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Background Concentrations of Contaminants in the Ogallala Aquifer at Pantex: An Evaluation

George Rice

Serious Texans Against Nuclear Dumping (STAND), Inc.

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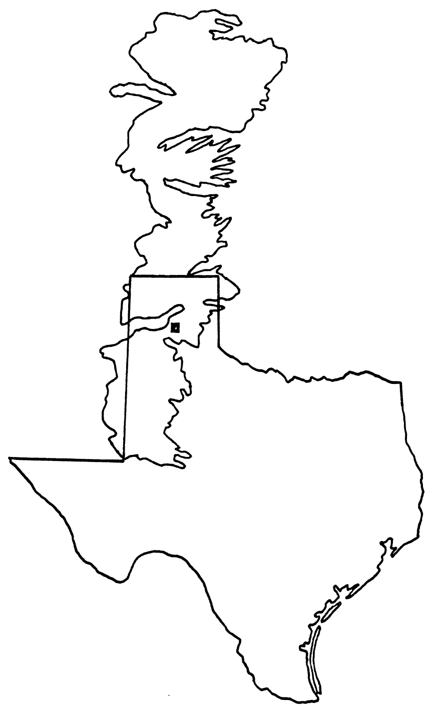

STAND
Technical Report 2003 – 1
May 2003

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STAND's goal is
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An Evaluation

by
George Rice
Groundwater Hydrologist

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1.0 Executive Summary

This report evaluates the Department of Energy's (DOE) *Risk Reduction Rule Guidance to the Pantex Plant RFI*. This evaluation was performed on behalf of Serious Texans Against Nuclear Dumping (STAND), a non-profit organization of concerned citizens.

The DOE has presented what it considers to be background concentrations of contaminants in the Ogallala Aquifer at the Pantex Plant. These background concentrations, once accepted by the State of Texas, will be used to define the amount and areal extent of groundwater contamination associated with the Pantex Plant. Cleanup will not be required in areas where contaminant concentrations are less than background.

This evaluation identified serious problems with DOE's methods of establishing background values:

- Some of the wells used to establish background concentrations are on Pantex property or down gradient of Pantex. Thus, they may have been affected by contaminants emanating from the Plant.

- Contaminants associated with Pantex have been found in wells used by the DOE to establish background concentrations.

- Some of the wells used to establish background concentrations appear to be completed in both the Ogallala Aquifer and the Dockum Group. Samples from these wells will be a mixture of waters from both units and, thus, will not be representative of water quality in the Ogallala Aquifer alone.

- The DOE appears to have used analyses of unfiltered samples to establish background concentrations for metals. Use of unfiltered samples can result in estimates of metal concentrations that are higher than actual concentrations.

- The DOE has not used the most sensitive analytical method to analyze background samples. This has resulted in the establishment of background concentrations for some man-made contaminants that equal or exceed health based standards.

- The DOE has overestimated the background concentration of thallium by a factor of more than 75.

- The DOE has overestimated the background concentration of chromium by a factor of more than four.

2.0 Physical Setting

The Pantex Plant is 17 miles northeast of Amarillo, Texas (Figure 1). Since the early 1950s Pantex has been operated by the Department of Energy (DOE) and its predecessor agencies as a facility to assemble and disassemble nuclear weapons, and to fabricate and test chemical explosives[1]. The Plant contains buildings and industrial structures, a wastewater treatment plant, landfills, waste disposal pits, borrow pits, and agricultural lands[2]. There are five playas on the Plant-site. DOE also controls Pantex Lake, a playa about 2.5 miles northeast of the Plant (Figure 2).

Pantex is underlain by three water-bearing zones that are commonly used in the region: a perched aquifer, the Ogallala Aquifer, and aquifers that occur in the Dockum Group. The perched aquifer is found at depths of about 200 to 300 feet below land surface[3]. The full extent of the perched aquifer at Pantex has not been determined. The Ogallala aquifer is below the perched aquifer and is separated from it by unsaturated material[4]. The Dockum Group immediately underlies the Ogallala Aquifer[5].

The Ogallala Aquifer is the major aquifer in the region[6]. At Pantex, groundwater in the Ogallala flows to the northeast (Figure 3). The City of Amarillo operates a public supply well field in the Ogallala north and northeast of Pantex. The nearest City well is about 2500 feet from the Plant. Landowners near the Pantex boundary use water from the Ogallala Aquifer for domestic and agricultural purposes, and the Plant obtains its water from five on-site Ogallala wells.

Contaminants from the Pantex Plant have entered the perched aquifer and the Ogallala Aquifer[7].

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[1] DOE, 1998a, page 2-1.

[2] DOE, 2000d, pages 2-11 and 4-2.

[3] DOE, 2000d, page 4-3.

[4] The thickness of the unsaturated zone between the perched aquifer and the Ogallala Aquifer varies from zero feet to more than 300 feet (DOE, 2000d, page 4-4). In the southwestern portion of the Plant the unsaturated zone is not present because the water table of the Ogallala intersects the perched aquifer (Battelle, 1997, Figure 4-16). The thickness is greatest north of the plant due to drawdown created by the City of Amarillo wellfield (Battelle, 1997, Figure 4-16; and DOE, 2000d, page 4-4).

[5] Battelle, 1997, page 15.

[6] DOE, 2000e, page 2.

[7] For more information on the Pantex Plant and groundwater contamination see Battelle, 1997, Rice, 2001, and Stoller, 2001.

3.0 Introduction

This report is an evaluation of DOE's *Risk Reduction Rule Guidance to the Pantex Plant RFI*[8] (April 2002)[9]. It was performed on behalf of Serious Texans Against Nuclear Dumping (STAND), a non-profit organization of concerned citizens.

A primary purpose of DOE's *Risk Reduction Rule Guidance* is to establish background concentrations of contaminants in soils and groundwater at the Pantex Plant[10]. The background concentrations established for the Ogallala Aquifer will also be applied to the perched aquifer[11].

Background may be defined as the quality of water that would exist if it had not been affected by activities at Pantex. This is not the same as native water quality, which is the quality that would exist if it were unaffected by any human activity.

Aquifer cleanup at Pantex will be governed by the Texas Risk Reduction Rules[12]. One feature of those rules, Risk Reduction Standard 1 (RRS 1) is particularly relevant to a discussion of background. RRS 1 incorporates the concepts of background and practical quantitation limits (PQLs)[13]. RRS 1 is defined as follows:

> *"RRS1: The site is not contaminated, and therefore, no risk to people or the environment exists (no further action is needed for RRS 1 sites) due to industrial activities at the site. Sample results are less than background (for naturally occurring compounds) or below the laboratory detection limits for non-naturally occurring compounds. The Laboratory detection limits are defined by the RRR*[14] *and are called practical quantitation limits (PQLs)."* [15]

The PQL is defined as the:

> "*lowest concentration of an analyte which can be reliably quantified within specified limits of precision and accuracy during routine laboratory operating conditions."*[16]

Both background concentrations and PQLs will be used to determine the extent of contamination:

> *"Background levels are used to define the limits of site contamination at Pantex Plant. The PQL is the background for non-naturally occurring compounds."* [17]

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[8] RCRA Facility Investigation.

[9] DOE 2002a.

[10] DOE 2002a, pages 2 and 3.

[11] DOE 2002a, page 23.

[12] DOE 2002a, page 1.

[13] DOE 2002a, page 39. The PQL is not the same as the detection limit. For water samples, DOE set the PQL at five times higher than the detection limit (DOE 2002a, page 28).

[14] *RRR = The Texas Risk Reduction Rules.*

[15] *DOE 2002a, page 1.*

[16] DOE 2002a, page 28

[17] DOE 2002a, page 10.

DOE used three sets of wells to establish background concentrations in the Ogallala Aquifer near the Pantex Plant: 1) City of Amarillo wells north of Pantex, 2) wells along the boundary of Pantex and the Texas Tech Research Farm and 3) a well on Pantex property[18]. Locations of the three boundary wells and the on-site Pantex wells are shown on Figure 2. Locations of the nearest City wells are shown on Figure 3.

The purpose of this evaluation is to determine whether the background concentrations (RRS 1) established for the Ogallala Aquifer are reasonable. It identified serious problems with DOE's methods of establishing background values:

- Some of the wells used to establish background concentrations may be affected by contaminants emanating from the Pantex Plant or Pantex Lake.
- Some of the wells used to establish background concentrations appear to be completed in both the Ogallala Aquifer and the Dockum Group.
- Analyses of unfiltered samples may have been used to establish background concentrations of metals.
- Inappropriate PQLs were used to establish RRS 1 concentrations.

These problems are discussed in the following sections.

[18] DOE, 2002a, page 23 and Figure 2-9.

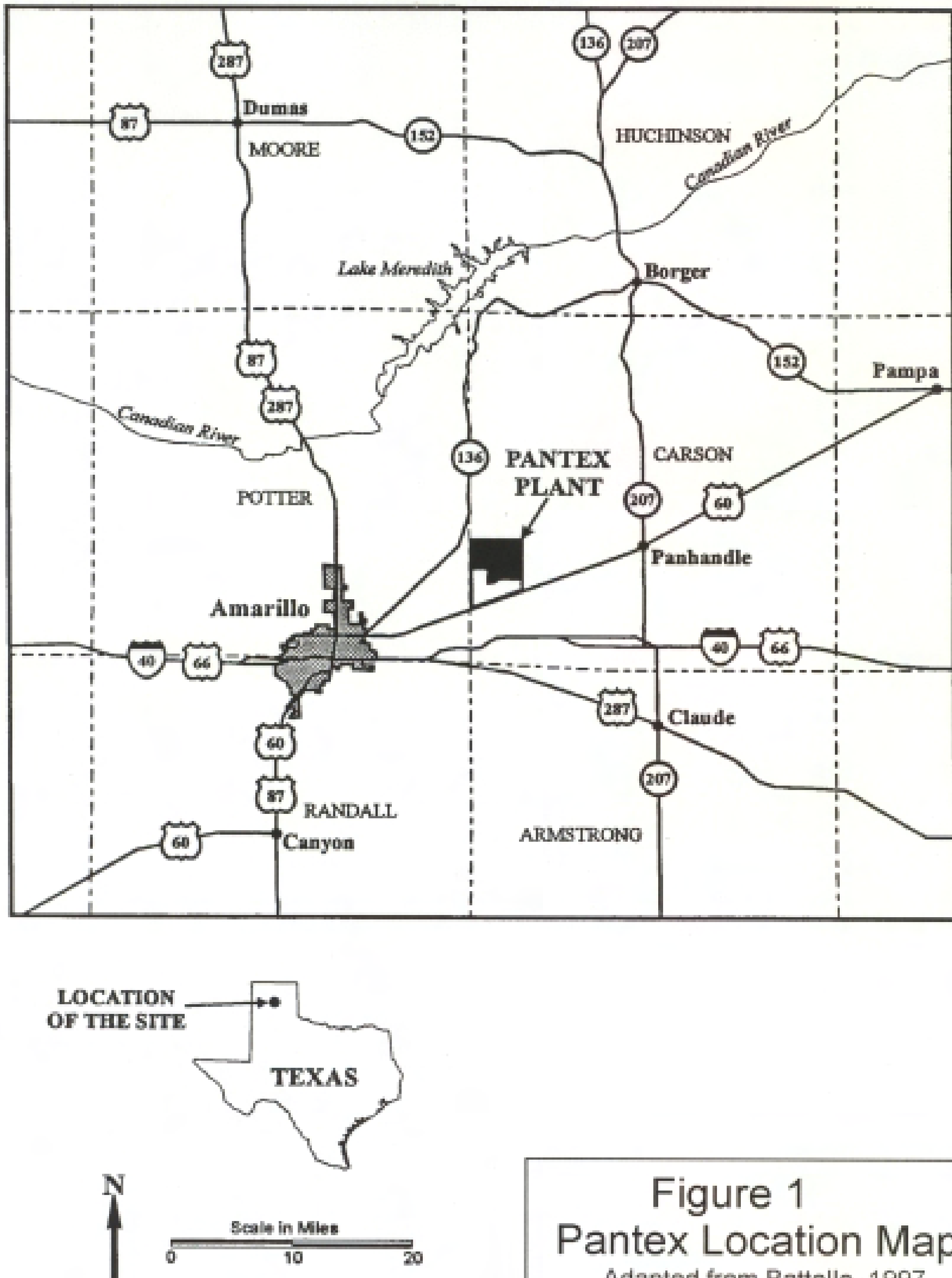

Figure 1
Pantex Location Map
Adapted from Battelle, 1997

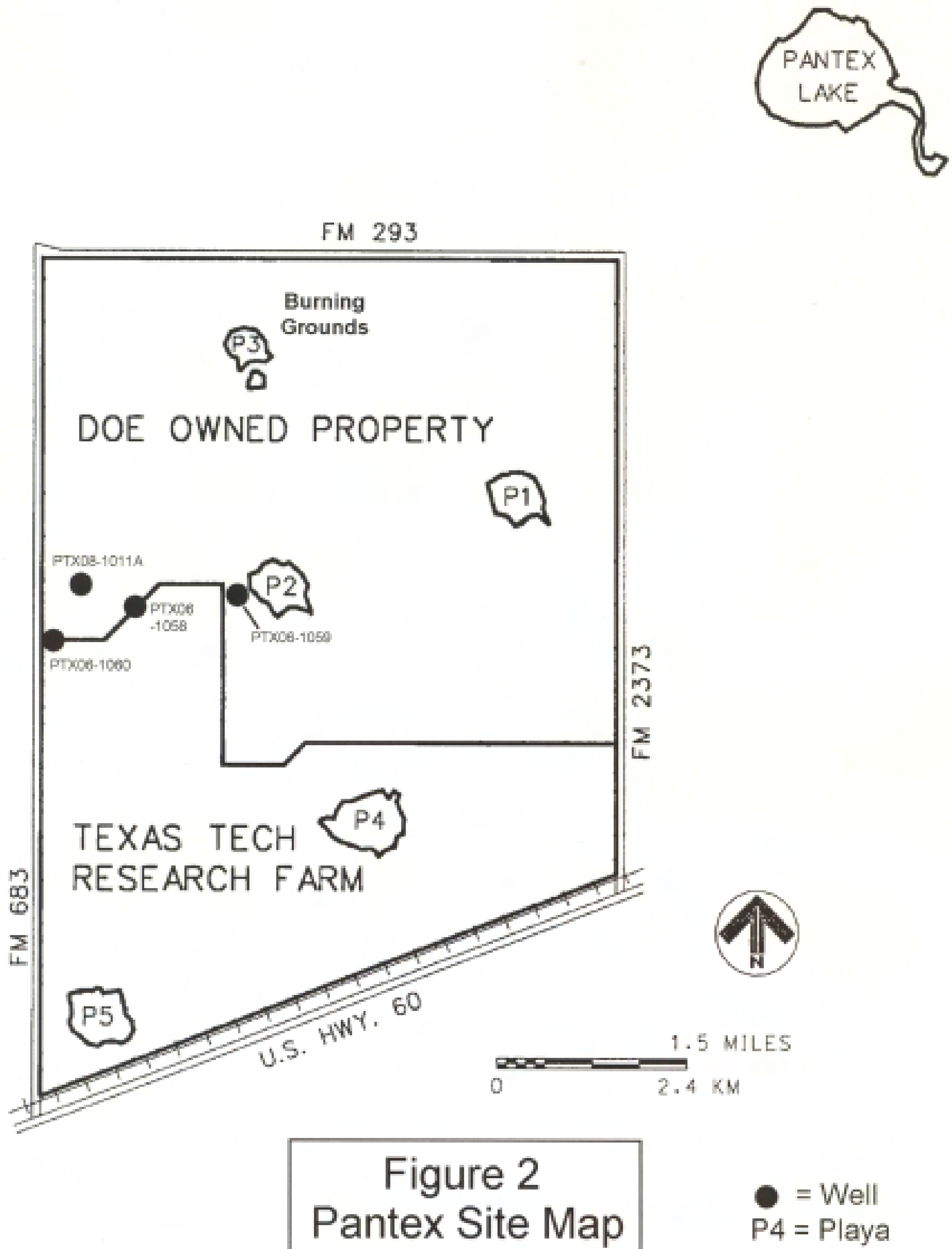

Figure 2
Pantex Site Map
Adapted from DOE, 1998b

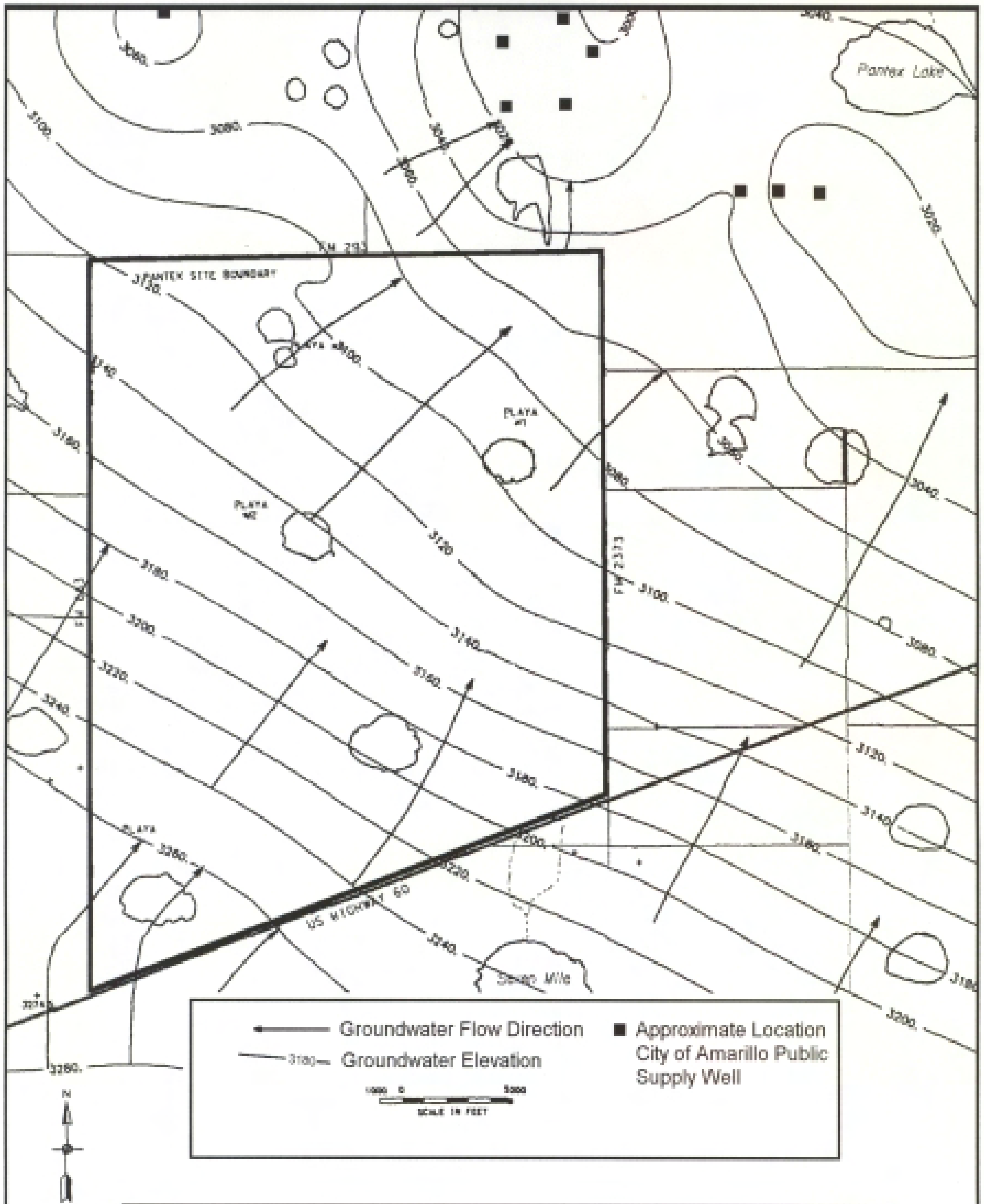

Figure 3
Groundwater Flow Directions in the Ogallala Aquifer
Adapted from Battelle, 1997

4.0 Wells

DOE used samples from 39 wells to establish background concentrations in the Ogallala Aquifer. Thirty five of the wells are City of Amarillo water supply wells. Three of the wells are along the boundary with the Texas Tech Research Farm. The other well is in the southwest portion of the Plant[19]. DOE states:

> *"Background samples were collected from areas representative of site conditions that have not been affected by waste management or industrial activities."*[20]

This is not correct. Some of the wells are in areas that may have been affected by activities at Pantex. Man-made contaminants associated with waste management or industrial activities have been found in wells used to establish background concentrations. These include: 1,2,4-trichlorobenzene[21], 2-nitrotoluene[22], acetone[23], bis[2-ethylhexyl]phthalate[24], perchlorate[25], RDX[26], toluene[27], and xylene[28].

4.1 City of Amarillo wells:

The City of Amarillo wells are down gradient of the Pantex Plant and Pantex Lake (Figure 3)[29]. Contaminant travel times from the Plant to the nearest City wells are on the order of a few decades or less[30]. It is incumbent upon DOE to clearly demonstrate that these wells are not affected by contaminants emanating from the Pantex Plant or Pantex Lake. DOE has not made such a demonstration.

Man-made contaminants have been found in four of the City wells used to establish background concentrations. Perchlorate has been found in City well 612[31]. Bis[2-ethylhexyl]phthalate has been found in City wells 615, 629, and 652[32]. Perchlorate and

[19] Although DOE considers this well (PTX08-1011A) to be on the Plant boundary, it is actually well within the Plant property; approximately 1400 feet from the western boundary and 1600 feet from the southern boundary (Mason & Hanger, 2000b).

[20] DOE 2002a, page 25.

[21] 1,2,4-trichlorobenzene is a solvent and is used to make herbicides (EPA 2002).

[22] 2-nitrotoluene is an explosive (DOE, 2002a, Table 3-13).

[23] Acetone is a solvent (ATSDR, 1995).

[24] Bis[2-ethylhexyl]phthalate (also known as di[2-ethylhexyl]phthalate, CAS number 117-81-7) is used as a plasticizer, a solvent, in vacuum pumps, and in pesticides (National Institutes of Health, 2001).

[25] Perchlorate is an explosive (Occupational Safety & Health Administration, 1991).

[26] RDX is an explosive (DOE, 2002a, Table 3-13).

[27] Toluene is a solvent and a component of gasoline (ATSDR, 2001, Harte et al., 1991).

[28] Xylene is a solvent and is a component of gasoline, plastics and pesticides (ATSDR, 1996, Harte et al., 1991).

[29] Figure 3 does not show all of the City of Amarillo wells used to establish background. The rest of the wells are north and northeast of the area shown on the map. See DOE 2002a, Figure 2-9.

[30] Rice, 2001, appendix II.

[31] Perchlorate = 6 µg/L (J), 03/05/01 (DOE, 2001a). City well 612 is also known as well 06-36-702 (DOE 2002a, attachment 1 to appendix C).

[32] Bis[2-ethylhexyl]phthalate = 2 µg/L (J), 0.22 µg/L (J), 0.26 µg/L (J) in City wells 615, 629, and 652, respectively (DOE, 2001a). City wells 615, 629, and 652 are also known as wells 06-36-811, 06-44-305, and 06-36-904, respectively (DOE 2002a, attachment 1 to appendix C).

bis[2-ethylhexyl]phthalate have been found in the Ogallala Aquifer at Pantex[33]. This may indicate that City wells have been affected by contaminants emanating from Pantex.

Three of the City wells (612, 613, and 621) appear to be partially completed in the Dockum Group[34]. Thus, the water produced by these wells would be a mixture of waters from both the Ogallala Aquifer and the Dockum Group.

City wells 612, 615, 629, and 652 should not be used as background wells because man made contaminants associated with Pantex have been detected in these wells. City wells 612, 613, and 621 should not be used as background wells because they appear to be partially completed in the Dockum Group.

<u>4.2 Wells along Pantex - Texas Tech Research Farm Boundary</u>

Wells PTX06-1058, PTX06-1059, and PTX06-1060 are along the boundary of Pantex and the Texas Tech Research Farm (Figure 2)[35].

Contaminants associated with waste management or industrial activities have been found in all three of the boundary wells:

- Bis[2-ethylhexyl]phthalate and toluene have been found in well PTX06-1058[36].
- 1,2,4-trichlorobenzene, acetone, bis[2-ethylhexyl]phthalate, toluene, and xylene, have been found in well PTX06-1059[37].
- 2-nitrotoluene, acetone, bis[2-ethylhexyl]phthalate, and toluene, have been found in well PTX06-1060[38].

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[33] Rice, 2001, appendix I; and DOE, 2001c, Table 6.1

[34] Table C-1 of the *Risk Reduction Rule Guidance* (DOE, 2002a) gives the unit code for City wells 612, 613, and 621 as '121OGDK'. This code means that a well is installed in both the Ogallala and the Dockum Group (see Nordstrom and Quincy, 1999, appendix D).

[35] DOE may be responsible for some industrial wastes disposed at the Texas Tech Research Farm. Until about 1992, sanitary and industrial wastes from Amarillo Air Base were discharged to Playa 5 (Battelle, 1997, page 8). DOE is reported to have had an agreement to treat the wastes (Pam Allison of STAND, 2002, personal communication).

[36] Bis[2-ethylhexyl]phthalate = 1.6 µg/L, toluene 3.6 µg/L (DOE 2001b).

[37] 1,2,4-trichlorobenzene = 0.38 µg/L (J) (5/14/01), acetone = 0.94 µg/L (J) – 10.3 µg/L (6/20/01 and 8/22/01), xylene = 0.64 µg/L (J) - 0.68 µg/L (J) (5/14/01, 6/20/01 and 8/22/01) (DOE 2002b). Bis[2-ethylhexyl]phthalate = 5.1 µg/L, toluene = 1 µg/L (DOE 2001b).

[38] Acetone = 2.2 µg/L (J) (1/23/02); toluene = 0.33 µg/L (J) (10/18/01) (DOE 2002b). 2-nitrotoluene = 0.065 µg/L (J) (1/23/02) (DOE 2002d). Bis[2-ethylhexyl]phthalate = 4.5 µg/L (DOE 2001b).

The logs for all three of the boundary wells[39] indicate that they are partly completed in the Dockum Group. Thus, the water produced by these wells would be a mixture of waters from both the Ogallala Aquifer and the Dockum Group.

- PTX06-1058: the materials from a depth of 480 feet to the bottom of the hole (546 feet) consist primarily of shale, siltstone, mudstone, and clay. These materials are characteristic of the Dockum Group in the vicinity of Pantex[40].
- PTX06-1059: the materials from a depth of 525 feet to the bottom of the hole (550 feet) consist primarily of red sand, shale, and mudstone. The log contains the note: “probable Dockum formation”.
- PTX06-1060: the materials from a depth of 465 feet to the bottom of the hole (530 feet) consist primarily of clay and siltstone. The log contains the note: “Geophysical log indicates top of Redbeds at 500’ BGS”.

Wells PTX06-1058, PTX06-1059, and PTX06-1060 should not be used as background wells because man made contaminants associated with Pantex have been detected in samples from these wells, and they may be partially completed in the Dockum Group.

4.3 Well on Pantex property

Well PTX08-1011A is on Pantex property, more than a quarter mile from the Plant boundary (Figure 2). Thus, it may have been affected by Plant activities. Given the long history of Pantex, it is not possible to know where all wastes were dumped or where all spills occurred. RDX, an explosive associated with Pantex, has been detected in this well[41].

This well contained the highest concentrations of thallium[42] and chromium[43] found in the Ogallala near Pantex. The thallium concentration was 77 times higher than that found in any other well (34 µg/L vs. 0.44 µg/L[44]). The chromium concentration was 4.6 times higher than that found in any other well (32 µg/L vs. 6.9 µg/L[45]). DOE intends to use the concentrations found in PTX08-1011A as background values[46].

Well PTX08-1011A should not be used as a background well because it is on Pantex property and a man made contaminant associated with Pantex has been detected in this well.

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[39] DOE 2002a, Appendix C, Attachment 3.

[40] Battelle, 1997, page 13.

[41] RDX = 0.3 µg/L (6/2/99) (Mason & Hanger, 2000a, Attachment 3). RDX, an explosive, is one of the most common contaminants found in the perched aquifer at Pantex (Rice, 2001, Figure 5).

[42] 34 µg/L (DOE 2002a, table C-2). The maximum contaminant level (MCL) for thallium is 2 µg/L (EPA 1998).

[43] 32 µg/L (DOE 2002a, table C-2).

[44] Maximum thallium concentration (excluding PTX08-1011A) = 0.44 µg/L, found in City well # 624 (DOE 2002a, table C-2).

[45] Maximum chromium concentration (excluding PTX08-1011A) = 6.9 µg/L, found in City well # 658 (DOE 2002a, table C-2).

[46] DOE 2002a, table 3-6.

5.0 Unfiltered Samples

DOE does not always filter the samples it collects for the analysis of metals[47]. The *Risk Reduction Rule Guidance*[48] contains no indication that any groundwater samples were filtered.

Unfiltered water samples may contain fine sediments that dissolve and release metals when acid is added to preserve the samples. Thus, estimates of background metal concentrations that are based on unfiltered samples may be too high.

DOE agrees that unfiltered samples may result in the overestimation of metal concentrations. In a report concerning off-site wells, DOE states the following:

> "*The undissolved metals and radiochemistry parameters are dissolved as the sample preservative is added. This gives the sample a higher reading than what would be obtained from a water sample. These samples should be filtered to remove these undissolved constituents.*"[49]

DOE should review its sampling records to ensure that only filtered samples were used to establish background concentrations of metals. If unfiltered samples were used, those results should be discarded and new background concentrations calculated using only results from filtered samples.

6.0 Practical Quantitation Limits

Under RRS 1, either background concentrations or PQLs will be used to define the limits of contamination[50]. PQLs will be used:

- For non-naturally occurring compounds[51] (e.g., explosives, solvents, pesticides).
- For contaminants not detected in any background well[52].
- When the PQL is higher than background concentrations[53].

DOE is not required to cleanup any contamination that does not exceed PQLs:

> " *... all contaminated environmental media must be remediated to background levels for naturally occurring compounds, or to PQLs, whichever is greater.*"[54]

[47] DOE 2002c, sections 16.1 through 16.4, and 23.

[48] DOE 2002a.

[49] DOE 2002c, section 23.

[50] DOE 2002a, page 39.

[51] DOE 2002a, page 10.

[52] DOE 2002a, page 4.

[53] DOE 2002a, page 39.

[54] DOE 2002a, page 23.

PQL concentrations depend on the methods used to analyze the samples[55]. Less sensitive analytical methods will result in higher PQLs. Some of DOE's PQLs equal or exceed health based standards (MCLs)[56].

6.1 PQLs exceed or equal MCLs

Some of DOE's PQLs are higher than MCLs:

- Vinyl chloride: PQL = 10 μg/L, MCL = 2 μg/L[57].
- Bis[2-ethylhexyl]phthalate: PQL = 20 μg/L, MCL = 6 μg/L[58].
- DBCP: PQL = 10 μg/L, MCL = 0.2 μg/L[59].

Therefore, DOE may not be required to cleanup groundwater that contains contaminant concentrations higher than MCLs.

Some of DOE's PQLs are set at the MCL:

- TCE: PQL = MCL = 5 μg/L[60].
- 1,2-dichloroethane: PQL = MCL = 5 μg/L[61].
- Thallium: PQL = MCL = 2 μg/L[62].

Therefore, DOE may not be required to cleanup groundwater that is significantly degraded, but does not exceed, MCLs.

6.2 Most sensitive analytical method not used for VOCs and SVOCs

PQLs are supposed to be based on the " ... *most sensitive standard available method for the contaminant ...* "[63]. However, DOE used a broad-spectrum analysis, rather than the most sensitive method to analyze samples for volatile organic compounds (VOCs) and semi-volatile organic compounds (SVOCs)[64]. This results in higher PQLs, and higher background (RRS 1) values.

[55] DOE 2002a, page 28.

[56] MCL = maximum contaminant level, the concentration limit set by the U.S. Environmental Protection Agency to protect human health (http://www.epa.gov/safewater/standard/setting.html).

[57] DOE 2002a, table 3-13; and EPA 1998. Note, vinyl chloride is a degradation product of TCE.

[58] DOE 2002a, table 3-13; and EPA 1998.

[59] DOE 2002a, table 3-13; and EPA 1998. Note: 1,2-Dibromo-3-chloropropane is a synonym for DBCP (CAS number 96-12-8).

[60] DOE 2002a, table 3-13; and EPA 1998.

[61] DOE 2002a, table 3-13; and EPA 1998.

[62] DOE 2002a, table 3-13; and EPA 1998.

[63] DOE 2000a, page 28.

[64] DOE 2000a, page 31.

The State of Texas has recognized the problems associated with DOE's failure to use the most sensitive analytical method. Thus, it has required Pantex to use the most sensitive analytical method for at least one round of samples before concluding the RFI[65]. This may result in lower PQLs for some contaminants.

7.0 Conclusions and Recommendations

The background concentrations DOE has established for the Ogallala Aquifer at Pantex are questionable. They were established through the use of inappropriate wells, inappropriate sampling techniques, and inappropriate PQLs.

Background concentrations should be determined primarily from samples collected immediately (within a few hundred feet) up gradient of Pantex. If existing wells will not suffice, DOE should install new monitor wells.

Because hazardous materials may have been used or disposed anywhere on the Plant, no background wells should be located on property controlled by the DOE or its predecessor agencies.

No background samples should be collected from wells down gradient of Pantex, as they may be in the flow paths of contaminants emanating from the Plant.

No background samples should be collected from wells completed in both the Ogallala Aquifer and the Dockum Group.

Only filtered samples should be used to establish the background concentrations of metals.

All background samples should be analyzed using the most sensitive standard analytical method. PQLs should be less than MCLs for all contaminants.

Until the full extent of contamination in the perched aquifer is known, it may be difficult to determine whether some Ogallala Aquifer wells represent background. This is because contaminated water in the perched aquifer may flow toward the up gradient boundaries of the Pantex Plant (up gradient with respect to flow in the Ogallala Aquifer)[66]. This contaminated water may migrate down to the Ogallala Aquifer. Thus, water contaminated by Pantex may enter the Ogallala Aquifer up gradient of the Plant boundaries. This potential problem illustrates the importance of determining the full extent of contamination in the perched aquifer.

[65] DOE 2000a, pages 30 and 31.

[66] Battelle, 1997, Figure 4-16.

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George Rice has a M.S. degree in Hydrology from the University of Arizona.
He has worked as a hydrologist for more than 20 years, mostly on hazardous waste projects, and has worked as an independent consultant since 1993.
His primary professional interest is the fate and transport of contaminants in groundwater.

STAND

7105 W 34th Ave, Suite E
Amarillo, TX 79109-2907
email: stand@arn.net