Were RPDs or relative standard deviations within the laboratory QC limits?					
R9	OI	**Practical quantitation limits (PQLs):**					
		Are the PQLs for each method analyte included in the laboratory data package?					
		Do the PQLs correspond to the concentration of the lowest non-zero calibration standard?					
		Are unadjusted PQLs included in the laboratory data package?					
R10	OI	**Other problems/anomalies**					
		Are all known problems/anomalies/special conditions noted in this LRC and ER?					
		Were all necessary corrective actions performed for the reported data?					
		Was applicable and available technology used to lower the SQL minimize the matrix interference affects on the sample results?					

1. Items identified by the letter "R" must be included in the laboratory data package submitted in required report(s). Items identified by the letter "S" should be retained and made available upon request for the appropriate retention period.
2. = organic analyses; I = inorganic analyses (and general chemistry, when applicable);
3. NA = Not applicable; and NR = Not reviewed;
4. ER# = Exception Report identification number (an Exception Report should be completed for an item if "NR" or "No" is checked on the LRC)

Laboratory Review Checklist: Reportable Data								
Laboratory Name:			LRC Date:					
Project Name:			Laboratory Job Number:					
Reviewer Name:			Prep Batch Number(s):					
#[1]	A[2]	Description	Yes	No	NA[3]	NR[4]	ER#[5]	
S1	OI	**Initial calibration (ICAL)**						
		Were response factors and/or relative response factors for each analyte within QC limits?						
		Were percent RSDs or correlation coefficient criteria met?						
		Was the number of standards recommended in the method used for all analytes?						
		Were all points generated between the lowest and highest standard used to calculate the curve?						
		Are ICAL data available for all instruments used?						
		Has the initial calibration curve been verified using an appropriate second source standard?						
	OI	**Initial and continuing calibration verification (ICCV and CCV) and continuing calibration**						
		Was the CCV analyzed at the method-required frequency?						
		Were percent differences for each analyte within the method-required QC limits?						
		Was the ICAL curve verified for each analyte?						
		Was the absolute value of the analyte concentration in the inorganic CCB < MDL?						
	O	**Mass spectral tuning:**						
		Was the appropriate compound for the method used for tuning?						
		Were ion abundance data within the method-required QC limits?						
	O	**Internal standards (IS):**						
		Were IS area counts and retention times within the method-required QC limits?						
S5	OI	**Raw data (NELAC section 1 appendix A glossary, and section 5.12 or ISO/IEC 17025 section 4.12.2)** ***(ONLY USE DATA FOR EPA LEVEL 3 QA/QC REVIEW, IF RAW DATA NOT APPLICABLE, THEN CHANGE APPROPRIATELY).***						
		Were the raw data (for example, chromatograms, spectral data) reviewed by an analyst?						
		Were data associated with manual integrations flagged on the raw data?						
	O	**Dual column confirmation**						
		Did dual column confirmation results meet the method-required QC?						
	O	**Tentatively identified compounds (TICs):**						
		If TICs were requested, were the mass spectra and TIC data subject to appropriate checks?						
	I	**Interference Check Sample (ICS) results:**						
		Were percent recoveries within method QC limits?						
	I	**Serial dilutions, post digestion spikes, and method of standard additions**						
		Were percent differences, recoveries, and the linearity within the QC limits specified in the method?						
	OI	**Method detection limit (MDL) studies**						
		Was a MDL study performed for each reported analyte?						
		Is the MDL either adjusted or supported by the analysis of DCSs?						
	OI	**Proficiency test reports:**						
		Was the laboratory's performance acceptable on the applicable proficiency tests or evaluation studies?						
	OI	**Standards documentation**						
		Are all standards used in the analyses NIST-traceable or obtained from other appropriate sources?						
	OI	**Compound/analyte identification procedures**						
		Are the procedures for compound/analyte identification documented?						
	OI	**Demonstration of analyst competency (DOC)**						
		Was DOC conducted consistent with NELAC Chapter 5C or ISO/IEC 4?						
		Is documentation of the analyst's competency up-to-date and on file?						
	OI	**Verification/validation documentation for methods** (NELAC Chap 5 or ISO/IEC 17025 Section 5)						
		Are all the methods used to generate the data documented, verified, and validated, where applicable?						
	OI	**Laboratory standard operating procedures (SOPs):**						
		Are laboratory SOPs current and on file for each method performed?						

1 Items identified by the letter "R" should be included in the laboratory data package submitted to the TCEQ in the required report(s). Items identified by the letter "S" should be retained and made available upon request for the appropriate retention period.

2 O = organic analyses; I = inorganic analyses (and general chemistry, when applicable).

3 NA = Not applicable.

4 NR = Not Reviewed.

5 ER# = Exception Report identification number (an Exception Report should be completed for an item if "NR" or "No" is checked).

Appendix A (cont'd): Laboratory Review Checklist: Exception Reports

Laboratory Name:	LRC Date:
Project Name:	Laboratory Job Number:
Reviewer Name:	Prep Batch Number(s):

ER #[1]	DESCRIPTION

ER# = Exception Report identification number (an Exception Report should be completed for an item if "NR" or "No" is checked on the LRC

Appendix 11D: Site Safety Plan

This Site Safety Plan has been presented herein to provide guidance when conducting groundwater and sampling activities at the site. Any other site specific health and safety procedures prepared by the City of Amarillo shall be adhered to. Personnel designated to perform the groundwater monitoring and sampling program should be trained in the operation, maintenance, and calibration of the sampling equipment. There should be two people at all times performing the monitoring and sampling activities. At the end of this plan is a site map that shows the well locations, routing to and from the wells, and entrance/exit to the facility. In case of emergency, it is recommended that all personnel meet at the landfill office located on the western side of the landfill, unless a specific location has been selected by the City of Amarillo management. The following safety precautions are recommended:

- During the monitoring and sampling activities, smoking and eating will **not** be permitted. These activities should only be permitted in designated areas and after washing hands with soap and water.
- At a minimum Level D protection should be worn at all times. Because groundwater is involved with this activity the protective gear should at least consist of coveralls, gloves, safety glasses or goggles, boots, and hard hat.
- Because the potential for methane and other gases to build-up in the monitor wells, extra precaution should be taken when opening monitor wells that have been closed for a period of time. Any equipment that may be a spark hazard should be removed from the area before opening the well. It is recommended to have a methane monitoring device, i.e. explosimeter, during sampling to monitor the air space around the well head prior to opening the well. If concentrations are within five percent or greater by volume of methane, then the well should be vented until readings decrease to zero.
- While working around the wells, an adequate working area should be maintained to allow free movement. In heavy traffic areas, the working area should be delineated with barriers or caution tape. Personnel should be aware of construction equipment and refuse trucks around the area at all times. In areas that are obstructed from view, adequate signs should be posted to warn on-coming vehicles that personnel are working in the area and that caution should be taken.

Since many of the constituents being analyzed are considered carcinogens, Material Safety Data Sheets (MSDS) should be posted at the facility and consulted on a regular basis. For this type of work the primary exposure routes will be by ingestion and skin absorption. Therefore, extra precaution should be given to avoid coming into contact with groundwater that is potentially impacted with volatile organic constituents. Personnel should thoroughly wash their hands with soap and water after completing the sampling activities and before they leave the site.

Part III

Attachment 12

Final Closure Plan

Permit – MSW No. 73A

City of Amarillo,
Potter County, Texas

July 2009

7-15-2009

This document is released for the purpose of review only under the authority of Michael W. Oden, P.E. # 67165. It is not to be used for bidding or construction. Firm Registration No. F-754

For pages i thru i

City of Amarillo
Landfill Permit – Part III, Attachment 12
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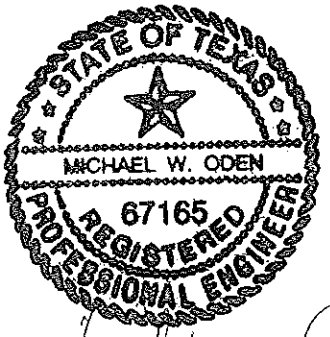
7-15-2009



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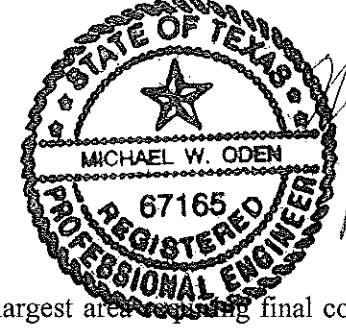

7-15-2009

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7.0 ESTIMATED COSTS

Table III.12.1 summarizes the estimated costs for final closure of the largest area requiring final cover. The unit costs used are based on recent projects and prices. The estimated costs will be updated annually or as required to reflect any increased or decreased costs in construction or materials or the closure of particular cells. A copy of the revised closure costs will be submitted to the Commission.

Table III.12.1: Closure Costs
CITY OF AMARILLO LANDFILL
COST ESTIMATE FOR CLOSURE OF THE LARGEST AREA
(LARGEST AREA ESTIMATED AT 526 ACRES)
MSW Permit No. 73A

Item	Quantity	Unit	Unit Cost	Total
Engineering				
Topo Survey	1	LS*	$7,500	$7,500
Boundary Survey	40	HR	$80	$3,200
Site Evaluation and Development of Plans	1	LS	$25,000	$25,000
Closure Plan	1	LS	$10,000	$10,000
Construction Observation/Testing	400	HR	$75	$30,000
Subtotal				$75,700
Contingency	20%			$15,140
Total Engineering				**$90,840**
Construction				
Plug and Abandon Wells	22	EA	$8,000	$176,000
Plug and Abandon Piezometers	5	EA	$5,000	$25,000
Fill to grade	1,129,333	CY	$2.00	$2,258,667
Infiltration Layer (12 inches)				
Placing/grading/compaction	848,013	CY	$1.50	$1,272,020
Erosion/Vegetative Layer (24 inches)	1,697,227	CY	$1.50	$2,545,840
Vegetation	526	ACRE	$1,000.00	$526,000
Backfill/grading/drainage	1	LS	$100,000.00	$100,000
Methane Gas Control Wells	10	EA	$1,000.00	$10,000
Subtotal				$6,913,526
Contingency	20%			$1,382,705
Total Construction				**$8,296,231**
Total Closure Costs (2005)				**$8,387,071**
5% increase for 2006				**$8,806,425**
5% increase for 2007				**$9,246,746**
5% increase for 2008				**$9,709,084**

Modified Text – Redline/Strikeout version

Part III

Attachment 5

Groundwater Characterization Report

Permit - MSW No. 73A
Issued August 22, 2007

City of Amarillo,
Potter County, Texas

Revised ~~March 2009~~July 2009

Donald D. James, P.G.

Michael M. Shiflett, P.E.

~~Signature and Seal are for Pages i through 13 only~~

City of Amarillo Landfill
Part III, Attachment 5

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- Groundwater Contour Map, October 16, 1995
- Groundwater Contour Map, April 15, 1997

Appendix 5B – Updated Hydrogeologic Information (continued)

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- Groundwater Contour Map, April 17, 2000
- Groundwater Contour Map, October 16, 2001
- Groundwater Contour Map, April 14, 2003
- Groundwater Contour Map, October 18, 2004
- Groundwater Contour Map, October 17, 2005
- Groundwater Contour Map, April 18, 2006
- Groundwater Contour Map, April 18, 2007
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- Groundwater Contour Map, March 18, 2008
- Groundwater Contour Map, August 14, 2008
- Groundwater Contour Map, November 19, 2008
- Groundwater Contour Map, January 12, 2009
- Groundwater Contour Map, April 13, 2009
- Structural Surface Contour Map of the Triassic Dockum Formation
- Kleinfelder Logs of Borings 203 and 204 with Piezometer Construction Detail
- Monitoring Well Data Sheet and Logs

OVERVIEW OF ATTACHMENT 5 INFORMATION

The City of Amarillo plans to vertically expand its landfill. The waste footprint of the proposed landfill will be identical to the footprint that the TNRCC (now TCEQ) originally approved in 1975 and reviewed again as part of the Alternate Liner Demonstration (ALD) submitted in compliance with the requirements of the RCRA Subtitle D upgrades. The ALD provided for utilizing a flexible membrane liner including a geosynthetic clay liner (FML/GCL). Additionally, the original permit (granted July 2, 1975) had no provision for limiting the depth of excavation. The 1994 Subtitle D upgrade prepared by HDR provided excavation grades for a portion of Cell 4, with the other cells indicating excavation depths. To comply with TCEQ rule changes made March 2006, this permit has been modified.

For this permit modification the hydrogeologic information that is contained in the 1994 Alternate Liner Demonstration (see Appendix 5B) and contained in the 2005 permit amendment has been reviewed. The 1994 Alternate Liner Demonstration interprets the field permeability tests, water level measurements, hydrogeologic units, potentiometric surface, recharge/discharge mechanisms, and groundwater flow regime (including groundwater flow and velocity) of the regional and site geology and the site subsurface data. The information contained in the 1994 report remains applicable to this permit amendment.

Groundwater flow direction and gradients from 2008 data are similar to those interpreted from the 1994 and 2005 data. The recent groundwater measurements indicates the Ogallala aquifer has lowered as much as 1 foot from the 2005 measurements and from 4 to 6 feet lower in elevation than measured in 1994, over the southern half of the site. Six groundwater-monitoring wells have been used for compliance monitoring.

As a portion of the 2005 permit amendment, four additional geotechnical borings were drilled. Borings 201 and 202 were drilled June 7 and 8, 2005 in the northeastern portion of the permitted area. The purpose of these borings was to retrieve soil samples and to review stratigraphic information with existing subsurface information (see Attachment 4 for discussion). Recovered

soil samples were used for further analysis regarding landfill foundation settlement as presented in Attachment 4, 2005 permit document. Borings 203 and 204 were drilled on September 7 and 8, 2005 in the western portion of the permitted area in order to install piezometers, and to gather additional groundwater information.

The groundwater characterization information from the 1994 permit documents is attached and incorporated in its entirety as Appendix 5A to this updated 2005 report. Appendix 5B to this 2008 report contains an updated site plan with monitoring well locations including twenty two new monitoring wells, the revised monitoring well network details, updated groundwater elevations, potentiometric surface map, and updated monitoring well data.

Attachment 5 Appendices

Appendix 5A – Limited Groundwater Characterization Investigation (1994 permit documents)

- 1994 Limited Groundwater Characterization Investigation with attachments

Appendix 5B – Updated Hydrogeologic Information ~~(2008)~~

- ~~2008 Site Plan With~~ Existing and Proposed Monitoring Well Locations
- ~~2008 Site Plan With Existing Monitoring Well Locations~~
- ~~2000 through September 2008 Groundwater Elevations Summary~~
  - ~~Tabular Format Groundwater Elevations~~
  - ~~Graphical Format Groundwater Elevations~~
- Typical Monitoring Well Detail
- Proposed Monitoring Well Network
- Groundwater Elevation Summary, September 1994 to April 13, 2009
- Groundwater Contour Map with Directional Flow and Point of Compliance
- Groundwater Contour Map, November 9, 1994
- Groundwater Contour Map, April 14, 1995
- Groundwater Contour Map, October 16, 1995
- Groundwater Contour Map, April 15, 1997

- Groundwater Contour Map, October 14, 1998
- Groundwater Contour Map, April 17, 2000
- Groundwater Contour Map, October 16, 2001

~~Appendix 5B – Updated Hydrogeologic Information (2008) (continued)~~

- Groundwater Contour Map, April 14, 2003

Appendix 5B – Updated Hydrogeologic Information (2008) (continued)

- Groundwater Contour Map, October 18, 2004
- Groundwater Contour Map, October 17, 2005
- Groundwater Contour Map, April 18, 2006
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- Monitoring Well Data Sheet and Logs

1.0 GROUNDWATER MONITORING SYSTEM

The groundwater monitoring system plan currently in place at the site was approved by TNRCC (TCEQ) in a letter dated March 28, 1995. Subsequent approval was made by the TCEQ for the December 2005 permit amendment for the groundwater monitoring system additions. The entire records of monitoring well installations are on file with the TCEQ. The current monitoring well network consists of six locations labeled MW-1 through MW-6. Piezometers labeled PZ-1, PZ-2, and PZ-3 (drilled July through August 1994) were converted to Monitoring Wells 7, 8, and 9 respectively, and are located interior of the landfill boundary. Monitoring Wells 10, 11, 12, and 13 (drilled October through November 1999) were subsequently constructed south of Monitoring Wells 7 and 8, but north of the southern landfill boundary. Since Monitoring Wells 7 through 13 are interior of the site, but outside the current fill areas, these wells are not the monitoring wells of record, but have been used for recording groundwater data.

For this permit modification and in compliance with the March 2006 TCEQ rule changes, the current monitoring well network is proposed to be replaced with a new network of twenty two (22) new monitoring wells. To spare confusion with previously documented borings and wells the new monitoring wells are to be numbered in an "800" series to relate to this 2008/2009 modification. Plate 1 of Appendix 5B presents the existing and proposed monitoring well locations.

An updated construction detail and table for the updated, proposed ~~e~~ monitoring well network is included in Appendix 5B, Plates 2 and 3. The table presented on Plate 3~~2~~, Appendix 5B, presents monitoring well designations and elevations for screened interval, filter pack, bentonite seal, and bottom of well for the proposed new monitoring well network. A discussion regarding Plate 3, Proposed Monitoring Well Network Screen Interval Elevations, is presented in Section 4.0. ~~See Section 4.0 Monitoring Well Screened Interval for the discussion regarding Plate 3. Monitoring wells MW-5 and MW-6 are the existing upgradient wells, while the remaining monitoring wells provide sampling points for downgradient samples. The locations of the monitoring wells across the landfill are presented on Plate 1, Appendix 5B.~~ A plan to add

seven additional proposed monitoring wells (MW-14 through MW-20) was proposed for the 2005 permit amendment butand is supercededsuperseded through this permit modification. For this permit modification and in compliance with the March 2006 TCEQ rule changes all of the current monitoring well network is proposed to be replaced with a new network of twenty two (22) new monitoring wells. To spare confusion with previously documented borings and wells the new monitoring wells are to be numbered in an "800" series to relate to this 2008 modification.

The existing monitoring wells are currently being sampled semi-annually according to the Groundwater Sampling and Analysis Plan (GWSAP). Each monitoring well has been verified by visual observations for the 2005 Amendment as to general location. The surface completions including caps, pads, and guard posts are in acceptable condition. The monitoring well sampling events continue to document that each well is functioning as intended.

The depths to groundwater within the monitoring wells are measured for each sampling event. The elevation of the groundwater as determined from these measurements is summarized in tabular form presented on Plates 4 and 5 3, Appendix 5B. These groundwater elevations have been presented in graphical form on Plate 4 and Plate 5, in Appendix 5B, in order to observe trends in the groundwater elevations, particularly as they relate to flow direction and gradient.

The trend in the saturated thickness of each existing monitoring locationwell screen is a thinning of the saturated zone.appears to be declining overall. The trend is due to increased groundwater usage throughout the region (i.e., not associated with Amarillo Landfill) resulting in a general decline in the groundwater elevations and differing recharge rates to the aquifer from localized percolation and permeability. The soils overlying the saturated zone of the Ogallala provide an unsaturated layer above the deeper water table. No shallow perched water tables within the unsaturated zone have been encountered beneath the landfill. The presence of the unsaturated zone is consistent with regional hydrogeology information.

Each of the six existing network monitoring wells continues to provide samples from screened well sections within the saturated zone of the Ogallala. The depths of sampling within the wells will continue to be monitored at each sampling event. The current monitoring well network continues to function effectively, but will be replaced as discussed in the following sections~~...~~. ~~However, twenty two (22) new monitoring wells are proposed as discussed in Section 3 of this Attachment 5.~~

2.0 POTENTIOMETRIC SURFACE

The existing monitoring wells indicate similar trends of increasing and decreasing groundwater elevations among all well locations for each sampling event. As interpreted from the groundwater measurements, the potentiometric surface continues to generally descend from the north to the south. Consistent with 1994, the 2008/2009 groundwater gradient is approximately twice as steep in the northeastern one-third of the site as compared to the southwestern two-thirds of the site. Additionally, a south-southwesterly trending hydraulic ridge is interpreted in the northeastern portion of the site locally forming radial flow to the southwest and southeast.

The 2008/2009 groundwater elevation trends indicate a continued decrease (lower) in the potentiometric surfaces since 2005. Decreases range from one foot along the northern perimeter of the site to ½-foot along the southern perimeter of the site. Saturated thicknesses of the Ogallala Aquifer estimated from the potentiometric surfaces down to the top of the Triassic Dockum formation (Plate ~~7B~~25, Appendix 5B) show thicknesses to be less than 2 feet along the northern perimeter and from approximately 47 to 55 feet along the southern perimeter. A chronology of groundwater elevation data for this site indicates a trend of thinning saturated thickness of the Ogallala aquifer. Regional and national data show this to be the trend for the entire Ogallala aquifer.

Two additional deep borings were drilled during the~~is~~ 2005 Permit Amendment and converted to standpipe piezometers. The borings/piezometers have been designated as B-203 and B-204 and are located along the western side of the permitted landfill. Including the groundwater elevation data from 203 and 204 along with the other monitoring locations, the potentiometric surface has been updated and presented as groundwater contour maps as presented on Plates 18 through 24~~5~~, Appendix 5B~~.~~. These groundwater maps provide the more recent historic data from the site. Groundwater contour maps presented upon Plates 7 through 17 provide the older historic data for comparison. Groundwater flow paths for 2008/2009 are similar to those estimated for 2005 and continue to generally indicate the northern and the northern two-thirds of the western boundaries of the landfill are upgradient for the permitted site. These supplemental groundwater elevation

points indicate the equipotential lines within the western quarter of the site bend slightly toward the southeast along the northern two-thirds ~~¾~~ of the western boundary, and flow direction approximately parallel ~~orthogonal or neutral~~ to the site boundary within the southern one-third ~~¼~~ of the western boundary. The eastern boundary of the landfill area has maintained a relatively consistent potentiometric surface since 1994. The eastern boundary of the landfill continues to show a slight southeastern groundwater vector, which places the eastern boundary as downgradient to the permitted site, although groundwater flow encountering the eastern boundary has a narrow site entry area east of existing Monitoring Well 5.

The groundwater elevation trends indicate that a slight decrease (lower) in the potentiometric surfaces since 1994, especially in the southern half of the site. This is consistent with the regional groundwater information published by the High Plains Underground Water Conservation District No. 1. The groundwater measuring locations (monitoring wells) confirm groundwater elevation trends and flow directions similar to those measured in 1994 and also measured within the monitoring wells during sampling events since 1994.

3.0 MONITORING WELL LOCATIONS

The existing monitoring well locations were verified in the field. The groundwater data trends indicate that variations in the groundwater elevations within the monitoring wells are similar across the networkk ~~(see Plate 4, Appendix 5B)~~. This indicates that groundwater flow directions and gradients continue to descend southward. Therefore, the existing monitoring well network continues to monitor both upgradient and downgradient locations as intended. However, a review of well configurations and the thinning of the aquifer saturated thickness has lead the City to desire to upgrade the entire monitoring well network for the site as a part of this modification.

Boring logs for the wells and the on-going groundwater measurements confirm the presence of groundwater within a single hydrogeologic unit (Ogallala) as interpreted by the 1994 permit document. There are no interpreted shallow, perched water pockets above the saturated zone of the Ogallala within the permitted area.

Subchapter J of the TAC Title 30 2006 revisions require that a facility have a point of compliance monitoring network with well spacing not to exceed 600 feet and for the detection of groundwater contamination in the uppermost aquifer at the point of compliance (vertical surface located no more than 500 feet from the hydraulically downgradient waste management boundary). The point of compliance is designated along the southern, ~~and~~ eastern, and southern one-third of the western permit boundaries as ~~(~~depicted on Plates 1 and 6, App. 5B,~~)~~ and is the first time the point of compliance has been designated for this landfill site. Groundwater measurements from 2005 to 2009~~8~~ consistently indicate inward gradients along the entire northern and northern two-thirds~~¾~~ of the western side~~perimeter~~ of the site. The southern one-third~~¼~~ of the western perimeter of the site has pressure~~flow~~ gradients approximately orthogonal, that is, groundwater flow direction parallel to the site boundary. ~~or neutral to the site boundary~~ Based on the flow paths, the entire eastern and southern boundaries~~perimeters~~ of the site are indicated to be within outward gradients from the site. Since there are no perched water tables at the site, the monitoring wells are each deep wells placed completely into the groundwater zone depicted by the potentiometric surface. On this premise 20~~2~~ new monitoring wells will be spaced

along the site perimeter at the point of compliance. Two additional upgradient wells (818, 819) will be ~~and will~~ installed as well as three upgradient piezometers (PZ-823, 206, and 207). The locations of the monitoring wells and piezometers are presented on Plates 1 and 6, Appendix 5B. ~~also include five upgradient well locations along the western and northern perimeter and 17 downgradient well locations along the eastern and southern perimeters.~~

Plate 6~~B~~, Appendix 5B has been included to show~~s~~ the groundwater contour elevations, selected flow paths and locations for the proposed monitoring wells and piezometers. This plate is intended to help the reader visualize the proposed monitoring well and piezometer network as it relates to the potentiometric surface.

Based on the six existing on site monitoring wells and two off site State registered water wells, a structural map of the top of the Dockum formation has been prepared and is presented as Plate 25~~7B~~, in Appendix~~Section~~ 5B of this permit modification. The screened intervals for the new monitoring well network will fully penetrate the Ogallala aquifer and terminate on top of the Triassic Dockum geologic formation. Plate 3~~2~~, Appendix 5B summarizes the proposed monitoring well network configurations including anticipated screening intervals ~~based on Plate 6B and Plate 7B data~~.

The 6 existing monitoring wells in the currently approved groundwater monitoring system will be left in place until the regulatory background sampling period for the new wells is satisfied.~~.~~ ~~–~~ at which time~~However,~~ the existing monitoring well network MW-1 through MW-4, and MW-6~~6~~ will be decommissioned. Monitoring Well 5 will be evaluated in comparison with PZ-823 to determine if MW-5 should be decommissioned or if it should remain within the monitoring well network. As previously mentioned, it is well documented that the entire Ogallala Aquifer is thinning due to withdrawal rates, due mainly to agricultural irrigation demands. The permitted site is experiencing the same trend. Therefore, replacing the existing monitoring wells allows for adjustment of the screened intervals within the saturated zone.

Therefore, the groundwater monitoring system for the site will consist of Upgradient Monitoring Wells 818, and 819 along with MW-5~~814, 815 (western boundary), 816, 817, 818 (northern boundary)~~ and, Downgradient Monitoring Wells 801, 802, 803, 804, 805, 806, 807, 808, 809~~.~~. 810, 811, 812, 813, 814, 815, 816, and 817. Downgradient Monitoring Wells 820, 821 and 822 will be installed once Cell 12 is developed, but prior to waste placement within this cell.

As mentioned, the groundwater level beneath the landfill continues to decrease, which is a regional trend. The groundwater flow gradients along the western side of the landfill will probably continue to shift if this groundwater lowering trend continues. Therefore in addition to the existing piezometers PZ-203 and PZ-204, piezometers PZ-206, PZ-207, PZ-821, and PZ-822~~19, 820, 821, 822, 823, 824, 825, 826, 827, 828, 829, 830, 831, 832, 833, 834, and 835 (eastern and southern boundaries)~~.will be installed along the western side of the site and groundwater measurements will be made in these piezometers when measurements and sampling occurs within the monitoring well network. Also, in order to further confirm groundwater levels being measured in MW-5, piezometer PZ-823 will be installed near MW-5 and groundwater levels measured during normal sampling events. After each sampling event, a groundwater contour map will be produced and the trend of the pressure gradients and flow directions, particularly along the western side of the site, will be analyzed. If gradients shift, the point of compliance may be altered and the monitoring well network updated to adequately monitor the groundwater flow.

~~The predominant downgradient groundwater monitoring boundary for the landfill site is the southern boundary. The groundwater equipotential lines trend easterly-westerly at this boundary, with a slight easterly flow component, particularly near the southwestern site corner near existing Monitoring Well 1. Although the flow gradients appear to be neutral at this boundary, with the addition of new Monitoring Well 814 and maintaining existing Piezometers B-203 and B-204, ongoing water level data will better define and update the flow gradients to determine the need for additional monitoring devices along the western boundary.~~ A groundwater contour map will be produced for each monitoring well sampling event and submitted ~~annually~~ as part of the ~~annual~~ groundwater monitoring report. ~~Piezometers 203 and~~

~~204 will also be measured along with the monitoring wells. This information will be evaluated to determine if additional upgradient wells are needed along the western boundary.~~ Due to the continued decrease in groundwater elevation within the Ogallala, this ongoing evaluation will be useful since it appears that the western portion of the site may be experiencing a slight shift in groundwater flow direction (more southerly without the easterly component). ~~Until this groundwater trend is more accurately measured with additional data from the new monitoring wells, the monitoring well network presented on Plate 1, Appendix 5B is proposed.~~ By observing groundwater flow lines as presented on Plate 6~~B~~, it can be seen that the proposed monitoring well network installed at upgradient locations will intercept groundwater flow, as well as intercepting downgradient flow along the southern and eastern boundaries. As can be observed, the southern boundary of the landfill intercepts most of the groundwater flow entering the site from the north and west.

~~A southeastern flow gradient component of the groundwater enters the site along a narrow 700-foot north boundary section between existing Monitoring Well 5 and the eastern landfill boundary. Newly proposed monitoring well nos. 819 and 820 will monitor this portion of groundwater flow for this portion of the site. As can be observed on Plate 6B, Appendix 5B, the remaining portions of the eastern perimeter of the permitted area will be monitored by newly proposed point of compliance Monitoring Wells 821 through 827. Monitoring Wells 827 through 835 will monitor the groundwater flowing outward from the site along the entire southern perimeter of the permitted site.~~

~~Existing Monitoring Wells 1 through 6 will continue to be monitored until background monitoring is established for the newly proposed monitoring well network.~~ Following acceptable background monitoring by TCEQ, existing Monitoring Wells 1 through 4 and 6~~6~~ will be decommissioned, with MW-5 evaluated at that time.

4.0 MONITORING WELL SCREENED INTERVALS

As discussed, it is well documented that the overall trend of the Ogallala formation that lies beneath the central section of the United States is decreasing in top surface elevation due to withdrawal. While it is the intent of the monitoring well system at the landfill to monitor the saturated zone, it is also necessary to maintain the bentonite seal above the screened interval below the water level for hydration purposes. With the current thinning of the saturated section, the placement of the screen and bentonite seal becomes important.

The groundwater levels at the landfill have been plotted and observed for trends. Although the groundwater level beneath the landfill is decreasing in elevation across the entire site, not every monitoring location presents identical rates of decrease. By observing the trends, an annual decrease of 0.2 feet per year has been approximated. When selecting a life expectancy of a monitoring well of at least 15 years, the elevation of top of seal can be calculated. Plate 3_Appendix 5B presents the calculated screen length for each planned monitoring location. Due to the relatively thin aquifer saturated thickness at locations MW-815, 816, and 817, and also at PZ-823, this projected decrease does not produce a saturated thickness suitable for monitoring.

At each proposed monitoring location, the initial pilot boring will determine saturated thickness at the time of drilling. For the thin sections mentioned above, the field geologist on site will communicate with the permitting engineer to determine the appropriate length of screen and depth of bentonite seal to be installed. The top of seal may be altered from the elevations presented in this document depending upon the actual observations at time of drilling.

~~3.14.1~~ POTENTIAL FLOW PATHWAYS

In the event that the primary composite liner system is compromised and a release occurs, the anticipated primary pathway of contaminant transport would be vertically and to a lesser extent horizontal through the unsaturated materials. The majority of the subsurface materials consist of

sand and clayey sand in the unsaturated zone, and then sand in the saturated zone of the Ogallala Formation. Caliche layers are also present in the upper portion of the unsaturated zone that would have some affect on vertical migration. Some horizontal migration would be expected as a result of the caliche and finer grained material in the unsaturated zone. Because of the relative thickness of the unsaturated zone and the finer grained nature of the unsaturated zone materials, any release of contaminants could likely become entrapped in the soil and slowly released over time. Infiltration of surface water is generally minimal in this area, and therefore it is not expected that percolation of surface water into the subsurface would aid in the leaching of any contaminant that may have been released due to a breach in the liner system.

In the event a contaminant reaches the saturated zone, the primary mechanisms controlling the distribution of chemical transport would be advection and dispersion through the aquifer materials in the direction of groundwater flow as shown on Plate 6~~7~~, Appendix 5B. The predominant downgradient groundwater-monitoring boundary for the landfill site is the southern boundary. The flow direction and gradient has been consistent at the site since monitoring was initiated during the 1994 permitting process. As previously discussed above, given the consistent nature of the groundwater flow and gradient at the site, the proposed monitoring network is anticipated to be adequate to monitor groundwater conditions at the site.

~~3.2~~4.2 GROUNDWATER MONITORING SYSTEM INSTALLATION

Upon approval of the proposed groundwater monitoring system, the City of Amarillo will begin the process of replacing the existing system with the upgraded and approved monitoring well network. The approved network will be installed, and background data developed prior to terminating groundwater testing within the existing monitoring well network. Once background analytical data has been established, the existing monitoring well network will be decommissioned and formally documented. At the time of submission of this permit modification, it is anticipated that 1~~2~~8 months will be required once the system has been formally approved to fully complete the extensive replacement of the existing monitoring well

network. During this time interval, dual sampling events will be occurring and will continue until the upgraded network is fully installed and appropriate background data established.

Notification of the Texas Commission on Environmental Quality (TCEQ) MSW Permits Section will be given at least 45 days prior to initiating any proposed plugging and abandonment procedures.

5.0 EXISTING GROUNDWATER ANALYTICAL DATA

The general water quality of the Ogallala is acceptable for numerous applications. The concentrations of Total Dissolved Solids (TDS) and Chloride increase from north to south. TDS concentrations in the Amarillo area have been reported (Nativ 1988; Knowles and others 1984) to be approximately 400 milligrams per liter (mg/l). Samples obtained in 1980 and in 1988 from water wells near the Amarillo landfill show similar TDS levels and levels of chloride in the range of 4 to 7 mg/l. Groundwater samples have been taken from monitoring wells at the landfill since 1995. These samples indicate that TDS levels range from 300 to 600 mg/l. Chloride levels range from 4 to almost 200 mg/l, with the higher results occurring in upgradient monitoring well, MW-5. Nitrate levels at the landfill historically range from 1 to 20 mg/l; sulfate levels from 10 to 33 mg/l; again the higher concentrations occurring in upgradient monitoring well, MW-5. The water is considered "hard" by the High Plains Underground Water Conservation District.

Some metals have been detected in small concentrations during monitoring events. The most prevalent metal that has been detected is Barium with levels ranging from 180 to about 550 micrograms per liter (µg/l). The higher concentrations of barium occur in upgradient monitoring wells, MW-5 and MW-6.

6.0 GROUNDWATER MONITORING SYSTEM CERTIFICATION

General Site Information

Site:	City of Amarillo Landfill
Site Location:	Amarillo, Potter County, Texas
Permit No:	73A
Date Permit Issued:	1974

Qualified Groundwater Scientist Statement

I, Donald D. James, P.G., have reviewed the groundwater monitoring system and supporting data. In my professional opinion, the existing groundwater monitoring system and the proposed additional monitoring wells is in compliance with the groundwater monitoring requirements specified in 30 TAC §330.230 through §330.235. The monitoring well system is currently operative at the site, ~~and will be updated and enlarged (additional wells installed), and appropriate modifications submitted and approved by TCEQ, and will remain in compliance with the referenced regulations.~~but will be replaced. The ~~enlarged~~ proposed groundwater monitoring system will consists of: upgradient wells MW-5, MW-818 and MW-819; ~~814, MW-815, MW-816, MW-817 and MW-818 and~~ downgradient wells ~~include~~ MW-801, MW-802, MW-803, MW-804, MW-805, MW-806, MW-807, MW-808, MW-809, MW-810, MW-811, MW-812, MW-813, MW-814, MW-815, MW-816, and MW-817. ~~MW-819,~~ Groundwater monitoring wells MW-820, MW-821, MW-822~~, MW-823, MW-824, MW-825, MW-826, MW-827, MW-828, MW-829, MW-830, MW-831, MW-832, MW-833, MW-834, and MW-835~~ will be installed once Cell 12 is developed, but prior to waste placement.~~.~~ This system has been designed for the exclusive use of the City of Amarillo, Texas for specific application to the Amarillo Landfill (TCEQ Permit No. 73). I am a qualified groundwater scientist as defined by 30 TAC §330.2. The only warranty made by us in connection with this document and specifically with the monitoring well network is that we have used that degree of care and skill ordinarily exercised under similar conditions by reputable members of our profession, practicing in the same or similar locality when designing or reviewing monitoring well systems. No other warranty, expressed or implied, is made or intended.

Firm/Address: Kleinfelder

6850 Manhattan Boulevard, Suite 300

Fort Worth, Texas 76120

Signature: _____

Date: _____

APPENDIX 5A

1994 Limited Groundwater Characterization Investigation

APPENDIX 5B

~~2008 Site Plan with~~ Existing and Proposed Monitoring Well Locations
Typical Monitoring Well Detail
Proposed Monitoring Well Network
Groundwater Elevation Summary~~,~~, September 1994 to April 13, 2009
~~2008 Monitoring Well Network/Typical Monitoring Well Detail~~
~~2000 through June 2008 Groundwater Elevations Summary~~
~~•Tabular Formatted~~
~~•Graphical Formatted~~
Groundwater Contour Map with Directional Groundwater Flow and Point of Compliance
~~-~~Groundwater Contour Map, November 9, 1994
~~-~~Groundwater Contour Map, April 14, 1995
~~-~~Groundwater Contour Map, October 16, 1995
~~-~~Groundwater Contour Map, April 15, 1997
~~-~~Groundwater Contour Map, October 14, 1998
~~-~~Groundwater Contour Map, April 17, 2000
~~-~~Groundwater Contour Map, October 16, 2001
~~-~~Groundwater Contour Map, April 14, 2003
~~-~~Groundwater Contour Map, October 18, 2004
~~-~~Groundwater Contour Map, October 17, 2005
~~-~~Groundwater Contour Map, April 18, 2006
~~-~~Groundwater Contour Map, April 18, 2007
~~-~~Groundwater Contour Map, October 15~~6~~, 2007
•Groundwater Contour Map, March 18, 2008
Groundwater Contour Map, August 14, 2008
Groundwater Contour Map, November 19~~8~~, 2008
Groundwater Contour Map, January 12, 2009
Groundwater Contour Map, April 13, 2009
Structural Surface Contour Map of the Triassic Dockum Formation
Kleinfelder Logs of Borings 203 and 204 with Piezometer Construction Detail
Monitoring Well Data Sheets and Logs

2005 Kleinfelder
Logs of Borings

B-203 and B-204

1994 – Dyess - Peterson Testing Laboratory, Inc.
Log of Boring
MW-1

1994 – Dyess Peterson Testing Laboratory, Inc.
Log of Boring

MW-2

1994 – Dyess Peterson Testing Laboratory, Inc.
Log of Boring

MW-3

1994 – Dyess Peterson Testing Laboratory, Inc.
Log of Boring
MW-4

1994 – Dyess Peterson Testing Laboratory, Inc.
Log of Boring

MW-5

1994 – Dyess Peterson Testing Laboratory, Inc.
Log of Boring

MW-6

Part III

Attachment 8

Closure and Post-Closure Care Cost Estimates

Permit – MSW No. 73A
Issued August 22, 2007

City of Amarillo,
Potter County, Texas

Revised ~~March~~July 2009

This document is released for the purpose of review only under the authority of Michael W. Oden, P.E. #67165. It is not to be used for bidding or construction. Firm Registration No. F-754

For pages _____ thru _____

City of Amarillo
Landfill Permit Amendment – Part III, Attachment 8

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1.0 GENERAL

This section includes the Closure Cost Estimate (Table III.8.1) and Post-Closure Cost Estimate (Table III.8.2) for the City of Amarillo Landfill.

1.1 Financial Assurance

In order to address financial assurance requirements, the City of Amarillo will submit documentation to verify its compliance with Chapter 37, Subchapter R: Financial Assurance for Municipal Solid Waste Facilities upon receipt of this amendment. The combined cost of closure and post-closure is $~~12,365,833~~12,645,053. This cost estimate is based upon Year 2005 dollars (escalated by 5% per annum to 2008) and provision of service by a third party. The unit costs used are based on previous projects in the area. This estimate also assumes that the largest landfill area that would require final cover at one time is 526 acres. The City has built cells in approximately 10 acre phases. Worst case scenario is for final closure of the entire site (526 acres) with 70 feet of depth for a 10 acre phase needing filling to maintain drainage.

Post-closure care estimates include activities associated with the entire site.

Table III.8.1: Closure Costs
City of Amarillo Solid Waste Disposal Facility
MSW Permit No. 73A

Item	Quantity	Unit	Unit Cost	Total
Engineering				
Topo Survey	1	LS*	$7,500	$7,500
Boundary Survey	40	HR	$80	$3,200
Site Evaluation and Development of Plans	1	LS	$25,000	$25,000
Closure Plan	1	LS	$10,000	$10,000
Construction Observation/Testing	400	HR	$75	$30,000
Subtotal				$75,700
Contingency	20%			$15,140
Total Engineering				**$90,840**
Construction				
Plug and Abandon Wells	22	EA	$8,000	$176,000
Plug and Abandon Piezometers	5	EA	$5,000	$25,000
Fill to grade	1,129,333	CY	$2.00	$2,258,667
Infiltration Layer (12 inches)				
Placing/grading/compaction	848,013	CY	$1.50	$1,272,020
Erosion/Vegetative Layer (24 inches)	1,697,227	CY	$1.50	$2,545,840
Vegetation	526	ACRE	$1,000.00	$526,000
Backfill/grading/drainage	1	LS	$100,000.00	$100,000
Methane Gas Control Wells	10	EA	$1,000.00	$10,000
Subtotal				$~~6,712,526~~6,913,526
Contingency	20%			$~~1,342,505~~1,382,705
Total Construction				**$~~8,055,031~~8,296,231**
Total Closure Costs (2005)				**$8,387,071~~8,145,871~~**
5% increase for 2006				**$8,806,425~~8,553,165~~**
5% increase for 2007				**$9,246,746~~8,980,823~~**
5% increase for 2008				**$9,709,084~~9,429,864~~**

* LS = Lump Sum

Table III.8.2: Post-Closure Care Costs
City of Amarillo Solid Waste Disposal Facility
MSW Permit No. 73A

Description	Quantity	Unit	Unit Costs	Total Costs
One-Time Costs				
Site Post-Closure Plan Update	1	LS*	$ 15,000	$15,000
Contingency	20%			$3,000
Subtotal				**$18,000**
Annual Costs				
Site Inspections and Report	40	HR	$ 80	$3,200
Correctional Plans & Specs	1	LS	$ 3,500	$3,500
Site Monitoring Groundwater Wells****	22	EA	$ 1,250	$27,500
Site Monitoring Gas Probes	20	EA	$ 50	$1,000
Maintenance**	1	LS	$ 34,750	$34,750
Subtotal Annual Cost				**$69,950**
Contingency	20%			$13,990
Total Annual Costs				$83,940
30-year Post-Closure Total*(2005)**				**$2,536,200**
5% increase for 2006				**$2,663,010**
5% increase for 2007				**$2,796,161**
5% increase for 2008				**$2,935,969**

* Lump Sum

** Maintenance may include leachate pumps, leachate collection system repairs, electrical, mowing, gate/fence repair, erosion and access control, surface water control, seeding, monitor well maintenance, and methane gas system repairs. See Table below.

*** 30-year Post-Closure Total includes the entire project site.

**** Site Monitoring assumed semi-annual and includes wells and probes around the entire site.

Total Estimated Closure and Post-Closure Costs **$12,645,053~~365,833~~**

Itemized Maintenance Costs				
Description	**Quantity**	**Unit**	**Unit Costs**	**Total Costs**
Leachate Pumps	1	EA	$2,750	$2,750
Leachate Collection System	1	YR	$1,000	$1,000
Electrical	1	YR	$500	$500
Mowing	526	AC	$50	$26,300
Gate/fence Repair	1	YR	$500	$500
Erosion and Access Control, Surface Water Control, Seeding	1	YR	$1,000	$1,000
Monitor Well Maintenance & Pump Replacement	1	EA	$2,500	$2,500
Methane Gas System Repairs	20	EA	$10	$200
Subtotal Annual Cost				**$34,750**

Part III

Attachment 11

Groundwater Sampling and Analysis Plan

Permit Amendment – MSW No. 73A

City of Amarillo,
Potter County, Texas

Permit Issued
August 22, 2007

Revised ~~January~~ July 2009

Henry L. Fleischhauer, P.G.
Hydrogeologist

July 7, 2009~~January 16, 2009~~
Date

City of Amarillo
Landfill Permit Amendment – Part III, Attachment 11
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Appendices

1.0 INTRODUCTION

This groundwater sampling and analysis plan (GWSAP) addresses the groundwater monitoring and sampling program to be implemented at the City of Amarillo's Municipal Solid Waste Landfill (MSWLF). The GWSAP is required by the Texas Commission on Environmental Quality (TCEQ) Municipal Solid Waste Regulations and will meet the requirements of Title 30 Texas Administrative Code, Subchapter F "Analytical Quality Assurance and Quality Control" and Subchapter J "Groundwater Monitoring and Corrective Action." Once approved by the TCEQ, this GWSAP will become part of the site operating record.

2.0 BACKGROUND SAMPLING

Background groundwater quality shall be established for monitored constituents by collecting groundwater samples quarterly and analyzing the samples for the detection monitoring or assessment monitoring constituents. Background sampling for inorganic and volatile organic detection monitoring constituents shall be conducted quarterly for a two-year period [a total of eight (8) sampling events]. This will allow the collection of groundwater data over the different seasons of the year, which should demonstrate the effects that seasonal and temporal changes may have on groundwater quality.

As described in Section 4.2, background determinations will be required if Appendix II constituents are detected at quantifiable concentrations during the initial assessment monitoring event. Background sampling for assessment monitoring constituents shall be conducted quarterly for 1 to 2 years [a total of four (4) to eight (8) samples].

If additional samples are needed for the statistical analysis of either detection or assessment monitoring constituents, they will be collected no closer than 30 days apart.

At the conclusion of the background monitoring period for either detection or assessment monitoring, all the results will be thoroughly reviewed, and a statistical evaluation of the

background monitoring shall be performed as described in Section 7 to determine the background limits for each constituent.

The background concentrations of monitored constituents may be reviewed and updated every two years by applying statistical methods described in Section 7 to data collected in the period following the last update. Revision of background may be performed after receiving written permission from TCEQ.

3.0 DETECTION MONITORING

Detection monitoring is the routine, periodic sampling that is conducted for purposes of detecting a release relative to certain constituents. Regulations pertaining to Detection Monitoring are codified at 30 TAC §330.407

3.1 Constituents

The constituents to be analyzed during the detection monitoring program are listed in Table 11.1. At the request of the TCEQ (formerly the Texas Natural Resource Conservation Commission [TNRCC]) during the initial preparation of this GWSAP, total alkalinity was substituted for antimony, total dissolved solids for beryllium, dissolved iron for thallium, and dissolved manganese for vanadium. In addition, ammonia was also added to the constituents to be analyzed. The list of constituents includes 16 inorganics and 47 organics. The test methods to be used for the constituents listed are presented in Table 11.2. If at a later date, the City determines that any of these constituents are not being detected and are not expected to originate from the waste contained in the MSWLF unit, the City may request a modification to the GWSAP for the deletion, substitution, and/or addition of other constituents.

3.2 Frequency of Monitoring

Monitoring for the detection monitoring constituents will occur semiannually during the active life of the MSWLF unit and the closure and post-closure care period, unless an alternate schedule is approved by the Executive Director.

3.3 Statistically Significant Increases Above Background

The determination of and responses to Statistically Significant Increases (SSIs) shall comply with 30 TAC §407(b). A summary of this rule is follows.

Detection monitoring data shall be evaluated for indications of potential landfill releases by comparing the sampling data with background concentrations for monitored constituents within 60 days after the end of each sampling event. A statistically significant increase (SSI) occurs when the concentration of a monitored constituent is higher than its background concentration. The TCEQ and any local pollution control agencies with jurisdiction must be notified within 14 days of this initial determination.

If an SSI is identified, field and laboratory quality control data should be examined. The occurrence of the constituent in laboratory blanks or failure to meet other laboratory quality control standards may suggest that analytical conditions contributed to the SSI and that re-analysis of the sample may be required. The occurrence of a constituent in field quality control samples may suggest field cross contamination or environmental sampling conditions which may require re-sampling.

An SSI may be confirmed by collecting a verification sample from the affected well. Verification sampling may be repeated for the affected well as long as all such sampling is completed within 60 days of the initial determination.

If there is evidence that a source other than the landfill caused an SSI, or that an SSI resulted from error in sampling, analysis, statistical evaluation, or natural variation in groundwater quality, then an alternate source demonstration report providing documentation to this effect may be submitted. The Landfill shall notify the TCEQ and any local pollution agency of the intent to perform an alternate source demonstration within 14 days of identifying an SSI. The report must be prepared and certified by a qualified groundwater scientist and submitted to the TCEQ within

90 days of the initial determination of the SSI. Samples collected for the alternate source demonstration shall not be filtered.

~~Assessment monitoring will be required i~~If an SSI is confirmed, or if a satisfactory alternate source demonstration is not made, a record shall be placed in the site operating record, and Assessment Monitoring shall be initiated.

3.4 Detection Monitoring Reports

An annual report documenting detection monitoring activities shall be submitted to the TCEQ within 90 days following the last groundwater monitoring event of the calendar year.

This report shall include the following information determined since the last groundwater monitoring report.

- The results of groundwater monitoring, testing, and analysis obtained under requirements of the permit, including a summary of monitoring analyses together with graphs or drawings, as appropriate (Data may be summarized on form TCEQ-0312, Appendix 11A);
- A summary of background water quality values, presentation of statistical calculations, a statement as to whether an SSI over background occurred during the monitoring period, and the status of any related verification sampling events or alternate source demonstrations;
- A contour map of piezometric elevations in the uppermost aquifer based on concurrent measurements, together with data or documentation used to prepare the map;
- The calculated groundwater flow rate and direction using data collected during the report period, including documentation of all information used to make this calculation.
- Recommendations for changes;
- Other information requested by the TCEQ.

3.5 Program Modification

If the Landfill determines that the Detection Monitoring Program no longer satisfies the requirements of Title 30 Texas Administrative Code Section 330.407, then within 90 days of the determination, the Landfill shall submit an application for a permit amendment or modification to make appropriate changes to the program.

4.0 ASSESSMENT MONITORING

Assessment monitoring is triggered when a statistically significant increase (SSI) in one or more detection monitoring constituents has been confirmed by 1 or more verification sampling events, or cannot be rejected by an alternate source demonstration. Assessment monitoring will be conducted in accordance with 30 TAC §409.

4.1 Regulatory Summary

The requirements for Assessment Monitoring are codified at 30 TAC §330.409 as follows:

- §330.409 (a) and (b) establish the assessment program;
- §330.409 (c) specifies a basis for modifying the frequency of sampling the full set of Appendix II constituents;
- §330.409 (d) establishes a semiannual monitoring program for detected Appendix II constituents and requires determining background values and groundwater protection standards;
- §330.409 (e) establishes the basis for discontinuing assessment monitoring;
- §330.409 (f) establishes the basis for continuing assessment monitoring;
- §330.409 (g) specifies actions to be taken when the groundwater protection standard is exceeded;
- §330.409 (h), (i) and (j) specify how groundwater protection standards are determined;
- §330.409 (k) specifies the requirements for the annual assessment monitoring report.

4.2 Implementation

If an SSI has occurred, the Landfill shall immediately place a notice in the Site Operating Record. An assessment monitoring program shall be initiated within 90 days of the notifying the TCEQ that an SSI has occurred. The entire groundwater monitoring system, i.e. all monitor wells, or an approved subset of wells, shall be sampled and analyzed for all constituents listed in 40 CFR 258 Appendix II (effective July 14, 2005)[hereafter, EPA Appendix II].

After the initial sampling, the TCEQ may be petitioned to authorize a reduced subset of wells to be sampled and analyzed for EPA Appendix II constituents, and/or to authorize an alternate sampling frequency.

If EPA Appendix II constituents are detected at quantifiable concentrations in point of compliance wells at the initial sampling, then

- Implement monitoring for detected constituents on at least a semi-annual basis. These results shall be reported to TCEQ within 60 days after each sampling event.
- Establish background concentrations for the detected EPA Appendix II constituents using 4 to 8 background samples collected from the upgradient well(s), using statistical methods described in Section 7.
- Establish groundwater protection standards for each EPA Appendix II constituent detected in point of compliance wells in accordance with §409(h) or §409(i) or §409(j).

Detected EPA Appendix II constituents shall be added to the detection monitoring list and shall be sampled and analyzed on a semiannual basis. Annually, however, the wells shall be sampled for all EPA Appendix II constituents, unless the frequency is modified in accordance with §330.409 (c).

4.3 Exceeding Groundwater Protection Standard

If the groundwater protection standard is exceeded, the City of Amarillo or the landfill operator shall install additional monitor wells as necessary, including at least one additional monitor well

between the next adjacent monitor wells along the point of compliance before the next sampling event. These wells shall be sampled at the next assessment monitoring sampling event.

If contaminants have migrated offsite, the owner/operator shall notify owners and occupants of land overlying the contaminant plume.

The City of Amarillo or landfill operator shall initiate assessment of corrective measures in accordance with 30 TAC §330.411 within 90 days of notice to the TCEQ.

4.4 Assessment Monitoring Reports

Assessment monitoring results must be submitted to the TCEQ within 60 days after each sampling event.

Not later than 60 days after a sampling event, the owner/operator shall determine if any EPA Appendix II constituents were detected at concentrations above the groundwater protection standard. If so, TCEQ and appropriate local agencies must be notified within 7 days of this determination.

An annual report shall be submitted within 60 days after the second semiannual sampling event each year. This report shall contain the following elements:

- A statement whether the groundwater protection standard has been exceeded;
- Groundwater monitoring data, including laboratory analyses, water level measurements, summaries of background values and analytical data, and as appropriate, statistical calculations, graphs and drawings;
- A contour map of the piezometric water levels in the uppermost aquifer;
- The groundwater flow rate and directions;
- Recommended changes;
- Other information requested by the TCEQ.

4.5 Termination of Assessment Monitoring Program

If detected EPA Appendix II constituents are shown to be at or below background concentrations for two successive sampling events, TCEQ shall be notified with a request to resume detection monitoring.

5.0 SAMPLING PROTOCOL

5.1 Groundwater Elevation Monitoring and Well Inspection

Prior to purging and sampling, all groundwater monitor wells will be measured for depth to water and total depth. To minimize the potential effects of water level fluctuation across the site, the water levels in all the monitor wells will be measured first, then they will be purged and sampled. During water level measurement events, each well will be inspected for damage to the well casing, protective cover, lock, well cap, and concrete pad. In addition, the ground surface around the well pads will be inspected for erosion. If any problems are discovered, they will be addressed and the appropriate corrective action(s) will be rendered as soon as practicable.

Groundwater level measurements will be collected using an electric well sounder with a tape marked in 1-foot increments with intermediate intervals marked in 0.01 foot. The groundwater level measurement will be recorded to the nearest 0.01 foot from an established survey mark on top of the monitor well casing. When a measurement is collected, the electric well sounder will be raised and lowered two to three times to be sure the correct reading is read off the tape measure. Water level measurements collected for each event will be recorded on the Groundwater Sampling Report form (Form TCEQ-0312) or other form required by the TCEQ (Appendix 11A).

5.2 Quality Assurance and Quality Control of Field Measurements

During each water level measurement event, the current measurements will be compared to the readings recorded from the previous event. It is anticipated that the water levels in this area of Texas should be fairly consistent for each monitor event. If an obvious discrepancy is

encountered, the water level will be measured again to ensure the measurement was recorded correctly.

Prior to collecting water level measurements, the electric sounder will be checked for damage, including bends or kinks in the tape. To maintain consistency and precision, the same electric well sounder will be used during each measuring event.

Prior to conducting the well purging activities, the pH and conductivity meters will be calibrated. Calibration of the instruments will be in accordance with the manufacturer's procedures for the particular instrument. At a minimum, the pH meter will be calibrated using standard calibration solutions consisting of an acidic solution (pH < 7), basic solution (pH > 7), and a neutral solution (pH = 7). The conductivity meter will be calibrated using standard solutions as recommended or supplied by the manufacturer.

5.3 Groundwater Sample Collection

5.3.1 Well Purging and Decontamination Procedures

Prior to each sampling event, the groundwater level in each well and the total well depth will be measured as described in Section 5.1. The volume of water to be removed from the well will be calculated based on well casing volume. The wells will be purged of at least 3 well casing volumes before collecting a groundwater sample. During purging, temperature, conductivity, and pH will be measured in a separate glass, stainless steel container or flow cell. The parameters will continue to be recorded throughout the entire purging of the well and until the readings stabilize and/or the required well volume of water is removed. Wells that dewater prior to achieving the 3 well casing volumes will be evacuated until dry then allowed to recharge before collecting a groundwater sample. For slowly recovering wells, a sample will be collected as soon as practicable to reduce the potential of volatilization in the well casing. Monitor wells that have not sufficiently recovered after 7 days will be considered dry and not sampled. The recommended recovery is 75% of the pre-purging water level. However, the sampler(s) may collect samples from a well with less recovery provided that the water level sufficient to supply the required sample volume from the dedicated sampling system, and provided that, in their

professional judgment, the recovery represents fresh formation water as opposed to filter pack drainage. For monitor wells that recharge quickly, a sample will be collected within 24-hours following purging. The calculated and actual purge volume achieved as well as the field parameters will be recorded on the Groundwater Sampling Report form (Form TCEQ-0312, Appendix 11A), or other form acceptable to the TCEQ.

The method of well purging will consist of using dedicated submersible pumps installed in the well casings. The pump intake will be set approximately halfway into the water column in the well casing. The discharge rate on the pump will be regulated to allow no more than 1-foot of drawdown for wells that can sustain continuous pumping without dewatering. This procedure will minimize any cascading effects that may volatilize constituents in the groundwater entering the well casing and will also minimize agitating any residual sediment that is in the bottom of the well. If the pump system fails, then the monitor well will be purged with a dedicated PVC or stainless steel bailer or back up submersible pump. If a bailer is used, a development rig will be used to raise and lower the bailer. The bailer will be of sufficient size in order to efficiently purge the well. The bailer will be lowered gently into the well casing and only submerged in the upper half of the water column during purging. The bailer will not be lowered to the bottom of the well. This procedure should minimize agitating any residual sediment that has collected in the bottom of the well. In the event bailers are used, care will be taken to prevent the bailer from coming into contact with the ground or potential contaminants that could be introduced into the well. Any non-dedicated equipment used with the development rig including the cable to raise and the lower the bailer, will be decontaminated between wells to avoid potential cross contamination.

The monitor wells will be purged in order from the well with the maximum groundwater elevation to the well with the minimum groundwater elevation, unless historical analytical data indicates the presence of volatile organic constituents (VOC) to be tested. If groundwater contains VOCs, then the order of purging and sampling will proceed from the well with the minimum to maximum VOC concentrations.

Prior to beginning each sample event and between wells, all non-dedicated equipment including the electric well sounder will be decontaminated thoroughly to minimize the potential for cross contamination. For non-dedicated submersible pumps, the decontamination procedures will consist of pumping a nonphosphatic detergent or solution with potable water through the pump system. Then the pump equipment will be flushed with potable water and cleaned a second time with the decontamination solution. Following the second cleaning, the pump equipment will be rinsed with potable water and given a final rinse with deionized water. If non-dedicated bailers are used, the same decontamination procedures will be used.

During the purging operations, a record of the climatic conditions, condition of the wells and surrounding ground surface, water turbidity, color, odors, water level, depth of well and purge rate will be maintained and recorded on the Groundwater Sampling Report form (Appendix 11A), or other form acceptable to the TCEQ. Additional sheets will be attached if necessary. The information will be recorded in ink and a copy of the information will remain on site at the landfill office and will become part of the site operating record.

5.3.2 Groundwater Sample Collection and Handling Procedures

During groundwater collection, disposable latex gloves will be worn to minimize cross contamination of samples and to reduce the possibility of coming into contact with groundwater containing VOCs. Prior to collecting a groundwater sample, the monitor wells will be purged of groundwater as described in Section 5.3.1. Purge water will be handled as discussed in Section 5.6. The monitor wells will be sampled in the same order they are purged. Samples will be collected within 24-hours following purging, but typically the day of the purging activities. For slowly recharging wells, samples will be collected when sufficient water is present to fill the appropriate number of containers. If sufficient recharge does not occur within 7 days following purging, then the well will be considered dry and samples will not be collected. A notation will be recorded in the site operating plan explaining why the well(s) was not sampled. Recommended sample containers, preservation, and holding times for the analyses listed in this GWSAP are presented in Table 11.3. The sample containers will be filled in the following order:

1) VOCs,
2) semi-volatiles or other organics, if collected,
3) total metals and dissolved constituents, and
4) other inorganics.

Samples will not be filtered in the field. In the case of analysis for dissolved constituents, the sample will be filtered in the laboratory using a 0.45u membrane filter and will be preserved with an appropriate acid such as nitric acid.

The samples will either be collected off the pump discharge or decanted from the bottom of the bailers, if used. The containers for the VOCs will be tilted slightly during the filling process so that the water runs down the inside of the container. If a pump is used, the pump discharge will be regulated at the time of sampling so as to maintain a slow enough discharge rate as possible to minimize cascading and volatilization as the sample containers are being filled. Once the discharge rate is set for sampling, it will be maintained at that rate for a few minutes so that the sample collected will not be from the period of time when the pump was operating at a higher discharge rate. The sample containers will be held as close to the pump ~~-~~discharge as possible without touching to minimize the loss of volatiles. If bailers are used, the sample will be decanted from the bottom of the bailer using a stop-cock to regulate flow. Once the sampling program is initiated, the samples will be collected by the same method throughout the program.

Following the filling of each sample container, they will be labeled with the well number, date and time collected, preservatives used, analyses to be performed, and sampler's initials. The containers will be placed in zip-locked plastic bags. In addition, immediately after the sample is collected, the temperature, pH, and conductivity will be measured again in either a glass or stainless steel container or flow cell. The sample containers for each well will include as a minimum, two-40 milliliter VOA glass vials with Teflon® septa screw caps for volatile organic constituents (VOC), two-1 liter glass bottles for metals, and one-1 quart glass bottle with Teflon® septa screw caps for inorganic and semi-volatile constituents. Sample containers for VOCs (i.e., VOAs and quart glass bottles) will be completely filled and sealed carefully to

prevent air bubbles. To check for air bubbles, invert the sample container and lightly shake it. If an air bubble is present, then the sample will be discarded and the sample will be collected again. All other sample containers for non VOCs will be filled as completely as possible.

Once the samples have been properly sealed and labeled as described above, they will be recorded on a Chain-of-Custody (COC), signed and dated by the sampling technician(s). An example of a typical COC is presented in Appendix 11B. The COC will accompany the samples to the laboratory the same day they are collected. The readings for temperature, conductivity, and pH will be submitted to the laboratory with the samples. The samples will be placed in a plastic ice chest (similar to an igloo ice chest) with ice, and will be maintained as close as possible to 4 degrees centigrade until the analyses are performed. Precautions will be taken to secure the samples in the ice chest to prevent them from breaking during transport. The samples will be delivered to the laboratory as soon as possible, generally the same day they are collected, therefore it will not be necessary to preserve the samples in the field, except samples collected for dissolved constituent analyses. Any samples, other than the samples collected for dissolved constituent analyses, requiring overnight transport to the laboratory will be collected in pre-preserved sample bottles prepared and provided by the laboratory.

5.4 Quality Assurance and Quality Control Samples

To provide screening of field procedures, additional samples will be collected. A trip blank will be prepared by the laboratory and will also accompany the sample containers and collected samples to and from the laboratory. The trip blank will consist of filling two-40 milliliter VOA vials with appropriate liquid designated by the laboratory performing the analyses. The purpose of the trip blank is to assess whether any of the sample containers or collected samples have been impacted before or during sampling. At least one trip blank will be prepared for each shipment of sample containers. The equipment and trip blank samples will be handled in a similar fashion as the other samples and will be analyzed for VOCs. On occasion, blind duplicate samples will be collected to assess the precision of the sampling and laboratory methods. If duplicates are collected, the duplicate sample will be collected from the same bailer water as was used to fill the original sample.

Duplicate samples should not be collected off the pump discharge. If needed, additional samples can be obtained with a bailer for the purpose of collecting duplicate samples. The duplicate sample should be collected from the same bailer water used to fill the original sample containers. The blind samples will usually be collected from well(s) with the maximum concentrations of VOCs. When a blind sample is collected, it will be handled in a similar fashion as the other samples, but will be labeled in such a way that the laboratory does not know which sample is the duplicate for QA/QC purposes.

5.5 Sampling in Adverse Weather Conditions

Sampling of the monitor wells will not be permitted during inclement weather, sandstorms, or during periods when the temperature drops below freezing. Caution should be taken when the temperature exceeds 100 degrees Fahrenheit.

5.6 Purge Water Handling Procedures

Purge and decontaminated water will be collected in approved Department of Transportation (DOT) 55-gallon drums and stored onsite for subsequent disposal. The analytical data will be reviewed to determine the proper disposal procedures. If needed, the TCEQ will be consulted to assist in assessing proper disposal procedures. Purge and decontaminated water will be disposed at an approved licensed facility.

6.0 ANALYTICAL TESTING

6.1 Laboratory Performing the Analyses

Analysis of landfill samples will be performed by either a NELAC accredited environmental testing laboratory, or a non-accredited, in-house environmental testing laboratory meeting requirements of 30 TAC §25.1(9) and §25.6. Presently, samples are analyzed by an in-house laboratory, owned and operated by the City of Amarillo, which provides data only to City departments for environmental compliance and enforcement, and for permits or authorizations

issued to the City. In the event that the in-house laboratory ceases to qualify for the exception under 30 TAC §25.6, then the City will use a NELAC-accredited laboratory having fields of accreditation for the matrix, methods and analytes used for the landfill's monitoring program.

6.2 Laboratory Procedures

The laboratory will analyze samples according to methods specified in "Test Methods for Evaluating Solid Waste, Physical/Chemical Methods" (U. S. Environmental Protection Agency Publication Number SW-846), 3rd Edition, September 1986, as revised or updated, or by other equivalent or better methods accepted by the TCEQ.

The PQL is defined as the lowest concentration reliably achieved within specified limits of precision and accuracy during routine laboratory operating conditions and is analogous to the limit of quantitation definition in the most recent available National Environmental Laboratory Accreditation Conference (NELAC) Standard. The PQL is method, instrument, and analyte specific and may be updated as more data becomes available. The PQL must be below the groundwater protection standard established for that analyte as defined by 30 TAC Section 330.409(h) unless approved otherwise by the TCEQ. The precision and accuracy of the PQL shall be initially determined from the PQLs reported over the course of a minimum of eight groundwater monitoring events. The results obtained from these events shall be used to demonstrate that the PQLs meet the specified precision and accuracy as shown in the Table 11.4 below. The PQL will be supported by analysis of a PQL check sample, which is a laboratory reagent grade sample matrix spiked with chemicals of concern at concentrations equal to or less than the PQL. At a minimum, a PQL check sample will be performed quarterly during the calendar year to demonstrate that the PQL continues to meet the specified limits for precision and accuracy as defined in the table below.

For analytes that the established PQL cannot meet the precision and accuracy requirements in the table above, the owner/operator will ensure the laboratory will submit sufficient documentation and information to the TCEQ for alternate precision and accuracy limits on a case by case basis.

Non-detected results will be reported as less than the established PQL limit that meets these precision and accuracy requirements.

6.3 Data Review and Laboratory Case Narrative

All analytical data submitted under the requirements of this permit will be examined by the owner and/or operator to ensure that the data quality objectives are considered and met prior to submittal for the commission to review. The owner or operator will determine if the results represent the sample are accurate and complete. The quality control results, supporting data, and data review by the laboratory must be included when the owner/operator reviews the data. Any potential impacts will be reported such as the bias on the quality of the data, footnotes in the report, and anything of concern that was identified in the laboratory case narrative summary.

The owner or operator will ensure that the laboratory documents and reports all problems and observed anomalies associated with the analysis. If analysis of the data indicates that the data fails to meet the quality control goals for the laboratory's analytical data analysis program, the owner or operator will determine if the data is usable. If the owner and/or operator determines the analytical data may be utilized, any and all problems and corrective action that the laboratory identified during the analysis will be included in the report submitted to the TCEQ.

A Laboratory Case Narrative (LCN) report for all problems and anomalies observed must be submitted by the owner and/or operator. The LCN will report the following information:

1. The exact number of samples, testing parameters and sample matrix.
2. The name of the laboratory involved in the analysis. If more than one laboratory is used, all laboratories shall be identified in the case narrative.
3. The test objective regarding samples.
4. Explanation of each failed precision and accuracy measurement determined to be outside of the laboratory and/or method control limits.
5. Explanation if the effect of the failed precision and accuracy measurements on the results induces a positive or negative bias.

6. Identification and explanation of problems associated with the sample results, along with the limitations these problems have on data usability.

7. A statement on the estimated uncertainty of analytical results of the samples when appropriate and/or when requested.

8. A statement of compliance and/or noncompliance with the requirements and specifications. Exceedance of holding times and identification of matrix interferences must be identified. Dilutions shall be identified and if dilutions are necessary, they must be done to the smallest dilution possible to effectively minimize matrix interferences and bring the sample into control for analysis.

9. Identification of any and all applicable quality assurance and quality control samples that will require special attention by the reviewer.

10. A statement on the quality control of the analytical method of the permit and the analytical recoveries information shall be provided when appropriate and/or when requested.

In addition to the LCN, the following information must be submitted for all analytical data:

1. A table identifying the field sample name with the sample identification in the laboratory report.

2. Chain of custody.

3. An analytical report that documents the results and methods for each sample and analyte to be included for every analytical testing event. These test reports must document the reporting limit/method detection limit the laboratory used.

4. A release statement must be submitted from the laboratory. This statement must state "I am responsible for the release of this laboratory data package. This data package has been reviewed by the laboratory and is complete and technically compliant with the requirements of the methods used, except where noted by the laboratory in the attached exception reports. By my signature below, I affirm to the best of my knowledge, all problems/anomalies, observed by the laboratory as having the potential to affect the quality of the data, have been identified by the laboratory in the Laboratory Review Checklist, and no information or data have been knowingly withheld that would affect the quality of the data."

    a. If it is an in-house laboratory, it must have the following statement: "This laboratory is an in-house laboratory controlled by the person responding to rule. The official signing the cover page of the rule-required report (for example, the

APAR) in which these data are used is responsible for releasing this data package and is by signature affirming the above release statement is true."

5. If the data is from soil and/or sediment samples, it must be reported on a dry weight basis with the percent solids and the percent moisture reported so that any back calculations of the wet analysis may be preformed.

A laboratory review checklist shall be submitted with all groundwater analytical data documents. An example laboratory review checklist is presented in Appendix 11C. For every response of "No, NA, or NR" that is reported on the checklist, the permittee will ensure the laboratory provides a detailed description of the "exception report" in the summary of the LCN.

7.0 STATISTICAL METHODS

The groundwater monitoring data will be evaluated to determine statistically significant increases (SSIs) above background values for each constituent listed in Table 11.1. The statistical analyses will be performed in accordance with 31 TAC 330.407 (e) and (f), using commercially available software, such as SANITAS. The statistical method currently used following establishment of background data for the currently approved groundwater monitoring system (February 1995 through October 1996) consists of two methods. One method is a control chart (CUSUM) and the other method is intra-well parametric and non-parametric prediction limits (PL). The rationale for utilizing these methods was presented in HDR's October 9, 1997 response to comments letter to the TCEQ.

The Landfill may use statistical tests other than those approved by TCEQ in Section 330.405(e), provided that the test meets the performance standards of Section 330.405(f) and provided that a satisfactory justification has been submitted to the TCEQ.

Table 11.1: Detection Monitoring Constituents

Total Alkalinity
Arsenic
Barium
Total Dissolved Solids
Cadmium
Chromium
Cobalt
Copper
Lead
Nickel
Selenium
Sliver
Dissolved iron
Dissolved Manganese
Zinc
Ammonia

Acetone
Acrylonitrile
Benzene
Bromochloromethane
Bromodichloromethane
Bromoform
Carbon disulfide
Carbon tetrachloride
Chlorobenzene
Chloroethane
Chloroform
Dibromochloromethane
1,2-Dibromo-3-chloropropane
1,2-Dibromoethane
o-Dichlorobenzene,(1,2)
p-Dichlorobenzene (1,4)
trans- 1,4-Dichloro-2-butene
1,1-Dichloroethane
1,2-Dichloroethane
1, 1 -Dichloroethylene
cis-1,2-Dichloroethylene
trans- 1,2-Dichloroethylene
1,2-Dichloropropane
cis-1,3-Dichloropropene
trans-1,3-Dichloropropene
Ethylbenzene
2-Hexanone
Methyl bromide
Methyl chloride
Methylene bromide
Methylene chloride
Methyl ethyl ketone
Methyl iodide
4-Methyl-2-pentanone
Styrene
1,1,1,2-Tetrachloroethane
1,1,2,2-Tetrachloroethane
Tetrachloroethylene
Toluene
1,1,1-Trichloroethane
1,1,2-Trichloroethane
Trichloroethylene
Trichlorofluoromethane
1,2,3-Trichloropropane
Vinyl acetate
Vinyl chloride
Xylenes (total)

Table 11.2: Test Methods and Containers

CONSTITUENT	METHOD
Volatile Organic Constituents	8260B
Total Alkalinity	310.1, titration, sulfuric acid
Total Dissolved Solids	160.1
Arsenic	ICP 6010C, ICPMS 6020A
Barium	ICP 6010C, ICPMS 6020A
Cadmium	ICP 6010C, ICPMS 6020A
Chromium	ICP 6010C, ICPMS 6020A
Cobalt	ICP 6010C, ICPMS 6020A
Copper	ICP 6010C, ICPMS 6020A
Lead	ICP 6010C, ICPMS 6020A
Nickel	ICP 6010C, ICPMS 6020A
Selenium	ICP 6010C, ICPMS 6020A
Silver	ICP 6010C, ICPMS 6020A
Dissolved Iron	ICP 6010C, ICPMS 6020A
Dissolved Manganese	ICP 6010C, ICPMS 6020A
Zinc	ICP 6010C, ICPMS 6020A
Ammonia	350.3, ion electrode

Containers & Preservation

Volatiles - Method 8260B - 3, 40-ml VOA Vials)
Metals - Methods ICP 6010 and ICPMS 6020 - 2, 1-liter, plastic, kept cold; one preserved with HNO_3 to pH <2; one with no preservative.
Ammonia – Method 350.3 - 1, 500-ml, glass, preserved with H_2SO_4.

The above test methods are taken from EPA SW-846, Test Methods for Evaluating Solid Waste, Third Edition, Update IIIB, November 2004. All samples shall be analyzed by SW846 methods or other methods accepted by the TCEQ.

Table 11.3: Sample Containers, Preservation, and Holding Times

Parameter	Recommended Containers	Preservation	Maximum Holding Time	Minimum Volume
pH Spec. Cond. Temperature Heavy Metals (includes iron and manganese)	P,G P,G P,G P,G	None None None *Acidify w/$HN0_3$ to *pH<2, 4°C*	Analyze immediately Analyze immediately Analyze immediately 6 months except *28* days for Hg	*25* ml 100 ml 1 liter
Calcium, Magnesium, Sodium, Potassium, Fluoride, Sulfate, Chloride, and Hardness	P,G	*4°C*	*28* days	1 liter
Total Dissolved Solids (TDS) (may be included with above parameters)	P,G	*4°C*	7 days	1 liter
Nitrate	P,G	*4°C*	*48* hrs	100 ml
Ammonia	P,G	4°C; acidify*w/*H_2S0_4, to *pH<2, 4°C*	7 days; *28* days if acidified	500 ml
Alkalinity	P,G	4°C	*48* hrs	*200* ml
NPOC	G amber, T-lined caps	*4°C;* acidify *w/HC1* to *pH<2, 4°C*	*48* hrs; *28* days if acidified	100 ml/ replicate
Chemical Oxygen Demand (COD)	P,G	*4°C;* acidify w/H_2S0_4, to *pH<2, 4°C*	*48* hrs; *28* days if acidified	100 ml
Semi-volatile organic constituents (SVOC)	G, T-lined caps	*4°C*	7 days until extraction, then analyze within *40* days	1 liter
Biological Oxygen Demand (BOD)	P,G	*4°C*	*24* hrs	1 liter
Volatile Organic Constituents (VOCs)	G, T-lined septa	*4°C;* acidify *w/HC1 to pH<2, 4°C*	*14* days	*2 x 40* ml

P=Polyethylene, G=Glass, T=Teflon.
***If analyzing for dissolved metals, filter in the lab before acidifying.**

Table 11.4 QC Specification Limits for the PQL and Lower Limit of Quantitation Check Samples

COC	Precision (% RSD)	Accuracy (% Recovery)
Metals	10	70-130
Volatiles	20	50-150
Semi-volatiles	30	50-150

Appendix 11A: Groundwater Sampling Report, Form TCEQ-0312

TEXAS COMMISSION ON ENVIRONMENTAL QUALITY

Waste Permits Division, Municipal Solid Waste Permits Section
Groundwater Sampling Report

Facility name_____ **1. MSW permit no.** _____ (Essential Field)

Permittee_____ **2. Monitor well no.** _____ (Essential Field)

County_____ **3. Date of sampling** _____ (Essential Field)

Name of sampler_____ Most recent previous sampling_____

Affiliation of sampler_____ Date of water level measurements_____

If split-sampled, with whom?_____ Datum reference point_____

Integrity of well_____ Datum elevation*_____

Installation date_____ Depth to water (below datum)*_____

4. Water level elevation*_____

5. Purging/Sampling method_____ (enter Bailer or Pump)
Were low-flow methods used? [ ] yes [ ] no (check one)
If yes, what volume was purged?_____

6. Well volumes purged_____ (enter 1, 2, 2.5, 3, etc)

7. Was the well dry before purging? [ ] yes [ ] no (check one)

8. Was the well dry after purging? [ ] yes [ ] no (check one)

9. How long before sampling?_____ (enter time)

10. Unit of measure?_____ (days, hours, or mins)

11. Sample Event_____
(enter one of the selections below)
- Background
- Corrective Action
- Detection Monitoring
- Other
- Assessment

12. Sample Schedule_____
(enter one of the selections below)
- Quarterly
- Fourth Year
- Semi-Annual
- Other
- Annual

13. Sample Type_____
(enter one of the selections below)
- Regular
- Split
- Duplicate
- Other
- Resample

Field Measurements:

14. pH _____

15. Spec. cond. _____ 16. [ ] umho/cm or [ ] mmho/cm (check one)

17. Temp. _____ 18. [ ] °F or [ ] °C (check one)

Laboratory:

19. Name _____ Phone _____

Address _____

Representative _____
(name) (signature) (date)

Site operator or representative: _____
(name) (signature) (date)

***Report depth to water and elevations to nearest 0.01 foot relative to mean sea level (MSL).**

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TEXAS COMMISSION ON ENVIRONMENTAL QUALITY

Waste Permits Division, Municipal Solid Waste Permits Section
Groundwater Sampling Report

HEAVY METALS

CONSTITUENT			CONCENTRATION		REPORTING LIMITS[3]		METHOD
Antimony	T[1]	D[2]	_____	µg/l	_____	µg/l	_____
Arsenic	T	D	_____	µg/l	_____	µg/l	_____
Barium	T	D	_____	µg/l	_____	µg/l	_____
Beryllium	T	D	_____	µg/l	_____	µg/l	_____
Cadmium	T	D	_____	µg/l	_____	µg/l	_____
Chromium	T	D	_____	µg/l	_____	µg/l	_____
Cobalt	T	D	_____	µg/l	_____	µg/l	_____
Copper	T	D	_____	µg/l	_____	µg/l	_____
Lead	T	D	_____	µg/l	_____	µg/l	_____
Mercury	T	D	_____	µg/l	_____	µg/l	_____
Nickel	T	D	_____	µg/l	_____	µg/l	_____
Selenium	T	D	_____	µg/l	_____	µg/l	_____
Silver	T	D	_____	µg/l	_____	µg/l	_____
Thallium	T	D	_____	µg/l	_____	µg/l	_____
Vanadium	T	D	_____	µg/l	_____	µg/l	_____
Zinc	T	D	_____	µg/l	_____	µg/l	_____
Iron	T	D	_____	mg/l	_____	mg/l	_____
Manganese	T	D	_____	mg/l	_____	mg/l	_____

[1, 2] Indicate whether analyses for Total (T) or Dissolved (D); use two pages if both are run. If analyses for dissolved concentrations, indicate filter pore size [ ] 0.45, [ ] 1, [ ] 10, [ ] ___ micron, and whether filtered [ ] in field or [ ] in laboratory.

[3] Indicate if reporting limits are _____ PQLs or _____ MDLs.

TEXAS COMMISSION ON ENVIRONMENTAL QUALITY

Waste Permits Division, Municipal Solid Waste Permits Section
Groundwater Sampling Report

VOLATILE ORGANIC COMPOUNDS (VOCs) [1]

CONSTITUENT	CONCENTRATION (ug/L)	REPORTING LIMIT (ug/L) [2]	METHOD	CAS NO.
Acetone				67-64-1
Acrylonitrile				107-13-1
Benzene				71-43-2
Bromochloromethane				74-97-5
Bromodichloromethane				75-27-4
Bromoform				75-25-2
Carbon disulfide				75-15-0
Carbon tetrachloride				56-23-5
Chlorobenzene				108-90-7
Chloroethane				75-00-3
Chloroform				67-66-3
Dibromochloromethane				124-48-1
1,2-Dibromo-3-chloropropane				96-12-8
1,2-Dibromoethane				106-93-4
o-Dichlorobenzene (1,2)				95-50-1
p-Dichlorobenzene (1,4)				106-46-7
trans-1,4-Dichloro-2-butene				110-57-6
1,1-Dichloroethane				75-34-3
1,2-Dichloroethane				107-06-2
1,1-Dichloroethylene				75-35-4
cis-1,2-Dichloroethylene				156-59-2
trans-1,2-Dichloroethylene				156-60-5
1,2-Dichloropropane				78-87-5
cis-1,3-Dichloropropene				10061-01-5
trans-1,3-Dichloropropene				10061-02-6
Ethylbenzene				100-41-4
2-Hexanone				591-78-6
Methyl bromide				74-83-9
Methyl chloride				74-87-3
Methylene bromide				74-95-3
Methylene chloride				75-09-2
Methyl ethyl ketone				78-93-3
Methyl iodide				74-88-4
4-Methyl-2-pentanone				108-10-1
Styrene				100-42-5
1,1,1,2-Tetrachloroethane				630-20-6
1,1,2,2-Tetrachloroethane				79-34-5
Tetrachloroethylene				127-18-4
Toluene				108-88-3
1,1,1-Trichloroethane				71-55-6
1,1,2-Trichloroethane				79-00-5
Trichloroethylene				79-01-6
Trichlorofluoromethane				75-69-4
1,2,3-trichloropropane				96-18-4
Vinyl acetate				108-05-4
Vinyl chloride				75-01-4
Xylenes (total)				1330-20-7

[1] **Samples for VOCs must not be filtered.**
[2] **Indicate if reporting limits are _____ PQLs or _____ MDLs.**

TEXAS COMMISSION ON ENVIRONMENTAL QUALITY

Waste Permits Division, Municipal Solid Waste Permits Section
Groundwater Sampling Report

OTHER CONSTITUENTS

CONSTITUENT [1]	CONCENTRATION [2]	REPORTING LIMIT [2, 3]	METHOD

[1] Indicate whether analyses for Total (T) or Dissolved (D) concentrations. If analyses for dissolved concentrations, indicate filter pore size [ ] 0.45, [ ] 1, [ ] 10, [ ] __ micron, and whether filtered [ ] in field or [ ] in laboratory.

[2] Indicate if reporting limits are _____ PQLs or _____ MDLs.

[3] Show units of concentration and reporting limit.

Appendix 11B: Chain of Custody Form

(insert form)

Appendix 11C: Example Laboratory Checklist

Laboratory Data Package Cover Page

This data package consists of:

- ☐ This signature page, the laboratory review checklist, and the following reportable data:
- ☐ R1 Field chain-of-custody documentation;
- ☐ R2 Sample identification cross-reference;
- ☐ R3 Test reports (analytical data sheets) for each environmental sample that includes:
  a) Items consistent with NELAC 5.13 or ISO/IEC 17025 Section 5.10
  b) dilution factors,
  c) preparation methods,
  d) cleanup methods, and
  e) if required for the project, tentatively identified compounds (TICs).
- ☐ R4 Surrogate recovery data including:
  a) Calculated recovery (%R), and
  b) The laboratory's surrogate QC limits.
- ☐ R5 Test reports/summary forms for blank samples;
- ☐ R6 Test reports/summary forms for laboratory control samples (LCSs) including:
  a) LCS spiking amounts,
  b) Calculated %R for each analyte, and
  c) The laboratory's LCS QC limits.
- ☐ R7 Test reports for project matrix spike/matrix spike duplicates (MS/MSDs) including:
  a) Samples associated with the MS/MSD clearly identified,
  b) MS/MSD spiking amounts,
  c) Concentration of each MS/MSD analyte measured in the parent and spiked samples,
  d) Calculated %Rs and relative percent differences (RPDs), and
  e) The laboratory's MS/MSD QC limits
- ☐ R8 Laboratory analytical duplicate (if applicable) recovery and precision:
  a) the amount of analyte measured in the duplicate,
  b) the calculated RPD, and
  c) the laboratory's QC limits for analytical duplicates.
- ☐ R9 List of practical quantitation limits (PQLs) for each analyte for each method and matrix;
- ☐ R10 Other problems or anomalies.
- ☐ The Exception Report for every "No" or "Not Reviewed (NR)" item in laboratory review checklist.

Release Statement: I am responsible for the release of this laboratory data package. This data package has been reviewed by the laboratory and is complete and technically compliant with the requirements of the methods used, except where noted by the laboratory in the attached exception reports. By my signature below, I affirm to the best of my knowledge, all problems/anomalies, observed by the laboratory as having the potential to affect the quality of the data, have been identified by the laboratory in the Laboratory Review Checklist, and no information or data have been knowingly withheld that would affect the quality of the data.

Check, if applicable: ☐ This laboratory is an in-house laboratory controlled by the person responding to rule. The official signing the cover page of the rule-required report (for example, the APAR) in which these data are used is responsible for releasing this data package and is by signature affirming the above release statement is true.

Name (Printed)	Signature	Official Title (printed)	Date

Laboratory Review Checklist: Reportable Data

Laboratory Name:	LRC Date:
Project Name:	Laboratory Job Number:
Reviewer Name:	Prep Batch Number(s):

#[1]	A[2]	Description	Yes	No	NA[3]	NR[4]	ER#[5]
R1	OI	**Chain-of-custody (C-O-C)**					
		Did samples meet the laboratory's standard conditions of sample acceptability upon receipt?					
		Were all departures from standard conditions described in an exception report?					
R2	OI	**Sample and quality control (QC) identification**					
		Are all field sample ID numbers cross-referenced to the laboratory ID numbers?					
		Are all laboratory ID numbers cross-referenced to the corresponding QC data?					
R3	OI	**Test reports**					
		Were all samples prepared and analyzed within holding times?					
		Other than those results < PQL, were all other raw values bracketed by calibration standards?					
		Were calculations checked by a peer or supervisor?					
		Were all analyte identifications checked by a peer or supervisor?					
		Were sample quantitation limits reported for all analytes not detected?					
		Were all results for soil and sediment samples reported on a dry weight basis?					
		Were % moisture (or solids) reported for all soil and sediment samples?					
		If required for the project, TICs reported?					
R4	O	**Surrogate recovery data**					
		Were surrogates added prior to extraction?					
		Were surrogate percent recoveries in all samples within the laboratory QC limits?					
R5	OI	**Test reports/summary forms for blank samples**					
		Were appropriate type(s) of blanks analyzed?					
		Were blanks analyzed at the appropriate frequency?					
		Were method blanks taken through the entire analytical process, including preparation and, if applicable, cleanup procedures?					
		Were blank concentrations < PQL?					
R6	OI	**Laboratory control samples (LCS):**					
		Were all COCs included in the LCS?					
		Was each LCS taken through the entire analytical procedure, including prep and cleanup steps?					
		Were LCSs analyzed at the required frequency?					
		Were LCS (and LCSD, if applicable) %Rs within the laboratory QC limits?					
		Does the detectability data document the laboratory's capability to detect the COCs at the MDL used to calculate the SQLs?					
		Was the LCSD RPD within QC limits?					
R7	OI	**Matrix spike (MS) and matrix spike duplicate (MSD) data**					
		Were the project/method specified analytes included in the MS and MSD?					
		Were MS/MSD analyzed at the appropriate frequency?					
		Were MS (and MSD, if applicable) %Rs within the laboratory QC limits?					
		Were MS/MSD RPDs within laboratory QC limits?					
R8	OI	**Analytical duplicate data**					
		Were appropriate analytical duplicates analyzed for each matrix?					
		Were analytical duplicates analyzed at the appropriate frequency?					
		Were RPDs or relative standard deviations within the laboratory QC limits?					
R9	OI	**Practical quantitation limits (PQLs):**					
		Are the PQLs for each method analyte included in the laboratory data package?					
		Do the PQLs correspond to the concentration of the lowest non-zero calibration standard?					
		Are unadjusted PQLs included in the laboratory data package?					
R10	OI	**Other problems/anomalies**					
		Are all known problems/anomalies/special conditions noted in this LRC and ER?					
		Were all necessary corrective actions performed for the reported data?					
		Was applicable and available technology used to lower the SQL minimize the matrix interference affects on the sample results?					

1. Items identified by the letter "R" must be included in the laboratory data package submitted in required report(s). Items identified by the letter "S" should be retained and made available upon request for the appropriate retention period.
2. = organic analyses; I = inorganic analyses (and general chemistry, when applicable);
3. NA = Not applicable; and NR = Not reviewed;
4. ER# = Exception Report identification number (an Exception Report should be completed for an item if "NR" or "No" is checked on the LRC)

Laboratory Review Checklist: Reportable Data								
Laboratory Name:			LRC Date:					
Project Name:			Laboratory Job Number:					
Reviewer Name:			Prep Batch Number(s):					
#[1]	A[2]	Description	Yes	No	NA[3]	NR[4]	ER#[5]	
S1	OI	**Initial calibration (ICAL)**						
		Were response factors and/or relative response factors for each analyte within QC limits?						
		Were percent RSDs or correlation coefficient criteria met?						
		Was the number of standards recommended in the method used for all analytes?						
		Were all points generated between the lowest and highest standard used to calculate the curve?						
		Are ICAL data available for all instruments used?						
		Has the initial calibration curve been verified using an appropriate second source standard?						
	OI	**Initial and continuing calibration verification (ICCV and CCV) and continuing calibration**						
		Was the CCV analyzed at the method-required frequency?						
		Were percent differences for each analyte within the method-required QC limits?						
		Was the ICAL curve verified for each analyte?						
		Was the absolute value of the analyte concentration in the inorganic CCB < MDL?						
	O	**Mass spectral tuning:**						
		Was the appropriate compound for the method used for tuning?						
		Were ion abundance data within the method-required QC limits?						
	O	**Internal standards (IS):**						
		Were IS area counts and retention times within the method-required QC limits?						
S5	OI	**Raw data (NELAC section 1 appendix A glossary, and section 5.12 or ISO/IEC 17025 section 4.12.2)** ***(ONLY USE DATA FOR EPA LEVEL 3 QA/QC REVIEW, IF RAW DATA NOT APPLICABLE, THEN CHANGE APPROPRIATELY).***						
		Were the raw data (for example, chromatograms, spectral data) reviewed by an analyst?						
		Were data associated with manual integrations flagged on the raw data?						
	O	**Dual column confirmation**						
		Did dual column confirmation results meet the method-required QC?						
	O	**Tentatively identified compounds (TICs):**						
		If TICs were requested, were the mass spectra and TIC data subject to appropriate checks?						
	I	**Interference Check Sample (ICS) results:**						
		Were percent recoveries within method QC limits?						
	I	**Serial dilutions, post digestion spikes, and method of standard additions**						
		Were percent differences, recoveries, and the linearity within the QC limits specified in the method?						
	OI	**Method detection limit (MDL) studies**						
		Was a MDL study performed for each reported analyte?						
		Is the MDL either adjusted or supported by the analysis of DCSs?						
	OI	**Proficiency test reports:**						
		Was the laboratory's performance acceptable on the applicable proficiency tests or evaluation studies?						
	OI	**Standards documentation**						
		Are all standards used in the analyses NIST-traceable or obtained from other appropriate sources?						
	OI	**Compound/analyte identification procedures**						
		Are the procedures for compound/analyte identification documented?						
	OI	**Demonstration of analyst competency (DOC)**						
		Was DOC conducted consistent with NELAC Chapter 5C or ISO/IEC 4?						
		Is documentation of the analyst's competency up-to-date and on file?						
	OI	**Verification/validation documentation for methods** (NELAC Chap 5 or ISO/IEC 17025 Section 5)						
		Are all the methods used to generate the data documented, verified, and validated, where applicable?						
	OI	**Laboratory standard operating procedures (SOPs):**						
		Are laboratory SOPs current and on file for each method performed?						

1 Items identified by the letter "R" should be included in the laboratory data package submitted to the TCEQ in the required report(s). Items identified by the letter "S" should be retained and made available upon request for the appropriate retention period.

2 O = organic analyses; I = inorganic analyses (and general chemistry, when applicable).

3 NA = Not applicable.

4 NR = Not Reviewed.

5 ER# = Exception Report identification number (an Exception Report should be completed for an item if "NR" or "No" is checked).

Appendix A (cont'd): Laboratory Review Checklist: Exception Reports			
Laboratory Name:		LRC Date:	
Project Name:		Laboratory Job Number:	
Reviewer Name:		Prep Batch Number(s):	
ER #[1]	**DESCRIPTION**		

ER# = Exception Report identification number (an Exception Report should be completed for an item if "NR" or "No" is checked on the LRC

Appendix 11D: Site Safety Plan

This Site Safety Plan has been presented herein to provide guidance when conducting groundwater and sampling activities at the site. Any other site specific health and safety procedures prepared by the City of Amarillo shall be adhered to. Personnel designated to perform the groundwater monitoring and sampling program should be trained in the operation, maintenance, and calibration of the sampling equipment. There should be two people at all times performing the monitoring and sampling activities. At the end of this plan is a site map that shows the well locations, routing to and from the wells, and entrance/exit to the facility. In case of emergency, it is recommended that all personnel meet at the landfill office located on the western side of the landfill, unless a specific location has been selected by the City of Amarillo management. The following safety precautions are recommended:

- During the monitoring and sampling activities, smoking and eating will **not** be permitted. These activities should only be permitted in designated areas and after washing hands with soap and water.
- At a minimum Level D protection should be worn at all times. Because groundwater is involved with this activity the protective gear should at least consist of coveralls, gloves, safety glasses or goggles, boots, and hard hat.
- Because the potential for methane and other gases to build-up in the monitor wells, extra precaution should be taken when opening monitor wells that have been closed for a period of time. Any equipment that may be a spark hazard should be removed from the area before opening the well. It is recommended to have a methane monitoring device, i.e. explosimeter, during sampling to monitor the air space around the well head prior to opening the well. If concentrations are within five percent or greater by volume of methane, then the well should be vented until readings decrease to zero.
- While working around the wells, an adequate working area should be maintained to allow free movement. In heavy traffic areas, the working area should be delineated with barriers or caution tape. Personnel should be aware of construction equipment and refuse trucks around the area at all times. In areas that are obstructed from view, adequate signs should be posted to warn on-coming vehicles that personnel are working in the area and that caution should be taken.

Since many of the constituents being analyzed are considered carcinogens, Material Safety Data Sheets (MSDS) should be posted at the facility and consulted on a regular basis. For this type of work the primary exposure routes will be by ingestion and skin absorption. Therefore, extra precaution should be given to avoid coming into contact with groundwater that is potentially impacted with volatile organic constituents. Personnel should thoroughly wash their hands with soap and water after completing the sampling activities and before they leave the site.

Part III

Attachment 12

Final Closure Plan

Permit ~~Amendment –~~ MSW No. 73A

City of Amarillo,
Potter County, Texas

~~December 2005~~July 2009

This document is released for the purpose of review only under the authority of ~~Mitch R. Davison~~Michael W. Oden, P.E. # ~~90908~~67165. It is not to be used for bidding or construction. Firm Registration No. F-754

City of Amarillo
Landfill Permit ~~Amendment~~ – Part III, Attachment 12
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For pages _____ thru _____

7.0 ESTIMATED COSTS

Table III.12.1 summarizes the estimated costs for final closure of the largest area requiring final cover. The unit costs used are based on recent projects and prices. The estimated costs will be updated annually or as required to reflect any increased or decreased costs in construction or materials or the closure of particular cells. A copy of the revised closure costs will be submitted to the Commission.

Table III.12.1: Closure Costs
CITY OF AMARILLO LANDFILL
COST ESTIMATE FOR CLOSURE OF THE LARGEST AREA
(LARGEST AREA ESTIMATED AT 526 ACRES)
MSW Permit No. 73A

Item	Quantity	Unit	Unit Cost	Total
Engineering				
Topo Survey	1	LS*	$7,500	$7,500
Boundary Survey	40	HR	$80	$3,200
Site Evaluation and Development of Plans	1	LS	$25,000	$25,000
Closure Plan	1	LS	$10,000	$10,000
Construction Observation/Testing	400	HR	$75	$30,000
Subtotal				$75,700
Contingency	20%			$15,140
Total Engineering				**$90,840**
Construction				
Plug and Abandon Wells	22	EA	$8,000	$176,000
Plug and Abandon Piezometers	5	EA	$5,000	$25,000
Fill to grade	1,129,333	CY	$2.00	$2,258,667
Infiltration Layer (12 inches)				
Placing/grading/compaction	848,013	CY	$1.50	$1,272,020
Erosion/Vegetative Layer (24 inches)	1,697,227	CY	$1.50	$2,545,840
Vegetation	526	ACRE	$1,000.00	$526,000
Backfill/grading/drainage	1	LS	$100,000.00	$100,000
Methane Gas Control Wells	10	EA	$1,000.00	$10,000
Subtotal				~~$6,712,526~~6,913,526
Contingency	20%			~~$1,342,505~~1,382,705
Total Construction				**~~$8,055,031~~8,296,231**
Total Closure Costs (2005)				**$8,387,071**
5% increase for 2006				**$8,806,425**
5% increase for 2007				**$9,246,746**
5% increase for 2008				**$9,709,084**