December 4, 2009

Mr. Johnny Williamson, 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 October 28, 2009
Tracking No. 12847511; RN100237551 / CN600130942

Dear Mr. Williamson:

We have reviewed your comments dated October 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 the specific comments followed by our response:

1. 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 updated and is attached.*

2. In response to Comment 2 of our August 20, 2009 NOD letter, you revised page 9 of Attachment 5 with the additional statement that "(m)onitoring wells 1 and 2 will remain active for assessment monitoring until TCEQ approval is granted for decommissioning." Instead, please revise this statement to require that existing monitor wells MW-1 and MW-2 will remain as point of compliance wells in the facility groundwater monitoring system until the TCEQ authorizes the decommissioning of the two wells.

   Response: *Page 9 of Attachment 5 has been revised; as requested.*

HDR Engineering, Inc.
4500 West Eldorado Parkway
Suite 3500
McKinney, TX 75070-5757
Phone: (214) 733-5900
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3. In comment 3 of our August 20, 2009 letter, we had requested the installation of additional monitor wells north of monitor well MW-820, to the approximate area of proposed piezometer PZ-206. In lieu of this request, we had given you the option of using the requested monitor wells as observation wells, though constructed to monitor well specifications. Your proposed groundwater monitoring system could be considered for acceptance in its current configuration provided that specific requirements were added to your application to address any southwestern groundwater flow revealed in future groundwater level data obtained for the northwestern corner of your facility. Reviewing you proposed revisions to pages 10-11 of Attachment 5 in response to our request, we have determined the changes inadequate to fully characterize the framework under which the alternate groundwater monitoring system would function. Please revise the proposed text on pages 10-11 to also include the following:

    a) that the MSW Permits Section staff will review the determination of the direction of groundwater flow for each sampling event;
    b) that the observation wells installed will be constructed to monitor well specifications per 30 TAC 330.421;
    c) that all groundwater level data obtained, and related groundwater piezometric surface contour map, will be submitted on a semi-annual basis for TCEQ review, an shall include a table providing all groundwater level data obtained for each observation well since installation; and
    d) specific requirements/timelines for the establishment of detection monitoring at the former observation well(s), including the accumulation of background data.

Response: *Pages 10-11 of Attachment 5 have been revised with the text listed above.*

Attached are revised documents incorporating the changes described above. The table containing a listing, description, and location of all changes to the facility permit has been updated, and Attachment 5 has been revised. Due to formatting requirements, the entire document (Part III, Attachment 5) has been revised and is included in its entirety. 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: Certification Statement (Part I Form)
Revised Table: Site Development Plan – Permit Modification SubChapter F and J
Part III, Attachment 5

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

Certification Statement

List of Revisions

Signature Page

I, MICHAEL G. RICE, DIRECTOR OF PUBLIC WORKS,
(Operator) (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 G. Rice Date: Dec. 2, 2009

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

I, _____, hereby designate _____
(Print or Type Operator Name) (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 G. Rice

On this 2nd day of December, 2009

My commission expires on the 10th day of June, 2010

BEVERLY ALTSMAN
NOTARY PUBLIC,
STATE OF TEXAS
My Commission Expires 06-10-2010

Beverly Altsman
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 December 2009 submittal

Modified Text

Part III

Attachment 5

Groundwater Characterization Report

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

City of Amarillo,
Potter County, Texas

Revised December 2009

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

12-2-09

Donald D. James, P.G.
Texas P.G. No. 360

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

Michael M. Shiflett, P.E.
Texas P.E. No. 43763

12-2-2009
Signing for Table of Contents (i, ii) and pages 1-16.

KLEINFELDER
Bright People. Right Solutions.

Kleinfelder Central, Inc. Engineering No. F-5592

City of Amarillo Landfill
Part III, Attachment 5

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

- Groundwater Contour Map, October 18, 2004
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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 wells MW-3, MW-4, and MW-6 will be decommissioned. Monitoring Wells 1 and 2 (MW-1 and MW-2) will remain as a point of compliance wells in the facility groundwater monitoring systems until TCEQ approval is granted for decommissioning. 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. Each of the piezometers to be constructed as discussed above will be constructed to monitor well specifications per 30 TAC §330.421After 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.

Each sampling event will include an updated groundwater contour map and a determination whether the point of compliance requires any modification due to the groundwater flow paths. Any recommendation for changes to the system will be made in accordance with 30 TAC §330.407(c)(5). The MSW Permits Section staff (TCEQ) will review the determination of the direction of groundwater flow for each sampling event. The groundwater level data and piezometric surface maps will be submitted on a semi-annual basis for TCEQ review. The submittal will include a table providing all groundwater level data obtained from each piezometer and monitor well since installation. If a determination is made that alters the point of compliance, a permit modification request will be submitted to the TCEQ in accordance with 30 TAC §305.70(j)(26) to alter the permit point of compliance and make necessary adjustment of the downgradient monitoring well plan. The modification will be submitted within 90 days after the determination is made. Once concurrence and approval is received from TCEQ for any permit modification, any additional wells required will be installed or the appropriate piezometers converted and background sampling initiated at or before the next Detection Monitoring Event for the groundwater monitoring system. The point of compliance will be extended to include any new wells installed or piezometers that are converted to monitor wells.

Following acceptable background monitoring by TCEQ, existing Monitoring Wells 3, 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.

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 ~~September~~ December 2009

Donald D. James, P.G.

Michael M. Shiflett, P.E.
Texas P.E. No. 43763

KLEINFELDER
Bright People. Right Solutions.

Kleinfelder Central, Inc. Engineering No. F-5592

City of Amarillo Landfill
Part III, Attachment 5

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- 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
- 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

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
- 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

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 wells MW-3, MW-4, and MW-6 will be decommissioned. Monitoring Wells 1 and 2 (MW-1 and MW-2) will remain ~~active for assessment monitoring~~ as a point of compliance wells in the facility groundwater monitoring systems until TCEQ approval is granted for decommissioning. 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. Each of the piezometers to be constructed as discussed above will be constructed to monitor well specifications per 30 TAC §330.421After 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.

Each sampling event will include an updated groundwater contour map and a determination whether the point of compliance requires any modification due to the groundwater flow paths. Any recommendation for changes to the system will be made in accordance with 30 TAC §330.407(c)(5). The MSW Permits Section staff (TCEQ) will review the determination of the direction of groundwater flow for each sampling event.~~an evaluation of direction of groundwater flow, with particular attention directed toward the western site boundary.~~ The groundwater level data and piezometric surface maps will be submitted on a semi-annual basis for TCEQ review. The submittal will include a table providing all groundwater level data obtained from each piezometer and monitor well since installation. ~~If three consecutive sampling/mapping events indicate consistent groundwater flow directions that alter the limits of the outward gradients as presently indicated,~~ If a determination is made that alters the point of compliance, a permit modification request will be submitted to the TCEQ in accordance with 30 TAC §305.70(j)(26) to alter~~ing~~ the permit point of compliance and make necessary adjustment of the downgradient monitoring well plan. ~~will be submitted to TCEQ.~~ The modification will be submitted within 90 days after the determination is made. ~~submission to TCEQ of the sampling event data and updated groundwater contour map.~~ Once concurrence and approval is received from TCEQ for any permit modification, any additional wells required will be installed or the appropriate piezometers converted and background sampling initiated ~~within 180 days.~~ at or before the next Detection Monitoring Event for the groundwater monitoring system. The point of compliance will be extended to include any new wells installed or piezometers that are converted to monitor wells.

Following acceptable background monitoring by TCEQ, existing Monitoring Wells 3, 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.