Record of Decision for
Groundwater, Soil and Associated Media

Pantex Plant
Carson County, Texas
U.S. EPA ID No. TX4890110527

Prepared for:

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LIST OF ACRONYMS AND ABBREVIATIONS

^{235}U or ^{238}U	Depleted uranium
μg/L	Micrograms per liter
AO	Administrative Order
AOC	Area of Concern
ARAR	Applicable or Relevant and Appropriate Requirement
B&W	Babcock and Wilcox
BRA	Baseline Risk Assessment
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CMI	Corrective Measures Implementation
CMS	Corrective Measures Study
CMS/FS	Corrective Measure Study/Feasibility Study
COC	Constituent of Concern
COPC	Constituent of Potential Concern
CSM	Conceptual Site Model
DAF	Dilution Attenuation Factor
DNT24	2,4-Dinitrotoluene
DNT26	2,6-Dinitrotoluene
DNT4A	4 Amino-2,6-Dinitrotoluene
DOD	Department of Defense
DOE	Department of Energy
DU	Depleted Uranium
EE/CA	Engineering Evaluation/Cost Analysis
EM	Office of Environmental Management
EPA	Environmental Protection Agency
EPC	Exposure Point Concentration
ESD	Explanation of Significant Difference
FFA	Federal Facility Agreement
FGR	Federal Guidance Report
FGZ	Fine-Grained Zone
FM	Farm to Market
FS	Feasibility Study
FS-5	Firing Site 5

FTA	Fire Training Area
GAC	Granular Activated Carbon
GI	Gastrointestinal
gpd	gallons per day
HE	High Explosives
HEAST	Health Effects Assessment Summary Tables
HHRA	Human Health Risk Assessment
HI	Hazard Index
HMX	Cyclotetramethylene-tetranitramine
HQ	Hazard Quotient
IAG	Interagency Agreement
IC	Institutional Control
ICM	Interim Corrective Measure
ILCR	Incremental Lifetime Cancer Risk
ISB	*In-situ* Bioremediation
ISM	Interim Stabilization Measure
LGUCIP	Land and Groundwater Use Control Implementation Plan
LOAEL	Lowest Observed Adverse Effects Level
lpd	liters per day
MCL	Maximum Contaminant Level
mgd	million gallons per day
MNA	Monitored Natural Attenuation
MOA	Memorandum of Agreement
MSC	Media-Specific Concentrations
NCP	National Contingency Plan
NEPA	National Environmental Policy Act
NNSA	National Nuclear Security Administration
NOAEL	No Observed Adverse Effects Level
NPL	National Priorities List
NWAR	Nuclear Weapon Accident Residue
NWS	National Weather Service
O&M	Operations and Maintenance
OSTP	Old Sewage Treatment Plant
OU	Operable Unit
P1PTS	Playa 1 Pump and Treat System
PAH	Polycyclic aromatic hydrocarbons
PGPTS	Perched Groundwater Pump and Treat System
POE	Point of Exposure
PPE	Personal Protective Equipment
PQL	Practical Quantitation Limit
RAO	Remedial Action Objective
RCRA	Resource Conservation and Recovery Act
RDX	Cyclotrimethylene-trinitramine
RFA	RCRA Facility Assessment
RfC	Reference Concentration
RfD	Reference Dose
RFI	RCRA Facility Investigation
RFIR	RCRA Facility Investigation Reports
RI	Radiological Investigation
RGO	Remedial Goal Option

ROD	Record of Decision
RRR	Risk Reduction Rule (30 TAC § 335, Subchapter S)
RRS	Risk Reduction Standard (30 TAC § 335, Subchapter S)
SARA	Superfund Amendments and Reauthorization Act
SEPTS	Southeast Pump and Treat System
SF	Slope Factor
SLM	Single Layer Model
SVE	Soil Vapor Extraction
SVS	Supplemental Verification Site
SWMU	Solid Waste Management Unit
TAC	Texas Administrative Code
TCE	Trichloroethene
TCEQ	Texas Commission on Environmental Quality
TEF	Toxic Equivalency Factor
TEQ	Toxic Equivalency Quotient
TI	Technical Impracticability
TNT	Trinitrotoluene
TRW	Technical Review Workgroup
TSWDA	Texas Solid Waste Disposal Act (Texas Health and Safety Code Ch. 361)
TTRF	Texas Tech Research Farm
TTU	Texas Tech University
UCL	Upper Confidence Limit
URF_i	Inhalation Unit Risk Factor
USDOE	United States Department of Energy
VOC	Volatile Organic Compounds
WMG	Waste Management Group
WWTF	Waste Water Treatment Facility
Z11PTS	Zone 11 Pump and Treat System

1.0 THE DECLARATION

1.1 Site Name and Location

The United States Department of Energy/National Nuclear Security Administration's (USDOE/NNSA) Pantex Plant is located 17 miles northeast of Amarillo, Texas in Carson County. The National Superfund Database Identification Number is TX4890110527.

1.2 Statement of Basis and Purpose

This Record of Decision (ROD) presents the USDOE/NNSA "Selected Remedy" for the Pantex Plant, which was chosen in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) (42 *United States Code* § 9601 et seq.), as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA). To the extent practicable, it was also chosen in accordance with the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) (40 *Code of Federal Regulations* [CFR] 300). The decisions in this ROD are based on the Administrative Record file established for the Pantex Plant.

The United States Environmental Protection Agency (EPA) and the Texas Commission on Environmental Quality (TCEQ) concur with the Selected Remedy.

1.3 Assessment of the Site

The remedial actions selected in this ROD are necessary to protect the public health, welfare and environment from actual or threatened releases of hazardous substances, pollutants, or contaminants into the environment.

1.4 Description of the Selected Remedy

The overall cleanup strategy for the Pantex Plant is to continue to protect human health and the environment through control of potential exposure to contaminated soils and perched groundwater for both human and ecological receptors, to restore the perched groundwater to drinking water standards, and to protect the underlying Ogallala Aquifer. The Selected Remedy has an estimated present worth of $135,292,000. This estimate is comprised of remaining capital cost for construction of the remedy components and discounted costs associated with periodic activities and operation and maintenance of the remedy. The components of the Selected Remedy are described in detail in Section 2.14 (Selected Remedy) of this ROD, and address soil sites requiring a remedial response, and perched groundwater contaminants in two focus areas, the Southeast Area and Zone 11. The Selected Remedy for soils is:

- Institutional controls (ICs) for select sites (Limited Action Soil Units, Burn Pads 11 through 13 (SWMUs 25, 26 and 27), and SWMU 5/12a).
- Presumptive Remedy of Soil Vapor Extraction (with future modifications to effectively reduce the source term) and Institutional Controls for SWMU 47.
- Containment and Institutional Controls for the following sites:
  - Covers installed for the Burning Ground Former Ash Disposal Trench (Solid Waste Management Units 14-24); and the former operational area of Firing Site 5 (SWMU 70) will control the potential for exposure to contaminants in soil and minimize the potential for migration of contaminants from soil to groundwater via infiltration. Institutional controls will be implemented to maintain these protective covers and provide for continued containment of contaminated soils, while also restricting access and land use.

    - Installed synthetic liners in Zone 12 ditches (SWMU 2 and SWMU 5/05) will prevent leaching of contaminants to perched groundwater via infiltration. Institutional controls will restrict access, land use, and protect the integrity of the covers or liners.

- Containment (presumptive remedy) and Institutional Controls for the Pantex Plant landfills. Covers installed will prevent exposure to soil contaminants, minimize the potential for contaminant leaching to groundwater, and promote surface water runoff and erosion control. Institutional Controls will restrict access and property use, and ensure continued integrity of the covers.

The Selected Remedy for the Southeast Area perched groundwater is:

- Continued operation of the installed Southeast Pump and Treat System (SEPTS) to stabilize migration and treat perched groundwater contaminants.
- Construction and operation of the Playa 1 Pump and Treat System (P1PTS) to reduce the mounding of perched groundwater in the Playa 1 area, mitigating the potential for contaminant migration from the perched groundwater to the Ogallala Aquifer.
- Continued operation of the *In-situ* Bioremediation System to treat high explosive (HEs) contaminants.
- Institutional controls to prevent exposure to contaminants and cross-contamination to the regional Ogallala Aquifer.

The Selected Remedy for the Zone 11 perched groundwater is:

- *In-situ* bioremediation to treat trichloroethene (TCE) and perchlorate contaminants.
- Institutional controls to prevent exposure to contaminants and cross-contamination to the regional Ogallala Aquifer.

Effectiveness of the Selected Remedy for the Pantex Plant Site will be determined through groundwater monitoring implemented through a Long-Term Groundwater Monitoring Plan, developed as part the Remedial Design, in accordance with the IAG.

1.5 Statutory Determinations

The Selected Remedy is protective of human health and the environment, complies with Federal, State, and local requirements that are applicable or relevant and appropriate to the remedial actions, is cost-effective, and utilizes permanent solutions and alternative treatment technologies to the maximum extent practicable.

The Selected Remedy for soil does not satisfy the statutory preference for treatment as a principal element of the remedy because treatment of Constituents of Concern (COCs) in soil is impracticable due to site characteristics (primarily depth to contamination), increases short-term risks to workers, and is cost prohibitive. The Selected Remedy for groundwater satisfies the statutory preference for treatment as a principal of the remedy (i.e., reduces the toxicity, mobility, or volume of hazardous substances, pollutants, or contaminants as a principal element through treatment).

Because this remedy will result in hazardous substances, pollutants, or contaminants remaining onsite above levels that allow for unlimited use and unrestricted exposure, a statutory review will be conducted every 5 years after initiation of remedial actions to ensure that the remedy is, or will be, protective of human health and the environment. Groundwater monitoring data will be reviewed on a more frequent basis to ensure continued protection of human health.

1.6 Data Certification Checklist

The following information is included in the Decision Summary (Section 2.0) of this Record of Decision. Additional information can be found in the Administrative Record file for this site.

- COCs and their respective concentrations (Section 2.7.1)
- Baseline risk represented by the COCs (Section 2.7.1)
- Cleanup levels established for COCs and the basis for these levels (Section 2.10.2)
- How source materials constituting principal threats are addressed (Section 2.13)
- Current and reasonably anticipated future land use assumptions and current and potential future beneficial uses of groundwater (Section 2.6)
- Potential land and groundwater use that will be available at the site as a result of the remedial actions (Section 2.6)
- Estimated capital, annual operation and maintenance (O&M), and total present worth costs, discount rate, and the number of years over which the remedy cost estimates are projected (Section 2.14)
- Key factors that led to selecting the remedial actions (Section 2.14).
- Institutional control discussion (Section 2.14.4)

1.7 Authorized Signatures

This ROD documents the Selected Remedy for the Pantex Plant. The remedy was selected by USDOE/NNSA, and approved by EPA Region 6, with the concurrence of the TCEQ. The Pantex Site Office Manager has the authority to issue the ROD; the Director of the Superfund Division (EPA, Region 6) has the authority to approve the ROD; and the Executive Director (TCEQ) has the authority to concur with the ROD.

U.S. Department of Energy/National Nuclear Security Administration
Issued By:

9/15/08

Steven Erhart — Date
Manager, Pantex Site Office

U.S. Environmental Protection Agency (Region 6)
Approved By:

Pamela Phillips, Acting — 9/25/08

Samuel Coleman — Date
Director, Region 6 Superfund Division

2.0 THE DECISION SUMMARY

2.1 Site Name, Location, and Brief Description

2.1.1 Site Name and Location

The Pantex Plant Superfund Site (EPA Site #TX4890110527**)**, located 17 miles northeast of Amarillo, Texas, in Carson County, is charged with maintaining the safety, security, and reliability of the nation's nuclear weapons stockpile. The Pantex Plant is a Federal Facility owned by the U.S. Department of Energy/National Nuclear Security Administration (USDOE/NNSA) and managed and operated by Babcock and Wilcox Technical Services Pantex, LLC (B&W Pantex).

The Pantex Plant is bounded on the north by Farm to Market Road (FM) 293, on the east by FM 2373, and on the west by FM 683. The Pantex Plant site consists of a total of 16,033 acres comprised of USDOE/NNSA owned land, including 5,856 acres of safety and security buffer owned by the Texas Tech University (TTU). TTU leases the property back to USDOE/NNSA; Texas Tech Research Farm (TTRF) manages the buffer zone as range and farmland. Figure 2-1 illustrates the regional setting and major site features of the Pantex Plant.

The USDOE/NNSA-owned main property covers 10,177 acres. Industrial operations occur in major operational areas, identified as Zones 10, 11, and 12, on approximately 2,000 acres in the central portion of the Pantex Plant. The remainder of this USDOE/NNSA main property is managed to support and secure the industrial operations, including more than 6,000 acres used for agricultural purposes. Most surface water runoff at the Pantex Plant flows through several major drainage ditches into four local playa basins (Playa 1, 2, 3, and 4) on, or adjacent to, the site. All four playas hold water intermittently throughout the year; however, Playa 3 holds water longest after a rain event. USDOE/NNSA also owns Pantex Lake, which is 2.5 miles northeast of the Plant boundary. Pantex Lake and Playas 1, 2, 3, and 4 were assessed for ecological impacts (as soils and sediments) and risk to human health (as soils).

2.1.2 Project Lead and Support Agencies

In the late 1980s, the DOE Office of Environmental Management (EM) initiated the Environmental Restoration Project at the Pantex Plant. In 2000, the USDOE/NNSA succeeded DOE EM as the designated lead federal agency to investigate, assess, and remediate environmental releases at the Pantex Plant.

On April 25, 1991, EPA and TCEQ jointly issued a Hazardous Waste Permit (HW-50284) to the Pantex Plant, which authorized the treatment, storage, and disposal of hazardous waste. TCEQ regulates waste at the Pantex Plant under both state- and federally-authorized programs. In 1984, TCEQ received authorization to carry out the Texas hazardous waste program, in lieu of the federal program, under § 3006 of RCRA, 42 U.S.C. § 6926(b). Since then, under the Texas Solid Waste Disposal Act (TSDWA), TCEQ has continued to revise the Texas hazardous waste rules so that the Texas rules are equivalent to, and no less stringent than, the federal regulations.

On July 29, 1991, EPA proposed the Pantex Plant for inclusion on the National Priorities List (NPL). The Pantex Plant was listed on the NPL on May 31, 1994 (59 FR 27989), making it subject to the CERCLA requirements in addition to those of the Texas Solid Waste Disposal Act, including implementation of the Resource Conservation and Recovery Act (RCRA).

In December 1994, EPA and TCEQ signed a Memorandum of Agreement (MOA) to address Department of Defense (DOD) and DOE facilities in the State of Texas, which were listed, or had potential to be listed, on the NPL. The Pantex Plant was not subject to an Interagency Agreement (IAG) at that time, and was included under the Agreement. The MOA was a procedural document that coordinated and integrated the remedial processes under state law, RCRA, and CERCLA to ensure that the requirements for each authority would be met, and to minimize duplicate efforts for equivalent phases of corrective/remedial action. The agreement also established oversight roles and responsibilities for EPA and TCEQ.

In 1996, TCEQ issued a modification to the Permit for Industrial Solid Waste Management at the Pantex Plant, pursuant to the Texas Solid Waste Disposal Act. The requirements outlined in the 1990 Administrative Order were incorporated into the parameters of the new permit. And in October 2003, TCEQ issued a Compliance Plan for Industrial Solid Waste (CP-50284), which modified the Hazardous Waste Permit corrective action and groundwater monitoring requirements, and included requirements for evaluation and implementation of interim stabilization measures.

In summary, the Pantex Plant environmental restoration project is subject to the authorities of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) (42 *United States Code* § 9601 et seq.), as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA), and in accordance with the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) (40 *Code of Federal Regulations* [CFR] 300), and the Resource Conservation and Recovery Act (RCRA), as amended by the Hazardous and Solid Waste Amendments of 1984. The U.S. Environmental Protection Agency (EPA) is the CERCLA regulatory authority. The State of Texas, as represented by the Texas Commission on Environmental Quality (TCEQ), is the RCRA regulatory authority. The remedial decisions in this ROD are based on the Administrative Record under Section 113(h) of CERCLA, and evaluated in the Feasibility Study against the nine criteria required by CERCLA in the Code of Federal Regulations (40 CFR §300.430(e)(9)(iii).

2.1.3 History of CERCLA Enforcement Activities

On June 29, 2007, EPA Region 6 issued a special notice letter to USDOE/NNSA concerning the Pantex Plant Site that included an offer to negotiate a draft IAG. USDOE/NNSA submitted a July 18, 2007 response to EPA indicating a willingness to negotiate. Negotiations between the EPA Region 6, USDOE/NNSA, and TCEQ resulted in the signing of an IAG for the Pantex Plant Site. TCEQ and USDOE/NNSA signed the IAG on November 2, 2007, and EPA signed the IAG on December 10, 2007. After completion of the public participation process, EPA Region 6 notified USDOE/NNSA and TCEQ that the IAG was effective February 22, 2008. The terms of the IAG are consistent with CERCLA Section 120 and IAG policy prescribed by EPA.

Under CERCLA Section 120(e) and the terms of the IAG, selection and implementation of remedies at the Pantex Plant Site will be closely coordinated between EPA, USDOE/NNSA, and TCEQ. The IAG sets forth the roles and responsibilities of the agencies for performing and overseeing the remediation activities pursuant to CERCLA, the NCP, and Executive Order 12580, as amended by Executive Order 13016. The IAG also integrates CERCLA and RCRA into the remediation process. USDOE/NNSA is defined in the IAG, as the lead agency under the NCP, responsible for planning and implementing remedial and removal actions necessary to protect public health or welfare of the environment from the release or threatened release of hazardous substances at or solely from the Site.

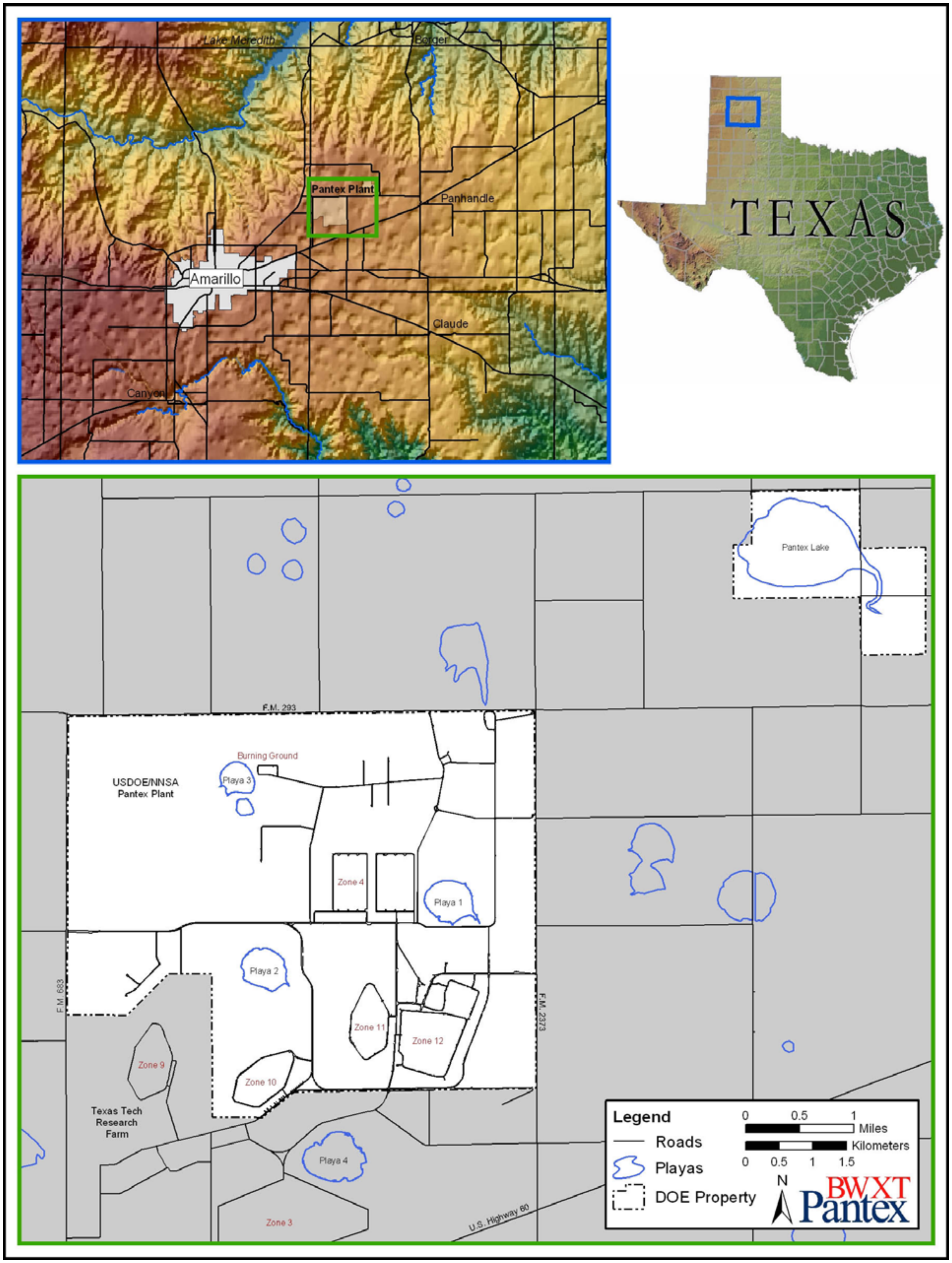

Figure 2-1. Regional Setting and Major Site Features at the Pantex Plant

2.2 Site History and Response Summary

2.2.1 Historical Operations and Releases to the Environment

The Pantex Plant was established in 1942 to build conventional munitions and high explosives compounds in support of World War II. The Plant facility was deactivated in 1945 and sold to Texas Technological University, currently known as Texas Tech University, subject to recall by the War Assets Administration. TTU used the property for agricultural purposes until 1951, when the Pantex Plant was reclaimed for use by the Atomic Energy Commission, as a nuclear weapons production facility. Portions of the conventional weapons plant were renovated, and new facilities were built for the manufacture of HE compounds. Current operations include the development, testing, and fabrication of HE components; nuclear weapons assembly and disassembly, interim storage of plutonium and weapon components; and component surveillance.

The Pantex Plant's historical waste management practices have included thermal treatment of explosives, explosive components, and contaminated liquids and solvents (including test residues of explosives and depleted uranium); burial of industrial, construction, and sanitary waste in unlined landfills; disposal of solvents in pits or sumps; discharge of untreated industrial wastewaters to unlined ditches and playas; and the use of surface impoundments for the disposal of chemical constituents. These prior practices have resulted in the release of both chemical and radionuclide constituents to the environment.

2.2.1.1 Historical Practices Leading to Chemical Impact

During Cold War operations, industrial process wastewaters were discharged directly to the unlined ditches that were used to carry water from effluent sources (industrial wastewater, treated sanitary wastewater, cooling water discharge, and storm water runoff) at the Pantex Plant to Playas 1, 2, and 4. The majority of the wastewaters from the production facilities, and their supporting operations were generated on the east side of Zone 12, flowed into the eastern ditch system, and either infiltrated into the ditch soils or flowed into Playa 1. Wastewater was primarily impacted with HEs from major Plant operations. The volume of wastewater discharged on the east side averaged approximately 224,000 gallons per day (gpd) up to an estimated maximum of 314,000 gpd (Ramsey, et al., 1995). Operations in Zone 11 produced relatively small amounts of wastewater (66,000-gpd average to a maximum of 95,000 gpd) that entered the Zone 11 ditch system, but most infiltrated into the ditch soils rather than flowing to the playas.

The high volume of treated and untreated wastewater discharge that entered Playa 1 and its ditch system, primarily from Zone 12 with smaller amounts from Zone 11, created the impacted portion of the main perched groundwater beneath the Pantex Plant.

Discharges of untreated industrial wastewater to the ditch system were eliminated in the late 1980s to implement improved environmental controls and to comply with permit requirements. During the 1990s, the Plant began reducing the discharge of treated wastewater to the ditches, and by 1999 all discharges to the ditches were discontinued (MHC, 2000). Since 1999, all wastewaters have been discharged to the sanitary sewer system and directed to the Pantex Plant Waste Water Treatment Facility (WWTF).

Until 2005, treated effluent from the WWTF was released into an outfall approximately 350 feet from Playa 1. A new subsurface irrigation system for the beneficial reuse of treated wastewater has been constructed, and routine discharge to Playa 1 has been eliminated. Flow in the other ditches since 1999 consisted of only storm water runoff and infrequent releases of potable water related to maintenance and testing of the Plant's fire protection systems.

The elimination of discharge to the ditches and Playa 1, with the exception of infrequent discharge of treated sanitary wastewater when subsurface irrigation is unavailable, has removed the primary driving force for further movement of constituents of potential concern (COPCs) through the ditches and Playa 1 soils, as well as the driving force that caused the expansion of the perched groundwater to its current extent.

2.2.1.2 Historical Practices Leading to Radiological Impact

As a final nuclear weapons assembly plant, the Pantex Plant primarily handles sealed nuclear weapon components. As a result of this particular type of nuclear material, and because of the stringent safety and material accountability controls, the Pantex Plant represents a unique U.S. Department of Energy nuclear facility that manages significant quantities of nuclear materials in a manner and form that has not resulted in significant environmental risk from radionuclides.

In addition to the extensive historical knowledge of nuclear operations at the site, the types, quantities, and form of nuclear sources managed at the Pantex Plant over its entire history of operations is well recorded. The potential for radiological release at the Pantex Plant is low because of the type of nuclear material handled (primarily sealed nuclear components), the historic reporting requirements, and stringent safety controls in place.

There are three primary types of nuclear materials that have been handled at the Pantex Plant:

- Non-weapon nuclear sources (calibration sources and radiography/equipment sources – the majority of which are sealed sources)
- Weapon nuclear sources (sealed and tracked special nuclear material and un-encapsulated depleted uranium and thorium)
- Other sources not produced at the Pantex Plant (stored U.S. Department of Defense nuclear weapon accident debris and depleted uranium components for high explosive firing tests).

As a result of past operations, three sites at the Pantex Plant are known to have been radiologically impacted:

- The Nuclear Weapon Accident Residue (NWAR) site, where depleted uranium from weapons operations and from the Firing Sites and nuclear weapon accident debris was temporarily stored
- The Burning Ground, where depleted uranium residue was separated from HEs
- The Firing Sites, where HE test shots, containing depleted uranium (DU) as a surrogate material, were detonated. Firing Site 5 (FS-5) is a closed firing site that was used for detonation of test shots containing depleted uranium.

2.2.2 History of Site Investigations and Response Actions

Beginning in the 1980s, the Pantex Environmental Restoration Project personnel investigated historical release sites, as well as sites impacted by past waste management practices, and conducted cleanup actions to remediate impacts at release units. In January 1988, the EPA conducted a RCRA facility assessment (RFA) at the Pantex Plant that identified solid waste management units (SWMUs) that potentially required investigation/corrective action under the 1984 Hazardous and Solid Waste Amendments (HSWA) to RCRA. The RFA report listed SWMUs and Areas of Concern (AOCs), identified during site assessment activities. In September 1989, a draft Administrative Order on Consent (AO) for corrective action at the Pantex Plant was issued to the USDOE/NNSA by the EPA. The terms of the AO were negotiated and a final AO (U.S. EPA Docket Number VI-002(h)-89-H) was issued pursuant to Section 3008(h) of the Solid Waste Disposal Act (SWDA), 42 U.S.C. 6928(h), as amended by RCRA, and HSWA of 1984. The final AO was signed by the EPA and USDOE/NNSA in December 1990. The AO outlined requirements for performing interim corrective measures (ICMs), RCRA facility investigations (RFIs), corrective measure studies, and corrective measure implementations at identified release sites or potential release sites at the Pantex Plant. Sites were assigned to 14 operable units (OUs) based on historical process and expected contaminants. Investigations and corrective action were to be implemented independently for each OU. In 1991, EPA and TCEQ jointly issued Hazardous Waste Permit (HW-50284) that authorized the Pantex Plant to store and process hazardous waste. TCEQ regulates waste at the Pantex Plant under both state- and federally-authorized programs. In 1984, TCEQ received authorization to carry out the Texas hazardous waste program, in lieu of the federal program, under § 3006 of RCRA, 42 U.S.C. § 6926(b). Since then, under the Texas Solid Waste Disposal Act (TSDWA), TCEQ has continued to revise the Texas hazardous waste rules so that the Texas rules are equivalent to, and no less stringent than, the federal regulations.

On July 29, 1991, EPA proposed the Pantex Plant for inclusion on the National Priorities List (NPL). The Pantex Plant was listed on the NPL on May 31, 1994 (59 FR 27989), making it subject to the CERCLA requirements in addition to those of RCRA.

On February 16, 1996, the TCEQ modified the original 1991 Hazardous Waste Permit and replaced it with a Permit for Industrial Solid Waste Management (HW-50284), issued pursuant to Chapter 361 of the Texas Health and Safety Code. The requirements outlined in the 1989 AO for performing ICMs, RFIs, corrective measures studies, and corrective measures implementations at identified Pantex SWMUs were incorporated into this original permit and the subsequent renewal.

In 2003, HW-50284 was renewed again. With this renewal, Compliance Plan (CP-50284) was issued to maintain the RFI and corrective action requirements, and establish a RCRA Interim Stabilization Measure (ISM) program for the Pantex Plant. The ISM program implemented two specific ISMs; the Southeast Pump and Treat System and the Burning Ground Soil Vapor Extraction (SVE) System, and established a network of perched and Ogallala groundwater wells to monitor the stabilization effectiveness. The Compliance Plan also replaced the process/contaminant-driven OUs. The units were grouped according to spatial proximity, referred to as Waste Management Groups (WMGs) and Zones, to complete the investigations. This approach increased the efficiency and effectiveness of final characterization, the risk assessment and remedial action efforts. This Sitewide ROD selects a remedy for releases across the Site, including select RCRA interim corrective measures and interim stabilization measures, as appropriate.

2.2.2.1 CERCLA/RCRA Coordination

The December 1994 Memorandum of Agreement (MOA), between the EPA and TCEQ, established procedures to coordinate and integrate the remedial processes under the federal and state requirements for CERCLA and RCRA, respectively, and to minimize the duplication of effort under equivalent phases of corrective/remedial action. The agreement also established lead and oversight responsibilities for EPA and TCEQ. Under the MOA, the EPA and TCEQ shared oversight of response actions for chemical releases at the Site. EPA was responsible for oversight of response actions for radiological releases. The CERCLA Interagency Agreement (IAG), effective February 2008, sets forth the roles and responsibilities of the agencies for implementing and overseeing the remedial activities pursuant to CERCLA, the NCP, and Executive Order 12580, as amended by Executive Order 13016. The IAG focuses on the phase of the project from issuance of the Proposed Plan to selection, design, and construction of the remedy.

The ROD remedy includes select interim corrective measures (ICMs) and interim stabilization measures (ISMs) implemented under Texas law and RCRA authority (i.e. landfill covers, ditch liners). Two components of the Southeast Area groundwater remedy (i.e. the SEPTS and *in-situ* bioremediation system) were also installed as early actions under CERCLA. Those interim and early actions were evaluated in the Feasibility Study against the nine criteria required by CERCLA in the 40 CFR §300.430 (e)(9)(iii), and supported by the Administrative Record.

For consistency, the ROD retains language from the initial RCRA assessment and subsequent permits to reference investigation sites [i.e. Solid Waste Management Units (SWMUs); Areas of Concern (AOCs)]. A number of Pantex investigation sites will be closed pursuant to the Texas Risk Reduction Rule and the 30 TAC § 335, Subchapter S (codified in 1993), and will not be carried forward in the CERCLA remedy selection process. Those sites are summarized in the following section.

2.2.2.2 Soil Units Summary

Through the initial RFA, 254 units were identified at the Pantex Plant for further investigation and cleanup. Units described in sections 2.2.2.2.1 through 2.2.2.2.3 (*Active Units, Administrative Closures, and Closure to Background*) will not be considered in this ROD. The remaining soil units described in Sections 2.2.2.2.4 and 2.2.2.2.5 (*Units Evaluated through Comparison to Screening Levels and Units Evaluated Through Risk Assessment*) require a remedial response and are included in the CERCLA remedy selection discussion, beginning in Section 2.8

2.2.2.2.1 Active Units

The following 16 soil units are active sites, and are deferred for future evaluation.

- SWMUs 28-36 Active Burn Trays (9 units)
- SVS 4 Old Pistol Range
- SWMU 69 Firing Site 4
- SWMU 72 Firing Site 21
- SWMU 74 Firing Site 10
- SWMU 75 Firing Site 22
- SWMU 78 Firing Site 24, Concrete Sump
- Permitted Unit 53: Igloo 4-72

2.2.2.2.2 Administrative Closures

The following 46 units were found to have no potential for release and have been administratively closed under the State program.

Zone 11

- SWMU 59: Landfill East of Pad 11-13 (Duplicate of SVS 5)
- SWMU 88: Building 11-41, Compressor Building Waste Accumulation
- SWMU 111: Building 11-36 Solvent Tanks
- SWMU 112: Building 11-36 Solvent Tanks
- SWMU 114: Building 11-36 Scrubber System
- SWMU 115: Building 11-36 Carbon Filter
- SWMU 116: Building 11-36 Sludge Filters
- SWMU 124: Building 11-50 Waste Water Treatment System
- SWMU 129a: Building 11-44 High Explosives Contaminated Sludge Containers
- SWMU 134: Building 11-29 Silver Recovery

Zone 12

- SWMU 85: Building 12-16 MOCA Waste Accumulation Area
- SWMU 89: Building 12-2 North Hall Waste Accumulation Area
- SWMU 90: Building 12-9 Waste Accumulation Area
- SWMU 91: Building 12-9 Solvent Storage Shed Waste Accumulation Area
- SWMU 92: Building 12-9 (outside) Waste Accumulation Area
- SWMU 93: Building 12-111 Paint Shop Waste Accumulation Area
- SWMU 94: Building 12-R-13 (outside) Waste Accumulation Area
- SWMU 95: Building 12-18 (outside) Waste Accumulation Area
- SWMU 96: Building 12-21 Waste Accumulation Area
- SWMU 98: Building 12-38 Solvent Storage
- SWMU 99: Building 12-41 Waste Accumulation Area
- SWMU 100: Building 12-42 Waste Accumulation Area
- SWMU 101: Building 12-59 Waste Accumulation Area
- SWMU 102: Building 12-68 Batch Master, Northeast Corner
- SWMU 104: Building 12-82 Waste Accumulation Area
- SWMU 105: Building 12-84 Waste Accumulation Area
- SWMU 125: Building 12-43 High Explosives Contaminated Charcoal Boxes
- SWMU 126: Miscellaneous High Explosives Contaminated Waste Dumpsters
- SWMU 129b: Building 12-43 High Explosives Contaminated Sludge Containers
- SWMU 131: Building 12-35 Portable Waste Oil Storage Tanks
- SWMU 137: Building 12-41, Paint Shop Waste Water Tank
- SWMU 138: Zone 12 Paint Shop Sandblaster Collection Cone
- SWMU 141: Classified Waste Incinerator

Units in Miscellaneous Areas

- SWMU 62: Landfill 11
- SWMU 65: Landfill 14 (Duplicate of SVS 6)
- SWMU 76: Firing Site 18
- SWMU 77: Firing Site 23, Filter/Exhaust System
- SWMU 83: Building 4-8, Container Storage Building, Asbestos Staging Area
- SWMU 107: Building 16-5, Flammable Liquid Storage
- SWMU 127: Miscellaneous Non-hazardous Waste Dumpsters
- SWMU 128: Portable High Explosives Waste water Tanks
- SWMU 132: Vacuum Guzzlers
- SWMU 142: Miscellaneous Hood and Filter Systems, 24 Buildings
- AOC 4: Site-Wide Asbestos Installation
- AOC 9: Site-Wide Underground Storage Tanks
- Unassigned: Unlined Landfill/Landfill 18 North of Firing Site 10

2.2.2.2.3 Closure to Background

The following 33 units were investigated and determined to not be impacted in comparison to background concentrations or Practical Quantitation Limits, and as such, require no action. These sites will be closed under the State program.

Zone 11

- SWMU 79a: 11-7A Pad Container (Permitted Unit 41)
- SWMU 79b: 11-7B Pad Container (Permitted Unit 42)

- SWMU 130: Portable Waste Solvent Tanks

Zone 12
- SWMU 108: Building 12-68 Batch Master
- AOC 6a: Building 12-35 Gasoline Leaks
- Unassigned: Building 12-5B: Underground Storage Tank #7
- Unassigned: Building 12-17E Underground Storage Tank #9
- Unassigned: Underground Storage Tank #38 Building 12-98
- Unassigned: Underground Storage Tank #39 North of Building 12-84A

Units in Miscellaneous Areas
- SWMU 80 (4 Units): Zone 4 Container Storage Area Conexes 1, 2, 3, and 4 (Permitted Units 4, 5, 6, and 7)
- SWMU 81: Magazine 4-19 Mixed Waste Storage
- SWMU 133: Building 16-1 Underground Storage Tank #30 Waste Oil Tank
- AOC 2: Main Electrical Substation (4-28)
- AOC 6b: Building 16-1 Gasoline Leak
- Permitted Units 8, 9, 10 & 11: Container Storage Area Conexes WM5, WM6, WM7, and WM8
- Permitted Units 36, 37, 38, & 39: Buildings 11-9, 11-15a, 11-15b and 11-9 Tanks
- Permitted Unit 40: Building 11-9 Storage
- Permitted Units 46, 47, 48, 49 & 50: Container Storage Area Conexes WM1-A, WM1-B, WM3-A, WM5-A, & WM5-B
- Permitted Unit 52: Igloo 4-46 Storage
- Permitted Unit 54: Igloo 4-74 Storage

2.2.2.2.4 Units Evaluated Through Comparison to Screening Levels

Twenty-four units were determined to be protective of human heath based on the intended industrial land use and on comparison of sampling data to risk-based soil screening levels. These units are sufficiently clean for industrial use and are protective of human health and the environment, but levels still exceed unrestricted use criteria. Therefore, institutional controls are necessary to prohibit use of the property for residential housing, elementary and secondary schools, childcare facilities, and playgrounds. These units will require institutional controls and are considered as, Limited Action Soil Units, as discussed further in Section 2.8.

2.2.2.2.5 Units Evaluated Through Risk Assessment

One-hundred-thirty-five units were further evaluated through a site-specific risk-assessment. Unlike closure to screening levels, these units required evaluation in a Human Health Risk Assessment (HHRA) to determine potential adverse effects to human health under both current and future conditions from COPCs in the absence of any action to control or mitigate the release. Some units were considered to be ecological habitats and also required further evaluation in the Ecological Risk Assessment. Of these 135 sites:

- Ninety units were found to require limited remedial action (i.e., institutional controls with long-term groundwater monitoring) because the risk to human health does not exceed the ILCR of 1E-06 or the HI of 1 for industrial use, and is protective of human health and the environment. These units, however, will require institutional controls to restrict use of the property to industrial use, since unrestricted residential use has not been demonstrated. Long-term groundwater monitoring will be required to manage those uncertainties associated with the deeper unsaturated zone overlying the perched groundwater. These units are considered Limited Action Soil Units, discussed further in Section 2.8.

- Forty-five units were found to require remedial action to control or reduce risks to onsite and/or offsite receptors. These sites are described in greater detail in Section 2.7. Remedial alternatives are described for these units in Section 2.11.1. Response actions for these sites will also include institutional controls with long-term groundwater monitoring of remedy effectiveness.

2.3 Community Participation

2.3.1 Historical Community Participation

The USDOE/NNSA routinely met with the public throughout the site investigation and assessment process to discuss the project schedule, and status of ongoing fieldwork, including the implementation of interim corrective measures, interim stabilization measures, and removal actions. A combination of regularly scheduled and special (non-routine) meetings provided opportunities for residents and other interested parties to be involved in cleanup decisions at the site. Special meetings were also conducted to support the State permitting process for issuance of the Pantex Plant Permits, specifically HW-50284 and subsequent renewals, and Compliance Plan No. 50284, and at completion of the investigation phase under both the TSWDA (including RCRA) and CERCLA. The CERCLA Administrative Record incorporates those activities in support of the selected remedies in this ROD.

The Pantex Plant Citizen's Advisory Board (PPCAB), formed in 1994, was a site-specific advisory board created to obtain independent advice and recommendations on environmental issues with the potential to affect communities surrounding Pantex. It was dissolved in 2001 and replaced by monthly public roundtable meetings to discuss environmental restoration, particularly focusing on groundwater. Since 2003, meetings have been held quarterly and focus on the status of accelerated cleanup, the remediation process, including interim corrective measures, interim stabilization measures, and CERCLA early actions.

In addition, USDOE/NNSA publishes a quarterly *Neighbor Newsletter* that highlights progress on cleanup projects and other environmental topics, mails information on special topics of interest, holds workshops and poster sessions on key components of the project (human health risk assessment, groundwater monitoring, etc), gives presentations to community groups, and posts information on its website (www.pantex.com).

2.3.2 Proposed Plan and Remedy Selection

Public review and comment on the preferred remedial alternatives for the Pantex Plant began on March 17, 2008, with issuance of the Proposed Plan, and ended on April 28, 2008. USDOE/NNSA held a public meeting on March 31, 2008, to explain the Proposed Plan and the alternatives presented, and to receive formal comments. Verbal and written comments were accepted during the public comment period and at the public meeting, and a transcript of the meeting was recorded in accordance with CERCLA § 117(a) and made available to the public.

The Responsiveness Summary section of this document (Section 3.0) summarizes significant written and oral comments and USDOE/NNSA responses on the preferred remedial alternatives.

2.3.3 Ongoing Community Relations

A Community Involvement Plan, originally developed in 1992 and last updated in 2007, outlines the methods that facilitate two-way communication between the community surrounding the Pantex Plant and the USDOE/NNSA Pantex Site Office. The Plan focuses on providing public information and serves as a guideline for community involvement in site environmental activities. The Pantex Site Office uses the community activities outlined in the plan to ensure that residents are continuously informed and provided with opportunities to sustain involvement.

An Administrative Record file, documenting the basis for the selection of remedial actions at the Pantex Plant in accordance with the NCP, was established and is maintained at the site:

USDOE/NNSA Pantex Plant
Highway 60 and FM 2373
Amarillo, Texas 79120

USDOE/NNSA also maintains a reading room at the Amarillo College Lynn Library, which allows the public easy access to unclassified documents concerning the Pantex Plant and other DOE facilities. Copies of final reports related to the environmental restoration program are available in the reading room, including the ROD.

Through these activities, USDOE/NNSA has fulfilled public participation requirements pursuant to CERCLA § 117(a) and NCP § 300.430(f)(2) for early actions and remedy selection.

2.4 Scope and Role of Response Actions

The site-wide response actions address all inactive areas at the Pantex Plant and perched groundwater. The selected response actions address current and potential future threats to human health and the environment, including:

- Releases to soils that pose a direct contact risk to onsite workers
- Releases to soils at concentrations that may impact perched groundwater above drinking water standards
- Perched groundwater that is impacted above drinking water standards and requires remedial actions
- Perched groundwater impacted above drinking water standards that could potentially impact the Ogallala Aquifer above drinking water standards

Response actions at the Pantex Plant are dominated by actions to mitigate perched groundwater contamination. The perched groundwater meets the yield and quality criteria to be considered a potential drinking water source, so its restoration to drinking water standards is one goal of the remedy. An equally important concern is the potential for perched groundwater to act as a source of future impacts to the underlying Ogallala Aquifer. Contaminant concentrations in the perched groundwater exceed drinking water standards throughout the plume, including: RDX, an explosive with the chemical name of cyclotrimethylene-trinitramine and the primary risk driver for the southeast plume; hexavalent chromium; perchlorate; and TCE. Most importantly, if no action is taken vertical migration of perched groundwater contaminants to the Ogallala Aquifer is likely in the south and southeast area. The Selected Remedy will reduce and stabilize the perched groundwater contaminants upgradient of this critical area. If contaminants migrate downward to the Ogallala Aquifer at concentrations exceeding drinking water standards, a groundwater exposure pathway to receptors onsite or offsite would be complete with potential for impacts to human health. Therefore, protecting the Ogallala Aquifer from future impact is one of the primary goals of the response action.

Risk at the site is primarily driven by chemical COCs. Source areas for groundwater impacts are limited to areas of focused recharge and historical industrial discharge. Releases in areas other than the ditches and playas, where focused recharge did not occur historically, tend to attenuate in the unsaturated zone overlying the perched groundwater because there is not enough driving force from surface infiltration to push contaminants deeper.

The response actions for soils, selected by this ROD, eliminate direct contact risks to onsite workers and minimize further migration of contaminants into the soil column and perched groundwater beneath the site. The Remedy for soils selects containment for sites with those potential risks, and includes covers and liners installed as interim corrective measures under the State RCRA authority. Similarly, the Burning Grounds Soil Vapor Extraction (SVE) System was installed as a stabilization measure under the State program to mitigate potential impact to the perched groundwater from residual contaminants in soil gas, and is selected in the CERCLA remedy.

Other RCRA interim corrective measures (Figure 2-2) were completed during the period from 1989 to the present. Four RCRA regulatory drivers (AO-1989, HW-50284-1991, HW-50284-1996, and CP-50284) directed USDOE/NNSA to cease industrial discharges to the ditches to eliminate the driving force for further migration of contaminants to perched groundwater; to perform ICMs, investigations, corrective measures studies, and corrective measures implementations at identified Pantex SWMUs; and to conduct corrective action as necessary to protect human health and the environment for releases from any SWMU, AOC, or WMG defined in CP-50284.

Interim corrective measures were taken to mitigate immediate risk, implement protective measures, and control exposure, as necessary. Appendix A of this ROD contains a table that identifies specific ICMs and removal actions implemented at the site. This table identifies the regulatory driver under which each ICM or removal action was completed. All but two of the cleanup actions taken at the site before this ROD (the Playa 1 Pump and Treat System and the Southeast *In-situ* Bioremediation System) were performed under RCRA authority. These two systems were implemented as non-time critical removal actions under CERCLA. The interim response actions are discussed further in the remainder of this section.

Two of the aforementioned interim corrective measures taken under RCRA authority, the Burning Ground SVE System and the SEPTS, were recognized as interim stabilization measures (ISM) in CP-50284, when it was issued in 2003. CP-50284 required these ISMs to be modified, as needed, to effectively stabilize the contaminants. Therefore, both systems have changed over the past five years. The SEPTS started as a treatability study when it was first installed in 1995. It later became an interim corrective measure through expansions designed to make it capable of capturing and removing more of the contaminants. The SEPTS was expanded to improve its capability to control and begin to dewater the impacted areas of the perched groundwater, reduce contaminants in the sensitive areas of the perched groundwater, and mitigate potential impacts from the perched groundwater to the Ogallala Aquifer. The Burning Ground SVE System, originally installed with 28 extraction wells, has been reduced to focus treatment on the area of the solvent evaporation pit, where solvent vapor concentrations continue to be sustained. Treatment of the extracted vapors is now accomplished using granular activated carbon units instead of the catalytic oxidation unit used when the system was first installed. This system is also being evaluated for conversion to passive *in-situ* treatment through bioremediation.

In accordance with CP-50284, several other interim stabilization measures were implemented under RCRA authority as information from the HHRAs and the CMS/FS efforts progressed. Engineered covers were placed on the Burning Ground Landfills (SWMUs 37 through 44), synthetic liners were installed in SWMU 2 and 5/05 ditches that drain Zone 12, and soil removals were performed at Burn Pad 16, and SWMUs 1, 5/4, 5/7, 64, 117, 118, and 122b to eliminate the hot spots driving the direct contact risk in these areas. In addition, a soil vapor extraction system was installed at SWMU 113 (Building 11-36) as an interim corrective measure. This system is a best management practice undertaken by USDOE/NNSA to reduce future risk of cross-media migration, even though fate and transport evaluations performed as part of the HHRA for Zone 11 do not indicate that it is a threat to human health or the environment. As such, the SWMU 113 stabilization was not carried forward in the CERCLA Selected Remedy.

Public participation will also be required as part of the State closure process for these interim corrective measures and the balance of the 254 SWMUs/AOCs, as CP-50284 is modified after issuance of this ROD.

As allowed under CERCLA, two Engineering Evaluation/Cost Analyses (EE/CAs) were issued in 2007 for non-time critical removal actions proposed by USDOE/NNSA to address the threat to the Ogallala Aquifer in the southeast area of the Plant from migration of perched groundwater contaminants; both EE/CAs were subject to public comment. Groundwater modeling, conducted by the Pantex Plant as part of the human health risk assessments (HHRAs), indicated that in the absence of corrective measures in the perched groundwater, the Ogallala Aquifer could be impacted above drinking water standards within approximately 20 years.

The following two CERCLA early actions were implemented in response to the modeling results:

- To reduce the volume of water in the perched groundwater and decrease the driving force for migration to the Ogallala Aquifer, a pump and treat system was installed to extract and treat the perched groundwater that is mounded beneath Playa 1.
- An *in-situ* bioremediation (ISB) system was installed to treat perched groundwater in areas sensitive to vertical migration to the Ogallala Aquifer.

The pump and treat system at Playa 1 is currently under construction. The *in-situ* system has already been constructed and the initial injection of amendments was completed in February 2008. Both actions are included in the remedial alternatives evaluation. The EE/CA actions were noticed for public comment; no comments were received. Action memoranda summarizing these CERCLA non-time critical removals were issued, and are available in the Administrative Record file.

The Selected Remedy for the Southeast Area perched groundwater effectively combines the SEPTS, the Playa 1 Pump and Treat System and an in-situ treatment system to minimize further vertical and lateral migration of the contaminant plume and restore the perched groundwater to drinking water standards. The remedy appropriately protects the Ogallala Aquifer, as the primary aquifer for the region, and the perched groundwater as a potential drinking water source. The Selected Remedy for the Southeast Area perched groundwater formally recognizes the combination of individual components, implemented as interim corrective measures or early actions, which will work together to accomplish the remedial action objectives. Each component, working effectively, is required to meet the protectiveness standard of this ROD.

The Selected Remedy for Zone 11 perched groundwater will treat the TCE and perchlorate and restore the groundwater to drinking water standards.

The Remedy for the Pantex Plant Superfund Site will also select Institutional Controls, such as restrictive covenants, to prohibit drilling through contaminated portions of the perched groundwater, beneath USDOE/NNSA owned property and to the east and south of the main property. Restrictions will also be placed to prohibit the use of the perched groundwater as a source of drinking water or for industrial purposes. Institutional controls will be placed to prevent unauthorized access to soils containing residual contaminants at levels that prohibit unrestricted use of the land. Land Use controls will be placed to prohibit the use of those properties included in this ROD for residential housing, elementary or secondary schools, childcare facilities, or playgrounds. Engineered controls (i.e. fences, barriers) and security measures will minimize access, and protect components, of active remedial systems.

Effectiveness of the Selected Remedy for the Pantex Plant Site will be determined through groundwater monitoring implemented through a Long-Term Groundwater Monitoring Plan, developed as part of the Remedial Design, in accordance with the IAG.

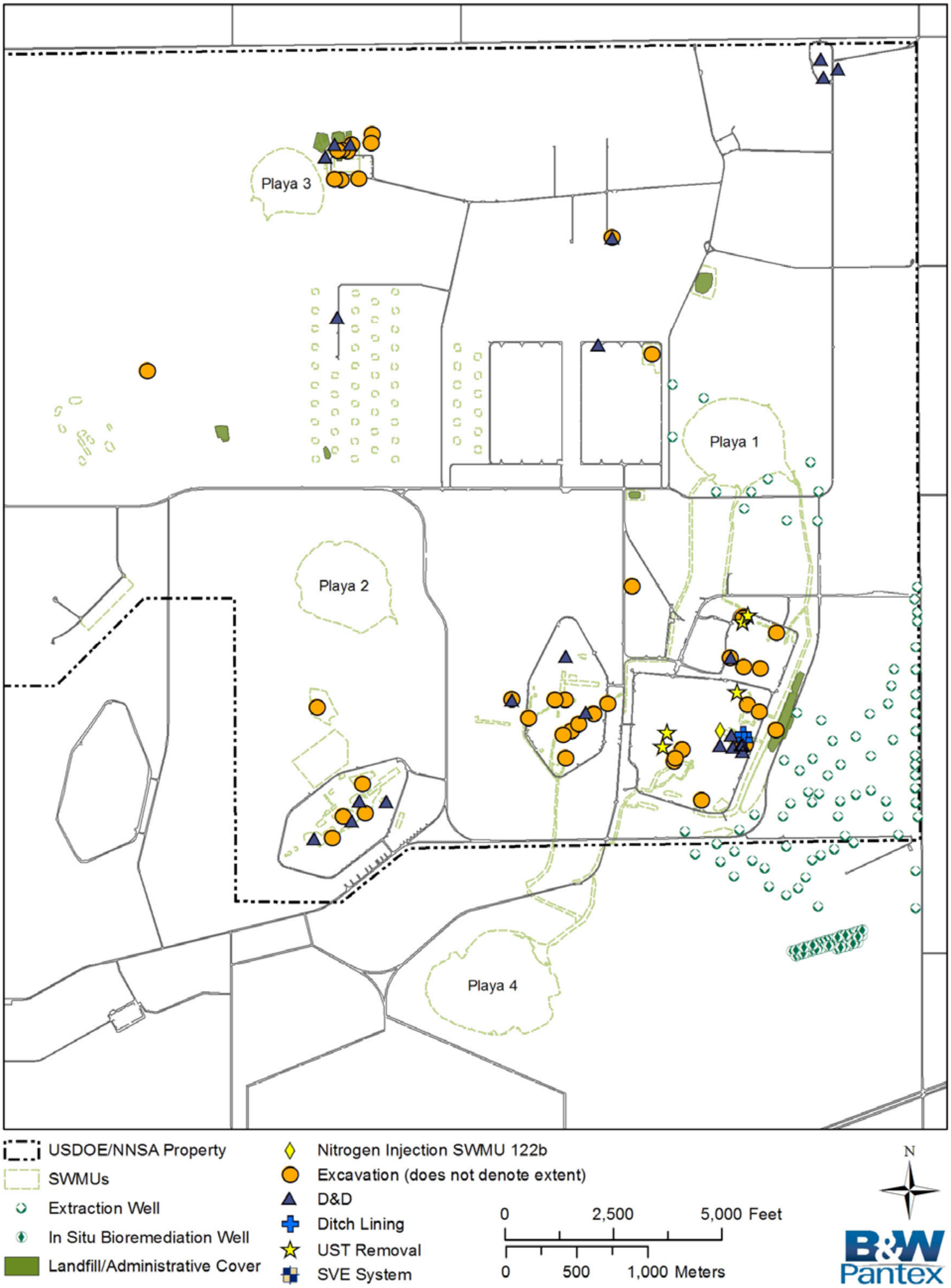

Figure 2-2. Interim RCRA Actions and CERCLA Removal Actions Conducted at the Pantex Plant

2.5 Site Characteristics

2.5.1 Conceptual Site Model

The general stratigraphy of the Pantex Plant subsurface geologic units is presented in Figure 2-3. A general depiction of the geology and important hydrogeologic and contaminant transport processes at the Pantex Plant are presented in Figure 2-4. This figure graphically portrays the geologic units beneath Pantex discussed in Section 2.5.2.3 and shows the relative thicknesses of the perched groundwater and Ogallala Aquifer underlying the Plant. As depicted in the figure, infiltration from areas of focused recharge, such as the playas, is significantly greater than in upland areas. Contaminants in soil and soil gas in the Blackwater Draw and Upper Ogallala formations may migrate downward via the processes of leaching and diffusion.

Infiltrating water and contaminants are captured by perched groundwater lying on top of the FGZ. Contaminants in perched groundwater may move laterally with groundwater flow via advection and dispersion or may migrate downward through the FGZ in more permeable areas. The figure also depicts the vertical relationship among surface features, perched groundwater, the FGZ, and the Ogallala Aquifer, including the unsaturated zone occurring above the Ogallala Aquifer.

Figure 2-5 is a summary conceptual site model (CSM) that incorporates all release sites and pathways identified at the Pantex Plant. This CSM depicts the areas with cross-media migration (Burning Ground, Zone 11, Zone 12, Playa 1, and Fire Training Area), and the three different perched groundwater bodies under the site.

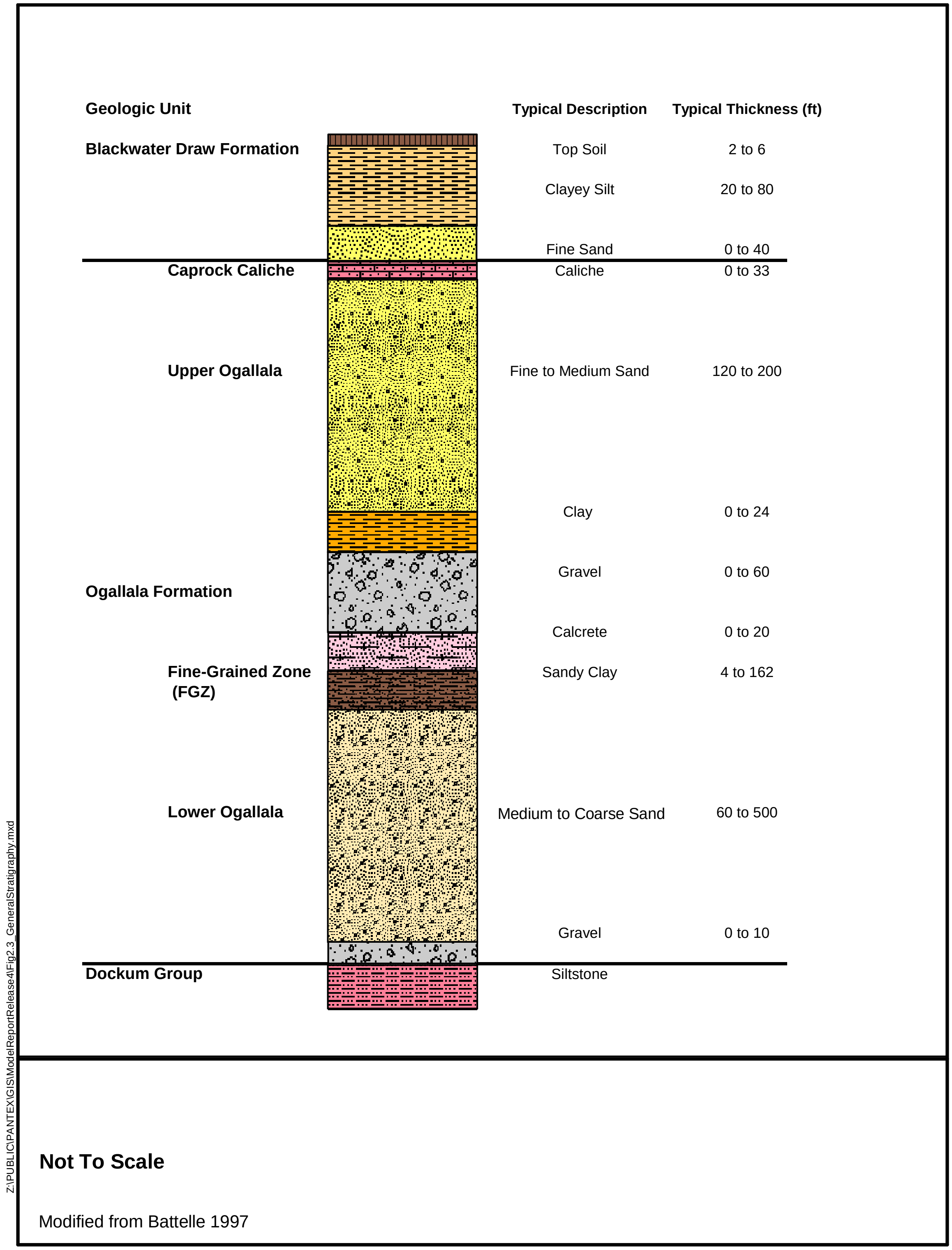

Figure 2-3. General Stratigraphy of Pantex Area
(BWXT Pantex/SAIC Subsurface Modeling Report, 2004)

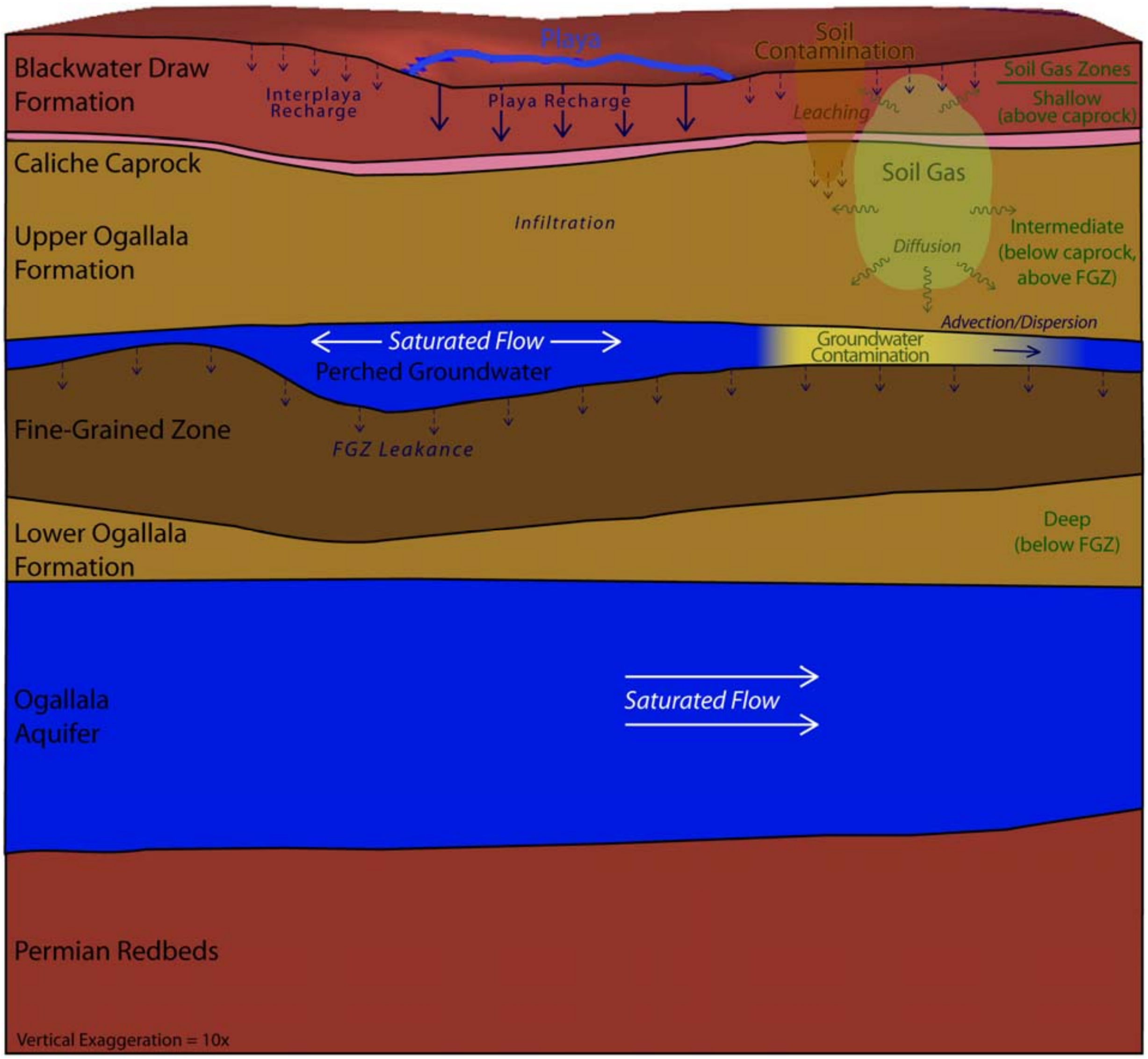

Figure 2-4. General Subsurface Conceptual Model at Pantex
(BWXT Pantex/SAIC Subsurface Modeling Report, 2004)

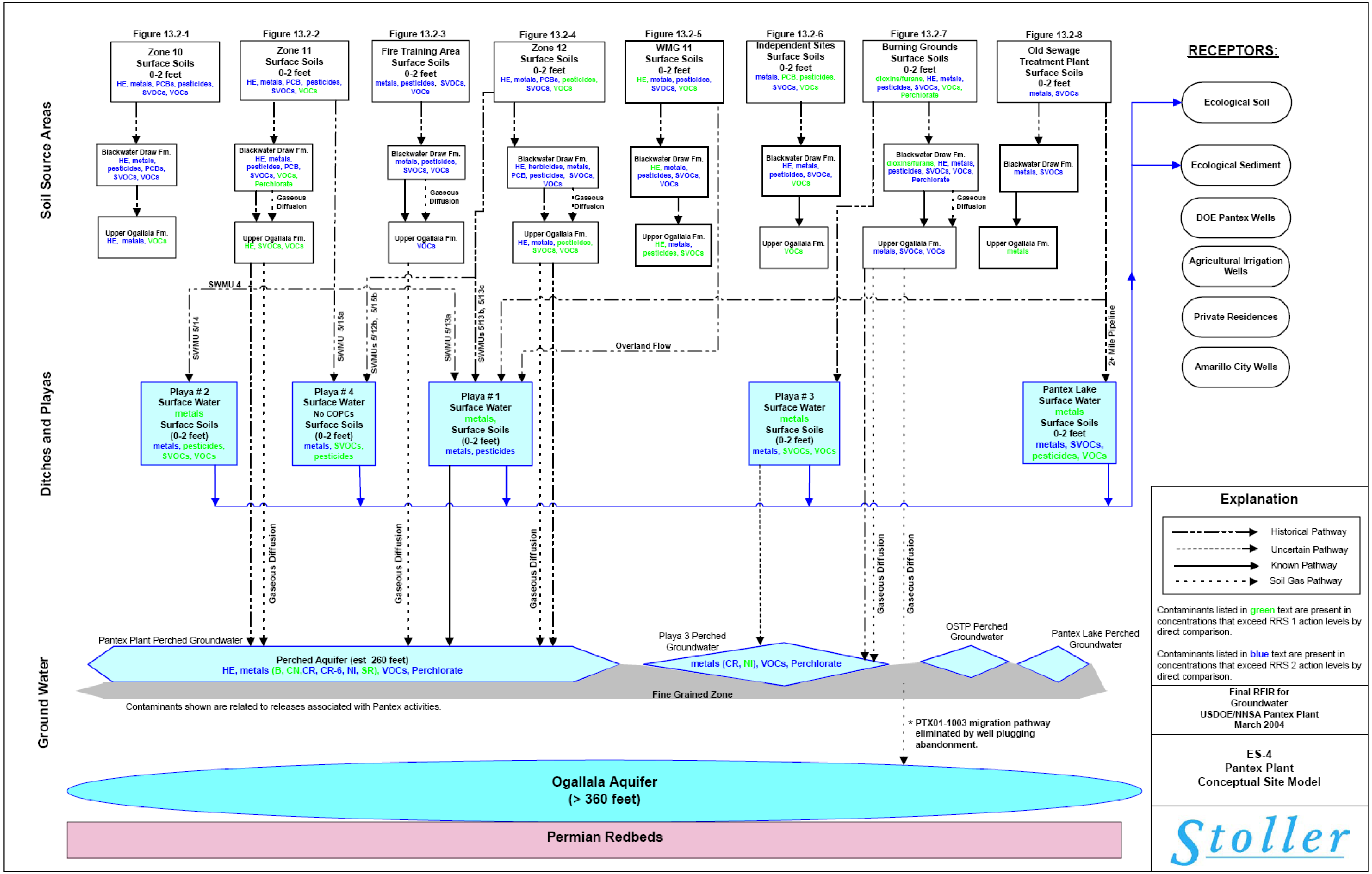

Figure 2-5. Pantex Plant Conceptual Site Model (Stoller 2004)

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2.5.2 Site Overview

2.5.2.1 Climate

The climate in the Texas Panhandle is typical of continental interiors; it is semi-arid with mild winters and hot, dry summers. The climate is characterized by large variations in daily temperature extremes, low relative humidity, and irregular rainfall of moderate amounts. Based on National Weather Service (NWS) records, average annual precipitation for Amarillo is 19.9 inches (50.5 cm).

Average wind speeds at the Amarillo NWS station are 13.1 mph (21.1 kph) based on a 33-year period of record. The prevailing wind direction is from the south for May through September and from the southwest for the remainder of the year. Analysis of NWS meteorological data for 1990 indicates local winds were predominantly from the south and southwest directions approximately 41 percent of the time with an average wind speed of 13.42 mph (21.60 kph). The Pantex Plant is in a windy area and in a moderate to high hazard zone for tornadoes.

The average annual temperature is 57.1°F (13.9°C) with a normal low temperature in January of 21.2°F (-6.0°C) and a normal high temperature in July of 91.7°F (33.2°C). The gross lake surface evaporation rate averages 73 inches (185 cm) per year, as measured from 1950 through 1975.

2.5.2.2 Topography

The Pantex Plant is located in the Texas Panhandle on the High Plains portion of the Great Plains Physiographic Province. This area is a broad, flat plateau that gently slopes east and south, and is known as the Llanos Estacados (Spanish for “Staked Plains”). Topographic elevation across the Pantex Plant ranges from approximately 3,501 to 3,595 feet (1,067 to 1,096 meters) above mean sea level (amsl), with an average elevation of approximately 3,554 feet (1,083 meters) amsl. The topography is relatively flat with slopes ranging from approximately 0.00005 feet in upland areas to approximately 0.07 feet near closed drainage basins containing ephemeral lakes (known as playas). The average topographic slope across the Plant area is approximately 0.006 feet.

2.5.2.3 Geology

The Blackwater Draw, the uppermost hydrostratigraphic unit, consists of eolian silts and sands, with an approximately 20 feet (6 meters) thick lower unit composed of silty sand and caliche. The upper surface of the Blackwater Draw is represented by surface topography. Numerous depressions representing the playa basins are apparent on the land surface. These depressions range from a few feet to more than 46 feet (14 meters) in relief and from several hundred feet to one mile or more in diameter. Sediments beneath the playas contain thick sequences, roughly 16 to 60 feet (5 to 18 meters) of lake sediments that are highly variable in lateral and vertical extent. The lake sediments intermingle with the Blackwater Draw sediments near the edges of the playa basins. Infiltration of water and consequent recharge to the perched groundwater is largely influenced by the Blackwater Draw Formation and the availability of water.

Underlying the Blackwater Draw Formation is the Ogallala Formation. The Ogallala sediments consist of coarse-grained fluvial sequences that fill the floors of paleovalleys, beginning with a higher percentage of gravel at the base of the formation to material dominated by fine sand at the top of the formation. The fining-upward sequences contain channel sands and gravels overlain by finer overbank deposits. Fine-grained eolian deposits overlie the coarse fluvial sediments. Regionally, the thickness of the Ogallala Formation ranges from a few feet to over 900 feet (274 meters). A massive Caliche Caprock layer generally defines the top of the Ogallala Formation (and the base of the Blackwater Draw Formation); however, it is not continuous in extent below the Plant. Where present, the Caprock layer consists of a hard, dense, finely crystalline caliche. The Ogallala Aquifer is contained within the Ogallala Formation.

Underlying the Ogallala Formation is the Dockum Group. Where present, the Dockum Group is estimated to be approximately 200 feet (61 meters) thick in the Pantex Plant area. The Dockum Group consists mostly of indurated sediments, these include mudstones, siltstones, sandstones, and minor conglomerates and claystones derived from fluvial, deltaic, and lacustrine depositional systems. Identification of the Dockum Group from the Ogallala Formation is more difficult than the identification of the Permian Redbeds or the Quartermaster Formation. The Quartermaster Formation is made up of red shale or clay with sandstone, dolomite, or gypsum. The Permian Redbeds have very low permeability values; therefore, there are limited permeable pathways between the Ogallala and Permian rocks. Table 2-1 displays the depth and thickness of each geologic unit.

More detailed information regarding the local geology is presented in the *Subsurface Modeling Report* (BWXT Pantex, 2004c).

The Pullman clay loam series predominately comprises upland surface soil at the Pantex Plant. Randall clay dominates the playa bottoms; Lazbuddie and Lofton soil occurs on the playa benches; and Pep and Estacado soil occurs on the playa side slopes. Subsurface soil is considered part of the Blackwater Draw and Ogallala Formations.

2.5.2.4 Hydrology

Surface Water

Most surface water runoff at the Pantex Plant flows into four local playa basins through a system of unlined drainage ditches across the site. Playas 1, 2, and 3 are located within the Pantex Plant boundary, and Playa 4 is located on the TTRF (Figure 2-1).

Historically, Playa 1 and Pantex Lake received treated wastewater from the Old Sewage Treatment Plant (OSTP) and the WWTF. Currently, treated wastewater discharge is routed to a subsurface irrigation system in accordance with Texas Land Application Permit requirements and applied onsite. Unlike continuous discharge to Playa 1, this system uses the wastewater in manner that prevents deep percolation (focused recharge) through controlled application at rates that match evapotranspiration. Periodically, when subsurface irrigation is not available because of maintenance or extremely heavy rainfall, treated wastewater is discharged to Playa 1 in compliance with permit requirements. The current amount of storm water and discharge to Playa 1 is minimal compared to the volume of industrial wastewater discharge received during historical operations.

Currently, Playas 2, 3, and Pantex Lake only receive storm water runoff. Water that enters the ditches and playas from runoff or Plant discharges infiltrates the soil and recharges groundwater in the perched groundwater zones. Natural recharge to playas and the underlying perched groundwater is limited by irregular and moderate precipitation, so historically; recharge has been largely contingent upon discharge from plant operations, in accordance with permits issued by the TCEQ.

Table 2-1. Vertical Dimension of Geologic Features within Pantex Plant Boundary

Geologic Features		High		Low		Average[b]	
		feet	meters	feet	meters	feet	meters
Elevation[c]	Topographic Elevation (Top of Blackwater Draw Formation)	3594.6	1095.6	3501.2	1067.2	3553.6	1083.1
	Topographic Slope (ft/ft)	0.07	0.07	0.00005	0.00005	0.006	0.006
	Elevation of Base of Blackwater Draw Formation (Top of Ogallala Formation and Caprock Caliche)	3532.9	1076.8	3436.9	1047.6	3480.6	1060.9
	Elevation of the Base of the Caprock Caliche	3522.4	1073.6	3426.3	1044.3	3470.5	1057.8
	Elevation of the Perched Water Table Surface	3321.9	1012.5	3257.4	992.8	3283.4	1000.8
	Elevation of the Top of the FGZ	3341.5	1018.5	3111.1	948.3	3277.5	999.0
	Elevation of the Base of the FGZ	3309.6	1008.8	3031.5	924.0	3226.3	983.4
	Top of Ogallala Water Table	3210.4	978.5	2677.2	816.0	3115.6	949.6
	Elevation of the Base of the Ogallala Formation (Top of the Dockum Group and Redbeds)	3152.4	960.9	2679.2	816.6	2895.9	882.7
Depth	Depth bgs to Base of Blackwater Draw Formation (Top of Ogallala Formation and Caprock Caliche)	105.0	32.0	33.6	10.2	72.9	22.2
	Depth bgs to Base of Caprock Caliche	115.0	35.0	43.6	13.3	83.0	25.3
	Depth bgs to Perched Water Table Surface	297.9	90.8	195.1	59.5	256.7	78.2
	Depth bgs to Top of FGZ	321.7	98.1	223.5	68.1	276.0	84.1
	Depth bgs to Base of FGZ	431.1	131.4	267.5	81.5	327.1	99.7
	Depth bgs to Ogallala Water Table Surface	507.5	154.7	343.5	104.7	437.9	133.5
	Depth bgs to Base of Ogallala Formation (Top of the Dockum Group and Redbeds)	888.9	270.9	390.9	119.2	657.6	200.4
Thickness	Thickness of Blackwater Draw Formation	105.5	32.2	33.6	10.2	72.8	22.2
	Thickness of Caprock Caliche	23.2	7.1	0.5	0.2	7.1	2.2
	Saturated Thickness of Perched Groundwater	79.4	24.2	0.0	0.0	22.0	6.7
	Thickness of FGZ	157.1	47.9	8.7	2.6	51.1	15.6
	Lower Ogallala Unsaturated Thickness	221.1	67.4	0.0	0.0	110.8	33.8
	Saturated Thickness of Ogallala Aquifer	406.2	123.8	29.0	8.8	219.7	67.0
	Thickness of Ogallala Formation (Total)	821.6	250.4	316.4	96.5	584.7	178.2

Note: Water surface information is based on April 2000 measurements collected from monitoring, investigation, municipal, private, and extraction wells (See Table 2-3 of Subsurface Modeling Report [BWXT Pantex, 2004c] for list of wells included).
[a]Table taken from the *Subsurface Modeling Report* (BWXT Pantex, 2004c).
[b]Averages were calculated as the arithmetic mean of the interpolated surfaces within the Pantex Plant boundary.
[c]Elevation data are above mean sea level (amsl).

Perched Groundwater

The perched groundwater is a discontinuous saturated interval encountered beneath the site that accumulates on top of a FGZ primarily composed of a layer of interbedded silts and clays. Perched groundwater is the shallowest water-bearing zone in the area, and is consequently the first groundwater unit affected by the migration of constituents released from the Pantex Plant SWMUs. The largest area of perched groundwater underlying the Pantex Plant is associated with natural recharge from Playas 1, 2, and 4, treated wastewater discharge to Playa 1, and historical releases to the ditches draining Zones 11 and 12. Smaller areas of perched groundwater are associated with Playa 3 (near the Burning Ground) and Pratt Playa (offsite near the northeast corner of the Pantex Plant). The three primary areas of perched groundwater beneath the USDOE/NNSA-owned Pantex Plant and the security buffer on TTRF to the south are shown in Figure 2-6. Perched groundwater at the site is a potential drinking water source, based on yield and quality.

The depth to perched groundwater ranges from about 215 feet near Playa 1 to about 280 feet at the southern fringe beneath the security buffer on TTU property, south of the Pantex Plant. Perched groundwater does not discharge to the surface. Saturated thickness of perched groundwater ranges from zero (no perched groundwater) at the perched groundwater fringe to nearly 80 feet beneath Playa 1, with an average saturated thickness of 22 feet within the USDOE/NNSA-owned Pantex Plant. Figure 2-12 depicts the perched groundwater saturated thickness. South and east of the Pantex Plant, perched saturated thickness is less than 15 feet in most areas. Because groundwater in areas having less than about 10 to 15 feet of saturated thickness is not amenable to extraction, the thin saturation thickness and depth to perched groundwater present significant challenges to conventional pump and treat or other technologies relying upon hydraulics either to remove impacted groundwater or to deliver amendments.

Flow in the main area of perched groundwater is governed by the topography of the FGZ and localized sources of groundwater recharge. Playa 1 has historically been the major source of recharge to perched groundwater resulting in a mound of perched groundwater beneath and radial flow away from the playa. On the eastern side of the Pantex Plant beneath Zone 12, perched groundwater generally flows to the southeast. Perched groundwater beneath Zone 11 generally flows to the south or southwest. The different flow directions are apparent in the perched water table between Zones 11 and 12 and are illustrated by comparing COC migration from Zones 11 and 12.

The FGZ varies in texture and ranges in thickness from a few feet to 140 feet, with an average thickness of 40 feet within the Plant boundary. Beneath and surrounding Playa 1, the FGZ exhibits a low permeability (less than 10^{-7} cm/sec) and is over 100 feet thick. These factors result in conditions that resist deeper infiltration and instead favor accumulation of water as it infiltrates at depth from areas of focused recharge, such as ditches and playas. Vertical flow between perched groundwater and the Ogallala Aquifer is limited by the FGZ. In areas where perched groundwater is present on the Pantex Plant property, a second unsaturated zone occurs between the perched groundwater and the Ogallala Aquifer.

The FGZ transitions into coarser-grained, more permeable materials to the south and east of the Plant. These areas occur near the extent of perched groundwater saturation. These transition areas are based on the measured increase in permeability at the top of the FGZ. The potential impact to flux across these areas to the underlying Ogallala Aquifer was considered significant when interim corrective measure and CERCLA early action decisions were made to mitigate potential impacts. These areas of greatest potential for migration from the perched groundwater to Ogallala Aquifer are shown on Figure 2-6.

Figure 2-7 depicts the locations of perched groundwater monitoring wells in the vicinity of the Pantex Plant and the extent of the perched aquifer. This monitoring network was used to determine the water levels, and potentiometric surface, of perched groundwater beneath the Pantex Plant.

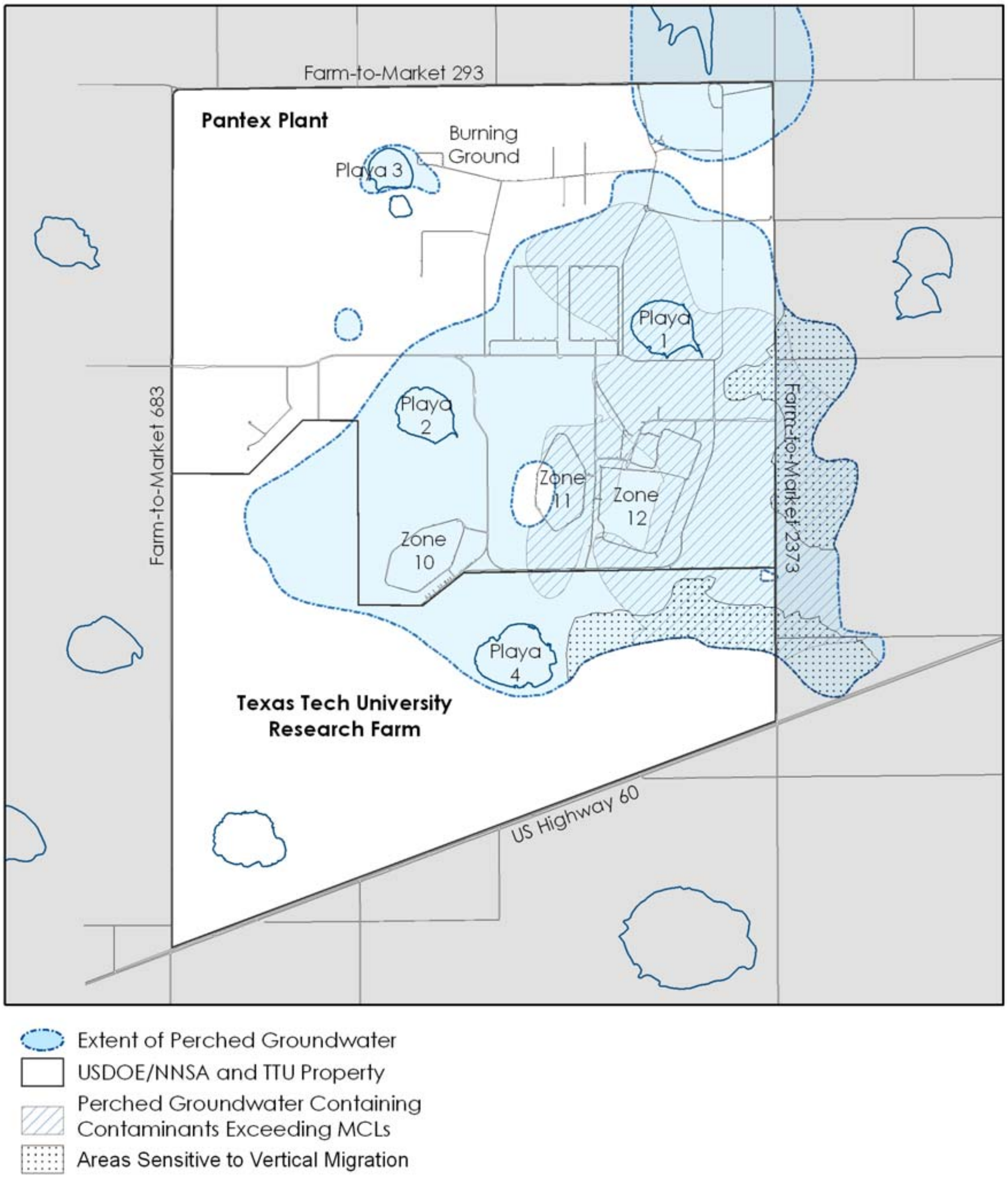

Figure 2-6. Three Primary Areas of Perched Groundwater beneath the Pantex Plant

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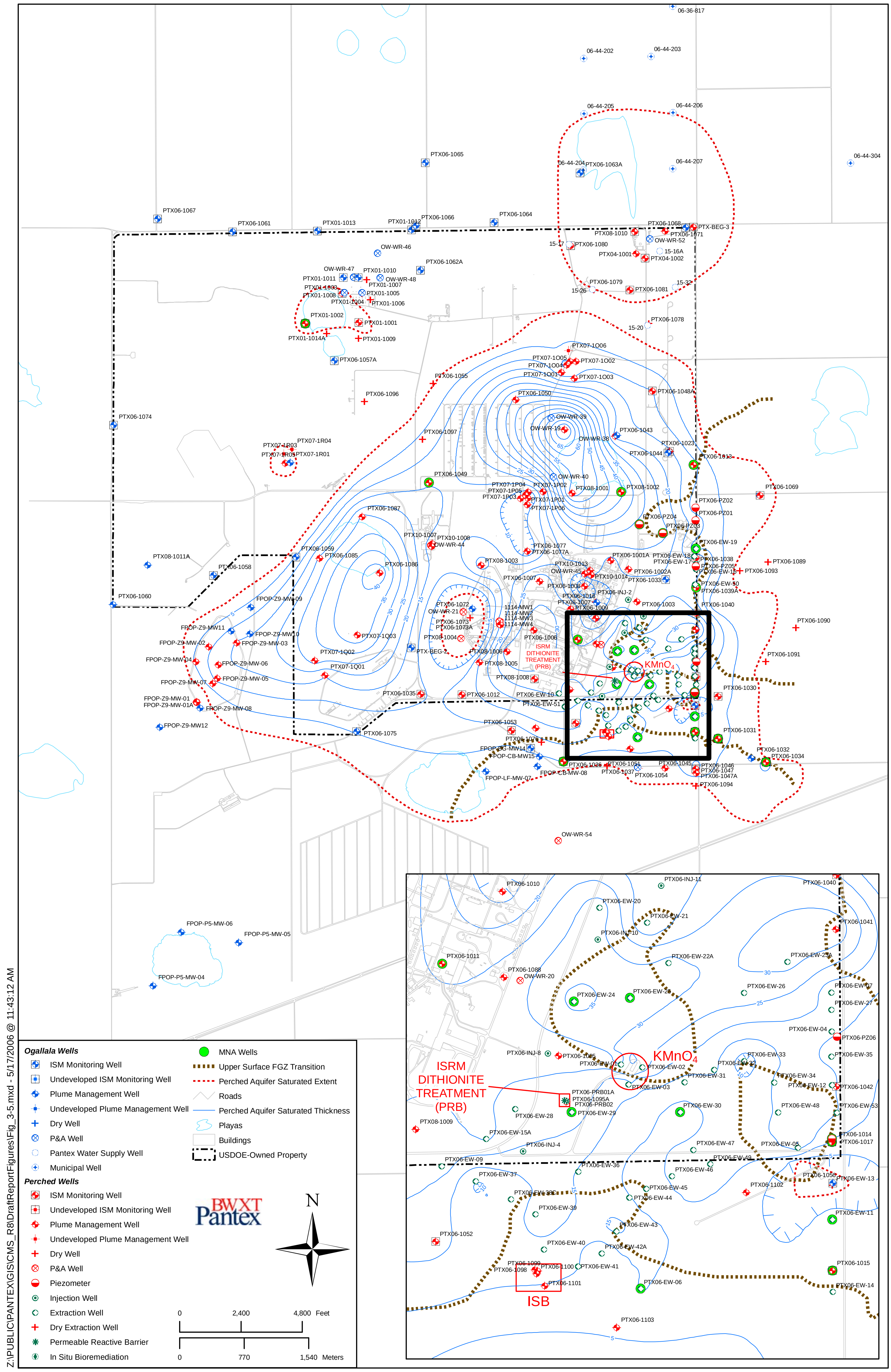

Figure 2-7. Perched Groundwater Saturated Thickness and Current Monitoring Wells

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Ogallala Aquifer

The principal source of groundwater for the region is the Ogallala Aquifer, the primary unit of the High Plains Aquifer, comprising the highly permeable basal sediments of the Ogallala Formation throughout the Southern High Plains.

The Ogallala Aquifer is typically composed of fluvial channel deposits of gravels, sands and silts and has a saturated thickness that varies greatly across the site (increases in saturation thickness from south to north below the facility). The Ogallala Aquifer ranges in depth from approximately 340 feet bgs south of the Pantex Plant to approximately 500 feet bgs at the northern Plant boundary.

Regionally, the Ogallala Aquifer water table slopes from northwest to southeast, generally following the regional topographic surface. However, in the vicinity of the Pantex Plant the water table slopes from southwest to northeast (Figure 2-13) in response to extensive pumping from the City of Amarillo, Carson County well field north of the Pantex Plant. The well field consists of 39 wells and produces an annual average of about 18 million gallons per day (mgd) (68.1 million liters per day [lpd]). The nearest of these wells to the Pantex Plant is 2,100 feet (640 meters) north of the Plant boundary. A number of private wells (domestic and irrigation) are also installed near the Pantex Plant.

The volume of discharge used primarily for irrigation greatly exceeds the amount of recharge, which has resulted in declining water levels in the aquifer. Water level declines in the Ogallala Aquifer have resulted in "dry" areas of no saturation where the elevation of the bottom of the aquifer is locally high, such as in the areas to the immediate south and southeast of the Pantex Plant, as shown in Figure 2-8. The development of local "dry" zones may isolate Ogallala Aquifer groundwater near the Pantex Plant from the regional flow regime or otherwise alter local flow patterns in the Ogallala Aquifer in a manner that would diminish flow of Ogallala Aquifer groundwater away from the Pantex Plant.

2.5.2.5 Site Delineation

The Pantex Plant is delineated by zones and areas based on operational history. Figure 2-9 shows the location of the major zones and areas at the Pantex Plant that are included in the CERCLA remedial action process. These zones and areas are described in greater detail in Section 2.5.3.

2.5.2.6 Areas of Archeological or Historical Importance

No areas of archeological or historical importance have been identified at the Pantex Plant that would be affected by the selected remedies. In general, areas of archeological importance have been identified near playas in the past as part of cultural resource surveys conducted by USDOE/NNSA in accordance with the National Environmental Policy Act, so care will be taken to carefully observe work in close proximity to Playa 1. Previous projects conducted in the Playa 1 area have not revealed such a site.

2.5.3 Areas Associated with Releases

Figure 2-9 shows those areas of the facility where hazardous substances were released to the soils, groundwater, or other media. These areas were associated with discharges from operational areas to the playas, operational areas and historical processes, the Burning Grounds area, and the storage/disposal areas (i.e. NWAR, landfills, etc.) Those areas were investigated for hazardous substances and releases indicated where background or detection levels were exceeded. Constituent concentrations were compared to background and both human health and ecological screening levels.

The ROD selects remedial action for those soil units that pose a risk to onsite workers because they contain COCs and/or have the potential to migrate to perched groundwater above drinking water

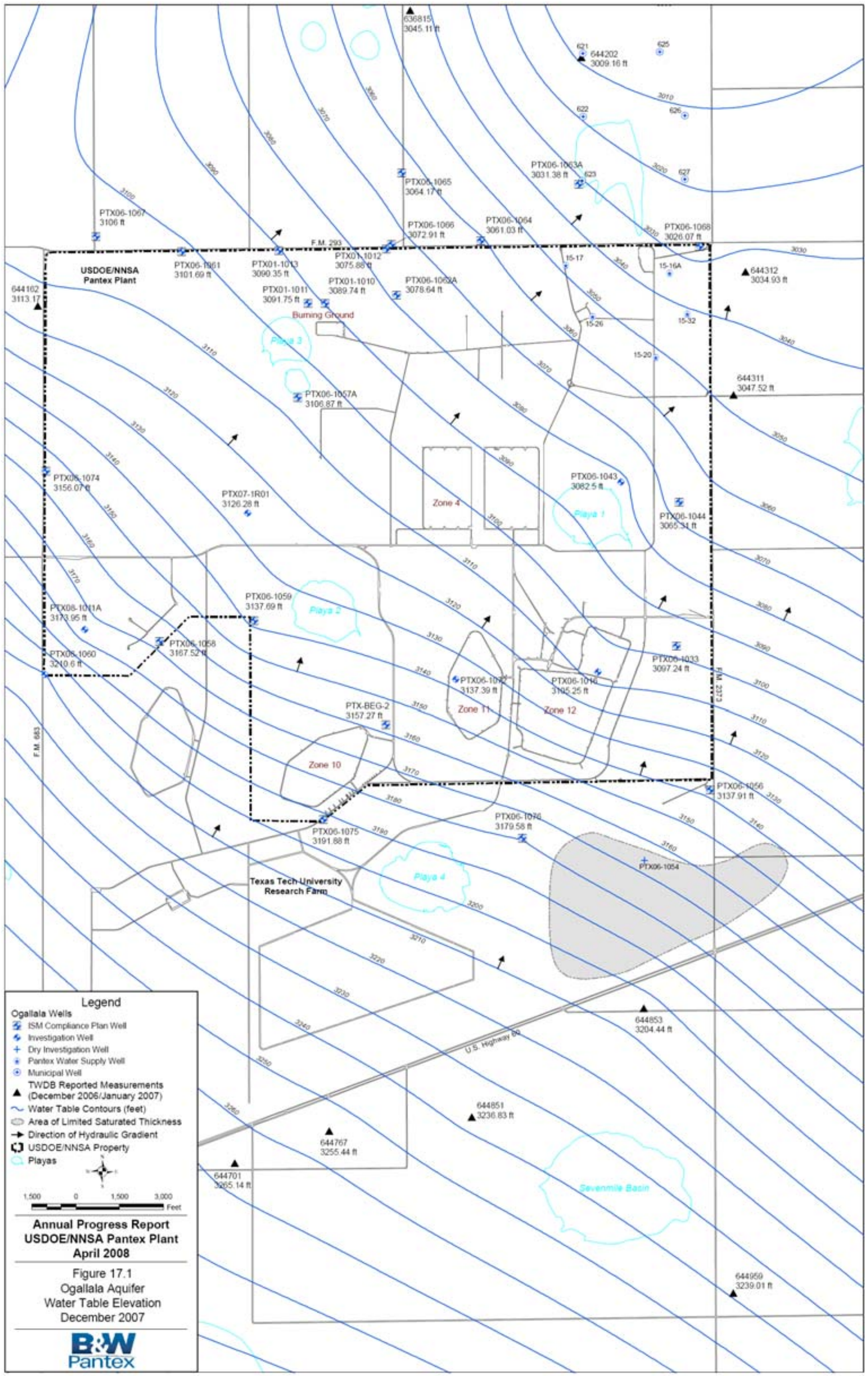

Figure 2-8. Pantex Plant Ogallala Aquifer Water Levels, December 2007

Figure 2-9. Location of Operation Zones and Site Features Associated with Pantex Plant Remedial Actions

standards. COCs are defined as COPCs having an individual incremental lifetime cancer risk (ILCR) greater than 1.0E-06 and/or hazard quotient (HQ) greater than 1.0, or substantially contributing to a cumulative ILCR greater than 1.0E-06 and/or a hazard index (HI) greater than 1.0.

The remedial action for groundwater was developed to address contaminants in the perched groundwater above drinking water standards with emphasis on areas with the potential to migrate to the underlying Ogallala Aquifer.

2.5.3.1 Soils

Several groups of chemicals (high explosives, VOCs, pesticides, metals, etc.) and some radionuclides (below screening levels) have been detected in soils at the Pantex Plant. Soil pH measurements generally range from 6.5 to 8. Many of these contaminants are bound to the upper soils because the clay-rich soils present at the Pantex Plant and semi-arid climate conditions limit leaching or migration to deeper soils or groundwater.

At the Pantex Plant, the vadose zone is extensive with a thickness greater than 250 feet in most areas. Soils investigations focused on defining the extent of contaminants in soils above 70 feet. A lower density of samples was collected in the deeper vadose resulting in higher uncertainty in the information available for these depths. This uncertainty will be managed ("uncertainty management") using an enhanced monitoring network for the perched groundwater and Ogallala Aquifer.

The COCs found in the 19 soil units considered for active remedial action alternatives are RDX, trinitrotoluene (TNT), and depleted uranium.

These 19 soil units are described in the following paragraphs according to operational zones at the site. Fifteen units were found to require action because of risk from direct contact and four units require action because they pose a risk to groundwater. The residual risk levels posed by the COCs found at these soil sites are relatively low (mostly between an incremental lifetime cancer risk of 1E-06 and 1E-05). See Section 2.7 for additional detail on risks posed by COCs at the Pantex Plant.

Zone 12

Operations in Zone 12 were primarily for the development, testing, and fabrication of HE components. Historically, treated and untreated industrial wastewater was discharged directly to the Zone 12 ditches and primarily flowed to Playa 1. The discharges to the ditches and playas infiltrated the soil and vadose and led to contamination of the perched groundwater. The volume of wastewater discharged from Zone 12 starting in the 1960s and continuing until the 1980s, averaged approximately 224,000 gpd up to an estimated maximum of 314,000 gpd.

Three units in Zone 12 (SWMUs 5-12a, 5-05, and 2) have a completed pathway to the perched groundwater and are known to contain contaminants in the vadose zone that may be continuing to migrate to the perched groundwater, resulting in concentrations above maximum contaminant levels (MCLs) or media-specific concentrations (MSCs). The surface soils in SWMU 5/12a also pose a risk to human health through direct contact as a result of RDX. The groundwater protection risk driver in the Zone 12 soils is RDX; hexavalent chromium is a secondary groundwater protection driver.

Burning Ground

The Burning Ground is an active operational area used for thermal treatment of high explosive-contaminated wastes. Legacy activities in this area resulted in historical releases to soils, both shallow and in the deeper vadose zone.

One unit in the Burning Ground (SWMUs 47) has a completed pathway to the perched groundwater and is known to contain soil gas VOCs in the vadose zone that may be continuing to diffuse into the perched groundwater.

As a result of historical operations, several units pose a direct contact risk to onsite workers in the Burning Ground: SWMUs 25, 26, 27, and the former Burning Grounds Disposal Trench (SWMUs 14-24). The risk drivers for these SWMUs are RDX, TNT, and depleted uranium, collectively.

Firing Site 5

Firing Site 5 was a test facility for high explosives and components containing high explosives. As a result of historical operations, FS-5 (SWMU 70) poses a direct contact risk to onsite workers. The risk driver is depleted uranium.

Remedial action alternatives for 26 landfills, historically used for disposal of construction debris and industrial/sanitary waste, were also evaluated in the Corrective Measures Study/Feasibility Study (FS). Many of the landfills did not pose a risk to industrial workers, but were evaluated to ensure they would continue to be protective of human health in the future. All of these landfills were also evaluated for protection of groundwater, since the potential exists for future migration of contaminants in the absence of mitigation measures.

2.5.3.2 Perched Groundwater

The main areas of the perched groundwater where constituents currently exceed drinking water standards (MCLs or MSCs) are in the southeast area of the plant and below Zone 11. Investigations indicate there are 16 contaminants above drinking water standards found in the perched groundwater (Table 2-2). In addition, there are two other constituents (boron and HMX) that have the potential to affect remedy design and treated water use.

Groundwater modeling conducted during the Baseline HHRA indicates perched groundwater COCs may impact the Ogallala Aquifer at levels above drinking water standards, if remedial actions are not taken. The greatest potential impacts to the Ogallala Aquifer from perched groundwater COCs are most likely to occur in areas near the horizontal extent of perched saturation southeast of the Plant, where the FGZ becomes more permeable and less resistant to downward flow, i.e., the areas sensitive to vertical migration.

Of the COCs found in the perched groundwater, the overall extent of impact to perched groundwater can be defined by examining the distribution of RDX, hexavalent chromium, and perchlorate. The distribution of the remaining COCs is within the plume boundaries defined by RDX, hexavalent chromium, and perchlorate.

RDX

The observed extent of RDX in perched groundwater is shown in Figure 2-10. The primary area of RDX contamination, referred to as the southeast plume, occurs to the east and southeast of Zone 12 underlying the Pantex Plant, TTU property, and property east of FM 2373. As shown in the figure, highest concentrations of RDX are present at the horizontal extent of perched groundwater to the south and east. RDX was detected in 44 of 65 perched monitoring wells sampled in 2006 at concentrations up to 4,400 µg/L. The southeast plume is a result of the discharge of process waters containing high explosives to unlined ditches along the east side of Zone 12. The highest concentrations of RDX are located down gradient of the source areas (Playa 1 and the Zone 12 ditches) indicating that continued leaching of RDX into perched groundwater is much less than what occurred historically prior to discharges being eliminated. The center of mass of the plume continues to move to the southeast.

A separate and much smaller plume of RDX occurs beneath and south of Zone 11 as a result of historical discharges from quality assurance testing and machining operations in this area. Observed concentrations in this plume are two orders of magnitude lower than those present in the southeast plume.

Table 2-2. Constituents Above Drinking Water Standards in Perched Groundwater

Zone 11 Perched	Perched East of Pantex	Perched South of Pantex	Standard (µg/L)	Basis for Standard
2,4 Dinitrotoluene	2,4 Dinitrotoluene	2,4 Dinitrotoluene	1.0	PQL[1]
2,6 Dinitrotoluene	2,6 Dinitrotoluene	2,6 Dinitrotoluene	1.0	PQL[1]
2-Amino-4,6 Dinitrotoluene	2-Amino-4,6 Dinitrotoluene	2-Amino-4,6 Dinitrotoluene	6.1[2]	$GW\text{-}Res_{NC}$
4-Amino-2,6 Dinitrotoluene	4-Amino-2,6 Dinitrotoluene	4-Amino-2,6 Dinitrotoluene	6.1[2]	$GW\text{-}Res_{NC}$
RDX	RDX	RDX	2	EPA Lifetime Health Advisory
TNT	TNT	TNT	18	$GW\text{-}Res_{NC}$
1,2 Dichloroethane	1,2 Dichloroethane	1,2 Dichloroethane	5.0	MCL
Hexavalent Chromium	-	Hexavalent Chromium	100	MCL
Chromium	-	Chromium	100	MCL
Trichloroethene	-	Trichloroethene	5.0	MCL
1,3 Dinitrobenzene	-	-	3.7[2]	$GW\text{-}Res_{C}$
1,3,5 Trinitrobenzene	-	-	1100[2]	$GW\text{-}Res_{NC}$
Perchlorate	-	-	26	$GW\text{-}Res_{NC}$
Tetrachloroethene	-	-	5.0	MCL
1,4 Dioxane	-	-	7.7	$GW\text{-}Res_{C}$
Chloroform	-	-	80	MCL for Trihalomethanes (including Chloroform)

GW-Res—TCEQ Standard No. 2 Groundwater MSC for Residential Use
MCL—EPA Maximum Contaminant Level
PQL—Practical Quantitation Limit
C—Carcinogenic
NC—Noncarcinogenic
µg/L—Micrograms per liter

[1]The PQL was chosen as the cleanup value in accordance with 40 CFR §300.430(e)(2)(i)(A)(2)(3) and 30 Texas Administrative Code (TAC) §335.563(j)(1) and as approved through the Pantex Risk Reduction Rule Guidance to the RFI (BWXT Pantex, 2002, updated March 2004). The PQL is approximately equal to a GW-Res value set to a risk level of 10^{-5} (calculated $GW\text{-}Res_{C}$ is 0.13 µg/L).

[2]Values for these constituents were adjusted below the calculated MSC because they target the same organs from a cumulative risk perspective.

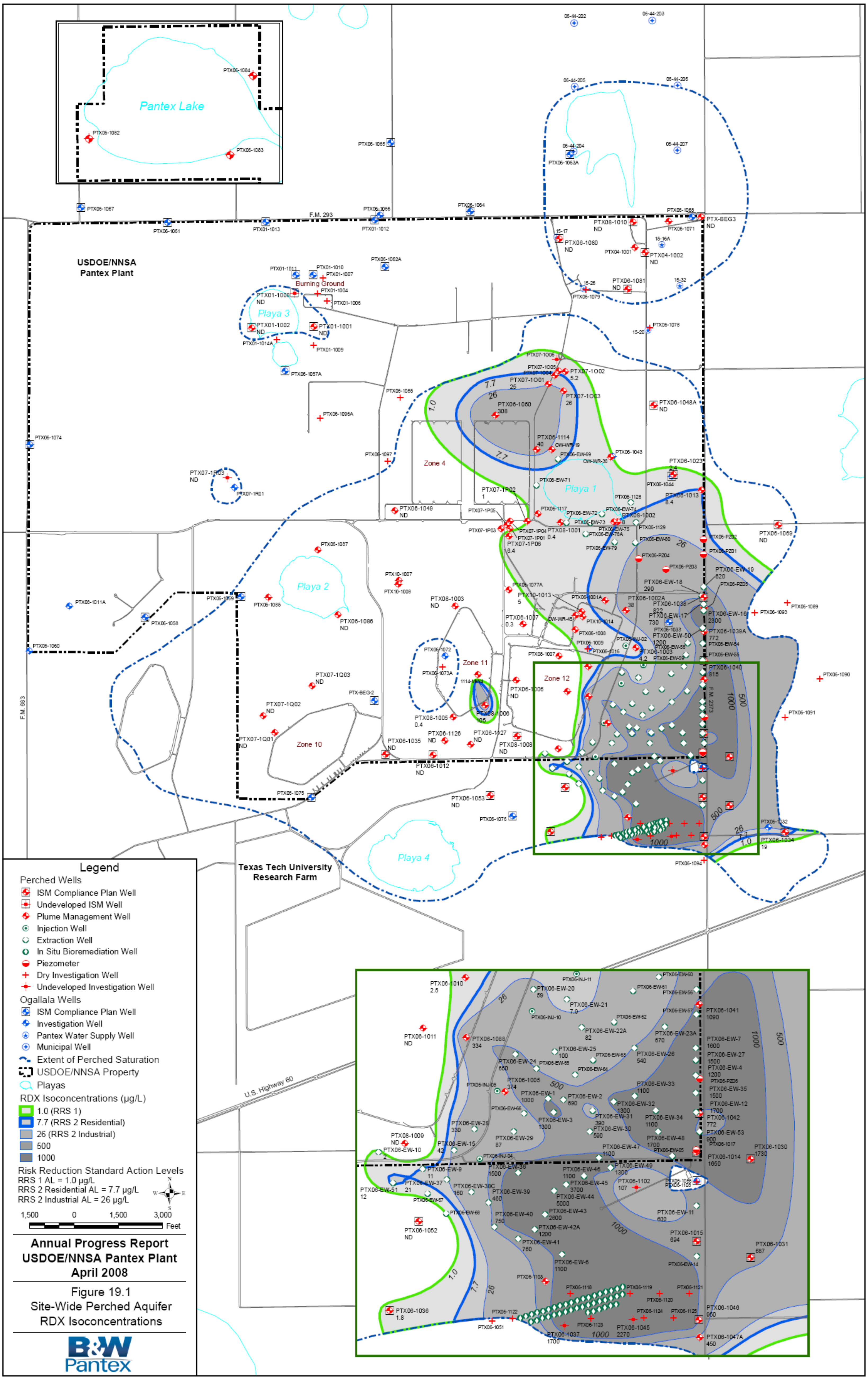

Figure 2-10. Perched Groundwater RDX Isoconcentrations*

* Note: The ROD modifies the RDX cleanup level to 2 µg/L (parts per billion), consistent with the EPA Lifetime Health Advisory guidance level.

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<u>*Hexavalent Chromium*</u>
The observed extent of hexavalent chromium in perched groundwater is shown in Figure 2-11. Hexavalent chromium occurs to the south and southeast of Zone 12 underlying the Pantex Plant and TTU property. Hexavalent chromium is present at the horizontal extent of perched saturation to the south, but the highest concentrations are located closer to the source areas (WMG 5 in Zone 12, and the Former Cooling Tower in Zone 12). Hexavalent chromium was detected above the Practical Quantitation Limits (PQLs) in nine of 77 perched monitoring wells sampled in 2006 at concentrations up to 3,900 µg/L (MCL is 100 µg/l). The hexavalent chromium plume is associated with two source areas in Zone 12. Plumes from the two source areas converge southeast of Zone 12 to form a single hexavalent chromium plume. The eastern source area is associated with historical operations in Zone 12 at the Former Cooling Tower. Observed concentrations near the source of this plume have declined by two orders of magnitude since 2002 indicating that the bulk of contaminated water discharged from the Former Cooling Tower area has probably already entered the perched groundwater. The southern source area is associated with historical discharges in Zone 12 south at WMG 5. Concentrations near this source area are variable and remain above 1,000 µg/L, but have declined by one order of magnitude since 2001. The highest concentrations of hexavalent chromium extend from the southern source area onto the TTRF security buffer. Higher concentrations in the plume continue to move to the southeast.

<u>*Perchlorate*</u>
The observed extent of perchlorate in perched groundwater is shown in Figure 2-12. Perchlorate occurs beneath Zone 11 and the western drainage ditch that runs to Playa 1. Perchlorate has also recently been found south of Zone 11 near the boundary with TTU property. Perchlorate originated in Zone 11 where water from machining operations was discharged to ditches draining the eastern side to Playa 1. This discharge resulted in the observed concentrations beneath Zone 11 and south of the zone; the gradient in the perched groundwater beneath Zone 11 is to the south. Concentrations at the three wells located in Zone 11 have been declining, indicating that the flux of perchlorate into perched groundwater from the unsaturated zone may be declining. Concentrations at the two wells located along the ditch leading to Playa 1 are stable. Perchlorate was detected above the Practical Quantitation Limit of 12 µg/L in seven of 62 perched monitoring wells sampled in 2006, at concentrations up to 180 µg/L. Perchlorate was recently determined to be present at concentrations of 700 and 1,000 µg/L in two new wells installed south of Zone 11 in November 2007.

2.5.3.3 Volume of Impacted Perched Groundwater

The main perched groundwater covers approximately 11 square miles, with a current water volume of approximately 15.1 billion gallons (BWXT Pantex/SAIC, 2007). The modeling completed for the *Baseline HHRA* indicated pre-Pantex perched groundwater volume of approximately 8 billion gallons. The simulation of 40 years of Plant operations, including the effects of significant discharges (from the mid 1950s to the late 1990s) resulted in the areal expansion of perched saturation and an increase in perched groundwater volume. The volume of impacted perched groundwater is approximately 7 billion gallons.

Modeling results also indicate pore water retained in the vadose zone will continue to drain, increasing the perched groundwater volume to approximately 16.1 billion gallons over the next 100 to 150 years. The majority of drainage from the vadose zone, beneath historical source areas, is predicted to occur within the next 50 years.

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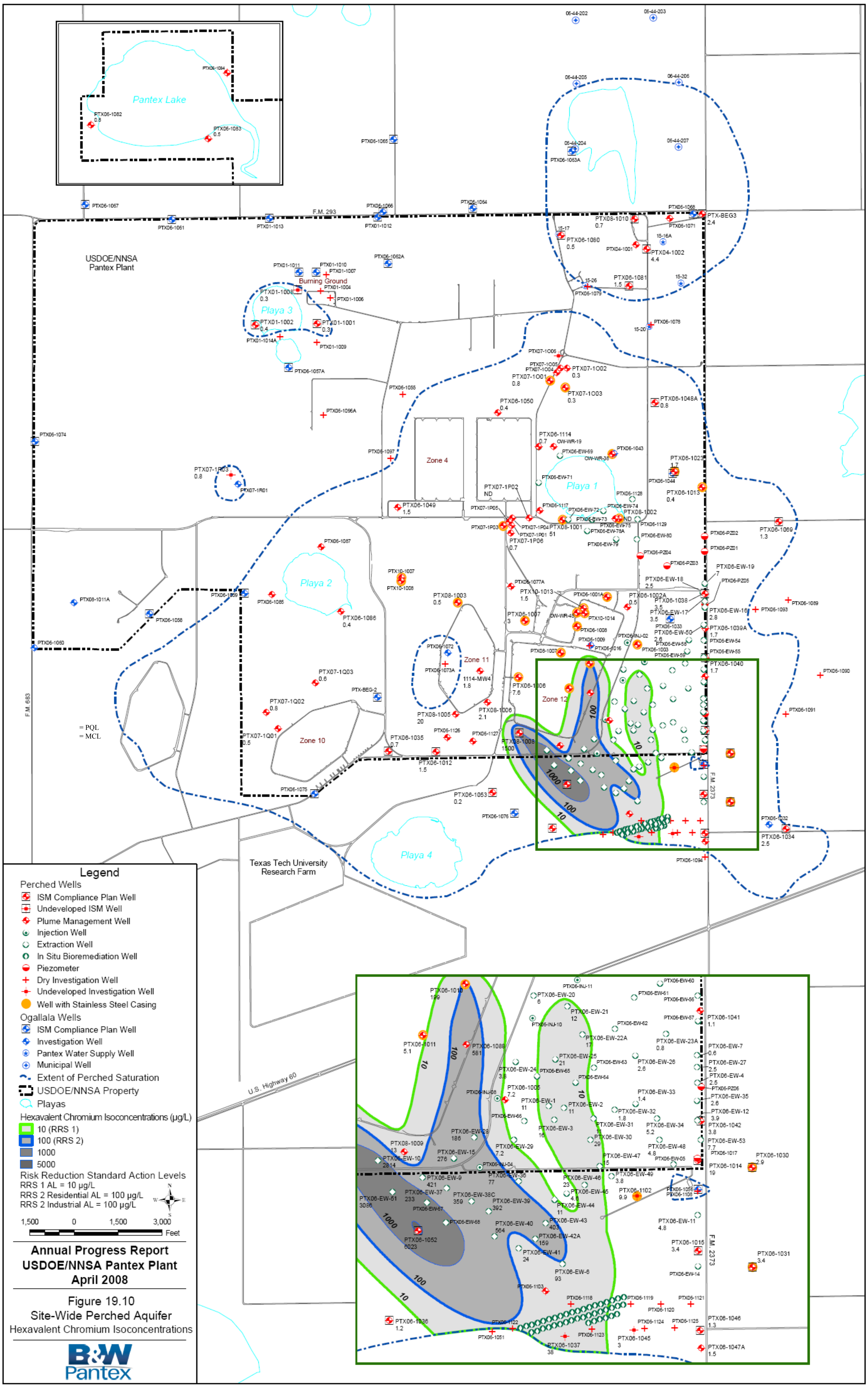

Figure 2-11. Perched Groundwater Hexavalent Chromium Isoconcentrations

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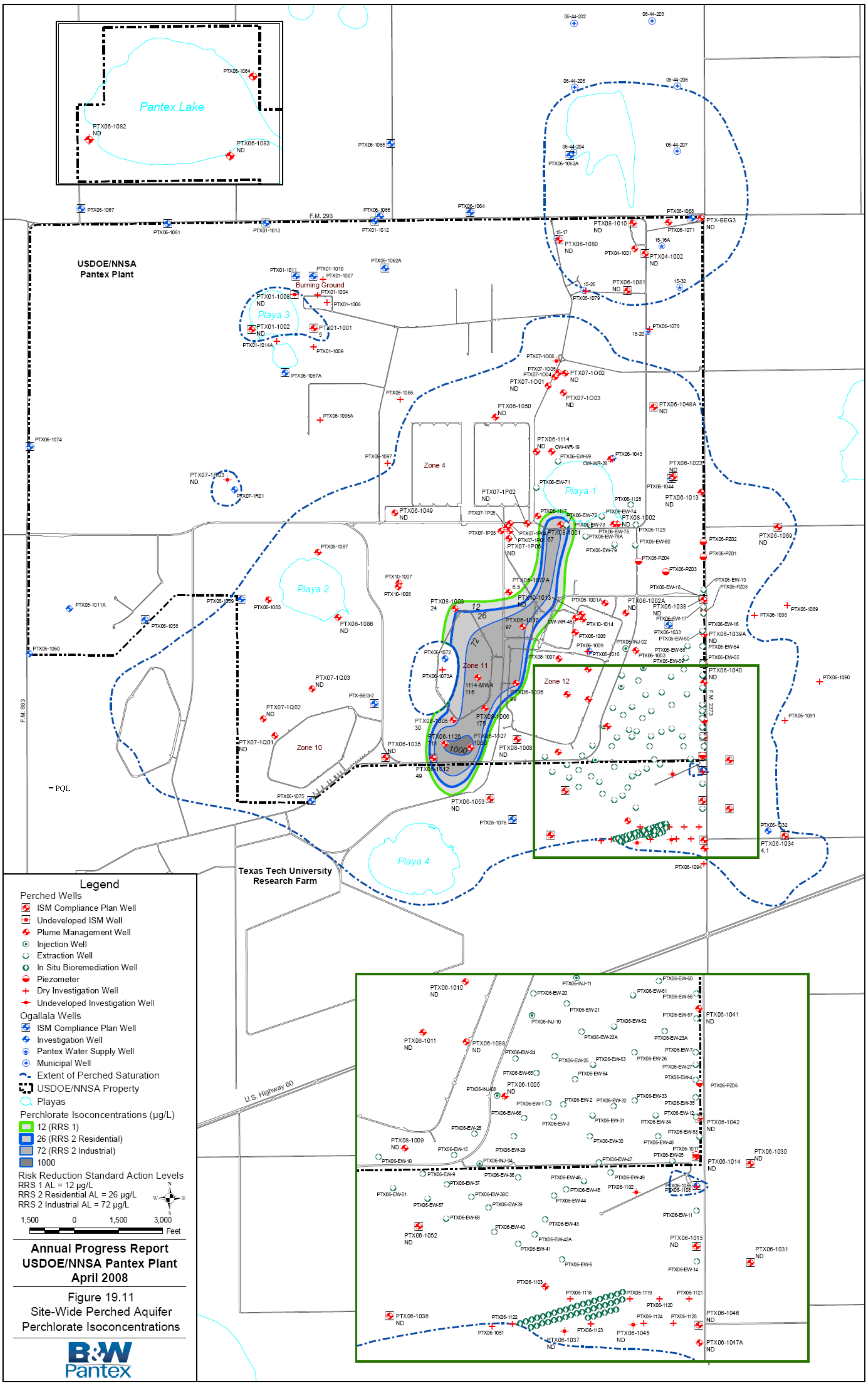

Figure 2-12. Perched Groundwater Perchlorate Isoconcentrations

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2.5.3.4 Ogallala Aquifer

Non-trending sporadic detections of constituents occur in the Ogallala Aquifer at low concentrations below regulatory screening levels. Based on groundwater modeling, COCs from soil, soil gas, and perched groundwater are predicted to impact the Ogallala Aquifer within 20 years in the absence of corrective measures.

2.5.4 Modeling Results

A fully three-dimensional, variably saturated flow and transport model has been developed to evaluate the potential effectiveness of the remedy for southeast perched groundwater beneath the Pantex Plant. The purpose of the model is to provide comprehensive insight based on solid science to decision makers to help understand and convey the behavior of water and constituents beneath the Pantex Plant. Model construction followed the graded approach recommended by the Groundwater Modeling Technical Advisory Group, and peer review was included throughout the process. A proprietary modeling code, known as BioF&T3D, was used to evaluate the potential for vertical transport of perched groundwater contaminants to the Ogallala Aquifer.

Two scenarios were evaluated with the model: a baseline, or no-action, scenario and components of the perched groundwater preferred remedial action alternative recommended in the FS. The preferred remedial action alternative focuses on protecting the Ogallala Aquifer from future impact and increasing the reliability of detection monitoring in the Ogallala Aquifer. These objectives will be accomplished by enhancing the current perched groundwater pump-and-treat system with additional extraction wells and eliminating injection of treated perched groundwater.

Key components of the perched groundwater preferred remedial action alternative modeling included enhanced contaminant mass removal through installation of extraction wells within the southeast perched RDX plume, reduction of upgradient head by extracting perched groundwater near Playa 1, continued use of current perched groundwater extraction wells for 30 years with no injection, and *in-situ* treatment near the extent of perched saturation southeast of Zone 12. This *in-situ* treatment was not included in the modeling because reliable results from field-scale pilot testing were not available at the time the modeling was conducted.

A separate model of the Ogallala Aquifer (local Ogallala model) was developed to evaluate flow paths in the aquifer and to provide boundary conditions for the three-dimensional site-wide model. Because of the uncertainty regarding future conditions in the Ogallala Aquifer over the 250-year simulation period, Ogallala water levels in the Site-Wide model were held constant for the baseline and remediation transport simulations. Additional transport scenarios with simulated declining Ogallala Aquifer water levels were conducted to assess the sensitivity of the static assumption.

2.5.4.1 Assumptions

All models are, by definition, approximations to real systems. A major limitation in the modeling of historical conditions at the Pantex Plant is the lack of detailed information that would allow precise flow and transport calibration. These data, such as the locations and volumes of process water discharges, constituent concentrations in process waters, and aquifer water levels and concentrations, were not historically collected—modeling of environmental impacts was neither envisioned nor possible at that time. While this lack of data restricts the degree to which the current flow and transport model can be calibrated and validated, the model is highly valuable. It provides understanding of subsurface behavior, insight for installation and operations of remediation systems in the context of engineering support, and specifics on current data gaps that may be addressed in the future.

The modeling was focused on the southeast groundwater and the movement of RDX in this area. The key assumption of this modeling is the rate of degradation of RDX, the primary constituent of concern. Natural attenuation of RDX was modeled and included the processes of dispersion, sorption, and biodegradation. For sorption, a linear distribution coefficient was estimated based on evaluation of the observed RDX distribution in perched groundwater and literature sources. The first-order half-life of 25 years was developed based on evaluation of the observed RDX distribution in perched groundwater and literature sources. To assess the sensitivity of model results to the assumed reaction rate, additional transport scenarios were conducted using a half-life of 100 years.

2.5.4.2 Results

Model results are consistent with the conceptual understanding of the hydrogeologic system. Perched groundwater containing RDX generally flows southeast into areas having less saturated thickness and where site investigation results indicate the underlying confining zone is more permeable. Beneath these areas, the Ogallala Aquifer is thin, having little or no saturated thickness, and the vertical distance to the Ogallala Aquifer is much less than in other areas of the Pantex Plant. Therefore, the greatest potential for RDX to migrate to the Ogallala Aquifer occurs in the southeast areas of the perched groundwater, as shown in Figure 2-13. The bands of color in this figure represent variation of the predicted concentration of RDX as water moves through the subsurface, from the perched groundwater vertically through the FGZ and into the Ogallala Aquifer. Bands representing the highest concentrations are at the red end of the color spectrum and decrease to the lowest concentrations at the blue/violet end of the spectrum.

Flow Results

Flow simulation of the preferred remedial action alternative (30 years of perched groundwater withdrawal without injection back into the perched zone) predicts significant reduction of perched groundwater flux through the FGZ relative to the baseline condition for the entire Site-Wide model area and for the southeast area. The southeast area includes the regions where the FGZ becomes more permeable and predicted impacts to the underlying Ogallala Aquifer are the greatest.

The extraction of perched groundwater acts to mitigate the impact of the uncertainties and simplifying assumptions noted above by:

- Reducing the amount of water and RDX mass available to migrate across the FGZ for the entire perched groundwater flow system, so even if preferred pathways (geologic heterogeneities) are not precisely known, the reduction in perched groundwater will result in reduction of flow and mass transport across the FGZ.
- Permitting more time for natural degradation processes to occur by reducing the hydraulic head driving much of the RDX transport laterally and vertically; the removal of perched groundwater near Playa 1 reduces the upgradient hydraulic heads that drive RDX-impacted perched groundwater to the southeast areas where the FGZ is more permeable, resulting in longer travel times to these areas.

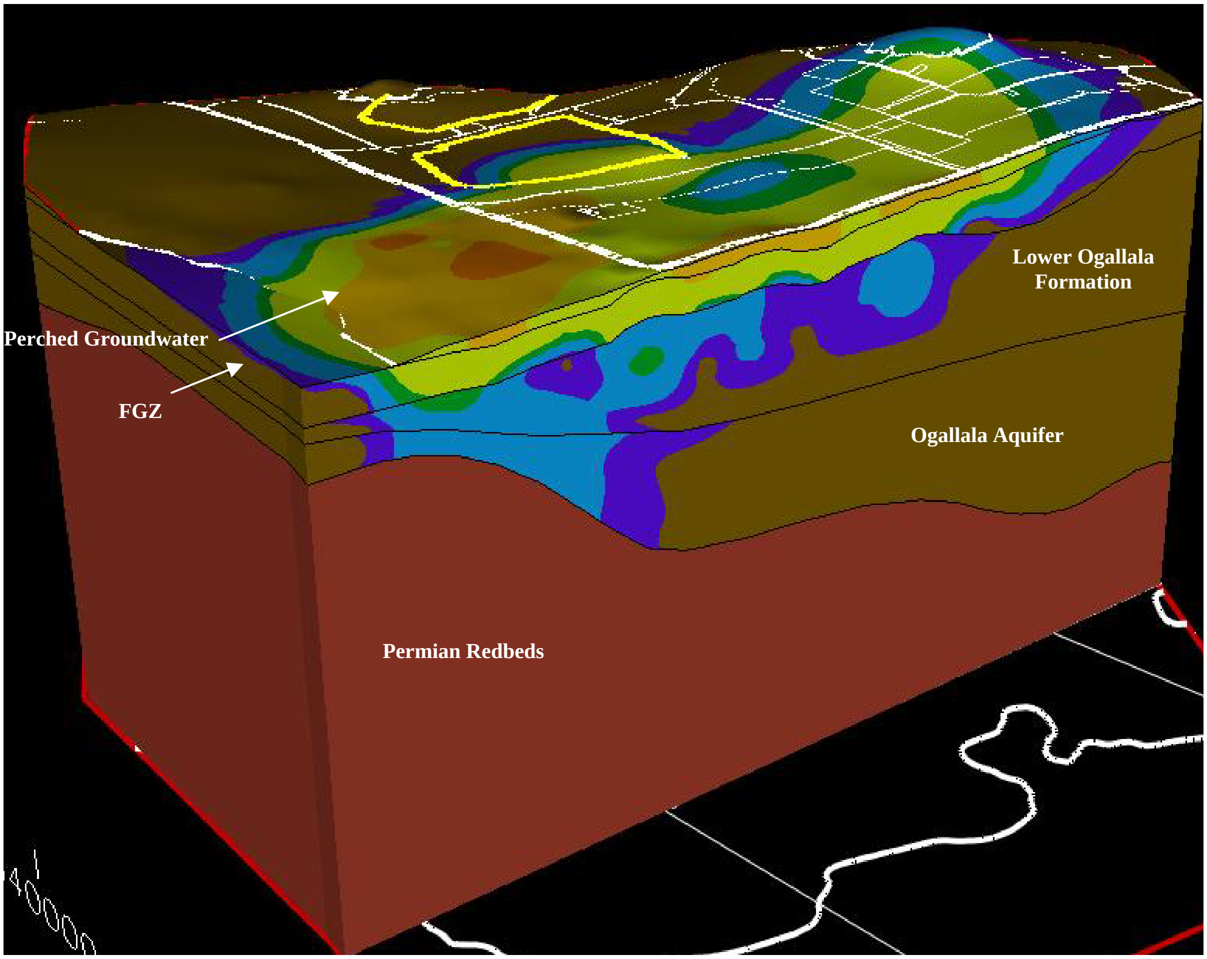


Figure 2-13. Eastern Pantex Plant Cross-Section of Modeling Prediction of Potential Impact to the Ogallala Aquifer

Transport Results

Results of the baseline transport simulation indicate RDX will reach the Ogallala Aquifer within 20 years in the absence of any remediation as a result of historical releases from the Pantex Plant.

- Using a biodegradation half-life of 25 years for RDX, the model predicts:
  - A maximum RDX concentration of 9 µg/L 30 years after the start of simulation at the Ogallala Aquifer water table surface beneath TTU property south of the Pantex Plant.
  - The maximum predicted RDX concentrations in the plume (4.6 µg/L) occur after 50 years, but concentrations then decline to less than the risk-based value between 150 and 170 years.
  - The maximum predicted RDX concentration in the Ogallala Aquifer at any point along FM 2373 does not exceed the risk-based concentration at any time.

- Using a biodegradation half-life of 100 years for RDX the model predicts:
  - A maximum concentration of 31 µg/L 75 years after the start of simulation at the Ogallala Aquifer water table surface beneath TTU property south of the Pantex Plant.

  - The maximum predicted RDX concentrations in the plume (19 µg/L) occur by 100 years, and then decline during the remainder of the simulation, to less than 10 µg/L after 250 years.

Transport simulation of the enhanced pump and treat component of the FS preferred remedial action alternative, i.e., extraction and treatment of 590,000 gallons/day without *in-situ* treatment in the southeast perched groundwater, indicates the potential for RDX to reach the Ogallala Aquifer within 20 years at low concentrations as a result of historical releases from the Pantex Plant.

- Using a biodegradation half-life of 25 years for RDX, the model predicts:
  - A maximum predicted RDX concentration of about 4 µg/L 20 years after the start of simulation at the Ogallala Aquifer water table surface beneath TTU property south of the Pantex Plant.
  - Modeled concentrations in the Ogallala Aquifer decrease to less than 1 µg/L 75 years after the start of simulation and continue declining through the end of the simulation period.
  - The maximum predicted RDX concentration in the Ogallala Aquifer at any point along FM 2373 does not exceed the risk-based concentration at any time.
- Using a biodegradation half-life of 100 years for RDX, the model predicts:
  - A maximum predicted RDX concentration of 6.9 µg/L 24 years after the start of simulation at Ogallala Aquifer water table surface beneath TTU property south of the Pantex Plant.
  - Following this early peak, RDX concentrations in the Ogallala Aquifer decline in response to implementation of the FS preferred remedial action alternative in perched groundwater (without *in-situ* treatment).
  - However, a second peak concentration of similar magnitude (6.6 µg/L) occurs at about 230 years in the Ogallala Aquifer as a result of the simulated slower rate of biodegradation of RDX.
  - Following the second peak, concentrations decline through the end of the 250-year simulation period.

In addition to the RDX biodegradation rate, other aspects of uncertainty in the modeling include those listed below. These uncertainties were overcome in the modeling by assumptions that addressed the amount of time that water existing in the perched zone, the quantity of perched groundwater present over the duration of the modeling, the change in mass and concentration of perched groundwater over the modeling duration, and the spatial changes in the subsurface soils that affect the rate and direction of movement of contaminants.

- Conditions in perched groundwater prior to development of the Pantex Plant, such as volume of pre-Pantex perched groundwater.
- Timing and volume of process water discharges to the ditches during the period of Cold War operations, i.e., the 1950s to 1980s.
- Continued drainage of RDX-containing water from the vadose zone into perched groundwater.
- Observed or potential local heterogeneities affecting soil porosity, unsaturated soil properties, and hydraulic conductivity.

The relative importance of the uncertainties in these parameters on the decisions for corrective action depends on the actual rate of RDX natural attenuation occurring beneath the Pantex Plant.

For the remediation transport scenarios of the enhanced pump and treat component of the preferred remedial action alternative (without *in-situ* treatment), RDX is predicted to reach the Ogallala Aquifer, but impacts are limited to a localized area beneath TTU property and the southeast corner of the Pantex Plant. Transport modeling results indicate a two- to four-fold reduction in the magnitude of the predicted impact to the Ogallala Aquifer through implementation of the preferred remedial action alternative. A larger area is affected in the 100-year biodegradation half-life scenario, but the plume is still localized and does not affect the locations of any existing water supply wells. The affected area in the Ogallala Aquifer decreases as the modeled biodegradation rate is increased. Although the site-specific rate of biodegradation in the Ogallala is currently an irreducible uncertainty, the recommended corrective actions will effectively mitigate predicted impacts to the portions of the Ogallala Aquifer used for water supply. Modeling results, and identification of modeling uncertainties, provide a greater understanding of the potential impacts of past RDX releases on the environment. Long-term monitoring information will validate the model results and improve the reliability of the model as a predictive tool.

2.6 Current and Potential Future Site and Resource Uses

This section discusses the current and future land uses, and current and potential beneficial ground and surface water uses at the site. This information forms the basis for reasonable exposure assessment assumptions and risk characterization conclusions presented in Section 2.7.

2.6.1 Land Use

The Pantex Plant will continue as an active industrial facility into the foreseeable future or in consideration of any potential agency mission. USDOE/NNSA will continue to formally restrict access to the site consistent with an industrial land use scenario.

The Pantex Plant contains active and inactive operational areas. The inactive areas generally serve as safety and security buffers around the active operational areas. Land use in active operational areas is industrial with occasional construction and excavation work. Zones 11 and 12 are highly restricted active operational areas surrounded by high security fencing and guarded by security personnel. Zone 10 and the Burning Ground are also active operational areas. Inactive operational areas will be managed consistent with an industrial land use scenario and include the Fire Training Area (FTA), landfills, FS-5, ditches, NWAR, and a portion of Zone 12 outside of the security fence along its eastern edge.

In addition to the active and inactive operational areas, Playa 1, Playa 2, Playa 3, and Pantex Lake are also areas managed by USDOE/NNSA. Playas 1, 2, and 3 are formally managed under the Playa Management Plan. These playas are accessed infrequently by sampling technicians, environmental scientists, and by TTU personnel who infrequently use the area for cattle grazing. Pantex Lake is also used for cattle grazing and USDOE/NNSA lands outside of the playa basin are farmed by TTU.
The predominant land use immediately surrounding the Pantex Plant and Pantex Lake is agricultural, including grazing and cultivation of crops. The property immediately to the south of the Pantex Plant is owned by TTU and leased by USDOE/NNSA as a safety and security buffer. This property is used primarily as rangeland with small areas of cultivation. Future land use for all areas surrounding the Pantex Plant is assumed to remain agricultural.

The sites referenced in this ROD were evaluated under a restricted industrial land use scenario. In the investigation and evaluation process for releases, contaminant concentrations were compared to industrial screening levels to be consistent with the present and future land use expectations. Site-specific risk assessments were based on industrial exposure assumptions.

The playas were assessed under an industrial scenario for human health exposure. Remedial evaluations also included consideration of the property for agricultural use, short-term grazing, and cattle production.

2.6.2 Surface Water Use

Surface water at the playas is not used onsite for any purpose. However, playas constitute the principal ecological habitat at the Pantex Plant and were included in both the evaluation of ecological risk and human health (i.e. sampling technicians, etc.). Surface water at Pantex Lake is not used for any purpose now, nor is it expected to be used for any purpose in the future.

2.6.3 Perched Groundwater Use

Perched groundwater meets the established yield and quality requirements to be designated as a drinking water resource pursuant to the Safe Drinking Water Act. So, actions selected in this ROD support restoration of the perched as a *potential* drinking water source. The perched groundwater is not used as a source of drinking water, nor is it used for industrial operations or any other purpose at the Pantex Plant. Perched groundwater beneath Pantex Plant property will continue to be restricted by USDOE/NNSA.

All public and most private wells in the vicinity of the Pantex Plant are completed in the Ogallala Aquifer; with the exception of one private domestic supply well that is completed in perched groundwater north of the Pantex Plant in an area that is not impacted (Figure 2-14).

Hazardous constituents are present at levels above drinking water standards in the perched groundwater onsite, and offsite, east of FM 2373 and south beneath TTU property. No private supply wells currently exist in these impacted areas; therefore, current exposure to constituents above drinking water standards in perched groundwater is not a complete pathway.

The extent of perched groundwater is limited and is a localized feature confined to the Pantex Plant and the areas immediately adjacent to the Plant boundary. There are areas of perched groundwater located throughout the Panhandle, created from surface drainage to the playas. However, the perched groundwater at the Pantex Plant was created, in part, through historical discharges of industrial waste streams to the onsite ditches and playas. Impacted perched groundwater east of FM 2373 is not expected to be considered for use as a drinking water source, as the feasibility of its potential use is, and will continue to be, limited by thin saturation and low hydraulic conductivities. USDOE/NNSA will continue to monitor impacted perched groundwater and implement institutional controls to prevent current and future use of perched groundwater that exceeds drinking water standards.

2.6.4 Ogallala Aquifer Use

The Ogallala Aquifer is designated as a drinking water resource pursuant to the Safe Drinking Water Act and is used as a principal drinking water source for surrounding populations. The Ogallala Aquifer provides water for municipal water supplies, crop irrigation, livestock operations, and industry and is one of the only reliable potable sources of water in the vicinity of the Pantex Plant.

Groundwater from the Ogallala Aquifer provides the sole potable and industrial water source for the Pantex Plant. This water supply is from five onsite wells shown in Figure 2-14. These wells are pumped at a combined average rate of 0.72 mgd (2.7 million liters per day). USDOE/NNSA also supplies water to the TTU property for potable and livestock uses at TTRF.

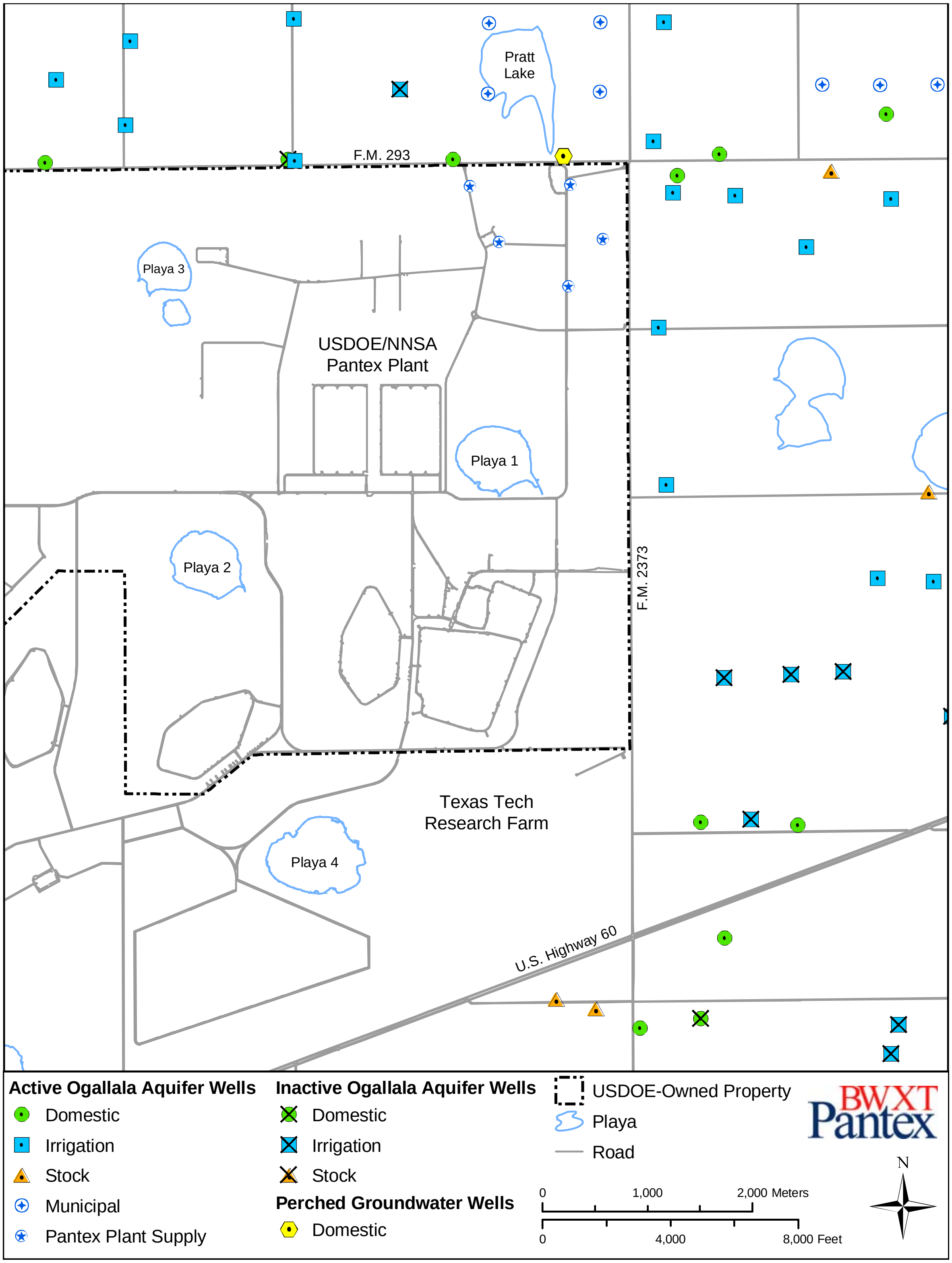


Figure 2-14. Groundwater Use North and East of the Pantex Plant

The Ogallala Aquifer does not currently pose an exposure risk to onsite and offsite receptors since COPCs do not exist above drinking water standards in the Ogallala Aquifer. Future exposure through the groundwater pathway is possible if COPCs migrate to the Ogallala Aquifer. The ROD selects a remedy to protect the Ogallala Aquifer as a current and future drinking water source.

2.7 Summary of Site Risks

2.7.1 Human Health Risks

The Baseline Human Health Risk Assessment (HHRA) was completed for the Pantex Plant to evaluate potential risks to onsite and offsite human receptors, in the absence of any remedial action. The Baseline HHRA follows the approach and methodology presented in the approved *Revised Final Baseline Risk Assessment (BRA) Work Plan* (BWXT Pantex/SAIC, 2003). The baseline risk assessment provides the basis for taking action and identifies the contaminants and exposure pathways that need to be addressed by the remedial action.

Human health risk assessments were completed for the Pantex Plant release units that were not eliminated from further evaluation administratively or by comparison to background or screening levels (i.e., those units closed to Texas Risk Reduction Standard (RRS) 1 and 2 under the TSWDA). Additionally, any unit that was positively identified as containing radiological contaminants was also evaluated to determine the potential cumulative risks from chemical and radionuclide contaminants (i.e., Firing Site 5).

Releases were evaluated in the Baseline HHRA for 135 soil release units located across the Pantex Plant. The HHRA also evaluated groundwater beneath the units for impacts from soils and areas of focused recharge.

The risk assessments were completed and reported in separate risk assessment reports, as listed below.

- *Burning Ground Human Health Risk Assessment Report* (BWXT Pantex, May 2006, revised September 2006).
- *Nuclear Weapon Accident Residue Storage Unit (NWAR) Human Health Risk Assessment Report* (BWXT Pantex, August 2006).
- *Baseline Human Health Risk Assessment Report for Zones 10, 11, and 12, Fire Training Area, Ditches and Playas, Independent Sites, and Groundwater* (BWXT Pantex/SAIC, December 2006).
- *Firing Site 5 Human Health Risk Assessment Report* (BWXT Pantex, May 2007).
- *Playa 4 Human Health Risk Assessment Report* (BWXT Pantex, October 2007).

The risk assessments determined that a few of the soil units and perched groundwater required further detailed evaluation in the FS and Proposed Plan, specifically:

- SWMU 2: Building 12-43 Drainage Ditch.
- SWMU 5-05: Buildings 12-21 and 12-24 Drainage Ditches.
- SWMU 5-12a: Zone 12 Main Perimeter Ditch.
- SWMUs 14-26 (13 Units): Explosive Burn Pads (including wash rack) – the portion of the pads considered for remediation focuses on a trench that was used to dispose of ash from the burn pads

and two burn pads along the western side of the Burning Ground where low levels of depleted uranium were a risk driver.

- SWMU 27: Explosive Burn Pad 13.
- SWMU 47: Chemical Burn/Evaporation Pits.
- SWMU 70: Firing Site 5.
- Miscellaneous Landfills (26 units).

Some of these areas were retained for evaluation of worker protection (industrial and/or construction worker), while others were retained to address uncertainties with groundwater. This summary focuses on the results of the risk assessment for these areas.

Both the perched groundwater and the Ogallala aquifer were investigated, and are being monitored through an existing monitoring and compliance network, for detections and changes in concentrations and trends. The ROD addresses contamination in the perched groundwater as a potential drinking water source and to protect the underlying Ogallala Aquifer. Risk was assessed on a hypothetical completed exposure pathway; the perched groundwater is not being used as a drinking water source.

The risk assessment methods and results are summarized to provide information concerning the different phases of the risk assessment including:

1. Identification of COPCs
2. Exposure assessment
3. Toxicity assessment
4. Risk characterization and uncertainty

Each of these topics is discussed below to provide a general understanding of the methods and results of the HHRAs. The results presented in this summary are focused on the units evaluated in the FS and Proposed Plan that required an active remedial response, i.e., more than institutional controls with long-term groundwater monitoring.

2.7.1.1 Identification of Constituents of Concern

Chemical and/or radiological data collected during the RFIs and Radiological Investigation (RI) conducted at each unit formed the basis for the final dataset used in each HHRA. For each medium and exposure/migration pathway, all COPCs (contaminants positively identified above background, or RRS 1 under the TSWDA) identified in the corresponding soil investigation documents, TCEQ and EPA conditional approval letters, and the *Groundwater RFIR* (Stoller, 2004b) were evaluated. For identification of radiological COPCs, preference was given to the *RI Report* (BWXT Pantex, 2004a) because the analysis performed in the *RI Report* (BWXT Pantex, 2004a) included newer background information not available in the corresponding soil investigation reports for each site. In addition, all metals were added to the list of COPCs for most units, because newer soil backgrounds were not available during completion of the investigation reports. Additionally for groundwater, all data collected since the RFIR were reviewed to ensure consistency in the COPCs. From the review, some COPCs were not evaluated because concentrations dropped below MCLs or risk-based standards (consistent with TCEQ risk-based screening criteria) or new COPCs were added. This combined list served as the starting point for the soils and groundwater to be evaluated in the HHRAs.

For each unit included in the HHRAs, the full list of COPCs quantitatively evaluated was narrowed in accordance with the *Consistency Document for Implementation of the Existing Risk Reduction Rule* (herein referred to as the *Consistency Document*) (TNRCC, 1998) and the approved *Baseline Risk Assessment (BRA) Work Plan* (BWXT Pantex/SAIC, 2003). Because of the number of pathways and COPCs to be addressed, the number of COPCs was narrowed to streamline the quantitative risk evaluation. The COPC evaluation was based on a comparison of maximum detected concentrations to background values for naturally occurring constituents (i.e., RRS 1 under the TSWDA). For non-naturally-occurring COPCs and naturally occurring COPCs exceeding background, the maximum detected concentrations were compared to risk-based screening (i.e. RRS 2 under the TSWDA) or other appropriate risk-based criteria based on the exposure/migration pathway being considered. Those COPCs and media that exceeded the appropriate criteria were carried forward for quantitative risk evaluation. The media evaluated for COPCs for the quantitative risk evaluation included:

- **Surface soil:** 0 to 2 ft depth interval (direct contact exposures at the source to industrial workers and offsite atmospheric transport) for each grid cell or single exposure area.
- **Soil:** 0 to 15 ft depth interval (direct contact exposures at the source to construction/excavation workers) for each grid cell or single exposure area.
- **Soil (to groundwater):** ground surface to top of groundwater (migration from soil to groundwater) for all data within an area (i.e., the data were not separated by grid cell or exposure area).
- **Perched groundwater:** (exposure to offsite resident farmer and migration to Ogallala Aquifer) all perched groundwater data evaluated according to source areas and individual wells.
- **Soil gas:** (air inhalation exposures to onsite workers at the source area and offsite resident farmers and migration to groundwater) data grouped by source area for evaluation.

This screening evaluation only removed COPCs from further consideration in the quantitative risk assessment if the COPC would not significantly contribute to cumulative risk. The tables listing all COPCs for the units and the final COPCs that were carried forward for quantitative risk evaluation are included in Appendices B through I.

In addition to the basic COPC screening evaluation methods using risk-based criteria, additional steps were taken to evaluate the soil-to-groundwater, soil gas-to-groundwater, and soil gas-to-air impacts if conventional screening comparisons were exceeded. These Tier 2 and 3 evaluations involved the use of simple dilution factors and then a travel time analysis to determine if the risk-based screening criteria would be exceeded using simplified, conservative assumptions. For evaluation of potential groundwater impacts, these tiered evaluations were applied to consider the thickness of the unsaturated zone (~ 200 feet) above the first-encountered groundwater, i.e., perched groundwater. As necessary, COPCs that exceeded the additional screening were evaluated in a fate and transport model.

In general, the combination of an infiltration-resistant upper soil unit (the Blackwater Draw Formation) and semi-arid conditions at the Site result in a situation that requires focused recharge to leach contaminants to the depth of perched groundwater. The complexity of the site conditions led to implementation of the aforementioned tiered approach for evaluating the potential for impacts to groundwater.

2.7.1.2 Exposure Assessment Results

The exposure assessment evaluates how, and to what extent, people may be exposed to contaminants in soil, soil gas, or groundwater from the Pantex Plant. The major steps in the exposure assessment:

- Determine current and potential future land use.
- Develop a conceptual site model.
- Develop exposure assumptions for each type of receptor.

Land use at the Pantex Plant is industrial and is expected to remain industrial for the foreseeable future. Therefore, only industrial exposures were considered for onsite. Two onsite receptors (i.e., industrial worker and a construction/excavation worker) were evaluated in the Baseline HHRA.

Offsite land use in the immediate vicinity of the Pantex Plant is primarily agricultural with scattered farm residences. Some industrial areas are located south and southwest of the Plant. The only urban centers in the Pantex Plant area are Highland Park Village to the southwest on the outskirts of Amarillo, Texas; Panhandle, Texas to the east; and Washburn, Texas to the south. Thus, the offsite exposure scenario for the HHRAs was a resident farmer living and farming in the area. Both an adult and a child offsite resident farmer were evaluated per the approved *Revised Final BRA Work Plan* (BWXT Pantex/SAIC, 2003).

The property to the south of the Pantex Plant is owned by TTU and leased as a safety and security buffer by USDOE/NNSA. The 1984 lease agreement allows for renewal of the lease for up to 99 years. The TTU property is managed and secured in a manner similar to the Pantex Plant (locked gates, entry only allowed with permission). The TTU property is managed by the Texas Tech Research Farm and is used primarily as rangeland with small areas of cultivation. The farm manager and workers live on the west side of the property in the former Pantex Village area. Much of the property is currently in the conservation reserve program. No water supply wells currently exist on TTU property, and USDOE/NNSA supplies all water to TTU, under a formal service agreement. Some areas are used for cattle grazing, primarily in the summer. Grazing is rotational; only stocker cattle are grazed for up to 60 days each year. After grazing is completed, the stocker cattle are sent offsite and do not return to the Pantex Plant.

Receptors may be exposed to COPCs through direct contact with source media or as the result of COPC migration away from the source into other media. The primary source medium at the Pantex Plant is soil impacted by historical waste management (treated and untreated wastewater discharges) and operational activities at the site. COPCs released to soil have impacted perched groundwater beneath the Pantex Plant via various transport mechanisms.

COPCs in the perched groundwater beneath the Pantex Plant have migrated east of FM 2373 and to the south. However, the impacted perched groundwater, onsite and offsite, has not been used. Therefore, no completed exposure pathways exist. USDOE/NNSA is in the process of purchasing land underlain by impacted perched groundwater east of FM 2373, to better facilitate access and control of potential future offsite exposure. Although not currently used, perched groundwater flowing offsite to the south is potentially available for use by offsite receptors.

The principal COPC release mechanisms and transport pathways evaluated for the Baseline HHRA were:

- Release of VOCs from soil (including soil gas plumes at the Burning Ground, Zone 11, and Zone 12) to the atmosphere

- Release of fugitive dust from onsite soil to the atmosphere with subsequent deposition to offsite soil and crops (fugitive dust were assumed to potentially contain organic substances, metals, and/or radionuclides)
- Infiltration and leaching of COPCs from soil and soil gas to perched groundwater and/or the Ogallala Aquifer
- Migration of COPCs in perched groundwater to offsite points of exposure (POEs)
- Migration of COPCs in perched groundwater to the Ogallala Aquifer
- Migration of COPCs in the Ogallala Aquifer to onsite/offsite POE
- Offsite crop irrigation and/or livestock watering with groundwater impacted by COPCs (perched groundwater or Ogallala Aquifer).

Conceptual site models were developed for onsite and offsite receptors that could contact contaminants in soil, air, or groundwater. See Figure 2-15 and Figure 2-16 for illustrations of potential exposure pathways. Potential receptors include:

- Onsite industrial workers
- Onsite construction/excavation workers
- Offsite resident farmers

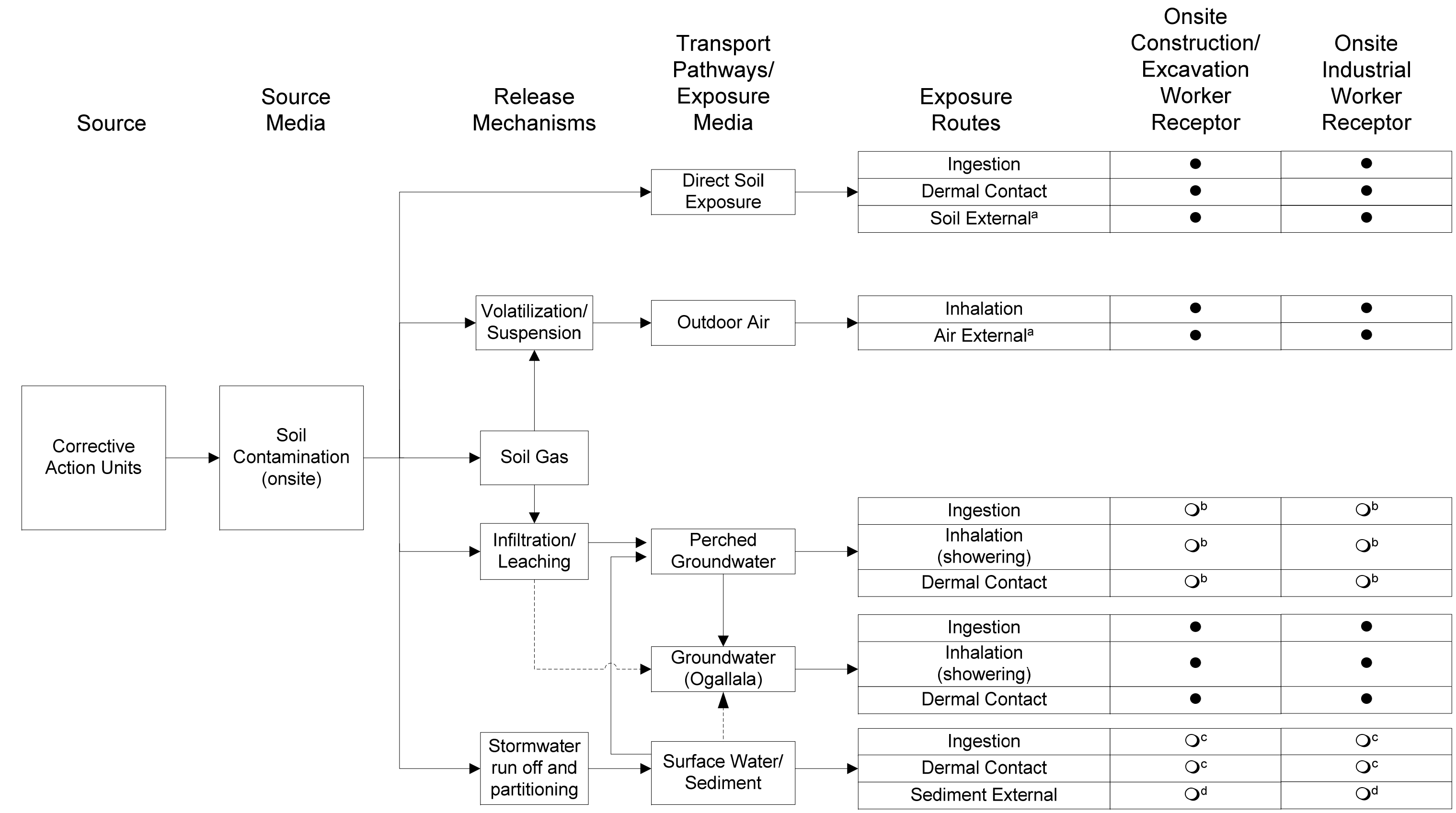
The following pathways were considered insignificant and were not evaluated in the HHRA:

- Airborne transport of COPCs in soil from the Pantex Plant to TTU property is considered insignificant because the prevailing wind direction is to the north, away from the TTU property.
- Because the Ogallala groundwater yield is too low in other areas of the Plant to support operational needs, the production well area, identified in Figure 2-14 as containing the *Pantex Plant Supply* wells, is the only area where groundwater from the Ogallala Aquifer is being pumped.
- Because perched groundwater is controlled onsite, onsite exposure to perched groundwater was not evaluated as a completed pathway. However, calculated risks for the offsite farmer at the fence line indicated that onsite exposure would be unacceptable, if the perched groundwater were used without treatment. Maximum concentrations were used in assessing risk at the fence line and would also represent a conservative risk estimate for a hypothetical onsite risk, if the perched groundwater was used.

Offsite surface water was not considered in the HHRA. Surface water runoff from units evaluated in the Baseline HHRA does not drain offsite, and perched groundwater does not discharge to surface water. Thus, the only mechanism to impact offsite surface water and sediment from the Pantex Plant is through deposition of airborne COPCs. Since the nearest permanent surface water features offsite are the Canadian River and Lake Meredith, located approximately 17 miles north of the Pantex Plant, the potential for air deposition to offsite surface water bodies is insignificant.

Exposure Assumptions

The HHRA quantitatively evaluated risks to onsite and offsite human receptor populations that were reasonably anticipated to be exposed to both chemical and radiological COPCs via the complete pathways presented in the conceptual site models in the HHRA reports. Both current and potential future land use scenarios were evaluated.



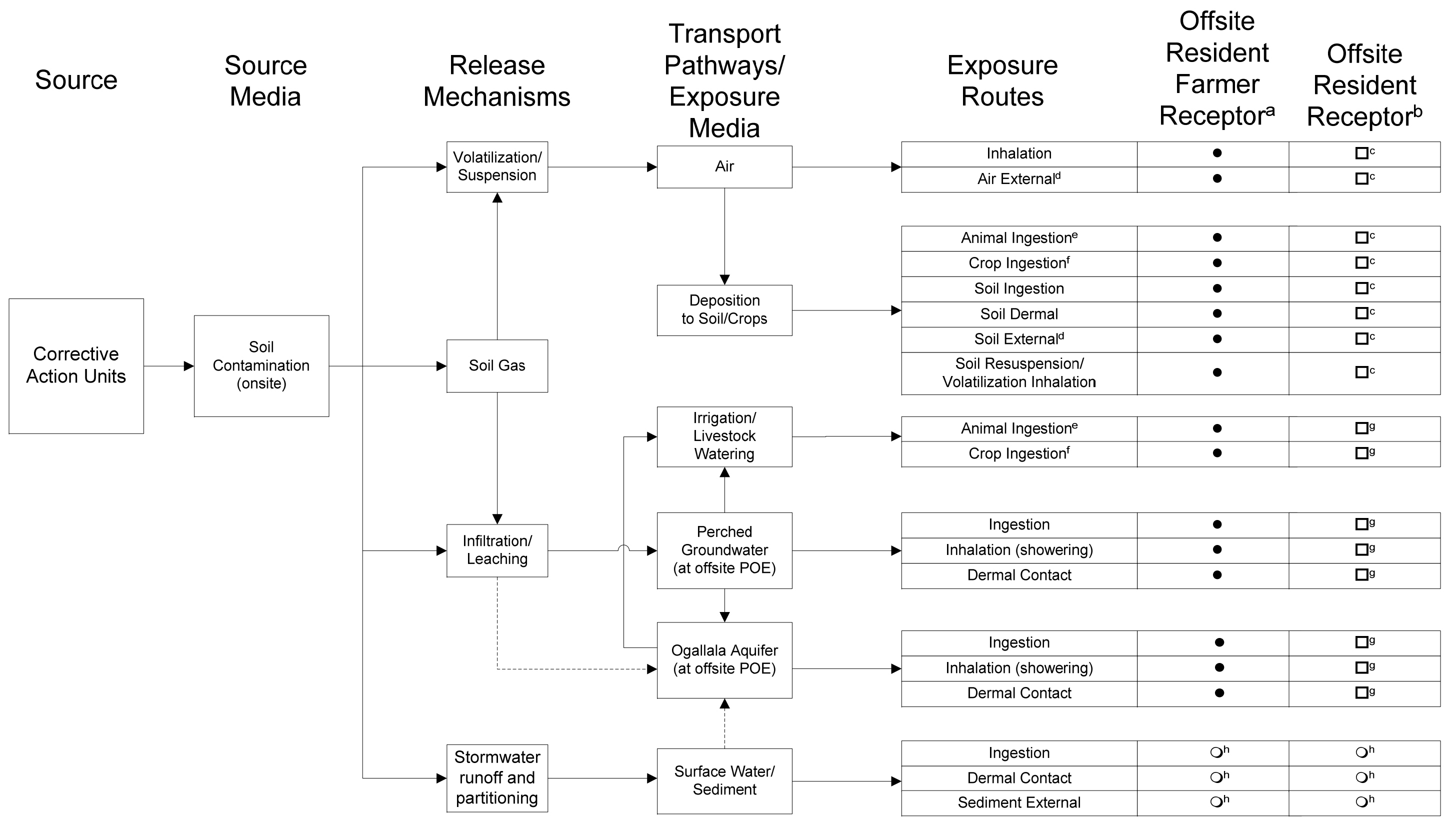
[a] External exposure routes refer to radiation exposures from radionuclides in soil particulates. This does not apply to volatilization which is an insignificant pathway for radionuclides.
[b] The perched groundwater does not discharge to the surface, is not a source of drinking water for Pantex Plant, nor is it used for any Pantex Plant operation. Perched groundwater is too deep for a construction worker to contact during excavation.
[c] Surface water in ditches and playas at Pantex Plant either evaporates or percolates to groundwater and is not used for drinking water or recreation.
[d] Playas are not used for worker activities or recreation and surface water/sediment meet RRS 2 closure criteria.

● Potentially complete exposure pathway at Pantex Plant. Complete pathways for each site are identified in site-specific CSMs discussions in Appendices A through G and I.
❍ Incomplete exposure pathway.

——▶ Potential movement of contaminants from source to receptor.

- - -▶ Transport pathway only potentially complete where perched groundwater is not present.

Figure 2-15. CSM for Onsite Worker Exposure Scenarios at the Pantex Plant (Current and Future)
(BWXT Pantex/SAIC, December 2006)



[a] The offsite resident farmer is conservatively modeled as an age-adjusted (adult/child) receptor to evaluate cancer health effects. Separate adult and child receptors are used to evaluate noncarcinogenic health effects. The offsite resident farmer is evaluated for exposure to soil and air anywhere offsite and exposure to groundwater north and east of the Plant boundary.
[b] Offsite resident is evaluated qualitatively for exposure to groundwater on TTU owned property south of the Plant boundary.
[c] Wind direction is predominantly to the north away from TTU property.
[d] External exposure routes refer to radiation exposures from radionuclides in soil particulates. This does not apply to volatilization which is an insignificant pathway for radionuclides.
[e] Animal ingestion includes consumption of animal meat products (beef, poultry, sheep, swine) and milk.
[f] Crop ingestion includes consumption of below-ground and above-ground vegetables.
[g] USDOE/NNSA is currently pursuing control measures on TTU property south of Pantex Plant.
[h] Surface water for the Baseline HHRA units at Pantex Plant does not discharge offsite and meets RRS 2 closure criteria at the playas.
● Potentially complete pathway at Pantex Plant. Complete pathways for each site are identified in site specific CSMs in Appendices A through G and I.
☐ Potentially complete but insignificant
❍ Incomplete pathway
——▶ Potential movement of contaminants from source to receptor
------▶ Transport pathway only potentially complete where perched aquifer is not present.
POE Point of Exposure

Figure 2-16. CSM for Offsite Exposure Scenarios at the Pantex Plant (Current and Future)
(BWXT Pantex/SAIC, December 2006)

Intake equations and exposure assumptions for all potentially complete pathways identified in the conceptual site models are presented in Appendix C of the *Revised Final BRA Work Plan* (BWXT Pantex/SAIC, 2003). Exposure assumptions for each of the three receptor types (onsite industrial worker, onsite construction/excavation worker, and offsite resident farmer) evaluated quantitatively are summarized briefly below.

All exposure assumptions were from the approved *Revised Final BRA Work Plan* (BWXT Pantex/SAIC, 2003). Exposure assumptions were developed through consideration of the EPA Risk Assessment Guidance, the Texas Risk Reduction Rule (Title 30 of the Texas Administrative. Code, Chapter 335, Subchapter S), and comments received from TCEQ and EPA on the *Revised Final BRA Work Plan*. This approach is consistent with EPA Risk Assessment Guidance.

Industrial Worker

The industrial worker is an individual who works outdoors while onsite; therefore, direct contact exposures (i.e., ingestion, dermal contact, and inhalation of volatiles and particulates) to surface soil (0 to 2 ft bgs) were evaluated for this receptor. Default occupational exposure factors (consistent with EPA guidance and State regulations presented in 30 TAC §335) were used to evaluate exposure to this receptor, as required. An occupational exposure period of 25 years with an exposure time of 8 hours per day and an exposure frequency of 250 days per year was used for all industrial worker pathways. This scenario is conservative because the Pantex Plant does not have outdoor workers that work full-time in one outdoor location on a daily basis, as assumed in this default scenario.

The potential exists for the industrial worker to be exposed to impacted groundwater in the future; however, this pathway was quantitatively evaluated only if the results of fate and transport modeling indicate COPCs migrate to the Ogallala Aquifer and reach onsite points of exposure (i.e., onsite Plant production wells) during the next 1,000 years. The current and future pathways considered for this worker include:

- Soil ingestion, skin contact, and external radiation (current and future)
- Air inhalation of vapors/dust and external radiation (current and future)
- Ogallala groundwater ingestion and inhalation while showering (future)

Construction/Excavation Worker

The construction/excavation worker is a site employee or subcontractor who is exposed to impacted soil (0 to 15 ft bgs) while doing construction/excavation work for one 12-week period in a year with an exposure frequency of 5 days per week. The worker is exposed 8 hours per day during each 5-day workweek (BWXT Pantex/SAIC, 2003). The potential exists for the construction/excavation worker to be exposed to impacted groundwater in the future; however, this pathway was quantitatively evaluated only if the results of fate and transport modeling indicated the potential for COPCs to migrate to the Ogallala Aquifer and reach onsite points of exposure (i.e., onsite Plant production wells) during the next 1,000 years. The current and future pathways considered for this worker include:

- Soil ingestion, skin contact, and external radiation (current and future)
- Air inhalation of vapors/dust and external radiation (current and future)
- Ogallala groundwater ingestion and inhalation while showering (future)

Offsite Resident Farmer

The offsite resident farmer is an individual living on a family farm for 40 years. Risks from carcinogenic chemicals were age-adjusted for an individual who is a child for 6 years and an adult for 34 years. For noncarcinogenic chemicals, the farmer was evaluated separately for an adult (34 years) and child (6 years). This separation of the child and adult was because a child may be a more sensitive receptor for exposure to toxicants. For all age groups, an individual was assumed to reside on the farm 350 days each year. The potential exists for the offsite resident farmer to be exposed to impacted groundwater in the future. This pathway was quantitatively evaluated for both the perched groundwater using current measured and future modeled exposure point concentrations (EPCs), and the Ogallala Aquifer using future modeled EPCs. The potential exists for the offsite resident farmer to be exposed to COPCs in air and soil as a result of atmospheric transport. This pathway was evaluated through fate and transport modeling at the Burning Ground, and was qualitatively evaluated, using the Burning Ground modeling results. The offsite resident farmer was assumed to ingest agricultural products impacted by uptake of COPCs from soil and/or groundwater (through irrigation). The following agricultural products were evaluated in the Baseline HHRA. Exposure factors were based on evaluation of surrounding land use and default parameters presented in EPA and State guidance.

- Root vegetables (belowground edible crops, such as potatoes, carrots, and onions)
- Other vegetables (aboveground vegetables, and leafy vegetables)
- Meat (beef, swine, lamb, and poultry)
- Milk (cow milk).

The current and future pathways considered for the farmer include:

- Perched groundwater ingestion, inhalation while showering, and ingestion of crops/animals that may be exposed to perched groundwater (current and future)
- Air inhalation of vapors/dust and external radiation due to resuspension of soils from the Pantex Plant and atmospheric dispersion to offsite locations (future)
- Soil ingestion of crops/animals, skin contact, external radiation, and farmer ingestion of crops/animals that feed from soils. The soils would be impacted due to resuspension of soils from the Pantex Plant and atmospheric dispersion to offsite locations (future).

Exposure Areas

Because some release units or release unit groupings to be evaluated in the HHRA covered large areas, USDOE/NNSA evaluated exposure to onsite workers according to a 6-acre or 12-acre grid, depending on whether the area was actively used. The grids were not established for active operational and inactive units of areas smaller than 6 or 12 acres, respectively; nor were they established for ditches and playas. Ditches were evaluated as one exposure unit (considering the most likely industrial use was grading of the ditches to maintain effective drainage away from operational areas), and playas are not used operationally because they collect storm water runoff. So, exposure was considered as random across each ditch or playa. Results of the risk assessment were presented according to the exposure grids created, or for the entire unit, as applicable.

Offsite exposure to perched groundwater was evaluated along the Pantex Plant fenceline (i.e., FM 2373 along the east edge of the site). Future risk from exposure to potentially future contaminated Ogallala groundwater that could be used for personal consumption or agricultural reasons was evaluated at all offsite locations to determine the area of potential impact.

COPC Concentrations and Calculation of the Exposure Point Concentration

For each unit, the final list of COPCs to be quantitatively evaluated was grouped according to exposure area, by well, or by source area, as appropriate. The data were then used to estimate the chemical concentration a receptor is likely to contact over the duration of exposure for the current scenario. Future exposure point concentrations (EPCs) were estimated using fate and transport models.

For soils, EPCs were calculated for two depth intervals (0 to 2 ft and 0 to15 ft) selected to conform to the anticipated exposure scenarios. EPCs estimated for the onsite workers represented both current and future scenarios based on the assumption that current EPCs calculated for both depth intervals represent worst case exposures as concentrations are not expected to increase in the future.

The current soil EPCs were calculated using statistical methods. The EPCs for each soil COPC in the 0 to 2 ft and 0 to 15 ft depth intervals represent the lesser of the 95% Upper Confidence Limit (UCL) or the maximum detected concentration for all sample locations within each exposure area. The 95% UCL provides an upper estimate of the mean concentration and ensures risk estimates are protective of the receptors considered. The 95% UCL was calculated using the following steps:

1. **Non-detects:** One-half the detection limit was used as a proxy value for all samples with no detected concentration.

2. **Distribution analysis:** The Shapiro-Wilkes test was used to determine if the data distribution of the reported concentrations, including non-detects, was normal, lognormal, or neither.

3. **95% UCL calculation methods:** The 95% UCL was calculated as described below using either the Student's *t*-statistic or the Land Method, as applicable, based on the underlying distribution of the data. The Student's *t*-statistic was used for normally distributed data, and Land's Method was used for lognormal distributions. For data that were neither normally nor lognormally distributed or when the dataset contained more than 50% non-detects, the 95% UCL was calculated using the Student's *t*-statistic. Consistent with EPA recommendation, EPCs were not calculated for datasets with fewer than 10 samples. If a dataset had less than 10 observations (n<10), the maximum detected concentration was used as the EPC.

Soil EPCs for the units that were evaluated in the FS are presented in Appendices B through I. The summary tables also present the range of detected concentrations and the frequency of detection for each COPC. These soil EPCs were used as the starting point for the offsite air pathway and for the onsite industrial and construction/excavation worker.

For groundwater COPCs, the EPC was based on either the most recent concentration or the 95% UCL. Trending was performed to determine the most appropriate method to apply for the EPC. For trends determined to be statistically significant using the Mann-Kendall test for a given COPC/well, the most recently measured concentration was designated the EPC for determining current offsite risks. When no significant trend existed, the EPC was calculated as the 95% UCL of data acquired from 1999 to 2004 for each COPC at each well location. The 95% UCL was calculated consistent with the methods for soils.

Future onsite and offsite groundwater concentrations were calculated based on fate and transport modeling. Numerical modeling was used to simulate the transport of COPCs via subsurface pathways for future onsite and offsite exposures. The modeling determined if complete exposure pathways existed for groundwater at onsite and offsite receptor locations under future scenarios. Subsurface fate and transport models were used to assess subsurface migration of COPCs in soil, soil gas, and perched groundwater to the Ogallala Aquifer. Table 2-3 provides a summary of the modeling completed to quantify future impacts.

Table 2-3. Summary of Fate and Transport Analysis Performed to Evaluate Exposure Pathways and Quantify Future EPCs

Transport Mechanism of Interest	General Purpose	Modeling Software Package	Brief Discussion	COPCs Evaluated
Soil → groundwater	Assessment of migration of COPCs through the soil column to perched groundwater	BIOF&T3D	Particle tracking analysis to determine travel times through the vadose zone to perched groundwater and Ogallala Aquifer	All COPCs requiring further evaluation in the soil-to-groundwater pathway.
Soil gas → groundwater	Assessment of soil gas transport and potential impacts to groundwater	BIOF&T3D	Soil gas migration to perched groundwater and potential for migration to Ogallala groundwater in areas where perched groundwater was not present	All soil gas COPCs that exceed their respected screening levels ($ASGL_{GW}$) for groundwater.
Perched groundwater → perched groundwater at Pantex Plant	Assessment of migration of observed COPCs from perched groundwater to perched groundwater exposure points offsite.	BIOF&T3D	Particle tracking analysis to determine travel times to exposure points in the perched groundwater and transport simulations to determine EPCs	COPCs in perched groundwater requiring further evaluation in the groundwater-to-groundwater pathway.
Perched groundwater → Perched groundwater at Pantex Lake	Assessment of migration of observed COPCs from perched groundwater to perched groundwater exposure points offsite.	None	Future perched groundwater EPCs were assumed equal to current concentrations.	COPCs in perched groundwater requiring further evaluation in the groundwater-to-groundwater pathway.
Perched groundwater → Ogallala Aquifer at Pantex Plant	Assessment of migration of observed COPCs from perched groundwater through the FGZ and lower Ogallala unsaturated zone to the Ogallala Aquifer for the development of future EPCs.	BIOF&T3D	Quantitative evaluation in the focused transport model (FTM)	10 of 14 COPCs in the perched groundwater requiring further evaluation in the groundwater-to-groundwater pathway were modeled. The remaining 4 COPCs were estimated from the results of the 10 modeled.
Perched groundwater → Ogallala Aquifer at Pantex Lake and Burning Ground	Assessment of migration of observed COPCs from perched groundwater through the FGZ and lower Ogallala unsaturated zone to the Ogallala Aquifer for the development of future EPCs.	None	Dilution Attenuation Factors (DAFs) were used to estimate Ogallala Aquifer concentrations from current perched groundwater concentrations.	All COPCs in the perched groundwater requiring further evaluation in the groundwater-to-groundwater pathway
Soil → Offsite Air	Assessment of windblown soil particles to offsite locations along the closest downgradient Pantex fenceline	ISC3	Quantitative evaluation of offsite air concentrations in the plume model applied for the Burning Grounds. The ratio of deposition rates to the calculated Burning Ground risks were used to estimate risks for all other release units/areas.	All soil COPCs that were quantitatively evaluated for the industrial and construction/excavation worker.

2.7.1.3 Toxicity Assessment Results

The purpose of the toxicity assessment is to evaluate the potential for COPCs to cause adverse health effects in exposed individuals. Where possible, it provides an estimate of the relationship between the intake or dose of a COPC and the likelihood or severity of adverse health effects as a result of that exposure.

Toxicity data typically were obtained from critical reviews and interpretation of data from the scientific literature (e.g., epidemiologic, clinical, or experimental animal studies). For each COPC, evidence is first sought to determine if exposure to the chemical can cause an adverse health effect. Chemicals and radionuclides are classified as carcinogenic or noncarcinogenic based on the type of adverse effect they may cause. EPA (1989b) assigns carcinogens into one of five groups based on the evidence of causing cancer (weight-of-evidence classification): (A) Known human carcinogen, (B) Probable human carcinogen, (C) Possible human carcinogen, (D) Not classifiable as a human carcinogen, and (E) Evidence of noncarcinogenicity for humans. Chemicals exhibiting both carcinogenic and noncarcinogenic effects were evaluated as both a carcinogen and a noncarcinogen.

For carcinogens, risks were estimated as the probability that an individual will develop cancer over a lifetime as a result of exposure to the carcinogen. Cancer risk from exposure to COPCs was expressed as excess or incremental cancer risk, which is cancer occurrence in addition to normally expected rates of cancer development. Excess cancer risk was estimated using cancer slope factors (SF) and inhalation unit risk factors (URF_i). For chemicals, the SF (in units of risk per mg/kg-day) and URF_i (in units of risk per $\mu g/m^3$) are defined as a plausible upper-bound estimate of the probability of a response (i.e., cancer) per unit intake of a chemical over a lifetime (EPA, 1989). For radionuclides, ingestion and inhalation SFs are central estimates from a linear model of the age-averaged lifetime radiation cancer incidence risk per unit of activity inhaled or ingested, and are expressed in units of risk/pCi. For external exposure to radionuclides in soil and air, SFs are central estimates of lifetime radiation cancer risk for each year of exposure to external radiation from photon-emitting radionuclides in soil or air. These SFs are expressed as risk per yr-pCi/g soil or risk per hr-pCi/m^3 air.

Noncarcinogenic effects were evaluated by comparing an exposure or intake/dose with a reference dose (RfD) in units of mg/kg-day or reference concentration (RfC) in units of mg/m^3. The RfD/RfC is an estimate (with uncertainty spanning perhaps an order of magnitude or greater) of a daily exposure level for the human population, including sensitive subpopulations, that is likely to be without an appreciable risk of deleterious effects during a lifetime. The RfDs and RfCs are determined using available dose-response data for individual chemicals. Scientists determine the exposure concentration or intake/dose below which no adverse effects are seen (generally a no-observed-adverse-effect level [NOAEL] or lowest-observed-adverse-effect level [LOAEL] from animal tests, or benchmark values) and apply an uncertainty factor (from 10 to 1,000) reflecting limitations of the data used, to determine the RfD or RfC. RfDs and RfCs are identified by scientific committees supported by EPA. Toxic effects are diverse and measured in various target body organs (e.g., they may range from eye irritation to kidney or liver damage).

Since the primary receptors identified for the Baseline HHRA were generally projected to have long exposure durations, and no subchronic or acute toxicity values were available from TCEQ, chronic RfDs were used because they describe the maximum daily exposure level (e.g., intake) that will not cause an adverse effect over a lifetime exposure period. Both the oral RfD and inhalation RfC were compiled for use depending on the exposure routes evaluated.

Carcinogenic and noncarcinogenic toxicity values for oral exposures (RfD_o and oral SFs) were adjusted to estimate potential risk for the dermal exposure route. The oral toxicity values were adjusted using the gastrointestinal (GI) absorption factors provided by TCEQ. Dermal absorption fractions were provided in TCEQ guidance.

For radionuclides, the TCEQ published values were supplemented with values from the EPA Health Effects Assessment Summary Tables (HEAST) (EPA, 2001) and Federal Guidance Report (FGR) 13 (for external exposure to radionuclides in air only) (EPA, 1999). The TCEQ toxicity values were obtained from the following references listed in a general hierarchy of sources:

1. Integrated Risk Information System
2. HEAST
3. National Center for Environmental Assessment
4. TCEQ Chronic Effects Screening Levels
5. Agency for Toxic Substances Disease Registry Minimal Risk Levels
6. Other documentation as approved by the TCEQ executive director.

A complete listing of toxicity values used in the Baseline HHRA is provided in Appendix I. Radionuclides listed with the suffix "+D" indicate that cancer risk estimates using these SFs include contributions to toxicity from short-lived decay products.

The effect of simultaneous exposure to multiple noncarcinogenic chemicals was addressed by summing the HQs for individual chemicals. This method may overestimate the magnitude of the adverse effect because it adds chemicals that may impact different target organs or produce differing health effects.

Therefore, when the HI exceeded 1.0, the chemicals contributing to the HI were evaluated to determine whether their summation was appropriate based on target organ effects. The description of those effects was included as an appendix to each HHRA report, when necessary.

Several classes of chemicals (dioxins/furans, polycyclic aromatic hydrocarbons [PAHs], and lead) were evaluated slightly differently from other COPCs. The methods for evaluation are included below.

To assess risks posed by exposure to mixtures of PCDDs and PCDFs in the environment, TCEQ and EPA have adopted an interim procedure, based on dioxin toxic equivalency factors (TEFs). The TEF procedure compares the potential toxicity of each dioxin-like compound in an environmental mixture to the well-studied and understood toxicity of 2,3,7,8-tetrachlorodibenzo-p-dioxin (2,3,7,8-TCDD). The procedure involves assigning individual TEFs to the 2,3,7,8-substituted PCDD/PCDF congeners. To apply the TEF concept, the concentration of each congener/homologue class present in a mixture was multiplied by the TEF. The products were then summed to yield a 2,3,7,8-TCDD toxic equivalent (TEQ) for each sample location. Because all TEQs for all samples at the Pantex Plant were less than acceptable criteria (TCEQ protective concentration limit of 5 ppb) and were not carried forward for evaluation of remedial alternatives, the results are not presented in this summary.

Lead was evaluated by comparing its EPC to a remedial goal that considers the acceptable blood lead level of a fetus that may be exposed via the occupationally exposed mother to lead at the site. The approach used to assess risk due to lead exposure relates intake of lead from soil to blood lead concentrations in residential children and to women of childbearing age who may be exposed to lead in soil while working at the site. Protection of a hypothetical fetus of an occupationally exposed mother ensures other workers at the site will be adequately protected. Recommendations of EPA's Technical Review Workgroup (TRW) for lead were used to assess risk associated with adult worker exposures to lead in soil (EPA, 1996). From this method, an acceptable concentration of lead in soil is calculated and expressed as a remedial goal option (RGO). Onsite soil EPCs were screened against the RGO (1,600 mg/kg) to determine if lead values exceed acceptable criteria.

Potential cancer risks associated with the seven PAHs considered to be potentially carcinogenic (benzo(a)pyrene, benzo(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, dibenz(a,h)anthracene, and indeno(1,2,3-cd)pyrene) were also evaluated using a toxicity equivalency approach. Adequate toxicity data is available to determine an SF only for benzo(a)pyrene. A relative potency factor (RPF) is assigned to each of the other six carcinogenic PAHs as compared to benzo(a)pyrene. Using this method, SFs are calculated by multiplying the benzo(a)pyrene SF by the appropriate RPF. RPFs, available from EPA (1993), were used to calculate the SFs provided by TCEQ. This method was applied to both oral and inhalation exposure pathways. The TCEQ SFs were used to calculate risk, as discussed in the risk characterization section.

2.7.1.4 Risk Characterization

The risk characterization brings together exposure and toxicity information to calculate a risk for workers or Plant neighbors (offsite resident farmer). Risks are determined differently for contaminants that cause cancer than for those that cause other kinds of health effects (e.g., asthma, nervous system effects, etc.).

For contaminants that may cause cancer, risks are generally expressed as the incremental probability of an individual developing cancer over a lifetime as a result of exposure to the carcinogen. Excess lifetime cancer risk is calculated from the following general equation:

$$\text{Risk} = \text{CDI} \times \text{SF}$$

Where:	Risk	=	A unitless probability of an individual developing cancer
	CDI	=	Chronic daily intake averaged over 70 years (mg/kg-day)
	SF	=	Slope factor, expressed as $(\text{mg/kg-day})^{-1}$

These risks are probabilities that usually are expressed in scientific notation (e.g., 1×10^{-6}). An excess lifetime cancer risk of 1×10^{-6} indicates that an individual that may be exposed to the contamination at the levels estimated has a 1 in 1,000,000 chance of developing cancer as a result of site-related exposure. This is referred to as an "excess lifetime cancer risk" because it would be in addition to the risks of cancer an individual faces from other causes such as exposure to too much sun. The chance of an individual developing cancer from all other causes has been estimated to be as high as 1 in 3. Although EPA generally considers 1×10^{-6} risk as the point of departure, risk management decisions recognize an acceptable risk range for site-related exposure at 1×10^{-4} to 1×10^{-6}. Similarly, TCEQ generally accepts that risk range for multiple chemicals, but considers 1×10^{-6} as the point of departure for single chemicals.

The potential for noncarcinogenic effects is evaluated by comparing an exposure level over a specific time period (e.g., 25 years or 40 years) with a reference dose (RfD) for ingestion exposure or reference concentration (RfC) for inhalation exposure. The result is termed as a hazard quotient (HQ). The equation for the HQ follows:

$$\text{HQ} = \text{CDI/RfD or RfC}$$

Where:	HQ	=	Hazard quotient
	CDI	=	Chronic daily intake averaged over exposure period (mg/kg-day) or mg/m^3-day
	RfD	=	Reference dose (mg/kg-day)
	RfC	=	Reference concentration (mg/m^3-day)

For oral and dermal exposures, the HQ was calculated as the ratio of the chronic intake to the RfD as shown. Dermal exposures were treated as equivalent to ingestion exposures. Dermal absorption fractions were provided in TCEQ guidance.

The RfD/RfC is the threshold level below which no toxic effects are expected to occur in a population, including sensitive subpopulations. Therefore, an HQ less than 1 indicates that a receptor's dose of a single contaminant is less than the reference dose or concentration and that toxic non-carcinogenic effects from that contaminant are unlikely.

The hazard index (HI) was generated by adding the HQs for all COPCs. This method may overestimate the magnitude of the adverse effect because it adds chemicals that may impact different target organs or produce differing health effects. Therefore, when the HI exceeded 1.0, the chemicals contributing to the HI were evaluated to determine whether their summation was appropriate based on target organ effects. An HI less than 1 indicates that a receptor's dose of a single contaminant is less than the reference dose or concentration and that toxic non-carcinogenic effects from that contaminant are unlikely. An HQ or HI greater than 1 indicates that site-related exposures may present a risk to human health, if a person would be exposed as assumed in the onsite and offsite scenarios.

For the Pantex HHRA, after considering uncertainty, any COPC with an ILCR greater than $1x10^{-6}$ or with an HQ greater than 1 was considered as a COC to be carried forward for remedial action in the FS and Proposed Plan.

The detailed tables presenting the risk for each receptor are included in Appendices B through I. These appendices provide the results by Zone (Zone 10, 11, 12), Burning Ground, Miscellaneous Landfills, and Firing Site 5. Groundwater results are presented separately as Appendix H. More detailed risk equations and toxicity criteria used to evaluate risk is included in Appendix J.

2.7.1.5 Risk Characterization Summary for Soils

Conclusions of the Human Health Risk Assessment (HHRA) recommended the following response actions for soils units:

- **Limited Action (Institutional Controls/Groundwater Monitoring) Units:** 90 units exhibited cumulative risks that did not exceed the ILCR of 1E-06 or the HI of 1 and are protective of human health and the environment based on the non-residential assumptions implemented, such as a typical exposure area of six acres. These units were included in the quantitative risk assessment because of their potential to impact groundwater in the future; however, the risk assessment concluded that these 90 units do not pose a future risk for the intended industrial land use. Institutional controls with long-term groundwater monitoring will be implemented for these units as limited further actions to restrict land use and maintain exposure controls, and to monitor for future impacts to groundwater. Institutional controls and ground water monitoring is also required for closure of these units under the Texas Solid Waste Disposal Act.

- **Units Requiring Remedial Action:** 45 units were found to require remedial action to control or reduce risks to onsite and/or offsite receptors. Not all of these units posed a direct contact risk. Included in these 45 units are 26 Pantex Plant landfills; the landfills were evaluated in the HHRA and included for further remedial action. The 26 landfills are shown on Figure 2-17. The 19 remaining soil sites are depicted in Figures 2-18 through 2-21.

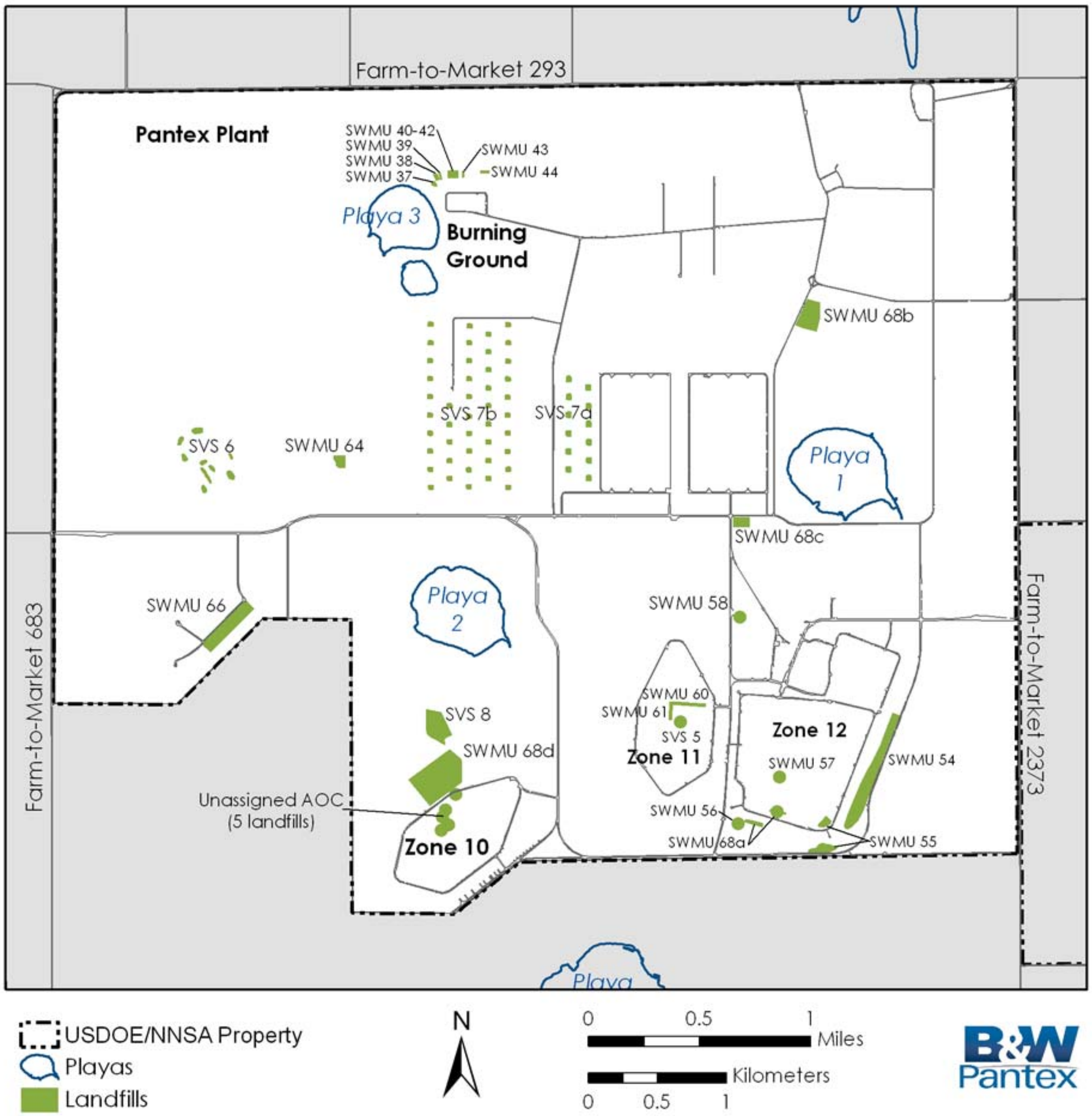


Figure 2-17. Pantex Plant Landfills

Figure 2-18. Burning Ground Former Ash Disposal Trench and SWMUs 25, 26, & 27

Figure 2-19. Burning Ground SWMU 47, Solvent Evaporation Pit

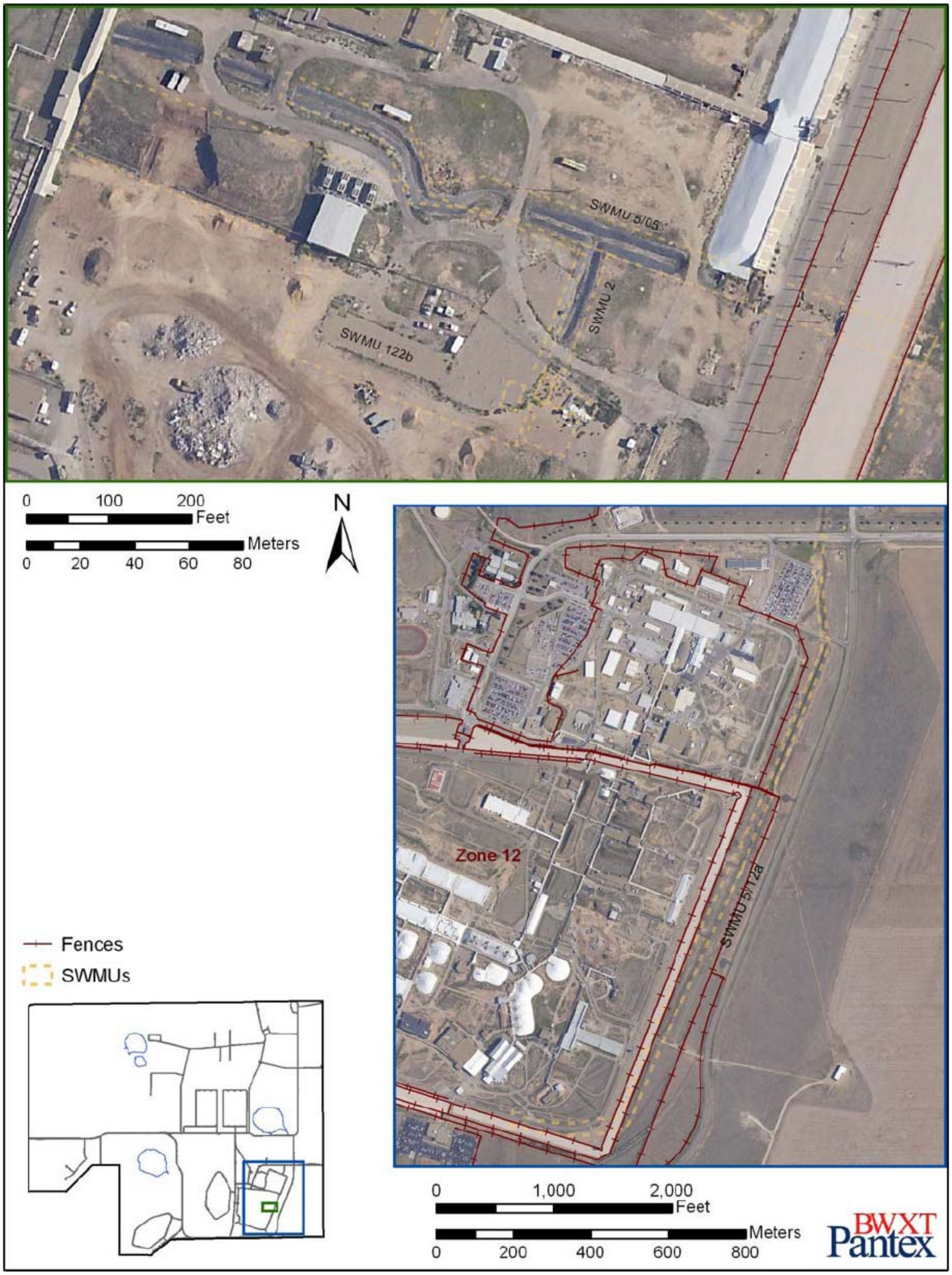


Figure 2-20. Zone 12 SWMU 2, 5/05, and 5/12a Ditches

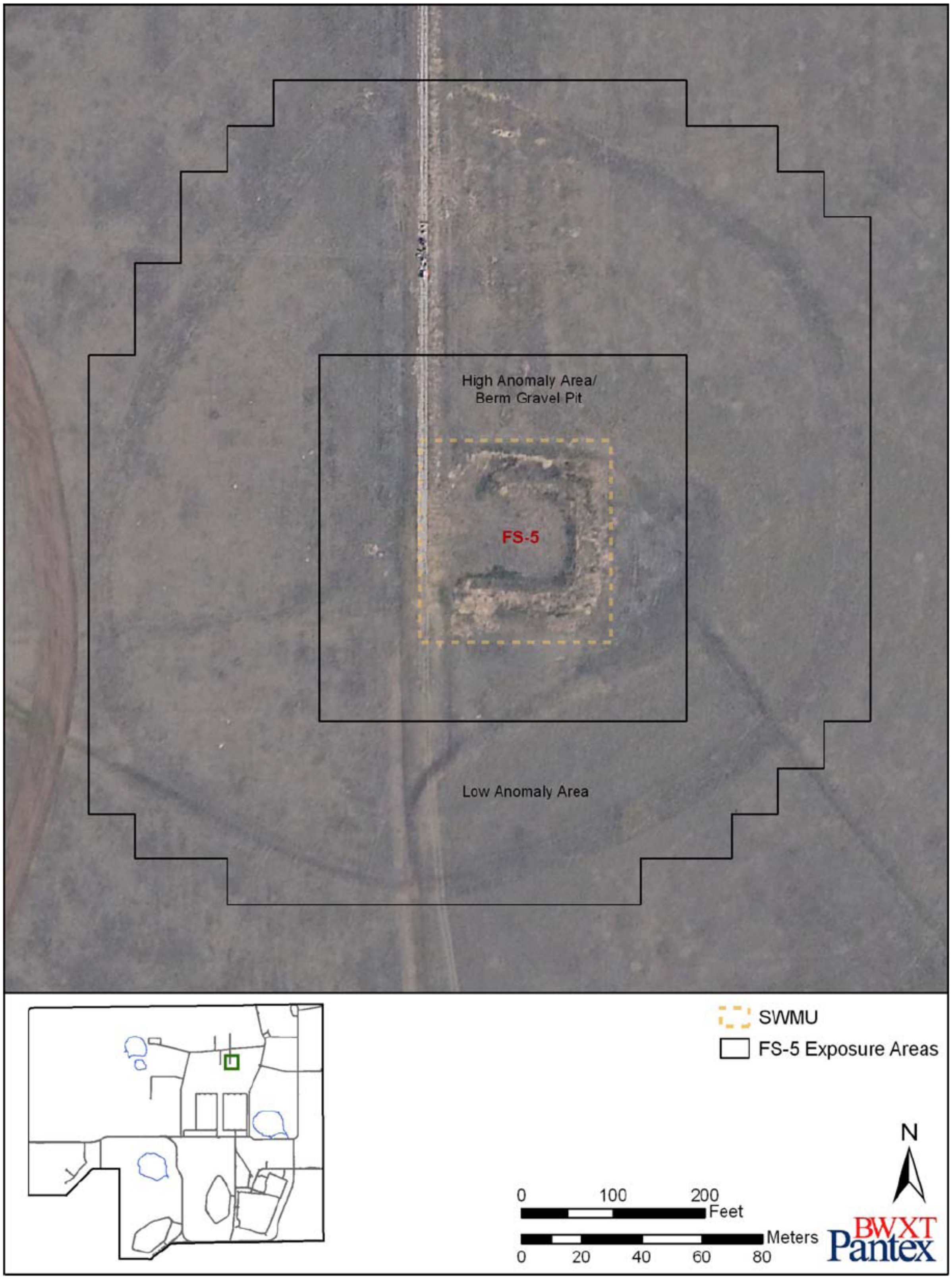


Figure 2-21. Firing Site 5

2.7.1.5.1 Soil Sites with Direct Contact Risk and Potential to Impact Perched Groundwater

Tables 2-4 and 2-5 contain a summary of the direct contact risk (above the ILCR of 1E-06 or the HI of 1) posed by the 45 soil units requiring remedial action to control or reduce risks to onsite and/or offsite receptors. These tables also identify those units with the potential to impact perched groundwater.

Table 2-4. Direct Contact Risks for Landfills (26 Soil Units)

	Solid Waste Management Unit (SWMU)/Area	Direct Contact Risk (ILCR>1E-06 or HI>1) to Industrial Workers	Direct Contact Risk (ILCR>1E-06 or HI>1) to Construction/ Excavation Workers	Constituents of Concern	Current Impact to Perched Groundwater Above Background/PQL
Zone 10	SVS 8: Abandoned Zone 10 Landfill: Construction Debris Landfill	**ILCR** 6.0E-06	**ILCR** 3.2E-05	BZAA, BZAP, BZBF, DBAHA, INP123	None
	ZONE 10 Building Construction Debris Landfills (5)	None	None	None	None
	SWMU 68d: Active Sanitary Landfill	None	None	None	None
Zone 11	SVS 5: Landfill East of 11-13 Pad: Construction Debris from Buildings 11-12,11-13	None	None	None	None
	SWMU 60: Landfill 9 (Group III): Building Demolition Debris Landfill	None	None	None	None
	SWMU 61: Landfill 10 (Group III): Building Demolition Debris Landfill	None	None	None	None
Zone 12	SWMU 54: Landfill 3	None	None	None	None
	SWMU 55: Landfill 4	None	**HI** 3.7	Antimony[1]	None
	SWMU 56: Landfill 5 (Group III): Building Construction Debris Landfill	None	None	None	None
	SWMU 57: Landfill 6 (Group III) Building Construction Debris Landfill	**ILCR** 4.40E-06 **HI** 0.015	None	BZAP	None
	SWMU 68a North: Original General Purpose Sanitary Landfill	None	None	None	None

[1] Single high detect of antimony could be false positive due to spectral interference by calcium

Table 2-4. Direct Contact Risks for Landfills (26 Soil Units)

	Solid Waste Management Unit (SWMU)/Area	Direct Contact Risk (ILCR>1E-06 or HI>1) to Industrial Workers	Direct Contact Risk (ILCR>1E-06 or HI>1) to Construction/ Excavation Workers	Constituents of Concern	Current Impact to Perched Groundwater Above Background/PQL
Burning Grounds	SWMU 37: Burning Grounds Landfill 1	**ILCR** 1.6E-05 **HI** 2.2	**HI** 2.8	RDX, TNT, ^{238}U	None
Burning Grounds	SWMU 38: Burning Grounds Landfill 2	**ILCR** 1.6E-05 **HI** 2.2	**HI** 2.8	RDX, TNT, ^{238}U	None
Burning Grounds	SWMU 39: Burning Grounds Landfill 3	None	**HI** 2.1	TNT, dioxins	None
Burning Grounds	SWMU 40: Burning Grounds Landfill 4	**ILCR** 1.6E-05 **HI** 2.2	**HI** 2.8	RDX, TNT, ^{238}U	None
Burning Grounds	SWMU 41: Burning Grounds Landfill 5	**ILCR** 1.6E-05 **HI** 2.2	**HI** 2.8	RDX, TNT, ^{238}U	None
Burning Grounds	SWMU 42: Burning Grounds Landfill 6	**ILCR** 1.6E-05 **HI** 2.2	**HI** 2.8	RDX, TNT, ^{238}U	None
Burning Grounds	SWMU 43: Burning Grounds Landfill 7	None	**HI** 2.1	TNT, dioxins	None
Burning Grounds	SWMU 44: Burning Grounds Landfill 8	**ILCR** 1.4E-06 **HI** 0.01	None	TATB	None
Independent Sites	SWMU 58: Landfill 7 Associated with Concrete Batch Plant	None	None	None	None
Independent Sites	SWMU 64: Landfill 13	**ILCR** 3.7E-06	**ILCR** 2.7E-05	BZAA, BZAP, BZBF, DBAHA, INP123	None
Independent Sites	SWMU 66: Landfill 15 Demolition Debris Landfill	None	None	None	None
Independent Sites	SWMU 68b: General Purpose Sanitary Landfill 1	**ILCR** 1.3E-05	**HI** 2.3	BZAA, BZAP, BZBF, DBAHA, Lead	None

Table 2-4. Direct Contact Risks for Landfills (26 Soil Units)

	Solid Waste Management Unit (SWMU)/Area	Direct Contact Risk (ILCR>1E-06 or HI>1) to Industrial Workers	Direct Contact Risk (ILCR>1E-06 or HI>1) to Construction/ Excavation Workers	Constituents of Concern	Current Impact to Perched Groundwater Above Background/PQL
	SWMU 68c: General Purpose Sanitary Landfill 2	**ILCR** 1.6E-06	None	BZAP	None
	SVS 7a and 7b: Igloo Demolition Debris Landfills Zone 4 (SVS 7a) and Zone 5 (SVS 7b)	None	None	None	None
	Unnumbered Zone 7 Landfills: Demolition Debris Landfills	None	None	None	None

Abbreviation Key:
BZAA- Benzo(a)anthracene
BZAP- Benzo(a)pyrene
BZBF- Benzo(b)fluoranthene
DBAHA- Dibenz(a,h)anthracene
HMX – Cyclotetramethylene-tetranitramine
INP123- Indeno(1,2,3-c,d)pyrene
RDX - Cyclotrimethylene-trinitramine
TATB- 1,3,5-Triamino-2,4,6-trinitrobenzene
TNT – Trinitrotoluene
^{238}U- Uranium-238

Table 2-5. Direct Contact Risk for 19 Soil Units

	Solid Waste Management Unit (SWMU)/Area	Direct Contact Risk (ILCR>1E-06 or HI>1) to Industrial Workers	Direct Contact Risk (ILCR>1E-06 or HI>1) to Construction/ Excavation Workers	Constituents of Concern	Current Impact to Perched Groundwater Above Background/PQL
Zone 12	SWMU 5/05: Zone 12 Drainage Ditch	**ILCR** 7.4E-05 **HI** 2.4	**ILCR** 1.2E-06 **HI** 4.5	None	HMX, RDX, TNT, TNB135, DNT24, DNT26, DNT2A, DNT4A, NT2, B, TCE
Zone 12	SWMU 5/12a: Zone 12 Main Drainage Ditch	**ILCR** 1.2E-06	None	RDX	HMX, RDX, TNT, TNB135, DNT24, DNT26, DNT2A, DNT4A, B, TCE, DNB13, TETRYL, CN, CR, CR6, NI, SR, PCE, DCA12
Zone 12	SWMU 2: Zone 12 Drainage Ditch	**ILCR** 7.2E-06 **HI** 2	None	None	HMX, RDX, TNT, TNB135, DNT24, DNT26, DNT2A, DNT4A, NT2, B, TCE

Table 2-5. Direct Contact Risk for 19 Soil Units

	Solid Waste Management Unit (SWMU)/Area	Direct Contact Risk (ILCR>1E-06 or HI>1) to Industrial Workers	Direct Contact Risk (ILCR>1E-06 or HI>1) to Construction/ Excavation Workers	Constituents of Concern	Current Impact to Perched Groundwater Above Background/PQL
Burning Ground	SWMU 25: Burning Ground Explosive Burn Pad	**ILCR** 3.9E-06	None	^{238}U	None
	SWMU 26: Burning Ground Explosive Burn Pad	**ILCR** 5.0E-06	None	^{238}U	None
	SWMU 27: Burning Ground Explosive Burn Pad	**ILCR** 1.6E-05	None	^{238}U	None
	SWMUs 14-24: Former Ash Disposal Trench	**ILCR** 4.1E-03 **HI** 1.23	**ILCR** 1.0E-05 **HI** 90	RDX TNT	None
	SWMU 47: Burning Ground Solvent Evaporation Pit	None	None	None	TCE, FC113
Independent Sites	SWMU 70: Firing Site 5	**ILCR** 1.3E-05 (LAA)[1] 4.1E-05 (HAA)[1]	None	^{238}U ^{235}U	None

1. LAA – Low Anomaly Area; HAA – High Anomaly Area

Abbreviation Key:
B- Boron
CN- Cyanide
CR – Chromium (total)
CR6 – Hexavalent Chromium
DNT2A - 2-Amino-4,6-dinitrotoluene
DNT4A - 4-Amino-2,6-dinitrotoluene
DCA12 - 1,2-Dichloroethane
DNB13 - 1,3-Dinitrobenzene
DNT24 - 2,4-Dinitrotoluene
DNT26 - 2,6-Dinitrotoluene
FC113- Freon-113
HMX – Cyclotetramethylene-tetranitramine
NI- Nickel
NT2- 2-Nitrotoluene
PCE - Tetrachloroethene
RDX - Cyclotrimethylene-trinitramine
SR- Strontium
TCE - Trichloroethene
TNB135 - 1,3,5-Trinitrobenzene
TNT – Trinitrotoluene
TETRYL- Tetryl
^{238}U- Uranium-238
^{235}U-Uranium-235

2.7.1.6 Risk Characterization Summary for Groundwater

The results of the HHRA for groundwater were as follows:

- The impacted portion of the southeast perched groundwater beneath the Pantex Plant was created by focused recharge resulting from a high volume of treated and untreated historic wastewater discharges. These historic discharges originated primarily from Zone 12, with smaller amounts from Zone 11, to Playa 1 via ditches. The ditches conveyed both storm water and wastewater discharges away from the operational areas of the facility.

- Perched groundwater contaminants pose unacceptable risk if consumed or used for domestic purposes. The majority of the carcinogenic risk, estimated as cumulative ILCRs exceeding 1E-02 beneath the Pantex Plant and TTU property and 1E-03 at locations on the east side of the Pantex Plant, is a result of RDX and DNT24, although other high explosives and a few chlorinated solvents contribute to the cumulative risk. This risk does not diminish significantly in the near future, since RDX is the primary risk-driving contaminant and it degrades very slowly. Noncarcinogenic risk is also unacceptable for perched groundwater consumption/domestic use. RDX, hexavalent chromium and TNT are the major contributors with HQs as high as 181, 55, and 17, respectively.

- Future carcinogenic risk in the Ogallala Aquifer is estimated to exceed a cumulative ILCR of 1E-04, as a result of predicted RDX migration in the absence of remedial action. DNT24 is predicted to contribute to the cumulative carcinogenic risk, but only at levels slightly exceeding 1E-06. Future noncarcinogenic risk is associated only with RDX, as expressed by an HQ of 2.2.

- Accordingly, protection of the Ogallala Aquifer is the immediate focus of the remedial actions, since the contaminated perched groundwater is not used and restrictions on its use can be implemented effectively. Table 2-6 presents details of the associated risks.

Table 2-6. Risks from Groundwater COCs

Location	Risk Drivers[a]	COCs[b]	Potential Source	Rationale
Current Perched Groundwater[c]				
Offsite East of FM 2373	Boron (HQ = 1.5) DNT2A (1.1E-05) (HQ = 23) DNT4A (6.1E-06) (HQ = 12) DCA12 (5.7E-05) DNB13 (HQ = 1.2) DNT24 (4.4E-04)(HQ = 1.1) DNT26 (1.9E-05) RDX (6.5E-03) (HQ = 41) TNT (7.5E-05)(HQ=17)	Boron DNT2A DNT4A DCA12 DNB13 DNT24 DNT26 RDX TNT	The primary source areas for these COCs are Zone 12 (SWMU 5-12a (North and South), SWMU 5-13c, and WMG 6/7 west of SWMU 5-12a) and Playa 1.	All risk drivers are site-related COPCs from known source areas with cumulative and one individual ILCR (for RDX) exceeding the upper limit of the TCEQ and EPA acceptable target risk range (1.0E-04) and HI/HQ greater than 1.0.
Offsite South of the Pantex Plant[e]	Boron (HQ = 1.5) Total Chromium (>MCL) Hexavalent Cr (HQ=55..3) DNT2A (1.7E-05) (HQ = 33.6) DNT4A (1.2E-05) (HQ = 24.6) DCA12 (6.9E-05) DNB13 (HQ = 1.1) DNT24 (1.7E-03) (HQ = 4.1) DNT26 (1.9E-05) RDX (1.8.E-02) (HQ = 181) TNT (1.6E-04)(HQ=36) HMX (HQ=2.1) TCE (4.3E-05) Perchlorate (HQ=1.8)	Boron CR CR6 DNT2A DNT4A DCA12 DNB13 DNT24 DNT26 RDX TNT HMX TCE Perchlor-ate	The primary source areas for these COCs are Zone 12 (SWMU 5-12a (North and South), SWMU 5-13c, and WMG 6/7 west of SWMU 5-12a) and Zone 11. 1,3,5-TNB has not been found on TTU property, but has been detected in wells along the southeastern boundary of Pantex and may be present currently at TTRF.	All risk drivers are site-related COPCs from known source areas with cumulative and three individual ILCRs (for RDX, TNT, and DNT24) exceeding the upper limit of the TCEQ and EPA acceptable target risk range (1.0E-04) and HI/HQ greater than 1.0, or the concentration > MCL.
Future Perched Groundwater[d]				
Offsite East of FM 2373	Boron (HQ = 1.5) DNT2A (1.1E-05) (HQ = 23) DNT4A (6.1E-06) (HQ = 12) DCA12 (5.7E-05) DNB13 (HQ = 1.2) DNT24 (4.4E-04)(HQ = 1.1) DNT26 (1.9E-05) RDX (4.0E-03) (HQ = 41) TNT (7.5E-05) (HQ = 17)	Boron DNT2A DNT4A DCA12 DNB13 DNT24 DNT26 RDX TNT	Impacts to perched groundwater will persist in the future as pore water containing COPCs drains from the overlying partially saturated formation. Potential future impacts are expected to continue in the future, but at lower levels than those currently observed in downgradient areas.	All risk drivers are site related COPCs from known source areas. Cumulative and individual ILCRs exceeding the upper limit of the TCEQ and EPA acceptable target risk range (1.0E-04) and HI/HQ greater than 1.0 are expected to persist more than 100 years in the future.

Table 2-6. Risks from Groundwater COCs, continued

Location	Risk Drivers[a]		COCs[b]		Potential Source	Rationale
Offsite South of Pantex Plant[e]	Boron (HQ = 1.5) Total Chromium (>MCL) Hexavalent Cr (HQ=378) DNT2A (1.7E-05) (HQ = 33.6) DNT4A (1.2E-05) (HQ = 24.6) DCA12 (1.7E-04) DNB13 (HQ = 1.1) Chloroform (5.2E-04) (HQ=1.1) 1,4-Dioxane[f] (1.43E-03)	DNT24 (1.7E-03) (HQ = 4.1) DNT26 (1.9E-05) RDX (1.8.E-02) (HQ = 181) TNT (1.6E-04)(HQ=36) HMX (HQ=2.1) TNB135 (HQ=1450) TCE (4.5E-05) PCE (2.2E-05) Perchlorate (HQ=38.6)	Boron CR CR6 DNT2A DNT4A DCA12 DNB13 Chloroform p-dioxane	DNT24 DNT26 RDX TNT HMX TNB135 TCE PCE Perchlor-ate	Impacts to perched groundwater will persist in the future as pore water containing COPCs drains from the overlying partially saturated formation. Potential future impacts are expected to continue in the future, but at lower levels than those currently observed in Zone 12 downgradient areas. Zone 11 will contribute 3 new COCs (chloroform, 1,4-dioxane, and PCE) and risk is slightly higher for 2 future COCs (DCA12 and TCE) from Zone 11. Modeling indicates that TNB135 concentrations in the perched will increase in the future (modeled values used for risk analysis).	All risk drivers are site-related COPCs from known source areas. Cumulative and individual ILCRs exceeding the upper and lower limit of the TCEQ and EPA acceptable target risk range (1.0E-06 to 1.0E-04) and HI/HQ greater than 1.0 are expected to persist more than 100 years in the future. Total chromium exceeds the MCL.

Table 2-6. Risks from Groundwater COCs, continued

Location	Risk Drivers[a]		COCs[b]		Potential Source	Rationale
Future Ogallala Aquifer[d]						
Onsite Production Wells	None		--		--	--
Offsite South and East of Pantex Plant boundary	Southeast Plume : DNT24 (2.5E-06) RDX (2.2E-04) (HQ=2.2)	Zone 11 Plume: Perchlorate (HQ=3.9)	DNT24 RDX	Perchlor-ate	COCs in perched groundwater that may migrate to the Ogallala Aquifer.	All risk drivers are site-related COCs from known source areas with cumulative and/or individual ILCRs exceeding the upper limit of the TCEQ and EPA acceptable target risk range (1.0E-04) and HI/HQ greater than 1.0.
Offsite at Pantex Lake	None		--		--	--

[a] Risk drivers are defined as COPCs having individual ILCR > 1E-06 or HQ > 1.0 or substantially contributing to cumulative ILCR > 1.0E-06 or HI > 1.0. Maximum individual ILCRs for all monitoring wells evaluated are provided in (parentheses), HQs are provided in (HQ = parentheses). Reported cumulative ILCR and HI are maximums for all monitoring wells evaluated.
[b] Risk drivers are retained as COCs unless eliminated by uncertainty analysis.
[c] No wells are currently completed in the COPC impacted area of perched groundwater. Current risks are calculated for a hypothetical future well completed in perched groundwater using current measured concentrations in the perched groundwater.
[d] Future risks are calculated for hypothetical future well completed in perched groundwater or Ogallala Aquifer at the predicted offsite location of maximum future concentration using subsurface modeling.
[e]Only COCs for TTU are listed here.

Abbreviation Key:
CR – Chromium (total)
CR6 – Hexavalent Chromium
DNT2A - 2-Amino-4,6-dinitrotoluene
DNT4A - 4-Amino-2,6-dinitrotoluene
DCA12 - 1,2-Dichloroethane
DNB13 - 1,3-Dinitrobenzene
DNT24 - 2,4-Dinitrotoluene
DNT26 - 2,6-Dinitrotoluene
PCE - Tetrachloroethene
TCE - Trichloroethene
TNB135 - 1,3,5-Trinitrobenzene
TNT – Trinitrotoluene
RDX - Cyclotrimethylene-trinitramine
HMX – Cyclotetramethylene-tetranitramine

Table 2-7 displays constituents that are found in the perched groundwater above MCLs or MSCs[2] and are maintained as COCs:

Table 2-7. Perched Groundwater COCs

Perched Groundwater Onsite (Beneath Zone 11 and Zone 12)	Perched Groundwater East of Pantex	Perched Groundwater South of Pantex
1,2 Dichloroethane	1,2 Dichloroethane	1,2 Dichloroethane
2,4 Dinitrotoluene	2,4 Dinitrotoluene	2,4 Dinitrotoluene
2,6 Dinitrotoluene	2,6 Dinitrotoluene	2,6 Dinitrotoluene
2-Amino-4,6-dinitrotoluene	2-Amino-4,6-dinitrotoluene	2-Amino-4,6-dinitrotoluene
4-Amino-2,6-dinitrotoluene	4-Amino-2,6-dinitrotoluene	4-Amino-2,6-dinitrotoluene
RDX	RDX	RDX
TNT	TNT	TNT
Trichloroethene	--	Trichloroethene
Hexavalent Chromium	--	Hexavalent Chromium
Total Chromium	--	Total Chromium
Perchlorate	--	--
1,3,5 Trinitrobenzene	--	--
1,3 Dinitrobenzene	--	--
1,4 Dioxane	--	--
Chloroform	--	--
Tetrachloroethene (PCE)	--	--

2.7.2 Ecological Risks

2.7.2.1 Identification of Receptors

The *Site-Wide Ecological Risk Assessment Report* (BWXT Pantex/SAIC, 2005) presented the results of the Site-Wide ERA conducted at Pantex Plant to evaluate potential risks to ecological receptors. Pantex followed a tiered ecological risk assessment process from the State of Texas that is consistent with EPA guidance. The tiered process starts with a Tier 1 assessment that consists of a checklist that evaluates habitat present at each remedial action unit, the types of contaminants and affected media, and the probability that ecological receptors in aquatic or terrestrial habitat can contact the contamination. The Tier 1 either focuses the continuing risk assessment only to the affected media and habitat that requires further assessment or allows a unit to be excluded from further consideration. Because many of the units at Pantex are within industrial areas that are not suitable habitat for wildlife receptors, those units were excluded from further risk assessment for the terrestrial habitat. However, those units were evaluated for their potential to impact downstream aquatic areas (i.e., playas at or near Pantex). All other units that were not excluded through the Tier 1 checklist were evaluated in a Tier 2 ERA for terrestrial and aquatic habitats. A site-specific Tier 3 ERA was not conducted.

Pantex contains two types of habitat: upland/grassland and playa (wetland). The playas are ephemeral wetlands and were addressed as both a wet and dry habitat (full-time for both and ½ year wet/dry). The receptors evaluated included representatives from each of the foraging/lifestyle guilds at Pantex Plant, and included surrogate species for threatened and endangered species identified at Pantex Plant. The following measurement endpoints were evaluated:

[2] Groundwater MSCs were calculated in accordance with the Texas Administrative Code (30 TAC §335.563)

Table 2-8. Terrestrial Indicator Species/Groups Included in Tier 2 SLERA for Playas 1, 2, 3, 4, and Pantex Lake

Indicator Group	Species/Taxonomic Group
Mammals	
Herbivore Omnivore Carnivore	Cottontail rabbit Mouse Coyote
Birds	
Insectivore Omnivore Raptor	Wren Meadowlark Red-tailed hawk
Macroinvertebrates	Terrestrial and soil macroinvertebrates
Vegetation	General vegetation

Table 2-9. Aquatic Indicator Species/Groups Included in Tier 2 SLERA for Playas 1, 2, 3, 4, and Pantex Lake

Indicator Group	Species/Taxonomic Group
Mammals	
Omnivore Carnivore	Raccoon Coyote
Birds	
Carnivore Omnivore Raptor	Sandpiper Duck Red-tailed hawk
Amphibians	
Carnivore Omnivore	Salamander Frog
Macroinvertebrates	Benthic macroinvertebrates
Aquatic receptors	Aquatic biota including aquatic vegetation
Rooted Vegetation	General rooted aquatic vegetation

2.7.2.2 Approach

The upland habitats were assessed in separate Tier 2 ERA reports and summarized in the Site-Wide ERA Report. The HQs from higher trophic-level receptors in the upland habitats were below LOAEL-based toxicity reference values (the typical cleanup or risk management range for animal receptors) with the exception of plants or macroinvertebrates in a few areas. Because of the small size of the areas and because higher trophic-level receptors were not at risk, cleanup was not required for these sites.

The Site-Wide ERA evaluated the playas as the most significant habitat at Pantex. The playas are representative of most site risk to ecological receptors for the following reasons:

- Playas and ditches provide habitat for ecological receptors and serve as a final repository for surface water drainage from Pantex Plant remedial action units.
- The playas associated with Pantex Plant provide the highest quality and most important ecological habitats.
- In general, the upland sites at Pantex Plant contribute little to cumulative ecological risk because of their small size relative to the playas.

The playa ERA evaluated current risk using measured concentrations in soil, sediment, and surface water of the ditches and playas. Evaluation of potential future risk was assessed using sediment transport modeling to determine whether contaminated sediments currently in upland source areas and/or ditches are migrating to the playas and if migration could cause COPC concentrations at the playas to increase in the future. Additionally, future water concentrations and risks to aquatic receptors were evaluated using predicted sediment concentrations. Tissue data that had been collected at the playas and at the Burning Ground previously were also considered in the final evaluation of results. Hotspots were also evaluated for risk and need for cleanup.

2.7.2.3 Ecological Effects Assessment Summary

The HQs were evaluated with respect to cleanup or risk management range (between the NOAEL-based HQ and the LOAEL-based HQ) and whether only lower-trophic level receptors were potentially affected. The results and conclusions of the playa evaluation are summarized in the table below.

Table 2-10. Summary of Site-Wide ERA Conclusions

Evaluation	Conclusion
	Playa 1
Individual Tier 2 SLERA Conclusions and Recommendations	Conservative NOAEL-based HQs exceed 1 for a variety of COPCs and receptors for all three exposure media (surface soil, sediment, and surface water). Refined LOAEL-based HQs exceed 1 for chromium in sediment (sandpiper=3.2). Chromium appears to be elevated above background over most of Playa 1. The background concentration of chromium also results in a refined LOAEL-based HQ > 1 for sandpiper (1.2). Risks to sandpiper are associated primarily with ingestion of modeled chromium concentrations in their prey (benthic invertebrates). However, tissue results for terrestrial invertebrates and salamanders provide some evidence that modeled uptake to benthic invertebrates is overestimated by as much as ten times the literature-based uptake values used in the model. Furthermore, tissue concentrations of chromium from prey at Playa 1 are the same as background; use of the actual tissue data indicates that risks at Playa 1 are the same as background. As a result, no further action for ecological receptors is needed for Playa 1.
Cumulative Site-Wide ERA Conclusions and Recommendations	Conservative NOAEL-based HQs for chromium (sandpiper) and thallium (raccoon and coyote) exceed 1. All refined NOAEL- and LOAEL-based HQs are well below 1. The conservative NOAEL-based HQ for chromium is primarily attributable to Playa 1. Because cumulative LOAEL-based HQs are below 1 and tissue data suggest chromium concentrations in sandpiper prey are similar to background, no further evaluation is needed for chromium in sediment at Playa 1. Conservative NOAEL-based HQs for thallium are associated with Playa 1 (surface soil and sediment) and Playa 2 (surface soil). Because cumulative NOAEL-based HQs only slightly exceed 1, LOAEL-based HQs are below 1, and thallium is present at concentrations similar to background, no further action for ecological receptors is needed for thallium in surface soil and sediment at Playa 1.
Future Sediment Modeling Conclusions and Recommendations	Future sediment entering Playa 1 is predicted to contain a lower concentration of chromium than is currently present at Playa 1. In general, future sediment entering Playa 1 is predicted to contain concentrations of inorganic chemicals equal to interplaya (Upland) background surface soil. Future sediment entering Playa 1 is predicted to contain higher concentrations of HMX (compared to current EPCs), and RDX and TNT (both currently non-detected). Future sediment entering Playa 1 also is predicted to contain higher concentrations of PAHs compared to current EPCs. These future PAHs in sediment are not predicted to result in exceedances of surface water benchmarks. Photolysis is a strong degradation mechanism for HEs and PAHs in sediment and surface water that was not accounted for in the quantitative transport model. As a result, future EPCs in sediment and associated surface water also are conservative and not likely to actually be greater than current EPCs. Thus, evaluation of risks based on current EPCs sufficiently characterizes risk to ecological receptors at Playa 1 for current and future conditions.
	Playa 2
Individual Tier 2 SLERA Conclusions and Recommendations	Conservative NOAEL-based HQs exceed 1 for a few inorganic COPCs and receptors for soil. Conservative NOAEL-based HQs > 1 range from 1.1 to 7.2. All refined LOAEL-based HQs are below 1. Inorganic COPCs with conservative NOAEL-based HQs > 1 are present at concentrations similar to background and/or are not bioavailable. Therefore, no further action for ecological receptors is needed for Playa 2.

Evaluation	Conclusion
Cumulative Site-Wide ERA Conclusions and Recommendations	Conservative NOAEL-based HQs for thallium (raccoon and coyote) exceed 1 with contributions primarily from Playa 1 and, to a lesser extent, from Playa 2. All refined NOAEL- and LOAEL-based HQs are well below 1. Because cumulative NOAEL-based HQs only slightly exceed 1, LOAEL-based HQs are below 1, and thallium is present at concentrations similar to background, no further action for ecological receptors is needed for thallium in surface soil at Playa 2.
Future Sediment Modeling Conclusions and Recommendations	Future sediment entering Playa 2 is predicted to contain lower concentrations of all organic chemicals currently present at Playa 2 except HMX. Photolysis is a strong degradation mechanism for HEs in sediment that was not accounted for in the quantitative transport model. As a result, future EPCs in sediment also are conservative and not likely to actually be greater than current EPCs. Future sediment entering Playa 2 is predicted to contain concentrations of inorganic chemicals equal to interplaya (Upland) background surface soil. Thus, evaluation of risks based on current EPCs sufficiently characterizes risk to ecological receptors at Playa 2 for current and future conditions.
Playa 3	
Individual Tier 2 SLERA Conclusions and Recommendations	Conservative NOAEL-based HQs exceed 1 for a few inorganic COPCs and receptors for soil and surface water. All refined LOAEL-based HQs are below 1. Inorganic COPCs with conservative NOAEL-based HQs > 1 for soil are present at concentrations similar to background. Inorganic COPCs with conservative NOAEL-based HQs > 1 for surface water may be elevated above background; however, calculated background HQs are as high as 53. In addition to these HQ results, review of population studies for salamanders and benthic invertebrates indicates populations of these organisms are not adversely affected by aquatic contamination at Playa 3. Therefore, no further action for ecological receptors is needed for Playa 3.
Cumulative Site-Wide ERA Conclusions and Recommendations	Playa 3 does not contribute significantly to cumulative risk for any receptors.
Future Sediment Modeling Conclusions and Recommendations	Future sediment entering Playa 3 is predicted to contain higher concentrations of HMX and TATB compared to current conditions (currently non-detected). Photolysis is a strong degradation mechanism for HEs in sediment and surface water that was not accounted for in the quantitative transport model, which is a significant process as supported by current observed conditions. As a result, future EPCs in sediment and associated surface water also are conservative and not likely to actually be greater than current EPCs. Mercury is predicted to increase in sediment and surface water at Playa 3 but not at concentrations exceeding benchmarks. In general, future sediment entering Playa 3 is predicted to contain concentrations of inorganic chemicals equal to interplaya (Upland) background surface soil. Thus, evaluation of risks based on current EPCs sufficiently characterizes risk to ecological receptors at Playa 3 for current and future conditions.
Playa 4	
Individual Tier 2 SLERA Conclusions and Recommendations	Conservative NOAEL-based HQs exceed 1 for a few inorganic COPCs and receptors for soil. Conservative NOAEL-based HQs > 1 range from 1.0 to 3.7. All refined LOAEL-based HQs are below 1. Inorganic COPCs with conservative NOAEL-based HQs $\geq$ 1 are present at concentrations similar to background. Therefore, no further action for ecological receptors is needed for Playa 4.
Cumulative Site-Wide ERA Conclusions and Recommendations	Playa 4 does not contribute significantly to cumulative risk for any receptors.
Future Sediment Modeling Conclusions and Recommendations	Future sediment entering Playa 4 is predicted to contain higher concentrations of HMX compared to current conditions. Photolysis is a strong degradation mechanism for HEs in sediment and surface water that was not accounted for in the quantitative transport model. As a result, future EPCs in sediment and associated surface water also are conservative and not likely to actually be greater than current EPCs. In general, future sediment entering Playa 4 is predicted to contain concentrations of inorganic chemicals equal to interplaya (Upland) background surface soil. Thus, evaluation of risks based on current EPCs sufficiently characterizes risk to ecological receptors at Playa 3 for current and future conditions.

Evaluation	Conclusion
	Pantex Lake
Individual Tier 2 SLERA Conclusions and Recommendations	Conservative NOAEL-based HQs exceed 1 for a variety of COPCs and receptors for all three exposure media (surface soil, sediment, and surface water). Refined LOAEL-based HQs exceed 1 for chromium in sediment (sandpiper 1.4). Chromium concentrations at Pantex Lake approximate background levels. The background concentration of chromium also results in a refined LOAEL-based HQ > 1 for sandpiper (1.2), indicating that it is not practical to remediate chromium in sediment to result in HQs <1 for all receptors. Risks to sandpiper are associated primarily with ingestion of modeled chromium concentrations in their prey (benthic invertebrates). However, tissue results for terrestrial invertebrates and salamanders collected at Playa 1 provide evidence that modeled uptake to benthic invertebrates is likely overestimated by the literature based uptake factors used.
Cumulative Site-Wide ERA Conclusions and Recommendations	Pantex Lake was not included in the cumulative site-wide ERA because of its history and its distance from the other Pantex playas.
Future Sediment Modeling Conclusions and Recommendations	Future impacts were not predicted as Pantex Lake does not receive direct storm runoff from Pantex Plant and the Pantex Lake drainage basin does not include any portion of Pantex Plant.

2.7.2.4 Risk Characterization Summary

Based on the evaluation of surface soil, sediment, and surface water at Playas 1, 2, 3, 4, and Pantex Lake and the upland habitats in the individual Tier 2 ERAs, ecological receptors are generally not at risk from residual contamination. Future risks are predicted to be similar or lower than current risks, so further cleanup or evaluation is not necessary for units that may contribute contaminants to the playas. Cumulative site-wide analysis did not result in any refined NOAEL- or refined LOAEL-based HQs ≥ 1. Thus, there are no site-wide COPCs that require a Tier 3 Site-Specific ERA or derivation of cleanup values.

2.7.2.5 Stakeholder Involvement

Land trustees were given the opportunity to participate in the process of assessing ecological risk for Pantex. The following agencies are Trustees for the Pantex Plant:

- Department of Commerce (NOAA)
- Department of Energy
- Department of the Interior (US Fish and Wildlife)
- State Trustees (Texas General Land Office, Texas Parks and Wildlife, and the Texas Commission on Environmental Quality)

The State of Texas has a formal Natural Resource Trustee Program (www.tceq.state.tx.us/remediation/nrtp/nrtp.html) that includes a Memorandum of Understanding (MOU) with all of the above listed agencies. Pantex followed this MOU in completing the ecological risk assessment. The ecological risk assessment (ERA) was used as the tool to gain agreement on the process for determining ecological risks and potential impacts. The formal program through the state ensures the Trustees are involved at specific points in the ecological risk assessment and that comments are addressed. The ERA Work Plan and subsequent ERA work was reviewed, commented on, and approved by TCEQ, EPA, and the Trustees. The final conclusions of the ERA were that risks to plants and wildlife were below regulatory thresholds of concern and that no further actions are necessary for ecological receptors.

2.8 Summary of Actions for Soil Units and Groundwater

A total of 254 active and inactive soil release units were initially identified at the Pantex Plant for further investigation and cleanup; Section 2.2.2.2 lists those soil sites that require no action in the ROD; these sites are summarized as follows:

- 16 active units are deferred for evaluation and closure until after operations have ceased at those locations.
- 46 units have been administratively closed; further assessment concluded that no releases were associated with these sites.
- 33 units were closed to background; investigations confirmed that constituents did not exceed background concentrations or practical quantitation limits, and concluded that no releases had occurred at these sites.

The soil units requiring CERCLA actions and groundwater monitoring are discussed in sections 2.8.1 and 2.8.2.

2.8.1 Limited Action (Institutional Controls with Long-Term Groundwater Monitoring) Soil Units

The 114 soil units listed in this section and shown in Figure 2-22, have been investigated and determined to be protective of human health and the environment under CERCLA for the intended industrial land use. Soil units that are closed to industrial screening levels require institutional controls to ensure that the property is used for industrial use only and that protective actions are maintained. The standards for residential reuse are considered most protective, and if considered for reuse decisions, can support the use of the property without restriction. Properties at Pantex Plant were assessed for an industrial use, and industrial exposure assumptions. Restrictions are imposed as institutional controls so that the property cannot be used for residential use, unless there is further evaluation to the more conservative residential risk-based standards.

Soil units assessed in the site-specific HHRA that do not exceed the ILCR of 1E-06 or the HI of 1 will require institutional controls with monitoring of groundwater in downgradient locations to address uncertainties documented through investigation approvals. These soil units are considered Limited Action Soil Units because no further remedial action is required at these soil units aside from implementing institutional controls and/or long-term groundwater monitoring.

The Limited Action Soil Units are broken into different categories that correspond to results of the risk evaluated:

- Units Compared to Screening Levels (appropriate for industrial use).
- Units Assessed through Site-Specific Risk Assessment that require institutional controls and long-term groundwater monitoring.
    - Soil units without COCs identified for a direct contact risk, but with the potential to impact underlying groundwater.
    - Soil units with COCs identified for direct contact.

- Soil units with interim remedial actions completed after the human health risk assessments.

These categories are described in the following sections, along with lists of the soil units contained in each.

2.8.1.1 Limited Action Soil Units At or Below Screening Levels

These soil units were investigated and demonstrated to meet protective risk-based screening levels, based on an industrial exposure scenario. These soil units contain contaminants at levels that are protective of human health and the environment with placement of institutional controls to restrict the property to industrial use. The institutional controls will also need to prohibit future reuse for residential housing, elementary and secondary schools, childcare facilities, or playgrounds.

These soils units do not pose a risk to groundwater and therefore, will not require long-term monitoring for the underlying groundwater. These soil units are considered Limited Action (Institutional Controls) Soil Units:

Zone 11

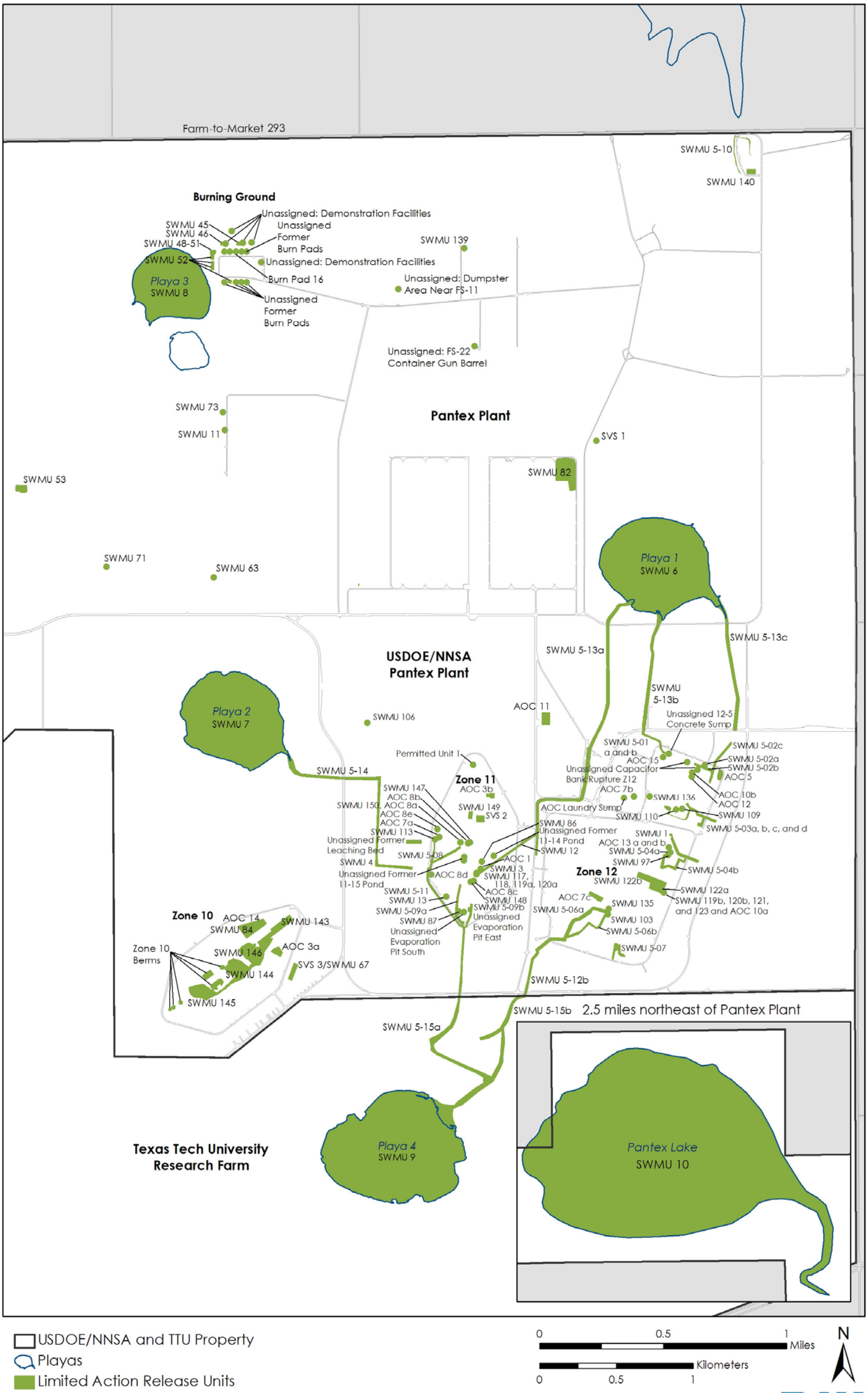
- Unassigned SWMU: 11-14 Hypalon Pond and Waste Water Line
- Permitted Unit 1: Container Storage 11-7 North Pad

Zone 12

- SWMU 5-03a: Building 12-68 Drainage Ditches
- SWMU 5-03b: Building 12-18 Drainage Ditches
- SWMU 5-03c: Building 12-9 Drainage Ditches
- SWMU 5-03d: Building 12-10 Drainage Ditches
- SWMU 97: Building 12-34 Waste Accumulation Area
- SWMU 109: Building 12-68 Concrete Sump
- SWMU 110: Building 12-68 Electroplating Waste Retention Basin (Moat)
- AOC 7b: Building 12-4 Sulfuric Acid Spill
- Unassigned AOC: Building 12-1 Laundry Sump

Units in Miscellaneous Areas

- SWMU 5-10: Drainage Ditches near the Old Sewage Treatment Plant
- SWMU 5-14: Drainage Ditch from Zone 11 to Playa 2
- SWMU 11: Firing Site 16 Surface Impoundment in Zone 5
- SWMU 53: Temporary High Explosives Burning Ground
- SWMU 63: Landfill 12
- SWMU 71: Firing Site 6
- SWMU 73: Firing Site 15
- SWMU 106: Building 16-1 Waste Accumulation Site
- SWMU 139: Firing Site 10 Photo Processing Leaching Bed
- SWMU 140: Old Sewage Treatment Plant/Sludge Beds
- SVS 1: Denuded Area near Playa 1
- Unassigned SWMU: Firing Site 22 Container Gun Barrel
- Unassigned: Dumpster Area near Firing Site 11



B&W Pantex

Figure 2-22. Pantex Plant Limited Action Release Units

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2.8.1.2 Limited Action Soil Units with No Direct Contact Risk but Potential to Impact Ground Water

Contaminant concentrations for these soil units exceeded risk-based screening levels and were further evaluated in the site-specific HHRAs and ERA. “Hot spot” excavations and removals were conducted at a number of these sites under the State’s RCRA interim corrective measures authority to mitigate risk. The risk assessment for these sites evaluated post-excavation contaminant concentrations. The risk assessment results subsequently indicated that these units did meet CERCLA risk-based levels appropriate for industrial worker contact (i.e., do not exceed the ILCR of 1E-06 or the HI of 1) and are protective of human health and the environment with industrial use restrictions. However, there is direct contact risk remaining for the construction/excavation worker at these sites, which will be addressed with institutional controls.

The contaminant concentrations for these units also exceeded the screening levels protective of groundwater. Further evaluation, considering depth to groundwater and site conditions (Section 2.7.1.1), was conducted to determine if the sites posed a future threat to groundwater. It was determined that these soils units were unlikely to contribute to the perched groundwater contamination as continuing source areas, but long-term groundwater monitoring would be required to address any uncertainties for the deeper vadose zone (below a 70’ depth).

All soil units in this section will require institutional controls to restrict the properties to industrial use and limit construction/excavation worker exposure. These units will be included in the long-term groundwater monitoring plan.

These soil units are considered Limited Action Soil Units, requiring institutional controls and long-term groundwater monitoring.

Zone 10

- SWMU 84: Building 10-9 Scrap, Salvage, and Storage Yard
- SWMU 143a: Building 10-9 Former Waste Drum Storage Areas
- SWMU 143b: Building 10 7 Former Waste Drum Storage Areas
- SWMU 144: Building 10-13 Zone 10 TNT Settling Pit
- SWMU 145: Building 10-17 Zone 10 TNT Settling Pit
- SWMU 146: Building 10-26 Zone 10 TNT Settling Pit
- AOC 3a: Former Boiler House Areas
- AOC 14: Battery Storage Area (Building 12-18)
- SVS 3 (SWMU 67): Carbon Black Burial Area near Building 10-7
- Unassigned SWMU: Zone 10 Berms

Zone 11

- SWMU 3: Building 11-44 Drainage Ditch
- SWMU 5-08: Building 11-36 Drainage Ditch
- SWMU 5-09a: Building 11-17 Drainage Ditch
- SWMU 12: Drainage Ditch near Former 11-14 Pond
- SWMU 13: Building 11-51 Former Solar Evaporation Pond
- SWMU 86: Building 11-14 Solvent Storage Shed
- SWMU 87: Building 11-20 Solvent Storage Shed
- SWMU 119a: High Explosives Filters

- SWMU 120a: Carbon Filters
- SWMU 147: Building 11-13 TNT Settling Pit
- SWMU 148: Building 11-17 TNT Settling Pits
- SWMU 149: Building 11-26 TNT Settling Pit
- SWMU 150: Building 11-12 TNT Settling Pit
- AOC 1: Building 11-14A Transformer Leak
- AOC 3b: Former Boiler House Areas
- AOC 7a: Building 11-36 Sulfuric Acid Spills
- AOC 8a: Pad 11-12 Solvent Leaks
- AOC 8b: Pad 11-13 Solvent Leaks
- AOC 8c: Building 11-17 Solvent Leaks
- AOC 8d: Pad 11-22 Solvent Leaks
- AOC 8e: Building 11-36 Solvent Leaks
- SVS 2: Building 11-26 Parallel Depressions
- Unassigned - Former 11-15 Pond
- Unassigned: Former Leaching Bed North of Building 11-50 and West of Building 11-36

Zone 12

- SWMU 5-02a: Building 12-51 Drainage Ditch
- SWMU 5-02c: Building 12-110 Drainage Ditch
- SWMU 119b: High Explosives Filters
- SWMU 120b: Carbon Filters
- SWMU 121: High Explosives Settling Tank
- SWMU 123: Concrete Sump & Waste Water Treatment Unit
- AOC 5: Electrical Equipment Bone Yard near Building 12-5
- AOC 10a: Building 12-43A Pesticide Rinse Area
- AOC 13a: Former Cooling Tower in Zone 12 (Pad)
- AOC 13b: Former Cooling Tower in Zone 12 (Piping/Soil)

Burning Ground

- SWMU 8: Playa 3
- SWMU 45: Explosive Burn Cage
- SWMU 46: Explosive Burn Cage
- SWMU 48: Burning Ground Solvent Evaporation Pans
- SWMU 49: Burning Ground Solvent Evaporation Pans
- SWMU 50: Burning Ground Solvent Evaporation Pans
- SWMU 51: Burning Ground Solvent Evaporation Pans
- SWMU 52: Burn Racks and Flashing Pits
- Unassigned: Demonstration Facilities

Units in Miscellaneous Areas

- SWMU 4: Building 11-50 Drainage Ditch
- SWMU 5-12b: Perimeter Drainage Ditch from Zone 12 to SWMU 5-14
- SWMU 5-15a & b: Drainage Ditch to Playa 4
- SWMU 6: Playa 1
- SWMU 7: Playa 2
- SWMU 9: Playa 4
- SWMU 10: Pantex Lake

- SWMU 82: Nuclear Weapon Accident Residue Storage
- AOC 11: Fire Training Area Burn Pits

2.8.1.3 Limited Action Soil Units with Identified COCs at Protective Concentrations

Contaminant concentrations for these soil units exceeded risk-based screening levels and were further evaluated in the site-specific HHRAs and ERA. These soil units were evaluated in the site-specific HHRAs and ERA under CERCLA and the TCEQ RRR program; these units will also be closed to RRS 3 under TSWDA. The results of the HHRAs indicates that while COCs exist for the following soil units, they are within the CERCLA risk-based range appropriate for industrial worker contact (i.e., do not exceed the ILCR of 1E-06 or the HI of 1) and are protective of human health and the environment with industrial use restrictions. Further evaluation determined that these soils units were unlikely to contribute to the perched groundwater contamination as continuing source areas, but long-term groundwater monitoring will be required to address any uncertainties for the deeper vadose zone (below a 70' depth). Therefore, these soil units require only institutional controls and long-term groundwater monitoring for one or more of the following reasons:

- Risk levels only slightly exceeded the regulatory threshold (carcinogenic risk of 1E-6 or noncarcinogenic risk of 1).
- Contaminant concentrations were questionable because of problems with the laboratory analysis of a small amount of samples. Re-sampling and reanalysis of some of those samples indicated that the constituent was not present.
- Interim corrective measures were conducted under RCRA authority prior to the risk assessments in the upper soils (upper 1 foot) and the remaining risk to construction/excavation workers from contaminants at depth can be managed through institutional controls focused on restricting excavation and construction worker practices.

Institutional controls and long-term groundwater monitoring will be implemented for these soil units to restrict property use and to monitor underlying groundwater for potential impacts from the deeper vadose zone. Therefore, these soil units are considered Limited Action Soil Units.

Zone 11

- SWMU 5-09b: Building 11-20 Drainage Ditch
- SWMU 5-11: Main Perimeter Ditch
- Unassigned SWMU: Building 11-20 Evaporation Pit East of Bay 3
- Unassigned SWMU: Building 11-20 Evaporation Pit South of Bay 11/West of Bay 6 Solvent Storage Shed

Zone 12

- SWMU 5-01a: Building 12-5 Drainage Ditches
- SWMU 5-01b: Building 12-5B Drainage Ditches
- SWMU 5-02b: Building 12-67 Drainage Ditch
- SWMU 5-04a: Building 12-19 Drainage Ditch
- SWMU 5-06a: Building 12-44E Drainage Ditch
- SWMU 5-06b: Building 12-81 Drainage Ditch
- SWMU 5-07: Building 12-41 Drainage Ditch
- SWMU 103: Building 12-81 Former Battery Storage Area
- SWMU 135: Building 12-44E Leaching Bed
- SWMU 136: Building 12-59 Subsurface Leaching Bed

- AOC 7c: Building 12-64 Sulfuric Acid Spills
- AOC 10b: Building 12-51 Pesticide Rinse Area
- AOC 12: Building 12-5D Paint Shop/ Solvent Pit
- AOC 15: Building 12-35 DDT Release
- Unassigned: SWMU Capacitor Bank Rupture
- Unassigned: Concrete Sump (near Building 12-5B)

Units in Miscellaneous Areas
- SWMU 5-13a, b, c: Drainage Ditches to Playa 1

2.8.1.4 Limited Action Soil Units with Post-Risk Assessment Interim Actions Completed

Contaminant concentrations for these soil units exceeded risk-based screening levels and were further evaluated in the site-specific HHRAs and ERA. These soil units were evaluated in the site-specific HHRAs and ERA under CERCLA and the State's RRR program; these soil units will also be subject to RRS 3 closure requirements under TSWDA. The results of the HHRAs determined that these soil units posed unacceptable risks to workers if no remedial actions were taken. Based on the results of the risk assessments, removals, as interim corrective measures, were implemented under RCRA authority to immediately reduce the impact to workers and meet soil cleanup standards. The interim corrective measures are consistent with the site-wide strategy and the final remedial actions selected in this ROD. The results of these interim corrective measures will be reported in the Remedial Design Submittal to demonstrate compliance with the Remedial Action Objectives (RAOs).

A pre-removal evaluation determined that these soils units were unlikely to contribute to the perched groundwater contamination as continuing source areas, but long-term groundwater monitoring will be required to address any uncertainties for the deeper vadose zone (below a 70' depth).

As with all soil units requiring remedial actions, institutional controls with long-term monitoring will be implemented to restrict use and access, as appropriate, to these sites and to address the potential for migration of contaminants to groundwater from contaminants in the deeper vadose zone. Therefore, these soil units are considered Limited Action Soil Units.

Zone 11
- SWMU 113: Building 11-36 Overflow Collection System/Sump
- SWMU 117: High Explosives Settling Tank
- SWMU 118: Equalization Basin

Zone 12
- SWMU 1: Building 12-17 Drainage Ditch
- SWMU 5-04b: Building 12-73 Drainage Ditch
- SWMU 122a: Equalization Basin
- SWMU 122b: Building 12-24N & Building 12-43 Upland Soil

Burning Ground
- Explosive Burn Pad 16 (part of SWMUs 14-27)

2.8.2 Soil Units with Recommended Response Actions

Forty-five units were found to require remedial action to control or reduce risks to onsite and/or offsite receptors. These units are depicted in Figures 2-18 through 2-21, and are as follows:

Zone 10
- SVS 8: Abandoned Zone 10 Landfill
- ZONE 10 Building Construction Debris Landfills
- SWMU 68d: Active Sanitary Landfill

Zone 11
- SVS 5: Landfill East of 11-13 Pad
- SWMU 60: Landfill 9
- SWMU 61: Landfill 10

Zone 12
- SWMU 54: Landfill 3
- SWMU 55: Landfill 4
- SWMU 56: Landfill 5
- SWMU 57: Landfill 6
- SWMU 68a North: Original General Purpose Sanitary Landfill
- SWMU 2: Building 12-43 Drainage Ditch
- SWMU 5-05: Buildings 12-21 and 12-24 Drainage Ditches
- SWMU 5-12a: Zone 12 Main Perimeter Ditch

Burning Ground
- SWMU 37: Burning Grounds Landfill 1
- SWMU 38: Burning Grounds Landfill 2
- SWMU 39: Burning Grounds Landfill 3
- SWMU 40: Burning Grounds Landfill 4
- SWMU 41: Burning Grounds Landfill 5
- SWMU 42: Burning Grounds Landfill 6
- SWMU 43: Burning Grounds Landfill 7
- SWMU 44: Burning Grounds Landfill 8
- SWMUs 14-26 (13 Units): Explosive Burn Pads
- SWMU 27: Explosive Burn Pad 13
- SWMU 47: Chemical Burn/Evaporation Pits

Units in Miscellaneous Areas
- SWMU 58: Landfill 7 Associated with Concrete Batch Plant
- SWMU 64: Landfill 13
- SWMU 66: Landfill 15
- SWMU 68b: General Purpose Sanitary Landfill 1
- SWMU 68c: General Purpose Sanitary Landfill 2
- SVS 7a and 7b: Igloo Demolition Debris Landfills Zone 4 (SVS 7a) and Zone 5 (SVS 7b)
- Unnumbered Zone 7 Landfills
- SWMU 70: Firing Site 5

RCRA interim corrective measures have been taken at some of these sites to eliminate exposure from direct contact with soils, including soil excavation, and to minimize further impact to groundwater through the installation of ditch liners and landfill covers. Remedial options for these sites will be discussed in the "Description of Alternatives." In addition to being subject to remedial response under

CERCLA and the ROD, these sites will also be subject to State closure requirements under the TSWDA, including implementation of institutional controls and long-term groundwater monitoring for both perched groundwater and the Ogallala Aquifer.

2.8.3 Groundwater Summary of Actions

The perched groundwater was evaluated in the HHRA for both the potential future use as a drinking water source and for future impacts to the underlying Ogallala Aquifer. Both scenarios resulted in unacceptable risk at hypothetical points of exposure. Although use of the perched groundwater is restricted onsite, it does extend offsite with the potential to migrate vertically and horizontally to points of exposure in the Ogallala Aquifer. The perched groundwater meets the minimum yield and quality requirements to be designated a potential drinking water source. Response actions for the perched groundwater will address both the continued migration of COCs, as well as the restoration of those areas that exceed drinking water standards and risk-based cleanup levels.

2.9 Basis for Response Action

The actual or threatened release of hazardous substances from the Pantex Plant, if not addressed by implementing the Selected Remedy documented in this ROD will present a current or potential threat to public health, welfare, or the environment.

2.10 Remedial Action Objectives (RAOs) and Remediation Goals

2.10.1 Remedial Action Objectives

2.10.1.1 Surface Soil

Most of the current risk onsite from soil units assessed in the HHRAs is attributed to the potential for industrial workers to be exposed to COCs. In the absence of controls, soil units may also pose a current and future risk to workers that perform construction and/or excavation activities. Remedies will ensure that the health of industrial and construction/excavation workers is protected through the actions taken to remove, treat and prevent contact with the contaminants.

<u>The RAO developed for surface soil is to</u>:

- Reduce the exposure risk to onsite industrial and construction/excavation workers through removal, treatment, or prevention of contact with COCs in the soil.

2.10.1.2 Subsurface Soil

Designation of the perched groundwater and the Ogallala Aquifer as drinking water sources dictates a need to preserve the designated beneficial use, i.e. maintain or restore drinking water standards. Contaminants exist in the vadose zone that do not pose an exposure risk, but could migrate to the perched at levels above drinking water standards.

<u>The RAO developed for subsurface soil is to</u>:

- Reduce potential impact to perched groundwater and the Ogallala Aquifer through source abatement and stabilization/control measures in the vadose zone.

2.10.1.3 Perched Groundwater

Perched groundwater RAOs were developed to address two separate groundwater issues: 1) restoration of perched groundwater to drinking water standards, and 2) protection of the Ogallala Aquifer. While remedial actions address both objectives, protection of the Ogallala Aquifer is the primary goal of implementing remedial actions for groundwater at the Pantex Plant. The specific RAOs for perched groundwater remedies are to:

- Reduce the risk of exposure to perched groundwater through contact prevention.
- Achieve cleanup standards discussed in greater detail in Section 2.10.2.2 for the perched groundwater COCs, i.e., restoration of the perched groundwater.
- Prevent growth of perched groundwater contaminant plumes.
- Prevent contaminants from exceeding cleanup standards in the Ogallala Aquifer (see Section 2.10.2.2).

2.10.2 Cleanup Standards

2.10.2.1 Soil

The target risk level for soil cleanup was established by assuming an acceptable individual cancer risk of 1.0E-06 with a cumulative 1.0E-04. For contaminants exhibiting a non-cancer risk, the target risk level is 1.0 for the HQ assuming the HI also does not exceed 1.0. For COCs with both cancer and non-cancer endpoints, both cancer and non-cancer levels were calculated, and whichever yielded a lower value was retained as the cleanup level. Table 2-11 summarizes the soil cleanup objectives equivalent to an ILCR of 1.0E-06 or HI of 1. These standards were applied in planning the post-risk assessment interim actions discussed in Section 2.8.1.4 and could be used to plan future removal actions, if necessary, as both industrial and construction/excavation worker scenarios are addressed. These cleanup levels are not appropriate for removal actions to protect groundwater from potential impacts, as site-specific evaluations would be needed to determine criteria for such removal actions.

Table 2-11. Soil (Direct Contact) Cleanup Levels

Receptor	COC	Cleanup Level[a] (mg/kg)
Zone 12 Industrial Worker	RDX	26 c
	TNT	71 c
Zone 12 Construction/Excavation Worker	TNT	87 nc
Burning Ground Industrial Worker	RDX	26 c
	TNT	71 c
	^{238}U	1.4 c
Burning Ground Construction/Excavation Worker	RDX	512 c
	TNT	87 nc

c = Level based on cancer endpoint
nc = Level based on non-cancer endpoint
[a] Cleanup level based on chemical-specific HQ of 1.0 and chemical-specific ILCR of 1.0E-06.

2.10.2.2 Perched Groundwater

Perched groundwater cleanup levels are provided in Table 2-12. Cleanup values for perched groundwater are based on the Safe Drinking Water Act MCLs, if available, or the groundwater medium-specific concentrations for residential use (GW-Res) calculated in accordance with State regulations that are consistent with EPA Risk Assessment Guidance. Residential values are used as the cleanup goals for perched groundwater.

The cleanup values are protective of residential ingestion of groundwater and are consistent with findings of the HHRA (BWXT Pantex/SAIC, 2006) that ingestion of groundwater is the risk-driving pathway. Carcinogenic cleanup levels are set to a risk level of 10^{-6}, except for Class C carcinogens, which are set at a 10^{-5} risk level. Although five of the cleanup values are based on carcinogenic health effects, the cumulative risk from the carcinogens will not exceed 10^{-4} as required by CERCLA guidance (EPA, 1997) and the NCP (40 CFR 300.430), so no downward adjustment is required. Cleanup levels for noncarcinogenic COCs are set at a risk level (hazard quotient) of 1.0. The cumulative risk level (hazard index = 1.0) must be considered (CERCLA guidance [EPA, 1997]) when the COCs affect the same target organ or act by the same method of toxicity.

Seven of the COC cleanup values are based on noncarcinogenic risk levels; five of those COCs are high explosives that cause similar health effects, as found in toxicological studies and as documented in toxicity profiles located in the HHRA (BWXT Pantex/SAIC, 2006). The two other noncarcinogenic COCs, boron and perchlorate, do not affect the same target organs or act by the same method of toxicity as the high explosives. Based on the toxicological evidence, cleanup values for the noncarcinogenic HEs have been adjusted by a factor of 5 to account for the similar health effects.

Table 2-12. Cleanup Levels for Perched Groundwater Constituents of Concern

Constituent	Cleanup Level (µg/L)	Basis
Metals		
Boron	7,300	$GW\text{-}Res_{NC}$
Chromium (hexavalent)	100	MCL
Chromium (total)	100	MCL
VOCs		
1,2-Dichloroethane	5.0	MCL
1,4-Dioxane[1]	7.7	$GW\text{-}Res_{C}$
Chloroform[1]	80	MCL for Trihalomethanes (including Chloroform)
PCE	5.0	MCL
TCE	5.0	MCL
High Explosives		
2-Amino-4,6-dinitrotoluene	1.2	$GW\text{-}Res_{NC\ Adj}$
4-Amino-2,6-dinitrotoluene	1.2	$GW\text{-}Res_{NC\ Adj}$
1,3-Dinitrobenzene	3.7	$GW\text{-}Res_{C}$
2,4-Dinitrotoluene	1.0	PQL[2]
2,6-Dinitrotoluene	1.0	PQL[2]
HMX	360	$GW\text{-}Res_{NC\ Adj}$
RDX	2	EPA Lifetime Health Advisory
1,3,5-Trinitrobenzene	220	$GW\text{-}Res_{NC\ Adj}$
TNT	3.6	$GW\text{-}Res_{NC\ Adj}$

Table 2-12. Cleanup Levels for Perched Groundwater Constituents of Concern

Miscellaneous		
Perchlorate	26	$GW\text{-}Res_{NC}$

GW-Res—TCEQ Standard No. 2 Groundwater MSC for Residential Use
MCL—EPA Maximum Contaminant Level
PQL—Practical Quantitation Limit
C—Carcinogenic
NC—Noncarcinogenic
Adj—Value adjusted for a cumulative hazard index of 1.
[1]Constituents of concern that are only associated with impacts to perched groundwater downgradient of Zone 11, not perched groundwater southeast of Zone 12.
[2]The PQL was chosen as the cleanup value in accordance with 40 CFR §300.430(e)(2)(i)(A)(2)(3) and 30 TAC §335.563(j)(1) and as approved through the Pantex Risk Reduction Rule Guidance to the RFI (BWXT Pantex, 2002, updated March 2004). The PQL is approximately equal to a GW-Res value set to a risk level of 10^{-5} (calculated $GW\text{-}Res_C$ is 0.13 µg/L).

2.11 Description of Alternatives

A number of alternatives were developed to address soil contamination, perched groundwater contamination, and to protect the beneficial uses of the Ogallala Aquifer. Summary tables provide a brief overview of the alternatives developed for soils, the Southeast perched groundwater and the Zone 11 perched groundwater. The alternatives are described in further detail in the following sections.

In addition to the alternatives developed to address soil and perched groundwater contamination, presumptive remedies have also been implemented at the Pantex Plant. Presumptive remedies were developed by EPA to streamline site investigation and the selection of cleanup methods for certain categories of sites by narrowing the consideration of cleanup methods or treatment technologies or remediation approaches that have a proven track record in the Superfund program. The presumptive remedies implemented at Pantex Plant are also described in the following sections.

The alternatives are described in further detail in the following sections.

2.11.1 Summary of Soil Alternatives

Soil alternatives evaluated at the Pantex Plant are summarized in Table 2-13.

Table 2-13. Soil Alternatives

	Limited Action Units	Landfills	SWMUs 25, 26 & 27	SWMUs 14-24	SWMU 5/05 & SWMU 2	SWMU 5/12a	SWMU 70
Alternative 1: No Action	$None	$None	$None	$None	$None	$None	$None
Alternative 2: Institutional Controls (ICs)	$Negligible Immediate	$Negligible Immediate	$Negligible Immediate	$Negligible Immediate	$Negligible Immediate	$Negligible Immediate	$270K* 3-6 Months
Alternative 3: Containment with ICs	Not Applicable Direct contact risk within thresholds; future groundwater impacts not predicted	Covers installed as interim corrective measures or on final receipt of waste	$300K 6-12 Months	Cover placed as Interim Corrective Measure	Synthetic liners installed as Interim Stabilization Measure	$3.7M 6-12 Months	$1.9M 6-12 Months
Alternative 4: Removal and Offsite Disposal with ICs	Not Applicable Direct contact risk within thresholds; future groundwater impacts not predicted	Alternative not evaluated due to presumptive remedy selection	$680K 6-12 Months Alternative partially conducted as interim corrective measure	Alternative not evaluated due to presence of cover	Alternative not applicable due to depth of contamination	Alternative not applicable due to depth of contamination	$24M 6-12 Months Alternative partially conducted as early interim action
Alternative 5: *In-situ* Ozone Treatment with ICs	Not Applicable Direct contact risk within thresholds; future groundwater impacts not predicted	Alternative not evaluated due to presumptive remedy selection	Alternative not applicable for depleted uranium	Alternative not practical for surface soils	$2.6M 2-3 Years (Effectiveness is Uncertain)	$11M 2-3 Years (Effectiveness is Uncertain)	Alternative not applicable for depleted uranium

* A physical barrier is evaluated as a part of this response action alternative for SWMU 70

2.11.1.1 Soil Units with Presumptive Remedies

2.11.1.1.1 *Landfills*

The landfills at the Pantex Plant have the basic characteristics of a municipal landfill as defined by EPA. EPA has identified containment as the selected remedies that are usually appropriate to address risks found at municipal landfills. USDOE/NNSA, EPA and TCEQ have determined that it is appropriate to apply the presumptive remedy for municipal landfills at the Pantex landfills based on the types of waste found at the site and guidance provided in the directive, *Presumptive Remedy for CERCLA Municipal Landfill Sites* (EPA 540-F-93-035, September 1993).

Landfills, found in many areas across the Pantex Plant (Figure 2-17), include construction debris (from demolition of buildings) and sanitary and industrial waste landfills from the former Pantex Ordnance Plant and from Pantex Plant. Each landfill and its type are listed in Table 2-14.

Table 2-14. Landfills at the Pantex Plant

Construction Debris Landfills	Industrial/Sanitary Waste Landfills
SVS 8: Abandoned Zone 10 Landfill This landfill was used as a construction debris landfill from the demolition of Zone 10 buildings.	SWMU 68d: Active Sanitary Landfill This landfill received typical sanitary waste.
SVS 5: Landfill E of 11-13 Pad This landfill contains debris from the demolition of Building 11-13.	SWMU 68a North: Original General Purpose Sanitary Landfill This landfill was one of four general-purpose sanitary landfills. It received general non-hazardous wastes and some construction debris from building demolition.
SWMU 60: Landfill 9 (Group III) This landfill received demolition debris from Buildings 11-26 and 11-5.	SWMU 68b: General Purpose Sanitary Landfill 1 This is a general-purpose sanitary landfill.
SWMU 61: Landfill 10 (Group III) This landfill contains debris from the demolition of Building 11-12 and 11-13.	SWMU 68c: General Purpose Sanitary Landfill 2 This is a general-purpose sanitary landfill.
SWMU 56: Landfill 5 (Group III) This landfill was initially used during construction of Zone 12 buildings, but was later used by USDOE/NNSA for disposal of Plant generated waste.	SWMU 37: Burning Ground Landfill 1 This landfill received waste, ash and residue from the burn pads, burn trays and cages, and solvent evaporation pits and pans. The landfill also contained construction debris.
SWMU 57: Landfill 6 (Group III) This landfill contains construction debris from the demolition of Zone 12 buildings.	SWMU 38: Burning Ground Landfill 2 This landfill received waste, ash and residue from the burn pads, burn trays and cages, and solvent evaporation pits and pans. The landfill also contained construction debris.
SWMU 54: Landfill 3 This landfill contains construction debris from the demolition of Zone 12 buildings.	SWMU 39: Burning Ground Landfill 3 This landfill received waste, ash and residue from the burn pads, burn trays and cages, and solvent evaporation pits and pans. The landfill also contained construction debris.
SWMU 58: Landfill 7 This landfill disposed of concrete and related debris from the concrete batch plant.	SWMU 40: Burning Ground Landfill 4 This landfill received waste, ash and residue from the burn pads, burn trays and cages, and solvent evaporation pits and pans. The landfill also contained construction debris.
SWMU 64: Landfill 13 This landfill received construction debris from SWMU 71 (Firing Site 6).	SWMU 41: Burning Ground Landfill 5 This landfill received waste, ash and residue from the burn pads, burn trays and cages, and solvent evaporation pits and pans. The landfill also contained construction debris.
SWMU 66: Landfill 15 Demolition Debris Landfill This landfill received construction debris from the demolition of the warehouse structures in Zone 8.	SWMU 42: Burning Ground Landfill 6 This landfill received waste, ash and residue from the burn pads, burn trays and cages, and solvent evaporation pits and pans. The landfill also contained construction debris.

Table 2-14. Landfills at the Pantex Plant

Construction Debris Landfills	Industrial/Sanitary Waste Landfills
UNNUMBERED ZONE 7 LANDFILLS This landfill received construction debris from the demolition of Zone 7 buildings.	SWMU 43: Burning Ground Landfill 7 This landfill received waste, ash and residue from the burn pads, burn trays and cages, and solvent evaporation pits and pans. The landfill also contained construction debris.
SVS 7a and 7b: Igloo Demolition Debris Landfills Zone 4 (SVS 7a) and Zone 5 (SVS 7b) These landfills receive debris from the demolition of explosive storage magazines.	SWMU 44: Burning Ground Landfill 8 This landfill received waste, ash and residue from the burn pads, burn trays and cages, and solvent evaporation pits and pans. The landfill also contained construction debris.
Zone 10 Building Construction Debris Landfills: These five small landfills contain construction debris from the Zone 10 buildings.	SWMU 55: Landfill 4 Interview records for this landfill were never confirmed through the investigation. Although debris or other waste was expected to be encountered, it was not.

Landfills were included in the investigation and site-specific risk assessment for Pantex Plant. Consistent with EPA's presumptive remedy for landfills, USDOE/NNSA has installed soil or engineered covers at each of the landfills as interim corrective measures. Hotspot removals were also completed prior to cover placement, as needed, to remove higher concentrations of contaminants in near surface soils, supporting overall risk mitigation. Uncertainties typically associated with landfills regarding the potential for leaching will be addressed through long-term monitoring of the underlying and downgradient groundwater. The design of the covers will be evaluated during Remedial Design to demonstrate compliance with the RAOs, and to support RRS 3 closure requirements under the TSWDA.

2.11.1.1.2 Solvent Evaporation Pit (SWMU 47)

The solvent evaporation pit (SWMU 47) was previously used for solvent disposal at the Burning Ground. This practice contributed volatile organic contamination to soils above the perched groundwater zone. A detailed analysis of alternatives for SWMU 47 was not performed because soil vapor extraction is one of the presumptive remedies recognized by the EPA for volatile organic contamination in soil. Site characteristics of SWMU 47 meet the criteria established in the EPA publication 540-F-93-048, *Presumptive Remedies: Site Characterization and Technology Selection for CERCLA sites with Volatile Organic Compounds in Soil.* . The EPA evaluated Soil Vapor Extraction (SVE) using the remedy selection criteria set in the NCP and has determined that SVE is presumptively the most appropriate remedy for addressing VOC-impacted soil. Institutional Controls are required as part of the presumptive remedy until unrestricted use criteria are achieved. In 2002, a soil vapor extraction and treatment system was constructed as an interim stabilization measure to address the volatile organic compounds detected at SWMU 47. This area will also be included in the long-term groundwater monitoring network.

2.11.1.2 Common Elements and Distinguishing Features

The Pantex Plant will be retained by USDOE/NNSA as an active facility. Accordingly, access to the Pantex Plant is restricted. The Pantex Plant is a secured site, with physical barriers in place to prevent unauthorized access to the facility. Barbed wire fences enclose the USDOE/NNSA Pantex Plant property, the security buffer area on TTU property south of the Pantex Plant, and the Pantex Lake property. Signs are posted on these outer fences that warn the reader that the property is controlled by USDOE/NNSA and that trespassing is not allowed. Multiple security fences exist between the property boundary and the majority of the release units, particularly those in the operational areas of the site. Security personnel are posted at the site 24 hours a day; security patrols are conducted along the perimeter of the site to prevent trespassing.

All soil alternatives, with the exception of Alternative 1 – No Action, include institutional controls and long-term groundwater monitoring.

Institutional controls, specifically proprietary controls, such as restrictive covenants entered in the Carson County deed records, will be implemented to prevent use of the property for anything but industrial purposes. Industrial use includes commercial agriculture and grazing of non-dairy stock cattle for durations less than 60 days each year in the safety and security buffer areas outside operational zones or facilities. Industrial uses that differ significantly from the present USDOE/NNSA mission, such as recreational areas and onsite company daycare centers, would not be considered without further evaluation and regulatory approval. USDOE/NNSA is responsible for implementing, maintaining, reporting on and enforcing the institutional controls until cleanup standards are achieved. Details of these institutional controls will be provided in the Land and Groundwater Use Control Implementation Plan, as part of the Remedial Design submittal. Institutional controls are evaluated as a “response action” and compared to the nine criteria under the National Contingency Plan (NCP). Section 2.14.4.1 provides additional provisions for implementing institutional controls under the ROD.

Long-term groundwater monitoring will be required for those soil units evaluated in the site-specific HHRAs. Most of those units were in areas with limited soil samples in the deeper part of the vadose zone (70’ bgs to the underlying perched groundwater). The groundwater will be monitored to identify potential future impacts associated with migration. These areas of uncertainty will be included in the groundwater monitoring network developed during the Remedial Design phase.

For all soil alternatives, with the exception of Alternative 1, the integrity of remedial action equipment/components and engineered controls, such as landfill covers and fences, would be preserved using institutional controls and maintained to ensure continued effectiveness of each of the soil alternatives. Similarly, any components or features completed as interim corrective measures or interim stabilization measures (i.e. covers or systems associated with presumptive remedy units) will also be preserved using institutional controls.

Five-Year Reviews will be required for all alternatives including the “no action” alternative. The Five-Year Review is a statutory requirement pursuant to CERCLA §121 and the National Contingency Plan to review those properties not available for unrestricted use.

2.11.1.3 Soil Alternative 1 – No Action

The NCP requires that the “no action” alternative be evaluated to establish a baseline for comparison with other alternatives. Under this alternative, USDOE/NNSA would take no action to prevent exposure to soil contamination or to prevent migration of contamination to groundwater. All contaminated media would be left in its current condition with no additional controls or remediation.

2.11.1.4 Soil Alternative 2 – Institutional Controls

Alternative 2 consists of institutional controls (proprietary controls) to restrict land use, along with existing engineering controls such as barriers, fences, and security personnel to mitigate human health and environmental risks by restricting access to the impacted soil. Another fence would be constructed at SWMU 70 (Firing Site 5) to provide an additional barrier between industrial workers and the depleted uranium impacted soils.

2.11.1.5 Soil Alternative 3 – Containment with Institutional Controls

Under this alternative, soil exceeding the cleanup goal for direct contact would be covered with compacted fill and topsoil, graded for drainage, and seeded to prevent direct exposure to industrial workers. Drainage ditch soil units that pose the potential for COCs to continue to migrate to the perched groundwater would be covered with a synthetic liner to minimize infiltration and prevent exposure to contaminants. Routine inspection and maintenance would be required to ensure the covers and liners remain protective. Institutional controls to be implemented are described in Section 2.11.1.1.

2.11.1.6 Soil Alternative 4 – Removal and Offsite Disposal with Institutional Controls

Under this alternative, soil exceeding the cleanup goals would be excavated to a depth of at least two feet for the protection of industrial workers. Protection of the construction/excavation worker is achieved through institutional controls (SWMU Interference Policy). Excavated soil would be characterized and transported to the appropriate offsite disposal facility and backfilled with clean soil. Institutional controls to be implemented are described in Section 2.11.1.1.

2.11.1.7 Soil Alternative 5 – In-Situ Ozone Treatment with Institutional Controls

Some subsurface soil, primarily beneath areas of focused recharge such as ditches, contains organic COCs that are above cleanup levels. These COCs have migrated and may be continuing to migrate to perched groundwater. Under this alternative, USDOE/NNSA would treat these subsurface soils using oxidation to degrade the organic COCs to acceptable levels. This alternative includes installing injection wells to depths of approximately 260 feet in the impacted area and connecting the wells to ozone generators. Institutional controls to be implemented are described in Section 2.11.1.1.

2.11.2 Summary of Southeast Perched Groundwater Alternatives

Table 2-15 summarizes the alternatives considered for the Southeast Area perched groundwater. Costs presented for each alternative is based on a 30-year project life-cycle. The costs estimates represent the discounted present worth calculated using a nominal rate of 3.1%.

Table 2-15. Southeast Perched Groundwater Alternatives

	Alternative 1: No Action	**Alternative 2: ICs**	**Alternative 3: Pump and Treat, and ICs**	**Alternative 4: Targeted *In-Situ* Treatment and ICs**	**Alternative 5: Pump and Treat, *In-Situ* Treatment and ICs**
Southeast Perched Groundwater	$None	$9M	$28M	$487M	$105M

* Early actions for the Southeast Perched Groundwater include a pump and treat system installed as an interim stabilization measure, and another pump and treat system and *in-situ* bioremediation conducted as non-time critical removal actions.

2.11.2.1 Common Elements and Distinguishing Features

All Southeast Perched Groundwater alternatives, with the exception of Alternative 1 – No Action, include institutional controls and long-term groundwater monitoring.

Institutional controls, specifically proprietary controls, such as restrictive covenants entered in the Carson County deed records, will be implemented to prevent perched groundwater use without treatment, and drilling into and/or through the perched zone without authorization from USDOE/NNSA. The integrity of remedial action equipment/components and monitoring wells that comprise the Long-Term Groundwater Monitoring Network would be preserved using institutional controls to ensure continued effectiveness of each of the remedial alternatives for the Southeast Perched Groundwater. USDOE/NNSA is responsible for implementing, maintaining, reporting on and enforcing the institutional controls until cleanup standards are achieved. A summary of inspection results would be provided annually in the progress report required through the IAG. Details of these institutional controls will be provided in the Land and Groundwater Use Control Implementation Plan, part of the Remedial Design submittal.

A MNA assessment completed in 2000, identified RDX degradation products in perched groundwater through sampling of twenty perched monitoring wells. The monitoring wells sampled were situated along the axes of the high explosive plumes originating from the Playa 1 and Zone 12 areas. The selected locations represent concentrations of contaminants and degradation products for a range of distances from the source and cover a range of RDX concentrations anticipate in perched groundwater beneath the site (i.e., from below the detection limit to greater than 1,000 μg/L). Sampling results indicate that degradation is occurring naturally; however, site-specific rates have not been determined. MNA is not considered a component of the Selected Remedy in this ROD, because additional monitoring is needed to improve site-specific understanding of natural attenuation of the perched groundwater COCs.

The current monitoring program is used to gather data needed to track the progression of natural attenuation. Additional wells and sample analyses will enable better evaluation of contaminant migration and uncertainties identified during the investigation phase, improve evaluation of active components of the remedies, and enable monitoring of natural attenuation parameters. The number and location of wells will be determined during the design phase and compliance plan modification. For cost estimating purposes, it was assumed that two new perched wells and eight new Ogallala wells would be installed, for a total of 37 perched ground water monitoring wells and 36 Ogallala Aquifer monitoring wells.

Each of the alternatives result in hazardous substances remaining on site above levels that allow for unlimited use and unrestricted exposure, so a review is required within five years after initiating the remedial action.

2.11.2.2 Southeast Area Groundwater Alternative 1 – No Action

The NCP requires that the "no action" alternative be evaluated to establish a baseline for comparison with other alternatives. Under this alternative, USDOE/NNSA would take no action to prevent perched groundwater contaminant migration and exposure. All contaminated media would be left in its current condition with no additional controls or remediation.

2.11.2.3 Southeast Area Groundwater Alternative 2 – Institutional Controls

Alternative 2, Institutional Controls, is similar to the "No Action" alternative; however, under this alternative, long-term groundwater monitoring, and institutional controls (proprietary controls) would be implemented. All early actions, however, would be discontinued. Natural attenuation processes would be the only mechanism to reduce the concentrations of COCs.

2.11.2.4 Southeast Area Groundwater Alternative 3 – Pump and Treat and Institutional Controls

This alternative would maintain use of the current Southeast Pump and Treat System until remedial goals are met. (For cost estimates purposes, 30 years was assumed for the treatment period.) All other early actions would be discontinued. The SEPTS would treat HEs and VOCs using granular activated carbon, and treats hexavalent chromium and boron using ion exchange systems.

Modeling efforts demonstrate that cumulative RDX mass exiting the perched groundwater zone can be reduced by over 50 percent, if extracted groundwater is not injected back into the perched groundwater after treatment. For this reason, this alternative seeks to limit the injection of extracted groundwater after treatment (i.e., groundwater recirculation). Instead, USDOE/NNSA would seek to beneficially use treated groundwater for a combination of onsite and/or offsite irrigation and industrial uses that would not contribute to recharge of the perched groundwater beneath the site. Long-term groundwater monitoring and institutional controls would be implemented to prevent exposure to perched groundwater constituents above cleanup standards.

2.11.2.5 Southeast Area Groundwater Alternative 4 – Targeted In-Situ Treatment and Institutional Controls

In addition to institutional controls and long-term groundwater monitoring, this alternative provides for targeted *in-situ* treatment along the south and east fringes of the perched groundwater at the Pantex Plant. Extraction from the wells associated with the current SEPTS and all other early actions would cease.

Several *in-situ* remediation technologies have been investigated at the Pantex Plant. These technologies include enhanced anaerobic bioremediation, redox manipulation using either sodium dithionite ($Na_2S_2O_4$) or calcium polysulfide (CaS_5), and chemical oxidation using potassium permanganate ($KMnO_4$). Extensive research has been conducted both at the Pantex Plant and other United States sites that demonstrates the effectiveness of the technologies proposed in this alternative. Collectively, these technologies would treat HEs and VOCs, and transform and immobilize hexavalent chromium. Each technology would need to be matched with the COCs requiring treatment in the area of application.

Since HEs are the primary risk driving COCs in the southeast perched groundwater, enhanced anaerobic bioremediation would be implemented. A field-scale study of this treatment technology indicates that it will effectively transform hexavalent chromium. Bench-scale testing is being performed as part of the remedial design to confirm that the chromium is immobilized through the process. Other *in-situ* treatment technologies could be implemented, if performance monitoring of the enhanced anaerobic bioremediation identifies the need.

The *in-situ* treatment will be focused on an area upgradient of the southern extent of perched saturation, which corresponds to where the groundwater model predicted the initial and most significant migration of impacted perched groundwater through the FGZ. Another line of treatment focuses on the southeasterly migrating plume (upgradient of the southernmost limit of saturation) where the FGZ permeability is less certain. The remedial objective for both treatment areas would be to mitigate the potential contaminant migration to the underlying Ogallala Aquifer. The locations and distribution of the treatment zones reflect an uncertainty regarding where the FGZ becomes more permeable relative to the RDX plume. The conceptual design errs on the side of conservatism by treating a broad RDX area, as opposed to only along a line of treatment.

The main treatment technology evaluated in this remedial action alternative is anaerobic *in-situ* bioremediation. In this alternative, several lines of regularly spaced vertical injection wells would be installed in the highest concentrations of the RDX plume, south of the Pantex Plant and on property east of FM 2373. The injection well lines would be oriented perpendicular to the direction of perched groundwater flow. Amendments, consisting of food-grade soybean oil, sodium lactate, sodium bicarbonate, and proprietary non-ionic surfactants, would be injected into the perched groundwater, and allowed to ferment to provide an anaerobic environment for reductive biodegradation of constituents.

The amendments would be injected periodically until RDX concentrations in this zone meet the remedial goals. The injections would occur over a short period of a few weeks, and would rely on temporary increases in head and radial flow away from the wells to distribute the amendment around and between the injection wells.

Extraction of groundwater would help to minimize the potential for increased flux across the FGZ associated with amendment injection and enhance groundwater circulation. The alternative proposes to remove the same amount of fluid as injected. The extraction rates are expected to proceed at a sufficient rate and duration to maintain the pre-existing hydraulic gradient until an amount of water equal to the volume injected each cycle is removed. Treated effluent would not be injected back into the perched zone. Instead, the treated effluent would be beneficially used for industrial processes and/or irrigation in onsite and offsite locations that would not contribute to recharge of the perched groundwater.

The primary focus of long-term groundwater monitoring would be performance of the *in-situ* treatment by assessing movement of the amendments through the groundwater, and subsurface conditions including COC concentrations and destruction. Performance monitoring requirements will be detailed in the Long-Term Groundwater Monitoring Plan that is part of the Remedial Design.

2.11.2.6 Southeast Area Groundwater Alternative 5 –Pump & Treat, In-Situ Treatment and Institutional Controls

Alternative 5 leverages a combination of technologies, including those previously discussed in the other alternatives and previously implemented as early actions. The combined technologies will address areas of immediate concern, and work together to achieve the longer-term remedial action objectives. *In-situ* anaerobic bioremediation will address the immediate need to reduce COC concentrations in the southeast area of the Plant. The SEPTS and the recently installed Playa 1 Pump and Treat System (P1PTS) will reduce the volume of perched groundwater over time, slowing migration of the contaminant plume to the critical southeast area and reducing the COC mass. Institutional controls would restrict use and access to the perched groundwater for the life of the project. USDOE/NNSA, TCEQ, and EPA have agreed not to drill through the perched ground water and the FGZ, into the Ogallala Aquifer, to reduce the risk of cross-contamination. The community supports this drilling constraint.

In-Situ Treatment for the Southeast Area (Immediate Concern):

An anaerobic *in-situ* bioremediation treatment system, scaled down from the system described in Alternative 4, has been installed as an early action to address the south and east fringes of the perched groundwater zone. Treatment focuses on an area of increasing vertical permeability in the FGZ, as documented in the Groundwater RFI (Stoller, 2004b). The thinner zone of saturation in this area makes pump and treat impractical; therefore, other remedial technologies were evaluated to treat the high concentrations of RDX. Pilot studies demonstrated that *in-situ* bioremediation is effective at reducing the concentrations of RDX in these sensitive areas where pump and treat is not feasible.

Treatment will decrease COC concentrations and minimize the potential for increased COC flux across the FGZ in this transitional area, identified as the area of most significant predicted impact to the Ogallala Aquifer through fate and transport modeling completed for the HHRA (BWXT Pantex/SAIC, 2006). Implementation of *in-situ* treatment will be used to provide an anaerobic environment for reductive biodegradation of HEs and VOCs, and the abiotic transformation of hexavalent chromium.

Pump and Treat Systems (Playa 1 and the Southeast Area):

The pump and treat component of Alternative 5 is important to the achievement of long-term remedial goals to reduce contaminant mass and prevent further migration of the perched ground water plume toward the critical southeast area. The combined effect of the expanded SEPTS and the recently constructed P1PTS will:

- Reduce concentrations of COCs in the perched groundwater.
- Stabilize, contain, and/or slow the migration of impacted perched groundwater southeast of the Pantex Plant, downgradient of the southeast corner of the Plant (COCs, primarily RDX, in this area comprise the primary potential threat to the Ogallala Aquifer based on predictive modeling). Water levels adjacent and east of FM 2373 are expected to decrease with sustained pumping, resulting in active remediation of perched groundwater beneath this area.
- Reduce the volume of water moving through the perched flow system. Alternatives that are effective in reducing the volume of water moving through the perched zone will also reduce the potential for vertical migration of COCs to the Ogallala Aquifer. Reduction of the volume of perched groundwater and its flow, and RDX mass flux across the southern boundary (lateral extent) of the perched groundwater flow system, is most critical based upon observed site conditions and predictive modeling.
- Reduce the upgradient driving head. Alternatives that reduce the upgradient driving head will reduce the rate of mass flux out of the perched groundwater flow system.

The pump and treat systems, incorporated through this alternative, will enhance RDX and hexavalent chromium mass removal through vertical extraction wells installed within the footprint of those contaminant plumes, and reduce the upgradient perched groundwater driving head by extracting groundwater, mounded beneath Playa 1. Extraction wells are also located at the leading edge of the RDX plume in the southeast area to contain further migration.

The vertical wells at P1PTS are expected to remove the greatest quantity of water over the 30-year period of simulation; however, the predicted yield is expected to decline over time from each group of extraction wells.

This projected cumulative pumping rate exceeds the current granular activated carbon treatment capacity of the SEPTS (500 gpm). While uncertainty in actual well production rates justifies not planning expansion of the SEPTS, an additional treatment system is being constructed at Playa 1 as part of the non-time critical removal action to provide treatment capability redundancy and long-term operational efficiency.

Recovered perched groundwater would be beneficially used for crop irrigation after treatment by USDOE/NNSA.

Institutional Controls:

In addition to the above active systems, institutional controls also continue as described in Alternatives 2 and 3. Institutional controls, specifically proprietary controls, would restrict use and access to the perched groundwater for the life of the project; thereby effectively preventing completion of an exposure pathway.

Synergistic effects of the remedial components will be realized only when injection of treated water back into the perched groundwater is reduced and eventually eliminated. Therefore, the current practice of injecting the treated water back into the perched groundwater will be reduced, and eventually eliminated, as irrigation and other uses/disposition methods are established.

2.11.3 Summary of Zone 11 Perched Groundwater Alternatives

Table 2-16 summarizes alternatives considered for the Zone 11 perched groundwater. Costs presented for each alternative is based on a 30-year project life-cycle.

Table 2-16. Zone 11 Perched Groundwater Alternatives

	Alternative 1: No Action	**Alternative 2: ICs**	**Alternative 3: Pump and Treat System and ICs,**	**Alternative 4: Targeted *In-Situ* Treatment and ICs**
Zone 11 Perched Groundwater	$None	$9M	$29M	$30M

2.11.3.1 Common Elements and Distinguishing Features

All Zone 11 Perched Groundwater alternatives, with the exception of Alternative 1 – No Action, include institutional controls and long-term groundwater monitoring.

Institutional controls, specifically proprietary controls, such as restrictive covenants entered in the Carson County deed records, will be implemented to prevent perched groundwater use without treatment, and drilling into and/or through the perched zone without authorization from USDOE/NNSA. The integrity of remedial action equipment/components and monitoring wells that comprise the Long-Term Groundwater Monitoring Network would be preserved using institutional controls and maintained to ensure continued effectiveness of each of the remedial alternatives for the Zone 11 Perched Groundwater. USDOE/NNSA will be responsible for implementing, maintaining, reporting on and enforcing the institutional controls. A summary of inspection results would be provided annually in the progress report required through the IAG. Details of these institutional controls will be provided in the Land and Groundwater Use Control Implementation Plan that is part of the Remedial Design submittal.

Zone 11 COCs will also be evaluated for natural attenuation potential. Monitoring will establish if degradation is occurring to determine the site-specific rates, as well as evaluate other indicator parameters important to contaminant fate and transport decisions.

The current monitoring program would be used to track the progression of natural attenuation processes. Additional wells would be added to better characterize contaminant migration and uncertainties identified during the investigation phase, evaluate active components of the remedies, and monitor natural attenuation parameters. The number and location of wells will be determined during the design phase and compliance plan modification. For cost estimating only, it was assumed that two new perched wells and eight new Ogallala wells would be installed, for a total of 37 perched ground water monitoring wells and

36 Ogallala Aquifer monitoring wells. This monitoring network will be a part of every alternative, with the exception of the "No Action" alternative.

Each of the alternatives would result in hazardous substances remaining on site above levels that allow for unlimited use and unrestricted exposure, so a review is required within five years after initiating the remedial action.

2.11.3.2 Zone 11 Alternative 1 – No Action

The NCP requires that the "no action" alternative be evaluated to establish a baseline for comparison with other alternatives. Under this alternative, USDOE/NNSA would take no action to prevent migration of and exposure to perched groundwater contaminants. All contaminated media would be left in its current condition with no additional controls or remediation.

2.11.3.3 Zone 11 Alternative 2 – Institutional Controls

Alternative 2 is similar to the "No Action" alternative; however, under this alternative, long-term monitoring, and institutional controls would be implemented. Proprietary controls such as restrictive covenants entered in the Carson County deeds will be implemented to prevent perched groundwater use without treatment, and drilling into and/or through the perched zone without authorization from USDOE/NNSA. USDOE/NNSA will be responsible for implementing, maintaining, reporting on and enforcing the institutional controls. Figure 2-25 depicts the general areas where institutional controls would be applied for perched groundwater.

2.11.3.4 Zone 11 Alternative 3 – Pump and Treat and Institutional Controls,

This alternative uses institutional controls to limit exposure to perched groundwater COCs. A perched groundwater pump and treat system for Zone 11 would be constructed and operated for up to 30 years; no additional remedial actions would be undertaken to treat or contain COCs in the Zone 11 perched groundwater. An *ex situ* treatment system would be used to remove HEs, VOCs, and perchlorate using granular activated carbon, ion exchange, and other appropriate technologies. Treated effluent would be discharged with the effluent from the SEPTS or injected back into the perched zone for recirculation, depending on the selected design of the groundwater extraction system.

The identified extraction area is upgradient of the southern Plant boundary with TTU property. Extraction of perched groundwater in these areas would prevent further migration of groundwater containing HEs, VOCs, and perchlorate onto TTU property. Treatment of the groundwater onsite would also minimize the potential for migration to the underlying Ogallala Aquifer near Playa 4, where uncertainty is associated with the characteristics of the FGZ.

Enhanced monitoring of this plume is recommended to confirm the rate of migration of COCs and to collect data for corrective/remedial action design for this area.

2.11.3.5 Zone 11 Alternative 4 – Targeted In-Situ Treatment and Institutional Controls

In addition to the current institutional controls and monitoring program, this alternative provides for targeted *in-situ* treatment south of Zone 11. Enhanced anaerobic bioremediation has been demonstrated to be effective for HEs, VOCs (including chlorinated solvents), and perchlorate. The potential location for the *in-situ* enhanced anaerobic bioremediation treatment is an area downgradient of Zone 11, where higher concentrations of perchlorate and TCE are present. This treatment area would be placed upgradient of the southern Plant boundary with TTU property, or on TTU property, to prevent the migration of groundwater containing HEs, VOCs, and perchlorate further to the south, beneath Playa 4. Treatment of the groundwater onsite would also minimize the potential for migration to the underlying Ogallala Aquifer near Playa 4, where uncertainty is associated with the characteristics of the FGZ. Performance monitoring would be conducted to assess amendment movement through groundwater, as well as the subsurface conditions including COC concentrations and destruction.

2.12 Comparative Analysis of Alternatives

This section contains a comparative analysis of remedial action alternatives using the nine NCP criteria (40 CFR §300.430 (e)(9)(iii)) to select site remedies for the cleanup of soil release units and perched groundwater at the site.

2.12.1 Description of the Nine Evaluation Criteria

The nine evaluation criteria are categorized into three groups: threshold, balancing, and modifying. The threshold criteria must be met in order of an alternative to be eligible for selection. The threshold criteria are overall protection of human health and the environment and compliance with ARARs. The balancing criteria are used to weigh major tradeoffs among alternatives. The five balancing criteria are long-term effectiveness and permanence; reduction of toxicity, mobility, or volume through treatment; short-term effectiveness; implementability; and cost. The modifying criteria are state acceptance and community acceptance. Each of these criteria is described in greater detail in Table 2-17.

Table 2-17. Description of Evaluation Criteria

Threshold Criteria:
• Overall Protectiveness of Human Health and the Environment determines whether an alternative eliminates, reduces, or controls threats to public health and the environment through institutional controls, engineering controls, or treatment. • Compliance with Applicable or Relevant and Appropriate Requirements (ARARs) evaluates whether the alternative meets Federal and State environmental statutes, regulations, and other requirements that pertain to the site. ARARs may be waived under certain circumstances. ARARs are divided into chemical-specific, location-specific, and action-specific criteria.
Primary Balancing Criteria:
• Long-Term Effectiveness and Permanence considers the ability of an alternative to maintain protection of human health and the environment over time. It evaluates magnitude of residual risk and adequacy of reliability of controls. • Reduction of Toxicity, Mobility, or Volume of Contaminants through Treatment evaluates an alternative's use of treatment to reduce the harmful effects of principal contaminants, their ability to move in the environment, and the amount of contamination present. • Short-Term Effectiveness considers the length of time needed to implement an alternative and the risks the alternative poses to workers, residents, and the environment during implementation. • Implementability considers the technical and administrative feasibility of implementing the alternative, including factors such as the relative availability of goods and services. • Cost includes estimated capital and annual operations and maintenance costs, as well as present worth cost. Present worth cost is the total cost of an alternative over time in terms of today's dollar value. Cost estimates are expected to be accurate within a range of +50 to -30 percent.
Modifying Criteria:
• State Support/Agency Acceptance considers whether EPA and TCEQ agree with the analyses and recommendations by the DOE. • Community Acceptance considers whether the local community agrees with the Preferred Alternative. Comments received on the Statement of Basis/Proposed Plan during the public comment period are an important indicator of community acceptance.

2.12.2 Comparative Analysis of Soil Alternatives

2.12.2.1 Overall Protection of Human Health and the Environment

Overall protection of human health and the environment addresses whether each alternative provides adequate protection of human health and the environment and whether an alternative eliminates, reduces, or controls threats to the public health and the environment through institutional controls, engineering controls, or treatment. This is a threshold criterion.

Alternative 1, "No Action," is not protective of human health and the environment, because it provides no monitoring of contaminants or restrictions to prevent exposure. Alternative 2, "Institutional Controls," is protective since it mitigates potential exposure to impacted surface soil by implementing, maintaining, reporting on, and enforcing the ICs needed to prevent exposure to the contaminants. Institutional controls are protective for SWMU 47 when coupled with the presumptive remedy of a SVE system and ongoing modifications to maintain its effectiveness. Alternative 3, "Containment," is protective because covering contaminated soils with clean soils and vegetation (or a liner) provides a barrier to the exposure pathways of concern. . Alternative 4, "Removal and Offsite Disposal," and Alternative 5, "*In-Situ* Ozone Treatment," are the most protective remedies since the contaminated soils are removed or treated.

2.12.2.2 Compliance with ARARs

Section 121 (d) of CERCLA and the NCP (40 CFR §300.430 (f)(1)(ii) (B)) require that remedial actions at CERCLA sites attain legally applicable or relevant and appropriate Federal and State requirements, standards, criteria, and limitations which are collectively referred to as “ARARs,” unless such ARARs are waived under CERCLA §121(d)(4). This is a threshold criterion.

Applicable requirements are those cleanup standards, standards of control, and other substantive requirements, criteria, or limitations promulgated under Federal environmental or State environmental or facility siting laws that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance found at a CERCLA site. Only those State standards that are identified by a state in a timely manner and that are more stringent than Federal requirements may be applicable. Relevant and appropriate requirements are those cleanup standards, standards of control, and other substantive requirements, criteria, or limitations promulgated under Federal environmental or State environmental or facility siting laws that, while not “applicable” to a hazardous substance, pollutant, contaminant, remedial action, location or other circumstance at a CERCLA site, are well-suited for addressing problems or situations sufficiently similar to those encountered at the CERCLA site under consideration.

Applicable or relevant and appropriate requirements (ARARs) for soil alternatives were determined as follows:

- Resource Conservation and Recovery Act (40 CFR parts 260-280, 42 USC § 6901-6933)
- Pantex Plant Compliance Plan for Industrial and Solid Waste Management (CP-50284) (TSWDA, Texas Health & Safety Code, Chapter 361; 30 TAC Chapters 305, 335 and 350)
- Texas Health & Safety Code, Section 382.085: Unauthorized Emissions Prohibited
- Procedures for Planning and Implementing Offsite Response Actions [The EPA Offsite Rule] (40 CFR §300.440)
- Shipping and Reporting Procedures Applicable to Generators of Hazardous Waste or Class 1 Waste and Primary Exporters of Hazardous Waste (30 TAC §335.10)

- Hazardous Material Transportation Act (49 USC § 5101-5127)
- Hazardous Materials Regulations (49 CFR §171.1 et seq.)
- Underground Injection Control (40 CFR Parts 144-148, et. seq.; 30 TAC 331)

All alternatives, except Alternative 1 - No Action, comply with ARARs. The action-specific requirements vary with the alternatives. However, all of the ARARs should be readily achievable. Alternative 2 - Institutional Controls requires no excavation or transportation of contaminated soils. Implementation requires placing restrictions in the Carson County deed records and maintenance of physical barriers, such as fences. These physical barriers are already in place for operational reasons, or can be constructed on land already owned by USDOE/NNSA. Emissions from the SVE presumptive remedy for SWMU 47 comply with permit by rule requirements of the Texas Health and Safety Code. Alternative 3 - Containment and Institutional Controls requires maintenance of landfill covers and/or liners installed in ditches as interim corrective measures and interim stabilization measures under previously issued orders, permits, and compliance plans. No hazardous or Texas Class 1 waste would be generated, handled, or transported. Fugitive dust could be managed in compliance with State laws. Alternative 4 - Removal and Offsite Disposal requires excavation and disposal of soils contaminated with depleted uranium. Excavation of these soils would generate low-level radioactive waste that would be handled, packaged and transported in accordance with the appropriate Department of Transportation hazard classification to an EPA approved facility, in accordance with 40 CFR §300.440 or the low-level radioactive waste landfill at the USDOE/NNSA Nevada Test Site. Alternative 5 – *In-Situ* Ozone Treatment requires TCEQ approval for installation of the injections wells and underground injection of the ozone. This process has been implemented for pilot studies conducted at the site in shallower soils and is therefore attainable in compliance with underground injection control regulations and the TCEQ CP-50284.

2.12.2.3 Long-term Effectiveness and Permanence

Long-term effectiveness and permanence refers to expected residual risk and the ability of a remedy to maintain reliable protection of human health and the environment over time, once cleanup levels have been met. This criterion includes the consideration of residual risk that will remain onsite following remediation and the adequacy and reliability of controls.

All of the alternatives, except for Alternative 1 - No Action, are effective and provide varying levels of permanence. Alternative 2 – Institutional Controls and Alternative 3 - Containment do not include treatment, but manage the potential risk from contaminated soils by institutional controls and/or covering/lining, which can both be maintained. The SVE presumptive remedy for SWMU 47 removes and treats VOCs, resulting in long-term effectiveness through permanent reduction of the contaminants. Alternative 3 is slightly more permanent because the soils are covered and/or lined, providing a physical barrier to the contaminants. Alternative 4 – Removal and Offsite Disposal and Alternative 5- *In-Situ* Ozone Treatment are more effective and permanent than the others because the impacted soils would be physically removed or the contaminants would be treated to achieve cleanup standards.

2.12.2.4 Reduction of Toxicity, Mobility, or Volume of Contaminants through Treatment

Reduction of toxicity, mobility, or volume through treatment refers to the anticipated performance of the technologies that may be included as part of the remedy.

The toxicity, mobility, and volume of COC in soils will not be reduced by Alternatives 1 and 2, No Action and Institutional Controls, respectively. Alternative 3 - Containment will not reduce the toxicity and volume of COCs in soil, but will reduce the mobility of the COCs through placement of a physical barrier to air dispersion, direct contact and precipitation. Alternative 4 – Removal and Offsite Disposal, and Alternative 5 – *In-Situ* Ozone Treatment, and the SVE presumptive remedy for SWMU 47 will reduce the toxicity, mobility, or volume of COCs in soil because the impacted soils would be physically removed or the contaminants would be treated to reduce the volume of contaminants .

2.12.2.5 Short-term Effectiveness

Short-term effectiveness addresses the period of time needed to implement the remedy and any adverse impacts that may be posed to workers, the community, and the environment during construction and operation of the remedy until cleanup levels are achieved. All of the alternatives are effective in the short-term, but vary in the amount of time to reach RAOs and prevent potential exposure.

The short-term effectiveness of Alternatives 1 and 2 (No Action and Institutional Controls) are high because there will be limited or no disturbance of contaminated soils during implementation. The short-term effectiveness for Alternative 3, 4 and 5 (Containment, Removal and Offsite Disposal, and In Situ Ozone Treatment) and the SVE presumptive remedy for SWMU 47 (with future modifications) is lower because there is a greater potential for fugitive dust emissions and risks to construction workers during the implementation of these remedial action alternatives (installation of covers and liners, excavation of contaminated soils and backfill with clean soils, and installation of injection wells, equipment and conveyance lines for ozone treatment).

2.12.2.6 Implementability

Implementability addresses the technical and administrative feasibility of a remedy from design through construction and operation. Factors such as availability of services and materials, administrative feasibility, and coordination with other governmental entities are also considered.

All alternatives (including the SVE presumptive remedy for SWMU 47 and future modifications to maintain effectiveness), except for Alternative 5 – *In-Situ* Ozone Treatment, are readily implementable. Alternative 4 – Removal and Offsite Disposal is more difficult to implement than the first three alternatives, because of the excavation and soil transportation activities. Alternative 5 would be most difficult to implement because it requires the installation of deep injection wells and uncertainty remains regarding the number and spacing of wells needed to distribute the ozone fully to reach the COCs within the vadose zone.

2.12.2.7 Cost

The costs of the remedial alternatives are dependent on the sizes of the impacted soil units. Alternative 3 – Containment and Institutional Controls, consists of covers and liners were previously installed as interim actions. Cost to inspect and maintain the covers and liners is considered negligible. Generally, Alternatives 1 and 2 are the most cost effective, cost for modifications to the SVE presumptive remedy for SWMU 47 are moderate, and Alternatives 4 and 5 are the most costly to implement.

2.12.2.8 State/Support Agency Acceptance

The TCEQ has reviewed and conditionally approved the CMS/FS and the Proposed Plan. Conditions of approval recognize post-ROD modification of the Compliance Plan for meeting State closure requirements.

2.12.2.9 Community Acceptance

The Proposed Plan was made available to the public for review and comment on March 17, 2008. Comments were received from the public through April 28, 2008. Responses to comments received are provided in Section 3.1.2.

2.12.3 Comparative Analysis of Southeast Perched Groundwater Alternatives

2.12.3.1 Overall Protection of Human Health and the Environment

Overall protection of human health and the environment addresses whether each alternative provides adequate protection of human health and the environment and whether an alternative eliminates, reduces, or controls threats to the public health and the environment through institutional controls, engineering controls, or treatment. This is a threshold criterion.

Alternative 1 – "No Action," would not restrict onsite use of groundwater, so a risk to human health would persist if the perched groundwater was used as a drinking water source. Migration of impacted perched groundwater and potential risks to offsite receptors would also persist.

Alternative 2, "Institutional Controls," would result in restricting access to and use of the contaminated perched ground water, thereby protecting human health by preventing contact with perched groundwater contaminants while they are being slowly reduced through natural processes. This would be accomplished using tools such as restrictive covenants placed in the property deed. Vertical migration of COCs toward the Ogallala Aquifer would not be slowed because this alternative does not include active remedies that would reduce the volume of perched groundwater or alter its flow direction and gradient.

Alternative 3 combines perched groundwater restrictions, implemented through proprietary controls such as restrictive covenants place in the deed, to prevent direct human health exposure and a pump and treat system in the southeast area of the perched groundwater to reduce COC concentrations. The SEPTS would continue to extract and treat COCs in that area of perched groundwater beneath the plant; injection of treated water back into the perched zone would be limited, reducing the volume of perched groundwater upgradient of the area of the fine-grained zone predicted to be most sensitive to vertical migration. Concentrations would be reduced in the long-term, but the immediate threat to the Ogallala Aquifer (by vertical migration from the perched groundwater) would not be addressed satisfactorily; future potential impacts to the Ogallala drinking water aquifer would remain.

Alternative 4 (*In-Situ* treatment) would significantly reduce COC concentrations in the perched groundwater. However, continued migration is still expected since this remedy does not reduce the volume of southeast perched groundwater or driving head for vertical migration of perched groundwater into the fine-grained zone. As with Alternatives 1, 2, and 3, Alternative 4 would establish institutional controls, implemented through proprietary controls such as restrictive covenants placed in the deed, to restrict use of the perched ground water and drilling into and through the perched zone without authorization from USDOE/NNSA.

Alternative 5 slows migration into and through the area where a vertical pathway may exist to the Ogallala Aquifer and addresses COCs using *in-situ* treatment. This alternative reduces the volume of southeast perched groundwater and, subsequently, the driving force for vertical migration of perched groundwater into the FGZ. Alternative 5 focuses on reducing both the concentrations and mass of risk driving contaminants in areas sensitive to vertical migration that could lead to predicted Ogallala Aquifer impacts and the saturated thickness of perched groundwater throughout the southeast area. This dual-tiered approach provides immediate protection of the Ogallala Aquifer with a long-term, robust plan for protecting human health and the environment, despite uncertainties about the geology and degradation of RDX. Long-term monitoring will be used to gather data to further evaluate the potential contribution of protection afforded through natural attenuation for the perched groundwater COCs. Institutional controls, implemented through proprietary controls, would prevent exposure to COCs in the perched groundwater and prevent the potential for cross-contamination of the Ogallala Aquifer by restricting drilling into and through the perched zone without USDOE/NNSA authorization.

2.12.3.2 Compliance with ARARs

Section 121 (d) of CERCLA and the NCP (40 CFR §300.430 (f)(1)(ii) (B)) require that remedial actions at CERCLA sites attain legally applicable or relevant and appropriate Federal and Stat requirements, standards, criteria, and limitations which are collectively referred to as “ARARs,” unless such ARARs are waived under CERCLA §121(d)(4). This is a threshold criterion.

Applicable requirements are those cleanup standards, standards of control, and other substantive requirements, criteria, or limitations promulgated under Federal environmental or State environmental or facility siting laws that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance found at a CERCLA site. Only those State standards that are identified by a state in a timely manner and that are more stringent than Federal requirements may be applicable. Relevant and appropriate requirements are those cleanup standards, standards of control, and other substantive requirements, criteria, or limitations promulgated under Federal environmental or State environmental or facility siting laws that, while not “applicable” to a hazardous substance, pollutant, contaminant, remedial action, location or other circumstance at a CERCLA site, are well-suited for addressing problems or situations sufficiently similar to those encountered at the CERCLA site under consideration.

Groundwater ARARs include:

- Safe Drinking Water Act (SDWA, P. L. 104-182, 40 CFR Part 141, et. seq.)
- Resource Conservation and Recovery Act (40 CFR parts 260-280, 42 USC § 6901-6933)
- Compliance Plan (CP-50284) (TSWDA, Texas Health & Safety Code, Chapter 361; 30 TAC Chapters 305, 335 and 350)
- General Regulations Incorporated into Permits (30 TAC 305 and 30 TAC 319) and Chapter 26 of the Texas Water Code
- Texas Water Code, Chapter 26, 30 TAC 305
- Section 402 of the Clean Water Act and Chapter 26 of the Texas Water Code (TPDES MSGP, TXR 150000)
- Underground Injection Control (40 CFR Parts 144-148, et. seq.;30 TAC 331)

Alternative 1, "No Action," does not provide any means for achieving regulatory compliance.

Alternative 2, "Institutional Controls," would prevent exposure to perched groundwater COCs and cross-contamination to the Ogallala Aquifer. Compliance with ARARs would be achieved by this alternative, only after COCs attenuate over two to three lifetimes. Natural attenuation is not predicted by modeling to occur quickly enough to prevent impact to the underlying Ogallala Aquifer above cleanup standards. Institutional controls would prevent exposure to the contaminants until cleanup is achieved through natural attenuation.

Estimates indicate that Alternative 3, "Pump and Treat," achieves ground water cleanup standards in 200 or more years, in the perched groundwater. However, operation of only the SEPTS might not reduce the contaminants and vertical migration potential of the perched groundwater quickly enough to prevent impact to the underlying Ogallala Aquifer above cleanup standards. The pump and treat system can be installed and operated in compliance with CP-50284 and UIC requirements. Institutional controls prevent exposure to the contaminants until cleanup is achieved.

Alternative 4, "Targeted *In-Situ* Treatment," treats the southern and southeastern portions of the plume and minimizes further migration; however, the timeframe for achieving media-specific cleanup standards for perched COCs is estimated at 100 years. Cleanup standards would eventually be met throughout the plume through implementation of *in-situ* treatment and . In the areas sensitive to vertical migration, COCs would be reduced to cleanup standards within 18 months and maintained through the addition of amendments on a semi-annual to annual basis. Compliance with underground injection control requirements, well construction requirements, and Safe Drinking Water Act MCLs is achievable.

Alternative 5, "Pump & Treat and *In-Situ* Treatment," achieves media-specific cleanup standards throughout the perched groundwater within approximately 200 years. In the areas sensitive to vertical migration, COCs would be reduced to cleanup standards within 18 months and maintained through the addition of amendments on an annual basis. As with Alternatives 2 through 4, use of the perched groundwater and drilling into and through the perched zone would be restricted by institutional controls, proprietary controls implemented through restrictive covenants placed in the deed, to prevent exposure and protect potential receptors. Controls implemented at release areas at the Pantex Plant have effectively reduced future impacts to the perched groundwater; monitoring has shown that perched COC concentrations are decreasing. The pump and treat systems and *in-situ* bioremediation system, implemented as an interim stabilization measure and two non-time critical removal actions, are slowing migration and mitigate contamination in the perched groundwater, so that ARARs would be achievable in the short-term at sensitive areas and also in the long-term throughout the perched groundwater. A higher volume of perched groundwater would be removed from the southeast area under this alternative than the others, resulting in protecting the Ogallala Aquifer from perched groundwater COCs and preserving its suitability for drinking water use. Compliance with underground injection control requirements, well construction requirements, and Safe Drinking Water Act MCLs is achievable.

2.12.3.3 Long-Term Effectiveness and Permanence

Long-term effectiveness and permanence refers to expected residual risk and the ability of a remedy to maintain reliable protection of human health and the environment over time, once cleanup levels have been met. This criterion includes the consideration of residual risk that will remain onsite following remediation and the adequacy and reliability of controls.

Site-specific pilot studies and the screening analysis conducted in the FS using a single layer model (SLM) greatly helped guide the decision process. These results are part of the analysis, and do not quantify the reduction in the predicted potential impact to the Ogallala Aquifer in absolute terms. Rather, the reductions discussed in the comparative analysis are sufficient for relative judgment of the effectiveness of the alternatives.

Under Alternative 1 – No Action, only natural attenuation processes would be occurring. However, attenuation rates and long-term effectiveness are uncertain. Organic COCs such as HMX, TNT, DNT24, DNT26, DNT4A, and DNT2A would degrade naturally. Inorganic COCs such as hexavalent chromium would not naturally degrade, transform, or attenuate with significance.

In Alternative 2 - Institutional Controls, proprietary controls implemented as restrictive covenants placed in the deed are anticipated to be effective into the future, as the site will continue as an active facility, and USDOE/NNSA will implement, maintain, report on and enforce the restrictions. Long-term effectiveness of natural attenuation is uncertain; degradation rates were estimated from literature and site-specific data, but have not yet been verified. RDX degradation products were detected in the MNA assessment conducted in 2000, when twenty perched groundwater monitoring wells were sampled and analyzed. Although degradation rates were not determined, presence of these degradation products indicates that natural degradation is occurring.

Alternative 3 includes pump and treat and institutional controls. Operational records for the existing SEPTS show that COCs are being removed from the perched groundwater; however, the system is not expected to achieve significant reduction of the mass of COCs to achieve the RAOs. The SEPTS is treating 9 to 11 million gallons of perched groundwater per month. The SEPTS has treated about 600 million gallons of perched groundwater with a monthly treatment average of 7 to 11 million gallons. Continued maintenance of the current SEPTS, such as carbon filter and pump replacements, should keep the system operating effectively. Replacement parts are readily available and relatively easy to install. Long-term reduction in RDX mass exiting the perched groundwater flow system is predicted due to the lowered perched water levels and hydraulic gradients, removal of RDX by the extraction wells, and natural attenuation. Modeling indicates that after 30 years, an estimated 710 kg of RDX will have left the perched groundwater. This is approximately 65% more effective than the reduction estimated for natural attenuation processes alone. After 150 years, an estimated 990 kg of RDX will have left the perched groundwater system. This is approximately 64% more effective than the reduction estimated for natural attenuation processes alone. While operation of the current SEPTS has a positive effect on reducing the rate of contaminants leaving the perched groundwater system, it does not totally eliminate continued offsite migration of constituents at concentrations exceeding drinking water standards. Therefore, this alternative relies on institutional controls, proprietary controls implemented as restrictive covenants placed in the deed, to prevent exposure to perched groundwater contaminants and cross-contamination of the Ogallala Aquifer.

Research suggests, and pilot studies performed at the Pantex Plant support, that ISB proposed in Alternative 4 would be effective in reducing COC concentrations in the perched groundwater. Degradation rates used for targeted treatment are estimated from available site data, but have not been measured directly at the site under site-specific conditions; thus, there is some uncertainty in the estimated mass removed. Degradation rates used in the modeling are at the low end (i.e., slowest rate) for areas not targeted for treatment relative to published literature values. The half-life of RDX represented for the targeted treatment zones in the model (10 days) is within the range determined from treatability testing, but is still subjective and carries a degree of uncertainty. Modeling indicates that after 30 years, an estimated 370 kg of RDX will have left the perched groundwater system. This is approximately an 82% greater reduction than the reduction estimated for natural attenuation processes alone; approximately 80% of the initial mass in the system is estimated to be removed in this alternative. After 150 years of simulation, an estimated 720 kg of RDX will have left the perched groundwater system. This is approximately 77% more effective at reducing the rate of contaminants leaving the perched groundwater system than the reduction estimated for natural attenuation processes alone. The long-term reliability of anaerobic ISB is uncertain due to subsurface heterogeneity and the ability to distribute the amendment evenly in the target area. Also, the effects of the geochemical environment on amendment effectiveness are uncertain. This alternative relies on institutional controls, proprietary controls implemented as restrictive covenants placed in the deed, to ensure that no one is exposed to perched groundwater contaminants and that cross-contamination of the Ogallala Aquifer does not occur.

Alternative 5 – Pump & Treat and *In-Situ* Treatment is estimated to remove approximately 4,310 kg of RDX in 30 years of active remediation. After 30 years of simulation, predicted RDX mass flux is estimated at 150 kg of RDX. After 150 years, 240 kg of RDX is estimated to leave the perched groundwater system. This is approximately 90% more effective than the reduction estimated for natural attenuation processes alone. Further, the extraction of perched groundwater at Playa 1 reduces the upgradient driving head for all areas downgradient of Playa 1, resulting in longer term reduction in RDX mass flux out of the perched groundwater by permitting more time for degradation and other attenuation processes. Pumping near Playa 1 also reduces the impacts of uncertainties associated with geologic heterogeneities in the perched groundwater flow system, by reducing the head of perched groundwater on the FGZ throughout the system. Investigations of the perched groundwater zone have identified geologic heterogeneities where more transmissive areas exist adjacent to less transmissive areas. Reduction of the upgradient hydraulic heads will affect zones exhibiting both of these conditions and mitigate, to some extent, the need to know exactly where all of the more transmissive regions are located. This alternative relies on institutional controls, proprietary controls implemented as restrictive covenants placed in the deed, to ensure that no one is exposed to perched groundwater contaminants and that cross-contamination of the Ogallala Aquifer does not occur.

2.12.3.4 Reduction of Toxicity, Mobility, or Volume of Contaminants through Treatment

Reduction of toxicity, mobility, or volume through treatment refers to the anticipated performance of the technologies that may be included as part of the remedy.

Under Alternative 1 - No Action, no active measures are taken to reduce COC toxicity, mobility, or volume. Naturally occurring processes including sorption, degradation, and dispersion (mixing) reduce mobility and toxicity.

Under Alternative 2 - Institutional Controls, no active measures are taken to reduce COC toxicity, mobility, or volume. Natural attenuation processes result in an estimated reduction in RDX mass at 30 years of 4,880 kg, with 6,290 kg at 150 years. This equates to approximately 48% of the initial mass in the modeled portion of the system being degraded in 30 years, and 62% of the initial mass in the modeled portion of the system being degraded in 150 years.

Alternative 3 – Pump and Treat uses the existing SEPTS to reduce the toxicity, mobility, and volume of constituents in perched groundwater. Data from historical operation of the existing SEPTS and transport simulations were used to estimate mass removal rates for this alternative. The SEPTS without injection of the treated water removes an estimated 2,800 kg of RDX over the 30-year period of operation and an estimated 3,700 kg of RDX after 150 years. This equates to approximately 31% of the initial mass in the modeled portion of the system being treated in 30 years, and 41% of the initial mass in the modeled portion of the system being treated in 150 years. This alternative reduces the volume of water leaving the perched groundwater flow system by 25% (806 million gallons) in 30 years. The model-predicted volume of groundwater extracted over 30 years of pumping is 1.83 billion gallons. Travel times to the boundaries are increased, allowing more time for degradation, and the volume of perched groundwater leaving the southeast area is reduced by 1.5 billion gallons. Natural attenuation processes result in an estimated reduction in RDX mass at 30 years of 3,130 kg, with 4,120 kg at 150 years. The RDX mass reduction results from lowered perched water levels and hydraulic gradients, removal of RDX by the extraction wells, and from natural attenuation. The reduction in water levels and hydraulic gradients also increases travel time, thus providing more time for natural attenuation processes to occur.

Alternative 4 - Targeted *In-Situ* Treatment results in an estimated reduction in RDX mass of 6,940 kg and 8,140 kg at 30 years and 150 years, respectively. This equates to degradation of approximately 69% of the initial mass in the modeled portion of the system in 30 years and 80% in 150 years. The focus of this alternative is treatment of the perched groundwater before it reaches the generalized area where the FGZ transitions to a less resistant and more permeable unit that exhibits a higher probability for vertical migration. Pump and treat systems to contain perched groundwater flow from beneath Playa 1 and the Zone 12 ditches is not part of Alternative 4, so the volume of water leaving the perched groundwater flow system would be similar to the Institutional Controls alternative (Alternative 2). Treatability studies demonstrate that each of the treatment technologies considered for the targeted zones has the potential to mobilize metals. *In-situ* treatment using oxidation has the potential to mobilize hexavalent chromium and result in elevated manganese. *In-situ* treatment using reduction has the potential to mobilize arsenic and strontium. In each case, the mobilization of metals has been transient, with elevated concentrations occurring post amendment injection, then declining to near pre-amendment injection levels.

Alternative 5 – Pump & Treat and *In-Situ* Treatment results in an estimated RDX mass removal rate of 4,310 kg RDX over a 30-year period of operation. While this mass removal rate is less than that of Alternative 4, groundwater extraction near Playa 1 and through the southeast area reduces the potential for long-term migration through reduction of the hydraulic head in the southeast/Playa 1 perched groundwater areas. Alternative 5 is estimated to remove 4.0 billion gallons of water from the southeast/Playa 1 perched groundwater areas.

2.12.3.5 Short-Term Effectiveness

Short-term effectiveness addresses the period of time needed to implement the remedy and any adverse impacts that may be posed to workers, the community, and the environment during construction and operation of the remedy until cleanup levels are achieved. All of the alternatives are effective in the short-term, but vary in the amount of time to reach RAOs and prevent potential exposure.

For Alternative 1 – No Action and Alternative 2 – Institutional Controls, no additional health risks to workers or the community occurs because no active remedial technologies are constructed or operated. Contaminated perched groundwater predicted to impact the Ogallala Aquifer in an area southeast of the site would continue to flow unabated.

Alternative 3 – Pump and Treat removes contaminant mass from the perched groundwater system, but provides no means for protecting the Ogallala Aquifer from the contaminants in areas where vertical migration is predicted because the FGZ transitions into a more permeable unit. Only limited new construction is associated with Alternative 3; therefore, short-term implementation risks are low. The use of personal protective equipment (PPE) and safe operating procedures would prevent adverse effects to personnel during installation of monitoring wells and subsequent sampling activities. The existing SEPTS would continue operation under this alternative following the established operating procedures at the Pantex Plant. Plant personnel are familiar with well drilling activities and operation of the treatment system equipment and processes. Work plans and safety plans would be prepared prior to installing the new monitoring wells and would be followed during construction to minimize safety risks.

In-situ bioremediation (Alternative 4) provides for robust treatment of the perched groundwater moving southeast of the site, but does nothing to reduce the potential for migration of water from the perched zone to the underlying Ogallala Aquifer. Immediate treatment (within approximately 12 months) of perched groundwater in the area predicted to allow impact to the Ogallala Aquifer would be provided. Drinking water standards are met within 10 years across the entire southeast area where transition of the FGZ has been identified, including the area sensitive to vertical migration. Treatment would continue in the northernmost line of injection wells to ensure protection of the Ogallala Aquifer as perched groundwater migrates into the area southeast of the Pantex Plant. Also, Alternative 4 requires the construction of a nutrient makeup facility and a large network of wells and conveyance lines that may pose high risks to construction workers, without implementing more than industry standard safety and protective measures. The use of PPE and safe operating procedures would reduce the potential for adverse effects to personnel during installation of injection, extraction, and monitoring wells. The anaerobic ISB amendment solution is non-hazardous and should not pose risks to workers. The extracted groundwater would be treated using granular activated carbon and ion exchange units following the established operating procedures at the Pantex Plant for the existing treatment system. While Plant personnel and subcontractors are familiar with well drilling activities and have conducted several treatability studies that used similar equipment and processes, the scale of this alternative is much greater than previously implemented corrective measures at the site. The project involves approximately four times as much drilling as implemented for the existing SEPTS. Work plans and safety plans prepared prior to installing the new system of wells would be followed during construction to minimize safety risks.

Alternative 5 – Pump & Treat and *In-Situ* Treatment provides a tiered approach to remediation of the perched groundwater. Immediate treatment (within 12 months) is provided using *in-situ* technology in the areas predicted to allow impact to the underlying Ogallala Aquifer, in the absence of remedial action. The enhanced pump and treat system, southeast of Zone 12, extracts and treats water from the perched groundwater upgradient of the *in-situ* treatment area, lessening the lateral flux of contaminants and increasing the time available for attenuation. New construction associated with Alternative 5 consists of drilling injection and monitoring wells, trenching and placing conveyance lines, and building infrastructure to support injection of amendments for *in-situ* treatment. Plant personnel and subcontractors are familiar with all of these activities, including well drilling activities and equipment and processes for *in-situ* treatment; therefore, short-term implementation risks are moderate for this scale and type of construction. Construction would be completed in approximately 12 months. The use of PPE and safe operating procedures would prevent adverse effects to personnel during installation of the wells and subsequent extraction, injection and sampling activities. The SEPTS would continue operation under this alternative following the established operating procedures at the Pantex Plant. Work plans and safety plans prepared prior to installing the new wells would be followed during construction to minimize safety risks. The anaerobic ISB amendment solution is non-hazardous and should not pose risks to workers. The extracted groundwater is treated using carbon and ion exchange units following the established operating procedures at the Pantex Plant for the existing treatment system.

2.12.3.6 Implementability

Implementability addresses the technical and administrative feasibility of a remedy from design through construction and operation. Factors such as availability of services and materials, administrative feasibility, and coordination with other governmental entities are also considered.

Implementation of Alternative 1 – No Action requires termination of the existing PGPTS and cancellation of the monitoring program and any additional planned remedial activities for perched groundwater.

Implementation of Alternative 2 – Institutional Controls requires termination of the existing PGPTS and cancellation of additional planned remedial activities for perched groundwater. Implementation of this alternative, including installation of new monitoring wells, could be completed in less than a year.

For Alternative 3 –Pump and Treat, if USDOE/NNSA cannot gain permission to undertake necessary remedial action because the landowner denies site access, additional actions can be pursued in accordance with CERCLA 104 (e) and Executive Order 12580 to gain access to property that is key to protecting human health and the environment. Therefore, placing institutional controls, as restrictive covenants in the deed, and installing additional monitoring wells is expected to be implementable for the entire site. In addition, no technical difficulties are anticipated in establishing or maintaining the monitoring program and institutional controls. Implementation of institutional controls and installation of the new monitoring wells is expected to take one year to complete. Operation of the SEPTS is assumed to continue for 30 years.

For Alternative 4 – Targeted *In-Situ* Treatment, the nutrient makeup facility and injection and extraction well network are readily implementable. The necessary equipment and materials are readily available. Each location of the bioremediation system will be started up and tuned separately; using techniques similar to those described in the pilot study reports (Llano Permian et al., 2006). If this alternative is implemented, design optimization analysis will be conducted. The cost estimate is prepared using reliable information based on a proven field application. Design optimization can refine and improve the expected cost within the limits of the system constraints. Due to the heterogeneity in the perched groundwater flow conditions and uncertainty in the locations where the FGZ becomes more permeable, exploratory borings would be used to identify the optimal locations for injection and extraction wells and to minimize the area to be treated. If USDOE/NNSA cannot gain permission to undertake necessary remedial action because the landowner denies site access, additional actions can be pursued in accordance with CERCLA 104 (e) and Executive Order 12580 to gain access to property that is key to protecting human health and the environment. Therefore, placing institutional controls, as restrictive covenants in the deed, and installing additional monitoring wells is expected to be implementable for the entire site. In addition, no technical difficulties are anticipated in establishing or maintaining the monitoring program and institutional controls. Implementation of institutional controls and installation of the new monitoring wells is expected to take one year to complete.

Implementation of deed restrictions to restrict use of the perched groundwater, installation of new monitoring wells, and installation of the retention basin, irrigation system, extraction wells, and injection wells and initial start-up is expected to take two years to complete, if the field work and design is performed concurrently and construction resources are available. It is assumed that the system will operate for 30 years. During this time, the research that is currently being conducted on the degradation of RDX will be regularly reviewed, and the system designed with intent to incorporate modular components and flexibility in operation and system modification. This approach would facilitate leveraging of scientific advances to minimize the need for reconstruction.

Alternative 5 – Pump & Treat and *In-Situ* Treatment consists of finalizing interim corrective measures, interim stabilization measures and non-time critical removal actions in the southeast area of the perched groundwater and enhancing the long-term groundwater-monitoring network through addition of perched groundwater and Ogallala Aquifer wells. In the southeast perched groundwater area, non-time critical removal actions were implemented to protect the Ogallala Aquifer, since modeling results indicated the potential for contaminant impact within twenty years, if remedial actions were not taken. As a proactive and immediate response, USDOE/NNSA proposed two actions; the southeast *in-situ* bioremediation system and the Playa 1 pump and treat system, as non-time critical removal actions. Public notice was issued for both of these early actions. No comments were received. This alternative is implementable since USDOE/NNSA is experienced with well drilling and construction of facilities for pumping, treating, and monitoring perched groundwater, as well as monitoring the Ogallala Aquifer. Equipment and materials needed to construct and operate the systems proposed in Alternative 5 are available and the areas of construction are on USDOE/NNSA property or in areas where access is readily available through landowner agreement.

2.12.3.7 Cost

No cost is associated with Alternative 1. Cost comparisons for the remaining alternatives are based on total capital and periodic costs.

Based on the FS, the estimated direct cost to implement Alternative 2 for the perched groundwater zone at the Pantex Plant is $2,289,000. Thirty year O&M costs are estimated to be $12,212,000 for groundwater monitoring. These costs assume collecting samples from 73 monitoring wells, including eight new

Ogallala Aquifer monitoring wells and two new perched groundwater monitoring wells. Approximately 146 sampling and analysis events are assumed each year. Installation of additional Ogallala Aquifer monitoring wells would cost about $135,000 each and each perched groundwater monitoring well would cost about $46,000. Annual sampling and analysis of each additional well would be approximately $2,000 to 4,000, depending on the sampling frequency. Applying discount factors, the estimated present worth of this alternative is $9 million.

Based on the FS, the estimated direct cost to implement Alternative 3 for the perched groundwater zone at the Pantex Plant is $3,193,000. Thirty-year O&M costs are estimated to be $39,517,000 for operation of the existing SEPTS and groundwater monitoring. The cost estimate assumes that the existing treatment system is adequate to handle the flow from the extraction wells after injection has been terminated. Because the extraction rates are uncertain, it may be necessary to upgrade the current system to handle the additional water requiring treatment for irrigation. Costs for upgrades to the current treatment system would be approximately $350,000. Applying discount factors, the estimated present worth of this alternative is $28 million.

Based on the FS, the estimated direct cost to implement Alternative 4 for the perched groundwater zone at the Pantex Plant is $45,267,000. Thirty-year O&M costs are estimated to be $616,504,000 for operation of the injection and extraction wells and environmental monitoring. The cost estimate assumes that the existing treatment system is adequate to handle the flow from the ISB wells. Because the extraction rates are uncertain, it may be necessary to upgrade the current system to handle the additional flow. Costs for upgrades to the current treatment system would be between $175,000 and $350,000. Applying discount factors, the estimated present worth of this alternative is $487 million.

Based on the FS, the estimated cost to implement Alternative 5 is $24,604,000 including construction to enhance pump and treat systems (both the SEPTS and the P1PTS), installation and amendment injection for the *in-situ* bioremediation system, providing infrastructure for use of the treated water to eliminate injection back into the perched zone, and enhancing the long-term groundwater monitoring system. Thirty year O&M costs are estimated to be $110,396,000. The estimated O&M costs are based upon the existing information for GAC units; ion exchange, controls, and other miscellaneous costs derived from the current operation of the SEPTS, and represent the best available information. Further, the O&M costs are based upon the volume of water treated (granular activated carbon and ion exchange replacement are conservatively estimated to occur based on the volume of groundwater treated). Groundwater beneath Playa 1 has much lower RDX concentrations and may require less frequent treatment system change outs than are included here. Also, O&M cost for the *in-situ* bioremediation system include amendment and injection on a semi-annual/annual basis. Applying discount factors, the estimated present worth of this alternative is $105 million.

2.12.3.8 State/Support Agency Acceptance

The TCEQ has reviewed and conditionally approved the FS and the Proposed Plan. Conditions of the approval include long-term groundwater monitoring of the perched and Ogallala Aquifers, and demonstration that proposed *in-situ* treatment technologies will irreversibly address the hexavalent chromium in the perched groundwater.

2.12.3.9 Community Acceptance

The Proposed Plan was made available to the public for review and comment on March 17, 2008. Comments received by April 28, 2008 were considered in selecting the final remedies for the southeast perched groundwater. Early Actions, to expand the pump and treat system to Playa 1 and to construct the *in-situ* treatment system in the southeast area, were formally noticed for public comment. No comments were received.

2.12.4 Comparative Analysis of Zone 11 Perched Groundwater Alternatives

2.12.4.1 Overall Protection of Human Health and the Environment

Overall protection of human health and the environment addresses whether each alternative provides adequate protection of human health and the environment and whether an alternative eliminates, reduces, or controls threats to the public health and the environment through institutional controls, engineering controls, or treatment. This is a threshold criterion.

Under Alternative 1 – No Action, perched groundwater remedies are not implemented and its use is not restricted, so protection of human health and the environment is not achieved. Migration of impacted perched groundwater and the potential risks to offsite receptors remains.

Under Alternative 2 – Institutional Controls, use of perched groundwater is restricted, thereby achieving protection of human health. This alternative does not include active remediation measures, so migration of impacted perched groundwater would continue and the Ogallala Aquifer would not be protected from potential future impact. Protection of the environment is only achieved if natural attenuation is sufficient to reach cleanup standards. Overall, protection of human health is achieved as long as the institutional controls are effectively implemented, maintained, reported on and enforced.

Alternative 3 - Pump and Treat protects human health and the environment by removing and treating perched groundwater contaminants. Overall, protection of human health would be adequate as long as the institutional controls are effectively implemented, maintained, reported on and enforced until cleanup standards are achieved. This alternative protects the Ogallala Aquifer by reducing the future possibility of vertical migration of contaminants in areas downgradient of Zone 11 on the TTU property.

Alternative 4- Targeted *In-Situ* Treatment, uses *in-situ* bioremediation and natural attenuation to achieve COC reduction and protection of the Ogallala Aquifer. Continued migration of the perched groundwater is expected. Therefore, this alternative relies on deed restrictions to restrict use of both onsite and offsite perched groundwater until the cleanup standards are achieved. Overall protection of human health and the environment would be adequate as long as the institutional controls are effectively implemented, maintained, reported on and enforced.

2.12.4.2 Compliance with ARARs

Section 121 (d) of CERCLA and the NCP (40 CFR §300.430 (f)(1)(ii) (B)) require that remedial actions at CERCLA sites attain legally applicable or relevant and appropriate Federal and State requirements, standards, criteria, and limitations which are collectively referred to as "ARARs," unless such ARARs are waived under CERCLA §121(d)(4). This is a threshold criterion.

Applicable requirements are those cleanup standards, standards of control, and other substantive requirements, criteria, or limitations promulgated under Federal environmental or State environmental or facility siting laws that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance found at a CERCLA site. Only those State standards that are identified by a state in a timely manner and that are more stringent than Federal requirements may be applicable. Relevant and appropriate requirements are those cleanup standards, standards of control, and other substantive requirements, criteria, or limitations promulgated under Federal environmental or State environmental or facility siting laws that, while not "applicable" to a hazardous substance, pollutant, contaminant, remedial action, location or other circumstance at a CERCLA site, are well-suited for addressing problems or situations sufficiently similar to those encountered at the CERCLA site under consideration.

Groundwater ARARs include:

- Safe Drinking Water Act (SDWA, P. L. 104-182, 40 CFR Part 141, et. seq.)
- Resource Conservation and Recovery Act (40 CFR parts 260-280, 42 USC § 6901-6933)
- Compliance Plan (CP-50284) (TSWDA, Texas Health & Safety Code, Chapter 361; 30 TAC Chapters 305, 335 and 350)
- General Regulations Incorporated into Permits (30 TAC 305 and 30 TAC 319) and Chapter 26 of the Texas Water Code
- Texas Water Code, Chapter 26, 30 TAC 305
- Section 402 of the Clean Water Act and Chapter 26 of the Texas Water Code (TPDES MSGP, TXR 150000)
- Underground Injection Control (40 CFR Parts 144-148, et. seq.; 30 TAC 331)

Alternative 1- No Action does not provide any means for achieving compliance with ARARs.

Under Alternative 2 – Institutional Controls, attainment of media-specific cleanup standards would not occur throughout the Zone 11 perched groundwater. Natural attenuation processes would provide the only means for reduction of COCs/contaminant mass, and has not yet been determined. Compliance with ARARs would not be achieved, as perched groundwater beneath Zone 11 and TTRF would continue to exceed drinking water standards.

Alternative 3 – Pump and Treat, might reduce COC concentrations in perched groundwater to media-specific cleanup standards within 30 years, but it is uncertain. The Zone 11 Pump and Treat System (Z11PTS) would treat the constituents found in the perched groundwater above MCLs/MSCs shown in Table 2-18:

Table 2-18. COCs Treated by Alternative 3

Perched Onsite	Technology to Treat Constituent
4-Amino-2,6 Dinitrotoluene	GAC
RDX	GAC
Chloroform	GAC
1,2 Dichloroethane	GAC
Trichloroethene	GAC
Tetrachloroethene	GAC
Perchlorate	Ion Exchange
1,4-Dioxane	GAC/Advanced oxidation

Alternative 4- Targeted *In Situ* Treatment, is expected to treat the onsite portions of the plume south of Zone 11 and minimize further offsite migration through treatment of the COCs to cleanup standards. Research suggests the proposed ISB will not be effective for 1,4-Dioxane. However, concentrations of

this constituent are low and present further north of the TTU property than the perchlorate and TCE. The injection wells, which are considered to be
Class V wells by the TCEQ, will require permitting for underground injection control. Issuance of a permit for underground injection requires that an injection well inventory be submitted to the TCEQ prior to construction of the wells. The mechanical integrity of the wells and the ability to prevent pollution are also required.

Alternative 4 would treat the constituents found in the perched groundwater above MCLs/ MSCs shown in Table 2-19:

Table 2-19. COCs Treated by Alternative 4

Perched Onsite	Technology to Treat Constituent
4-Amino-2,6 Dinitrotoluene	*In-situ* bioremediation
RDX	*In-situ* bioremediation
1,2 Dichloroethane	*In-situ* bioremediation
Chloroform	*In-situ* bioremediation
Trichloroethene	*In-situ* bioremediation
Tetrachloroethene	*In-situ* bioremediation
Perchlorate	*In-situ* bioremediation
1,4-Dioxane	NA

2.12.4.3 Long-term Effectiveness and Permanence

Long-term effectiveness and permanence refers to expected residual risk and the ability of a remedy to maintain reliable protection of human health and the environment over time, once cleanup levels have been met. This criterion includes the consideration of residual risk that will remain onsite following remediation and the adequacy and reliability of controls.

For Alternative 1 – No Action, long-term effectiveness of natural attenuation processes is uncertain, and therefore, it is not expected to achieve cleanup levels for Zone 11 perched groundwater COCs.

Under Alternative 2 – Institutional Controls, restricting onsite and offsite use of perched groundwater is expected to be reliable in the future as the Pantex Plant continues to maintain site control and access. These restrictions prevent the potential for exposure to the affected perched groundwater. Long-term effectiveness of natural attenuation processes is uncertain.

Under Alternative 3 – Pump and Treat, the Z11PTS successfully removes COCs from perched groundwater within extraction well capture zones. Over an assumed 30-year period of operation, the system is expected to intercept the areas of the plume having the highest concentrations of perchlorate and TCE and will effectively reduce the mass of these COCs in perched groundwater. However, it may not be feasible for the Z11PTS to eliminate continued offsite migration of constituents, if perched saturation decreases significantly in the future. Therefore, this alternative relies on institutional controls to prevent exposure to offsite perched groundwater south of the Pantex Plant.

Under Alternative 4, Targeted *In-Situ* Treatment, effectively reduces COC concentrations in perched groundwater. The long-term reliability of anaerobic *in-situ* anaerobic bioremediation is uncertain due to subsurface heterogeneity and the ability to distribute the amendment evenly in the target area. Also, the effects of the geochemical environment on amendment effectiveness are uncertain. *In-situ* anaerobic bioremediation has not been shown to be effective for treatment of 1,4-Dioxane, but this is not expected to be an impediment to implementing the technology because the concentrations observed for this constituent are low (i.e., about 40 µg/l).

2.12.4.4 Reduction of Toxicity, Mobility, or Volume of Contaminants through Treatment

Reduction of toxicity, mobility, or volume through treatment refers to the anticipated performance of the technologies that may be included as part of the remedy.

Under Alternatives 1 and 2 (No Action and Institutional Controls), no active measures are taken to reduce COC toxicity, mobility, or volume; naturally occurring processes including sorption, degradation, and dispersion (mixing) may act to reduce the mobility and toxicity of the contaminants, but additional information needs to be collected to determine if it is appropriate to consider as part of the remedy.

Alternative 3 uses pump and treat and natural attenuation to reduce the toxicity, mobility, or volume of constituents in perched groundwater.

For Alternative 4 – Targeted *In Situ* Treatment**,** pilot studies demonstrate that *in-situ* anaerobic bioremediation is effective in reducing mass and concentrations of some of the Zone 11 COCs as they move through the treatment zone. Additional studies would be needed to demonstrate effectiveness for perchlorate, but laboratory evidence and studies reported in the literature indicate anaerobic *in-situ* anaerobic bioremediation effectively treats perchlorate for concentrations similar to those observed in perched groundwater at the Pantex Plant. Mobilization of metals, such as arsenic and strontium, is expected to be a transient effect of the reducing conditions caused by the anaerobic biodegradation and will not result in long-term elevated concentrations.

2.12.4.5 Short-term Effectiveness

Short-term effectiveness addresses the period of time needed to implement the remedy and any adverse impacts that may be posed to workers, the community, and the environment during construction and operation of the remedy until cleanup levels are achieved. All of the alternatives are effective in the short-term, but vary in the amount of time to reach RAOs and prevent potential exposure.

Under Alternatives 1 and 2 (No Action and Institutional Controls), no additional health risks to workers or the community would occur because no active remedial technologies would be constructed or operated.

For Alternative 3 – Pump and Treat, the use of PPE and safe operating procedures would prevent adverse effects to personnel during installation of monitoring wells and subsequent sampling activities. Plant personnel are familiar with well drilling activities and operation of the treatment system equipment and processes. Work plans and safety plans would be prepared prior to installing the new monitoring wells and would be followed during construction to minimize safety risks.

For Alternative 4- Targeted *In-Situ* Treatment, *in-situ* bioremediation requires the construction of a nutrient makeup facility and a network of wells and conveyance lines that may pose moderate risks to construction workers. The use of PPE and safe operating procedures would reduce the potential for adverse effects to personnel during installation of injection, extraction, and monitoring wells. *In-situ* anaerobic bioremediation amendment solution is non-hazardous and should not pose risks to workers. Plant personnel and subcontractors are familiar with well drilling activities and have conducted several treatability studies that used similar equipment and processes. The scale of this alternative is similar to previously implemented corrective measures at the site. Work plans and safety plans prepared prior to installing the new system of wells would be followed during construction to minimize safety risks.

2.12.4.6 Implementability

Implementability addresses the technical and administrative feasibility of a remedy from design through construction and operation. Factors such as availability of services and materials, administrative feasibility, and coordination with other governmental entities are also considered.

Implementation of Alternative 1 - No Action, would result in cancellation of the monitoring program and any additional planned remedial activities for perched groundwater.

Implementation of Alternative 2 – Institutional Controls, including installation of new monitoring wells, could be completed in less than a year.

For Alternative 3 – Pump and Treat, the scope of this project is similar to the SEPTS and P1PTS. The SEPTS has been successfully implemented, and the P1PTS is currently being implemented. Therefore, the Z11PTS is implementable and is estimated to require about one year for design and construction.

For Alternative 4- Targeted *In-Situ* Treatment, the nutrient makeup facility and injection well network would be readily implementable. The necessary equipment and materials are readily available. Each location of the bioremediation system will be started up and tuned separately; using techniques similar to those described in the pilot study reports (Llano Permian et al., 2006). If this alternative is implemented, a design optimization analysis will be conducted. The cost estimate is prepared using reliable information based on a proven field application. Design optimization can refine and improve the expected cost within the limits of the system constraints. Due to the heterogeneity in the perched groundwater flow conditions, exploratory borings would be used to identify the optimal locations for injection wells and to minimize the area to be treated. Implementation of deed restrictions and other institutional controls to restrict use of the perched groundwater, installation of new monitoring and injection wells and initial start-up is expected to take no more than one year to complete, if the fieldwork and design is performed concurrently and construction resources are available. It is assumed that the system will operate for 30 years.

2.12.4.7 Cost

No cost is associated with Alternative 1.

For Alternative 2, costs for long-term monitoring were estimated on a site-wide basis and are the same as presented for southeast perched groundwater. Based on the FS, the estimated direct cost to implement Alternative 2 for the perched groundwater zone at the Pantex Plant is $2,289,000. Thirty-year O&M costs are estimated to be $12,212,000 for groundwater monitoring. These costs assume collecting samples from 73 monitoring wells, including eight new Ogallala Aquifer monitoring wells and two new perched groundwater monitoring wells. Approximately 146 sampling and analysis events are assumed annually. Installation of additional Ogallala Aquifer monitoring wells would cost about $135,000 each and each perched groundwater monitoring well would cost about $46,000. Annual sampling and analysis of each additional well would be approximately $2,000 to $4,000, depending on the sampling frequency. Applying discount factors, the estimated present worth of this alternative is $9 million.

Based on the FS, the estimated direct cost to implement Alternative 3 for the Zone 11 area at the Pantex Plant is $4,536,000. Thirty-year O&M costs are estimated to be $28,346,000 for operation of the Z11PTS and monitoring. Applying discount factors, the estimated present worth of this alternative is $29 million.

Based on the FS, the estimated direct cost to implement Alternative 4 for Zone 11 perched groundwater at the Pantex Plant is $4,480,000. Thirty-year O&M costs are estimated to be $30,553,000 for operation of the injection wells and monitoring. Applying discount factors, the estimated present worth of this alternative is $30 million.

2.12.4.8 State/Support Agency Acceptance

The TCEQ has reviewed and conditionally approved the CMS/FS and the Proposed Plan. Conditions of the approval include long-term groundwater monitoring of the perched and Ogallala Aquifers. The groundwater MCL for perchlorate has been promulgated under the State Risk Reduction Rule, and is considered an ARAR for remedial action.

2.12.4.9 Community Acceptance

The Proposed Plan was made available to the public for review and comment on March 17, 2008. Comments received by April 28, 2008, were considered in selecting the final remedies for the Zone 11 perched groundwater.

2.13 Principal Threat Wastes

Groundwater contaminants are not considered Principal Threat Wastes at the Pantex Plant. Contaminants in the perched ground water are in a dissolved phase only. There are no residual light non-aqueous phase liquids or dense non-aqueous phase liquids in the perched groundwater that will continue to source contaminants to the dissolved phase.

2.14 Selected Remedy

2.14.1 Selected Remedy for Soil Units

For the protection of onsite industrial worker and the prevention of continuing impact to the perched groundwater, interim actions (i.e., ICMs and ISMs) have been implemented to address the major sources of contaminants in the soil units. For the interim actions that resulted in permanent removals and soil units posing direct contact risk at levels that can be managed without active remedy (i.e., Limited Action Soil Units, Burn Pads 11 through 13 [SWMU 25, 26 and 27], and SWMU 5/12a) the selected remedy is **Alternative 2: Institutional Controls.** For SWMU 47, the selected remedy is the **Presumptive Remedy of Soil Vapor Extraction and Institutional Controls**. Some of the interim actions consisted of soil covers and ditch liners that require inspection and maintenance. As a result, the selected remedy is **Alternative 3: Containment and Institutional Controls** for the Pantex Landfills, the former operational area of Firing Site 5 (SWMU 70), the Burning Ground Former Ash Disposal Trench (SWMUs 14-24), and SWMUs 2 and 5/05.

2.14.1.1 Soil Units with Contact Risk to Onsite Workers

Interim Soil Excavation, Offsite Disposal, and Cover Placement, Institutional Controls for SWMU 25, 26 and 27- Burning Ground Explosive Burn Pads 11, 12 and 13: An interim action was implemented at SWMU 27 that included the excavation of depleted uranium-containing soil from the upper 3 feet of soil to remove hot spot. A total of 292 cubic yards of contaminated soil was transported and disposed at an appropriate offsite disposal facility. The cost of the interim action was about $400,000 and was completed in 1999. Additionally, as part of the interim corrective measure for two nearby landfills (SWMU 37 and SWMU 38); a cover was placed that effectively reduced the direct contact exposure risk from the exposure area that contains SWMU 27.

The ICs to be implemented will limit worker activities at the old burn pads. The integrity of remedial action equipment/components and engineered controls, such as landfill covers and fences, would be preserved using these institutional controls and maintained to ensure continued effectiveness of each of the soil alternatives. While ICs will need to be specified to ensure long-term permanence of access and use restrictions, this alternative addresses the remaining minimal direct contact risk effectively, and provides the best balance of short-term effectiveness, overall protectiveness, and cost.

Interim Soil Excavation, Offsite Disposal, and Cover Placement; Institutional Controls and Engineered Barrier for SWMU 70 – Firing Site 5: The interim action implemented at this soil release unit included the excavation of depleted uranium-containing soil within the berm/gravel pit. Surface soil surrounding the gravel pit and up to 20 feet of soil inside the gravel pit was excavated. Approximately 1,800 cubic yards of contaminated soil was transported and disposed at an appropriate offsite disposal facility. The approximate cost of the interim action was $4.5 million and was completed in 1998.

The early action of excavation and offsite disposal removed the impacted soil that presented the majority of the risk at this site. Excavated areas were backfilled and a soil cover was placed over the former operational center of Firing Site 5, within the berms, as a barrier to direct contact. This soil cover was sloped to drain storm water away from the operational area of Firing Site 5. The remaining impacted soil is in the lower end of the risk range (exhibiting an incremental lifetime cancer risk between 1E-05 and 1E-04). The integrity of remedial action equipment/components and engineered controls, such as landfill covers and fences, would be preserved using these institutional controls and maintained to ensure continued effectiveness of each of the soil alternatives. Implementing ICs to limit access and control use is effective at mitigating the remaining risk, and provides the best balance of short-term effectiveness, overall protectiveness, and cost.

Interim Cover Placement; Institutional Controls for the Burning Ground Former Ash Disposal Trench (SWMUs 14-24): The interim action implemented at this soil release unit included the installation of a cover over soil contaminated with RDX and TNT. The cover consists of a 40-mil high-density polyethylene liner placed over the compacted and prepared subgrade, overlain by 18 inches of compacted backfill and 6 inches of topsoil. The cost of the interim action was about $200,000 and was completed in 2006.

Implementing this alternative will ensure the cover implemented in the early action is fully protective by preventing unauthorized access and limiting worker activities. The integrity of remedial action equipment/components and engineered controls, such as landfill covers and fences, would be preserved using these institutional controls and maintained to ensure continued effectiveness of each of the soil alternatives. The preferred alternative would effectively address the remaining minimal direct contact risk and provides the best balance of short-term effectiveness, overall protectiveness, and cost.

2.14.1.2 Soil Units with the Potential to Impact Perched Groundwater

The selected remedy for SWMU 5/12a is **Alternative 2: Institutional Controls**. The selected remedy for SWMU 2 and SWMU 5/05 is **Alternative 3: Containment and Institutional Controls**. Implementing the ICs will restrict the use of these soil units and ensure the integrity of the synthetic liners placed in the SWMU 2 and 5/05 ditches is maintained. The integrity of remedial action equipment/components and engineered controls, such as landfill covers and fences, would be preserved using these institutional controls and maintained to ensure continued effectiveness of each of the soil alternatives. The selected remedy effectively addresses the remaining minimal direct contact risk and provides the best balance of short-term effectiveness, overall protectiveness, and cost to minimize the potential for continued and future perched groundwater impacts.

Zone 12 Drainage Ditches

- *Interim Synthetic Liner; Institutional Controls for SWMU 2 – Building 12-43 Drainage Ditch*: The interim action implemented at this soil release unit included the discontinuance of wastewater discharge to the ditch; removal of soil and a concrete sump associated with the HE wastewater filtration system; and the installation of a reinforced polypropylene geosynthetic material liner to stop water infiltration to the perched groundwater beneath this area. The cost of the interim action was about $100,000 and was completed in 2004.

- *Interim Synthetic Liner; Institutional Controls for SWMU 5/05 - Drainage Ditch between Buildings 12-21 and 12-24*: The interim action implemented at this soil release unit included the installation of a reinforced polypropylene geosynthetic material liner to stop water infiltration to the perched groundwater beneath this area. The cost of the interim action was about $400,000 and was completed in 2004.

- *Institutional Controls for SWMU 5/12a – Zone 12 Main Drainage Ditch*: Although interim action specific to SWMU 5/12a was not implemented, various hot spot removal interim actions were implemented in SWMUs that contributed wastewater discharge into SWMU 5/12a. Additionally, all untreated discharge to the ditches was discontinued in the 1980s and all discharges to the ditch system were discontinued by 1999.

The synthetic liners placed as an interim action will address the direct contact risk and reduce infiltration in the area but they may not be effective in preventing the COCs in deep soil from migrating into the perched groundwater. COCs from these soil units have already migrated to the perched groundwater at levels above drinking water standards. Based on the results of the liners installed in SWMU 2 and 5/05, the effectiveness of the liner on mitigating the continuing downward migration of COCs in deep soil may be negligible. Monitoring data from the perched groundwater wells downgradient of these ditches indicate that impacts have peaked and that concentrations of COCs have been declining in recent years.

2.14.1.3 Presumptive Remedies

SWMU 47, Burning Ground Solvent Evaporation Pit, and Landfills at the Pantex Plant will use EPA's presumptive remedy as the selected remedy. The integrity of remedial action equipment/components and engineered controls, such as landfill covers and fences, would be preserved using these institutional controls and maintained to ensure continued effectiveness of each of the soil alternatives. Specifically, the selected remedies are:

- Continued operation of the SVE system for SWMU 47, by either active or passive means, and implementation of ICs to ensure the integrity of the SVE cleanup is maintained and land use is restricted.

- Implementation of containment for all landfills with the addition of institutional controls to prevent exposure and mitigate infiltration.

Both of these types of presumptive remedies were implemented as interim corrective measures, as described in more detail as follows.

Interim Soil Vapor Extraction, Institutional Controls for SWMU 47 – Burning Ground Solvent Evaporation Pit:

A detailed analysis of alternatives for SWMU 47 was not performed because soil vapor extraction is one of the presumptive remedies recognized by the EPA for volatile organic contamination in soil.

The soil vapor extraction and treatment system was evaluated with the "no action" alternative and the SVE successfully meets the threshold and balancing criteria. The preferred alternative for SWMU 47 is to adopt soil vapor extraction as the final remedial action.

An interim corrective measure was conducted in 2002 address the solvent associated with SWMU 47 and incorporated in the Compliance Plan No. 50284 as an ISM. Based on EPA presumptive remedy guidance, Soil Vapor Extraction System was selected to address the VOC-impacted soil. The system included the installation of 21 shallow (80 feet) and 7 deep (260 feet) vapor extraction wells. The vapors extracted from these wells were treated using a catalytic thermal oxidation unit. The system was modified in 2006 to focus extraction on one shallow well adjacent the solvent evaporation pit. Treatment of vapor removed from this well is accomplished using a series of granular activated carbon unit. Since it began operation, the system has removed and treated 14,806 pounds of solvents. The cost to construct and operate this system has been about $2.5 million.

After most of the solvents are removed from the soil, the system will be adapted to operate passively to complete the cleanup. Transition of the system to passive treatment is being evaluated at this time.

Interim Cover Placement for Landfills:

A soil cover has been installed on each of the Pantex Plant landfills as interim actions under the State's RCRA authority, consistent with the EPA presumptive remedy for CERCLA landfills, which is containment.

Containment was evaluated with the "no action" alternative against the evaluation criteria and containment successfully meets the threshold and balancing criteria. Containment meets the cleanup objectives for soil by effectively breaking exposure pathways and minimizing movement of water through the landfill debris. The preferred alternative for the Pantex Plant landfills is to adopt the landfill covers, implement institutional controls, and conduct long-term groundwater monitoring and periodic inspection and maintenance of the covers.

The performance expectations for landfill covers at the Pantex Plant are to:

- Eliminate exposure pathways to onsite receptors (i.e., industrial and construction/excavation workers) consistent with the RAOs developed for onsite soil.
- Minimize the potential for infiltration and resulting contaminant leaching to groundwater.
- Control the surface water runoff and erosion.

Hotspot excavation was also conducted as interim corrective measures at several landfills to supplement the effectiveness of containment. The landfills will be inspected to ensure that the covers are maintained to effectively drain storm water away from the landfill and continue to eliminate exposure to onsite receptors.

2.14.1.4 Limited Action Sites

For the Limited Action Soil Units, the selected remedy is **Alternative 2: Institutional Controls**.

2.14.1.5 Expected Outcome of the Selected Remedy

Protection of the health of industrial and construction/excavation workers through:

- Physical barriers to contact (fences, soil covers, and synthetic liners).
- Institutional controls that require USDOE/NNSA authorization specifying worker protection measures (i.e., personal protective equipment, monitoring, decontamination, and soil management requirements) for disturbance of soils in a SWMU.

Protection of the public through:

- Institutional and engineered controls to prevent contact with contaminated soils.
- Barriers to contaminant leaching and diffusion to prevent continued and/or future migration at concentrations that exhibit increasing trends in the perched groundwater.
- Long-term groundwater monitoring to identify unexpected conditions in perched groundwater and the Ogallala Aquifer.

2.14.2 Selected Remedy for Southeast Perched Groundwater

2.14.2.1 Summary of the Rationale for the Selected Remedy

The Selected Remedy for the southeast perched groundwater is **Alternative 5: Pump & Treat, *In-situ* Treatment and Institutional Controls**. This Selected Remedy will achieve the RAOs by:

- Reducing the concentrations of COCs in perched groundwater
- Stabilizing, containing and/or slowing the migration of impacted perched groundwater southeast of the Pantex Plant, downgradient of the southeast corner of the Plant, because COCs (primarily RDX) in this area comprise the primary potential threat to the Ogallala Aquifer based on predictive modeling.
- Reducing the volume of water moving through the perched groundwater flow system - The perched groundwater represents the primary mechanism for mass transport of perched groundwater COCs. Alternatives that are effective in reducing the volume of water moving through perched groundwater will also reduce the potential for migration of COCs from perched groundwater to the Ogallala Aquifer. Reduction of the volume of perched groundwater and its flow, and RDX mass flux across the southern boundary (lateral extent) of the perched groundwater flow system is most critical based upon observed site conditions and predictive modeling.
- Reducing the upgradient driving head - Impacted perched groundwater currently occurs at the extent of saturation, beyond the influence of the existing SEPTS. Alternatives that reduce the upgradient driving head will reduce the rate of mass flux out of the perched groundwater flow system, potentially to the point where mass is bound or trapped within the underlying partially saturated media above the Ogallala Aquifer.

- Injecting amendments to initiate and sustain *in-situ* treatment in the southeast area of the perched groundwater, where modeling predictions indicate the potential for impact to the Ogallala Aquifer in the absence of remedial actions.

- Implementing institutional controls, specifically proprietary controls, to restrict use and access to the perched groundwater for the life of the project.

2.14.2.2 Description of the Selected Remedy

The selected remedy is summarized in Section 2.11.2.5.

2.14.2.3 Summary of the Estimated Remedy Costs

Estimated costs for the Southeast Perched Groundwater Remedy are presented in Table 2-20. This cost summary is based on the information updated since the FS. The capital costs are provided to show the work completed through April 2008 and the cost of work remaining for each of the components of this remedy. Expansion of the existing perched groundwater pump and treat system was conducted to better stabilize the perched groundwater plume, in accordance with Compliance Plan No. 50284. The Southeast *In-situ* Bioremediation System was installed and construction is progressing on the Playa 1 Perched Groundwater Pump and Treat System, in accordance with the Engineering Evaluation/Cost Analyses issued in May 2007 and March 2007, respectively. Operation and Maintenance (O&M) costs were estimated on an annual basis, applied for 30 years of operation for the components, and discounted using numbers based on a nominal rate of 3.1%. Details of the cost for each component of the remedy are presented in Appendix K.

Table 2-20. Estimated Cost for the Southeast Perched Groundwater Remedy

	Capital Cost		Periodic and O&M Cost
	Completed	Remaining	(Discounted)
Expansion of the Southeast Perched Groundwater Pump & Treat System	$1,850,000	$0	$25,200,599
Playa 1 Perched Groundwater Pump & Treat System	$4,420,000	$4,990,920	$22,177,352
Southeast *In-Situ* **Bioremediation System**	$6,672,500	$0	$36,272,861
Long-Term Groundwater Monitoring Network and Institutional Controls	$0	$2,139,000	$14,745,303
Total	**$12,942,500**	**$7,129,920**	**$98,396,115**

Present Value =	**$118,468,535**

2.14.2.4 Expected Outcome of the Selected Remedy

The suite of remedies (Figure 2-23) work together to provide the best option for meeting RAOs for the perched groundwater:

- Eventual restoration of the perched groundwater to cleanup standards presented in Table 2-12.
- Playa 1 Pump and Treat System: Provides long-term protection of the Ogallala Aquifer by dewatering the perched groundwater at the primary source of recharge; reducing mounding and flow (i.e., flux of perched groundwater) in this area where focused recharge occurred in the past.
- Southeast Pump and Treat System: Provides short-term protection of the Ogallala Aquifer by containing and treating the contaminated perched groundwater that would otherwise migrate offsite to the south and east. Gradually reduces water levels in the perched groundwater adjacent and east of FM 2373.
- *In-Situ* Bioremediation System: Provides immediate protection of the Ogallala Aquifer by treating the high concentrations of perched groundwater COCs in the primary area sensitive to vertical migration through the FGZ.
- Institutional Controls: Eliminates the potential for completing potential exposure pathways in the future, should someone desire to access the perched groundwater beneath or adjacent the Pantex Plant to the east and south, or the Ogallala Aquifer in areas where impact is predicted in the absence of remedial actions.

The ROD selects a groundwater remedy that both hydraulically controls further vertical and lateral migration of the contaminant plume, and also restores the perched as a potential drinking water source. The remedy appropriately protects the Ogallala Aquifer, as primary aquifer for the region, and the perched groundwater as a potential drinking water source. Also, the selected remedy for groundwater formally recognizes the combination of single components, implemented as interim corrective measures or early actions, which will work synergistically to accomplish the remedial action objectives. Each component, working effectively, is required to meet the protectiveness standard of this ROD.

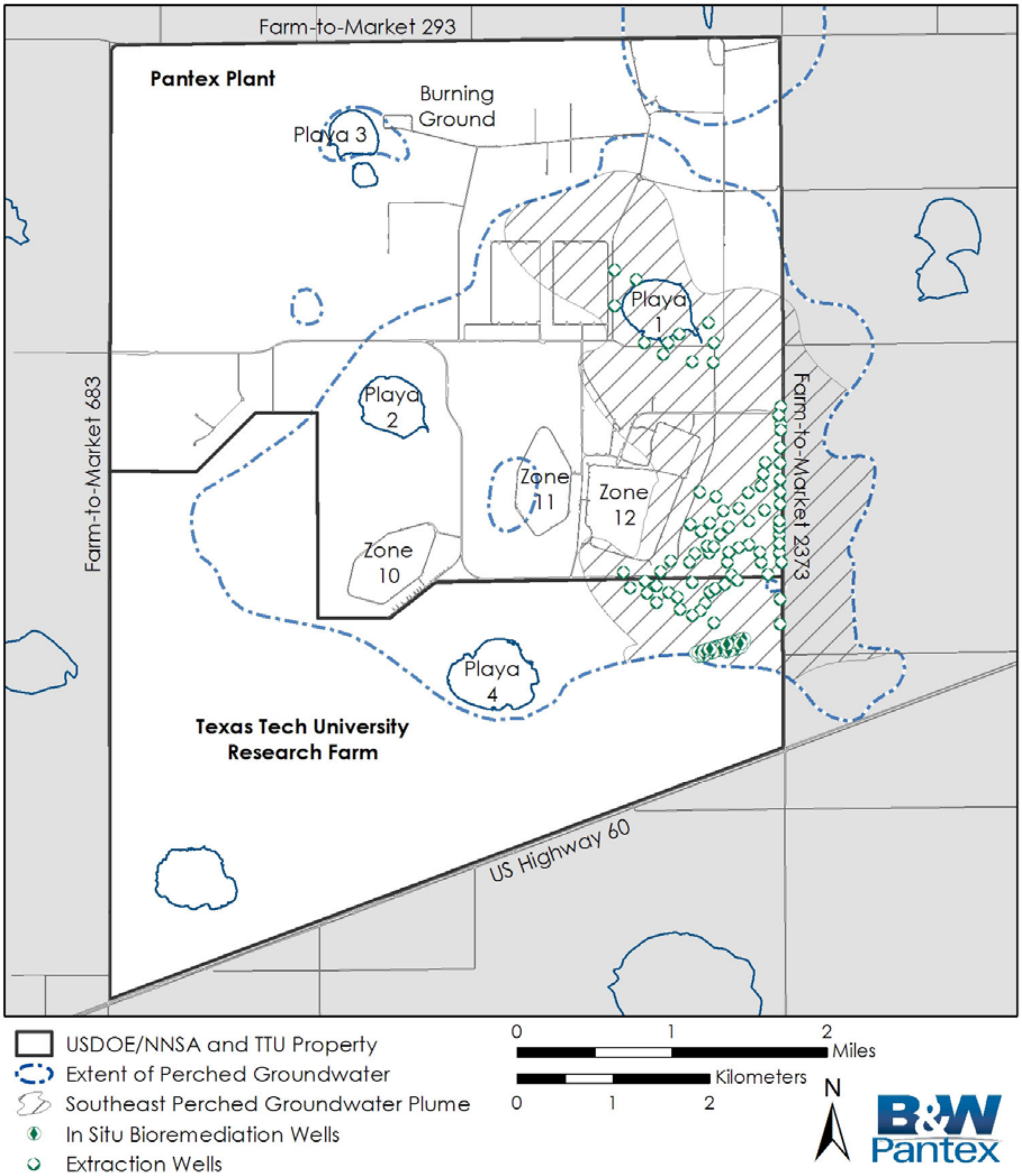

Figure 2-23. Preferred Alternative for the Southeast Perched Groundwater

2.14.3 Selected Remedy for Zone 11 Perched Groundwater

The selected remedy for Zone 11 Perched Groundwater is Alternative 4: Targeted *In-Situ* Treatment and Institutional Controls. This remedy allows contaminated perched groundwater to flow through a permeable treatment zone that accelerates the breakdown of the contaminants (primarily TCE and perchlorate). The treatment zone is created by injecting a readily fermentable carbon source into the perched groundwater to initiate and sustain anaerobic bioremediation. The reducing conditions caused by this process enable breakdown of the contaminants. Institutional controls, specifically proprietary controls, will also be implemented on TTRF, south of Zone 11, to eliminate the potential for completing exposure pathways in the future by restricting use and access to the perched groundwater for the life of the project.

2.14.3.1 Description of the Selected Remedy

The selected remedy is summarized in Section 2.11.3.4.

2.14.3.2 Summary of the Estimated Remedy Costs

Costs for the Zone 11 *In-Situ* Bioremediation System are presented in Table 2-21. The capital cost is assumed for the first year. Operation and Maintenance costs were developed on an annual basis, injection of amendment is assumed to continue for 30 years with a decreasing dosage at each 10-year increment. Operation and Maintenance (O&M) costs were estimated on an annual basis, applied for 30 years of operation, and discounted using numbers based on a nominal rate of 3.1%. Details of the cost for the Zone 11 Perched Groundwater remedy are presented in Appendix K.

Table 2-21. Estimated Cost for the Zone 11 Perched Groundwater Remedy

	Capital Cost		Periodic and O&M Cost
	Completed	**Remaining**	**(Discounted)**
Zone 11 In Situ Bioremediation System	$0	$3,610,800	$26,154,781

Present Value =	**$29,765,581**

2.14.3.3 Expected Outcome of the Selected Remedy

The selected remedy is anticipated to be the best option for meeting the RAOs for the Zone 11 perched groundwater.

- Eventual restoration of the perched groundwater to cleanup standards presented in Table 2-12 on page 2-78.
- *In-Situ* Bioremediation System: Provides immediate protection of the Ogallala Aquifer by treating the high concentrations of perched groundwater COCs in the area of uncertain sensitivity to vertical migration through the FGZ.

- Institutional Controls: Eliminates the potential for completing potential exposure pathways in the future, should someone desire to access the perched groundwater beneath or adjacent to the Pantex Plant to the south, or the Ogallala Aquifer in areas where impact could potentially occur in the absence of remedial actions.

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2.14.4 Additional Components of the Selected Remedy

2.14.4.1 Land and Groundwater Use Controls

The USDOE/NNSA Pantex Plant will remain an active facility into the foreseeable future. Operations at the site will support the continuing mission to maintain the safety, security and reliability of the nation's nuclear weapons stockpile. The property is restricted and access controlled for security reasons. The risk assessments supporting this ROD were based on assumptions that industrial activities would continue to be associated with the areas containing the soil units. This is consistent with the facility continuing to be fully operational. Figure 2-24 shows the locations of soil unit areas included in the ROD. The extent of releases in soils at each investigation unit is also defined in the RI reports and will be detailed in the Land and Groundwater Use Controls Implementation Plan (LGUCIP), to be developed as part of the remedial design in Fiscal Year 2009.

Land use controls, including institutional controls (IC), will be implemented to restrict the land use at units in this ROD to industrial use only, as concentrations of hazardous substances in soils and/or groundwater would not be protective of human health with unrestricted use and exposure. ICs include both proprietary controls (i.e. deed restrictions) and informational notices or policies. Deed restrictions will be filed with the County Clerk, Carson County, Texas, and will restrict land use for designated parcels to industrial use. Restrictions will also prohibit the use of these properties for residential housing, elementary and secondary schools, childcare facilities, and playgrounds. The deed restrictions will limit the use of those properties assessed if the ownership of the Plant, in part or total, changes. Although the USDOE/NNSA may later transfer these procedural responsibilities to another party by contract, property transfer agreement, or through other means, the USDOE/NNSA shall retain ultimate responsibility for remedy integrity.

Under the RRS 2 or RRS 3 closure requirements of the TSWDA, the TCEQ will also require that deed recordation, including property descriptions, are filed with Carson County, for those units with contaminants in place. Note, however, those units that closed administratively, or to background levels (Sections 2.2.2.2.2 and 2.2.2.2.3), can be used without restrictions and will not be subject to any further land use controls.

Land and groundwater use controls, including institutional controls, will be implemented to:

- Prohibit use of the perched groundwater until cleanup levels are achieved (deed restrictions). For the perched groundwater that occurs beneath TTU property, an agreement exists between TTU and USDOE/NNSA stating that USDOE/NNSA will provide drinking water to TTU. Another agreement will be established requiring TTU to file a deed restriction in the Carson County Records, or prohibit use of the perched groundwater through another mechanism. For the properties east of FM 2373, USDOE/NNSA will purchase the property and place deed restrictions, or negotiate deed restrictions with the property owner, if the property remains privately held. (See Figure 2-25).
- Restrict properties to industrial use only, where contaminants are left in place above unrestricted levels (deed restrictions). Restrictions will include prohibition of the development and use of

these properties for residential housing, elementary and secondary schools, childcare facilities and playgrounds.

- Control access to those properties that pose a health risk to construction/excavation workers (policies; notices of restricted areas), by prohibiting activities that would result in an unmitigated potential for exposure to soils above risk levels.
- Prohibit activities that would damage or degrade the integrity of all components of current and future remedies, including monitoring wells, *in-situ* and *ex-situ* treatment systems, liners, and covers (deed restrictions).
- Develop restrictions to prevent drilling through the contaminated portions of the perched groundwater into the underlying Ogallala aquifer.

USDOE/NNSA is responsible for implementing, maintaining, reporting on, and enforcing the necessary land use controls, including ICs, until the hazardous constituents in soils and groundwater reach protective levels for unrestricted use and exposure. USDOE/NNSA will annually inspect, and report on, those properties where land use controls, including institutional controls, are in place.

The LGUCIP will be developed, and submitted for EPA and TCEQ review and approval under the schedule negotiated in the IAG. The LGUCIP shall contain implementation and maintenance actions, including periodic inspections. The IAG stipulates a review and approval timeframe for each document submitted under the Site Management Plan, including the LGUCIP. The SMP is scheduled under the IAG for submittal 7 days after the issuance and approval of this ROD.

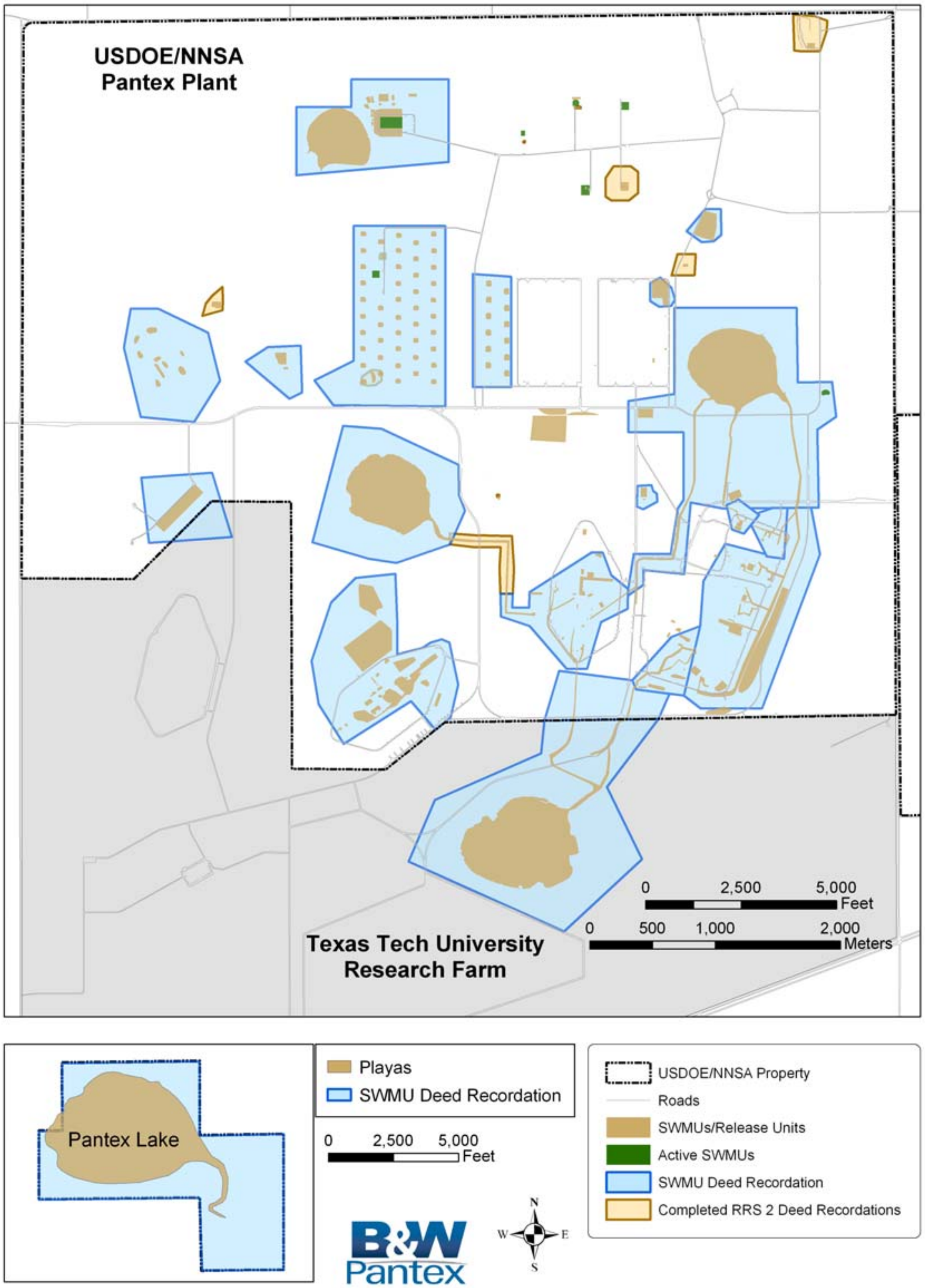

Figure 2-24. Soil Unit Institutional Control Areas

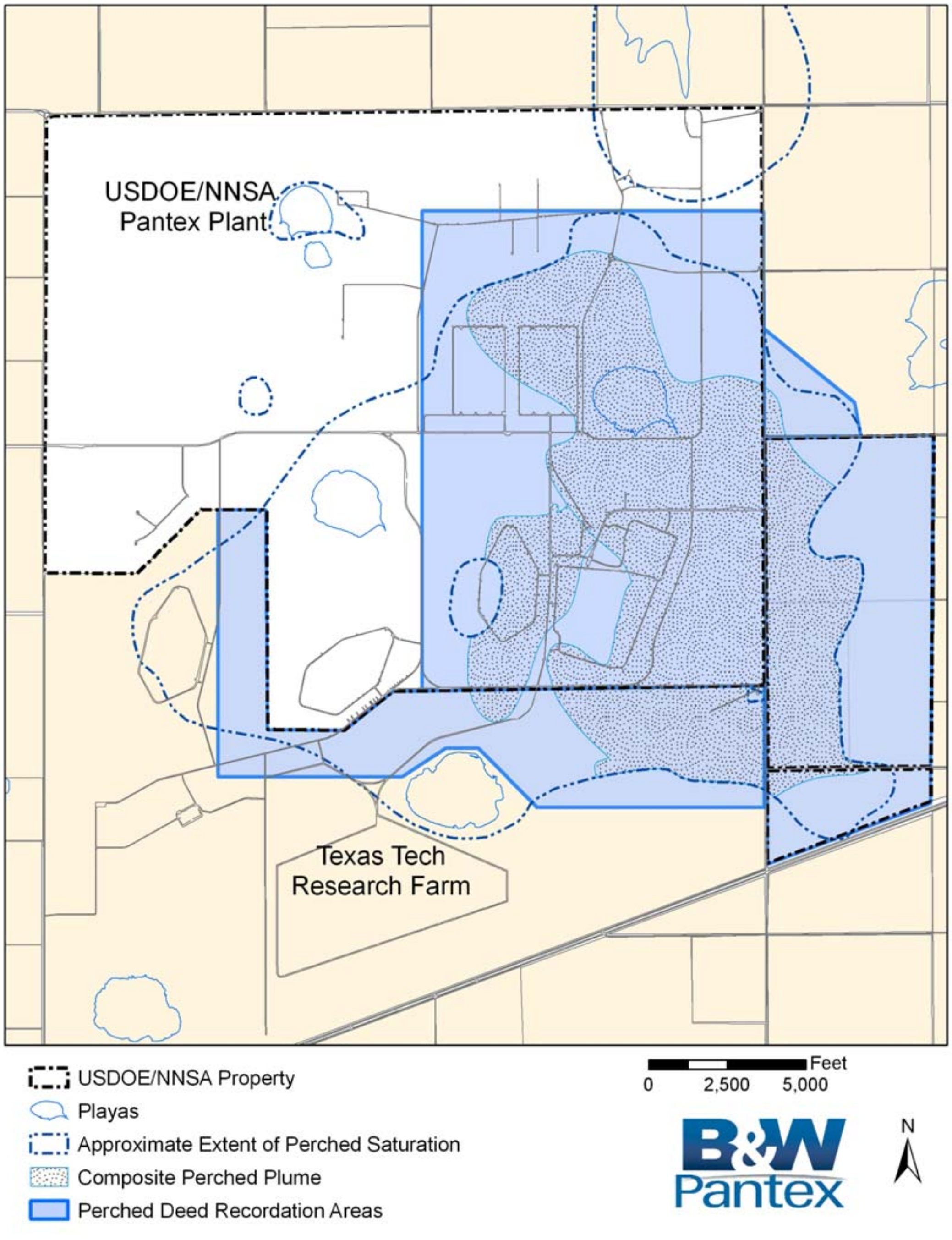

Figure 2-25. Perched Groundwater Institutional Control Areas

2.14.4.2 Contingency Plan

Uncertainties associated with changes in perched groundwater plumes and the effectiveness of preferred alternatives to be implemented for the selected remedy require development of a perched contingency plan as part of the Remedial Design Submittal Package, in accordance with the IAG. Remedial action alternatives are discussed in the Feasibility Study for the Pantex Plant, September 2007.

Table 2-22 outlines the framework that was developed to identify the areas of greatest uncertainty identified for operation of the selected remedy in the perched and outline the potential contingency plan that would be implemented if monitoring data show that the selected remedy is not meeting performance expectations. The framework defines the expected performance of the remedy, the potential deviations in technologies identified through the investigations and alternatives evaluation, the monitoring that will be performed to determine if the remedy is meeting performance expectations and contingencies that could be implemented if the performance expectations are not met.

Table 2-22. Perched Groundwater Contingency Matrix

Expected Performance	Deviations in technology performance	Monitoring	Contingency
Selected Remedy Component: In-Situ Bioremediation (ISB) in the Southeast Perched Groundwater- The primary purpose of the ISB system is to treat RDX			
1. The ISB system will result in the transformation of hexavalent chromium to its trivalent state resulting in immobilization of chromium within the soil matrix. 2. Resulting GW concentrations of Cr < MCL (100 ppb).	1. The trivalent chromium reaction is not permanent, and it will reoxidate resulting in mobile hexavalent chromium after leaving the treatment zone. 2. Total Cr > MCL (100 ppb) because Cr III becomes mobile.	1. A bench scale test of the ISB to determine if the hexavalent chromium will remain immobilized. 2. Monitor Cr downgradient of the ISB reducing area.	1. Modify the ISB amendment to achieve enhanced hexavalent chromium capture without decreasing RDX treatment effectiveness. 2. Addition of wells to the existing Southeast pump and treat system to increase Cr mass extraction resulting in a decrease of the concentration of hexavalent chromium before it reaches the ISB area.
1. Based on the pilot study, RDX will be bio-transformed to concentrations <cleanup levels.	1. RDX daughter products persist in perched groundwater downgradient of ISB.	1. Monitor for mono-, di- and tri-nitrosoamine.	1. Adjust amendment application dose or formulation.

Table 2-22. Perched Groundwater Contingency Matrix, continued

Expected Performance	Deviations in technology performance	Monitoring	Contingency
Selected Remedy Component: In-Situ Bioremediation (ISB) in the Zone 11 Perched Groundwater- The primary purpose of this ISB system is to treat Perchlorate and TCE			
1. ISB treatment of Perchlorate and TCE to concentrations <cleanup level.	1. Perchlorate or TCE is not reduced to cleanup levels. 2. Breakdown products of TCE persist in perched groundwater downgradient of treatment system.	1. Monitor perchlorate and TCE downgradient of ISB system 2. Monitor DCE (cis & trans), TCA, DCA, and vinyl chloride downgradient of ISB system	1. Adjust amendment application dose. 2. Stage amendment application to achieve reduction gradient through treatment zone. 3. Implement bioaugmentation. 4. Implement Pump and Treat option.
Selected Remedy Component: ISB in the Southeast Perched Groundwater, ISB in Zone 11 Perched Groundwater, Southeast Area Pump and Treat System, Playa 1 Pump and Treat System			
1. The selected remedy has targeted treatments in the areas sensitive to migration identified in the southeast area. Areas sensitive to vertical migration are limited to those previously identified in the southeast area.	1. Additional areas sensitive to vertical migration are identified.	1. Groundwater monitoring using the Ogallala monitoring network.	1. Addition of pump and treat systems or ISB based on the characteristics of the new area that is determined to be sensitive to vertical migration.
2. Selected remedy components treat secondarily targeted COCs.	2. Secondarily targeted COCs are not treated to cleanup levels.	2. Groundwater monitoring using the perched groundwater monitoring network.	2. Addition of treatment processes or adjustment of amendment application dose/formulation to achieve cleanup levels.
Selected Remedy Component: Southeast Area Pump and Treat System			
1. Reduction of perched groundwater levels adjacent and east of FM 2373.	1. Perched groundwater levels remain unaffected or rise faster than predicted through Fate and Transport Modeling.	1. Groundwater monitoring using the perched groundwater monitoring network.	1. Consider addition of extraction wells 2. Evaluate data to quantify attenuation rates for the perched groundwater COCs.

Table 2-22. Perched Groundwater Contingency Matrix, continued

Expected Performance	Deviations in technology performance	Monitoring	Contingency
Collective Remedy: ISB in the Southeast Perched Groundwater, ISB in Zone 11 Perched Groundwater, Southeast Area Pump and Treat System, Playa 1 Pump and Treat System, Monitored Natural Attenuation, Institutional Controls and Long-Term Groundwater Monitoring Network			
1. Restore perched groundwater to drinking water standards.	1. COCs and daughter products exhibit concentrations that demonstrate stable or increasing trends exceeding cleanup levels.	1. Groundwater monitoring using the perched groundwater monitoring network.	1. Continue/increase extraction and treatment using pump and treat systems. 2. Enhance *in-situ* treatment or implement emerging innovative technologies, if determined to be practical.
Beneficial Use of Treated Perched Groundwater			
1. Beneficial uses will remain available for the rate of perched groundwater being extracted and treated each year (i.e., crop irrigation and/or industrial use).	1. Need for perched groundwater decreases or selected beneficial use ceases.	1. Annual evaluation of SEPTS and P1PTS output and irrigation/industrial use demand.	1. Treatment through an onsite wastewater treatment system and discharge via a permitted outfall in compliance with a current industrial wastewater discharge permit 2. Additional treatment by means of air stripping, chemical precipitation, ion exchange, and/or carbon adsorption to allow for disposal at other authorized onsite or permitted offsite facilities. 3. Injection, after treatment, back into the contaminated portion of the perched groundwater, in accordance with applicable rules and permitting requirements

If the monitoring identified in the framework determines that the contingency plan will need to be implemented, USDOE/NNSA will invoke the contingency using an Explanation of Significant Difference (ESD), or a ROD Amendment, whichever is more appropriate for the specific situation as determined in accordance with 40 CFR 300.435(c)(2). The ESD, or ROD Amendment, will describe the selected remedy, the nature of the significant changes (including impacts on costs and remediation timeframes) and document that the selected remedy is protective of human health and the environment and meets

ARARs. USDOE/NNSA will follow the appropriate public participation requirements associated with the ESD, or ROD Amendment, as required by NCP §300.435(c)(2).

2.14.4.3 Ogallala Contingency Plan

The Ogallala Aquifer will be monitored for early detection of perched groundwater COCs. Early detection monitoring is important for confirming the effectiveness of perched groundwater remedies and monitoring for uncertainties defined through the approvals of the investigation reports. If monitoring results are obtained through the Ogallala Aquifer Monitoring Network, and do not match expected conditions, the contingency plan will be implemented to ensure protection of the aquifer. An Ogallala Contingency Plan is part of the Remedial Design Submittal Package required by the IAG.
The monitoring network in the Ogallala Aquifer will be designed to ensure there is coverage for:

- The areas of greatest potential for migration of source term (i.e., perched contaminants) to the Ogallala Aquifer.
- The areas identified in the investigation phase with uncertainty in vertical delineation of contaminants, and/or where focused recharge conditions are anticipated or have occurred historically.

If constituents are detected in the Ogallala Aquifer at concentrations above the Practical Quantitation Limits and are confirmed through repeated sampling results and/or trending, then remedial actions would be considered and developed to achieve the RAOs for the Ogallala Aquifer. The remedial actions would be dependent on the specific constituents, location, and conditions associated with the impact.

2.15 Statutory Determinations

2.15.1 Protection of Human Health and the Environment

To address unacceptable risks to human health and the environment, the following alternatives were combined and chosen as the Selected Remedy documented in this site-wide ROD:

- **Alternative 2: Institutional Controls** for Limited Action Soil Units, Burn Pads 11 through 13 (SWMUs 25, 26 and 27), and SWMU 5/12a.
- **Presumptive Remedy of Soil Vapor Extraction** (with future modifications to effectively reduce the source term) and Institutional Controls for SWMU 47.
- **Alternative 3: Containment and Institutional Controls** for Pantex Landfills, the Burning Grounds Former Ash Disposal Trench (SWMU 14-24), the former operational area of Firing Site 5 (SWMU 70) and SWMUs 2 and 5/05
- **Alternative 5: Pump and Treat Systems, *In-situ* Treatment and ICs for Southeast Perched Groundwater**
- **Alternative 4: Targeted *In-Situ* Treatment and ICs for Zone 11 Perched Groundwater**

The Selected Remedy, once implemented, will be protective of human health and the environment by preventing uncontrolled exposure to contaminants in environmental media and minimizing the potential for contaminant migration via infiltration or runoff.

2.15.2 Compliance with Applicable or Relevant and Appropriate Requirements

The National Contingency Plan 40 CFR 300.430 (f) (1)(ii)(B) requires that the Selected Remedy attains the Federal and State ARARs or obtains a waiver of an ARAR. The Selected Remedy documented in the ROD complies with the ARARs presented below and does not require any waivers of ARARs.

Soil ARARs include:

- Resource Conservation and Recovery Act (40 CFR parts 260-280, 42 USC § 6901-6933) (30 TAC §335.561 –30 TAC §335.563)
- Compliance Plan (CP-50284) (TSWDA, Texas Health & Safety Code, Chapter 361; 30 TAC Chapters 305, 335 and 350)
- Texas Health & Safety Code, Section 382.085: Unauthorized Emissions Prohibited
- Procedures for Planning and Implementing Offsite Response Actions [The EPA Offsite Rule] (40 CFR 300.440)
- Shipping and Reporting Procedures Applicable to Generators of Hazardous Waste or Class 1 Waste and Primary Exporters of Hazardous Waste (30 TAC §335.10)
- Hazardous Material Transportation Act (49 USC § 5101-5127)
- Hazardous Materials Regulations (49 CFR §171.1 et seq.)
- Underground Injection Control (40 CFR Parts 144-148, et. seq.; 30 TAC 331)

Groundwater ARARs include:

- Safe Drinking Water Act (SDWA, P. L. 104-182, 40 CFR Part 141, et. seq.)
- Resource Conservation and Recovery Act (40 CFR parts 260-280, 42 USC § 6901-6933)
- Compliance Plan (CP-50284) (TSWDA, Texas Health & Safety Code, Chapter 361; 30 TAC Chapters 305, 335 and 350)
- General Regulations Incorporated into Permits (30 TAC 305 and 30 TAC 319) and Chapter 26 of the Texas Water Code
- Texas Water Code, Chapter 26, 30 TAC 305
- Section 402 of the Clean Water Act and Chapter 26 of the Texas Water Code (TPDES MSGP, TXR 150000)
- Underground Injection Control (40 CFR Parts 144-148, et. seq.; 30 TAC 331)

2.15.3 Cost-Effectiveness

Based on the expected performance standards, the Selected Remedy is cost-effective. It effectively provides short and long-term protection of human health and the environment at a cost proportional to the risk reduction being achieved.

2.15.4 Use of Permanent Solutions and Alternative Treatment Technologies to the Maximum Extent Practicable and Preference for Treatment as a Principle Element

The selected remedy provides the best balance of tradeoffs among the alternatives with respect to the balancing criteria set forth in NCP§300.430(f)(1)(i)(B), such that it represents the maximum extent to which permanent solutions and treatment technologies can be utilized in a practicable manner at the Site.

2.15.5 Five Year Review Requirements

Since the selected remedies will result in hazardous substances remaining onsite above levels that allow for unlimited use and unrestricted exposure, a statutory review must be conducted within five years of the initiation of the remedial action to ensure that the remedy is, or will be, protective of human health and the environment. Pursuant to CERCLA Section 121(c), 42 U.S.C. § 9621(c), and as provided in the current guidance on Five Year Reviews [OSWER Directive 9355.7-03B-P, Comprehensive Five-Year Review Guidance (June 2001)], USDOE/NNSA must conduct a statutory review within five years from the initiation of construction at the Site. The IAG also stipulates that USDOE/NNSA "will review the remedial action no less often than every five (5) years after initiation of the remedial action to assure that human health and the environment are being protected by the remedial action being implemented. The Five-Year Review will include an evaluation of remedy effectiveness, the appropriateness of new technologies, changes in ARARs, recommendations to implement remedial contingencies, and will be consistent with EPA Five-Year guidelines per CERCLA Section 120(a)(2), 42 U.S.C. § 9620(a)(2). USDOE/NNSA will conduct the review consistent with the requirements of CERCLA, the NCP, and EPA guidance concerning the conduct of such reviews."

2.16 Documentation of Significant Changes from Preferred Alternative of Proposed Plan

Groundwater RAO Expanded: The Remedial Action Objective (RAO) for the perched groundwater was expanded in the ROD to be consistent with the NCP expectation for restoration throughout the perched groundwater, if the criteria for a drinking water source are met. The RAO was changed from: *[Proposed Plan]* "Achieve cleanup standards for all contaminants in the perched groundwater at the property boundary and/or areas sensitive to downward migration," to *[ROD]* "Achieve cleanup standards for all contaminants in the perched groundwater throughout the plume." Changing the RAO, does not change the scope, schedule, cost, or expectations of the selected remedy compared to the preferred alternative in the Proposed Plan.

RDX and Chloroform Cleanup Levels: The perched groundwater cleanup level for RDX, a suspected carcinogen, was lowered from 7.7 µg/L (Proposed Plan) to 2 µg/L in the ROD, to be consistent with the EPA Lifetime Health Advisory level for RDX. The 7.7 µg/L proposed cleanup level was calculated to an individual ILCR at 1E-5. Similarly, chloroform was reduced from 370 µg/L to 80 µg/L (in the ROD), based on the MCL established for trihalomethanes (including chloroform).

No Action Units: Release units identified as requiring "No Action" or "No Further Remedial Action" on pages 49-53 of the Proposed Plan, require institutional controls and long-term groundwater monitoring, which are defined as response actions under CERCLA. An alternatives evaluation is presented in this ROD for these units, which are now referred to as "Limited Action" sites.

Containment and Institutional Controls: The preferred alternative presented in the Proposed Plan for soil units was institutional controls in addition to interim actions already taken by USDOE/NNSA, such as landfill covers and ditch liners. Containment was added to the title of the selected remedy for the Pantex Landfills, the Burning Ground Former Ash Disposal Trench (SWMUs 14-24), the former operational area of Firing Site 5 (SWMU 70), and SWMUs 2 and 5/05 to specifically recognize that facet of the remedy and preserve the need for review of soil cover and liner systems requiring ongoing inspection and maintenance. Containment was evaluated in the Feasibility Study against the nine criteria required by CERCLA in the Code of Federal Regulations (40 CFR §300.430(e)(9)(iii).

Monitored Natural Attenuation: Monitored Natural Attenuation was presented as part of each remedial action alternative for the perched groundwater in the Proposed Plan. The selected remedy for perched groundwater in this ROD does not include MNA because further detailed information is needed to demonstrate that natural attenuation is occurring for each of the applicable perched groundwater COCs and to determine the site-specific rate of degradation processes, as appropriate. However, the remaining components of the selected groundwater alternative are expected to achieve the remedial action objectives.

Long-Term Groundwater Monitoring: Long-Term Groundwater Monitoring is presented as part of each remedial action alternative for the perched groundwater in the Proposed Plan. The selected remedy for perched groundwater in this ROD does not include Long-Term Groundwater Monitoring, because it is not defined as a remedy, but rather a system to evaluate the performance of the selected remedy and confirm expected conditions in perched groundwater as a means of managing uncertainties identified through the investigation. The Long-Term Groundwater Monitoring System will be proposed, reviewed and approved as part of the Remedial Design Submittal Package, in accordance with the IAG, and periodically evaluated under the CERCLA Five-Year Review process.

3.0 RESPONSIVENESS SUMMARY

The responsiveness summary serves four primary purposes. First, it provides the DOE, EPA, and TCEQ with information about community concerns with the site and preferences about the Preferred Alternative presented in the Proposed Plan. Second, it shows how the public's comments were factored into the decision making process for selection of the final remedy. Third, it provides the DOE, EPA, and TCEQ with information about the EPA Remedy Review Board concerns about the Preferred Alternative presented in the Proposed Plan. And fourth, it provides a formal mechanism for the DOE to respond to public and Remedy Review Board comments.

The public comment period for the Proposed Plan was held from March 17 to April 28, 2008. A public meeting was held on March 31, 2008, to present the Preferred Alternative in the Proposed Plan. Based on the comments received at the public meeting and during the comment period, the public and the EPA support the Preferred Alternative. During the public meeting DOE representatives presented an overview of the Proposed Plan and TCEQ and EPA representatives were present to discuss the remedial alternatives with the public informally. The formal presentation and questions officially submitted by the public during this meeting can be found in the meeting transcript as part of the Administrative Record.

On April 15, 2008, the EPA Remedy Review Board met to review the selected remedy at the Pantex Plant. The purpose of the Board is to review proposed Superfund cleanup decisions that meet cost-based review criteria to assure they are consistent with Superfund law, regulations, and guidance.

This Responsiveness Summary documents the formal public comments received on the Site-Wide Proposed Plan for Pantex Plant (B&W Pantex, 2008), formal comments made by the EPA Remedy Review Board, and the DOE's responses to the comments.

3.1 Stakeholder Issues and Lead Agency Responses

3.1.1 National Remedy Review Board Advisory Recommendations

1. The Board notes that cleanup of the Pantex site is being conducted pursuant to a three-party agreement between EPA, the State of Texas, and the DOE. The package presented to the Board described both RCRA and CERCLA actions, past and future. This combination of authorities and actions made it difficult for the Board to evaluate past and future remediation measures for the site. This uncertainty affected the Board's understanding of the site and hence, the comments and recommendations that it is making, since flexibility available under one authority may not be available under the other authority. The Board recommends clarifying the relationship between the use of RCRA and CERCLA authorities for the site, and the relative federal and state roles and responsibilities, in subsequent decision documents. The Region may find "Coordination between RCRA Corrective Action and Closure and CERCLA Site Activities" (September 24, 1996, http://www.epa.gov/correctiveaction/resource/guidance/gen_ca/coordmem.pdf) and "Improving RCRA/CERCLA Coordination at Federal Facilities," (OSWER Directive 9279.0-22, December 21, 2005, http://www.epa.gov/fedfac/pdf/oswerdir9272_0-22.pdf) useful in clarifying these relationships.

   USDOE/NNSA Response:
   There has been a collaborative approach to the environmental work at the Pantex Plant, between the three participating Agencies (DOE, EPA, and the State), since 1989, beginning with the early investigations of the site. As discussed in the Board package, the State began permit actions in the early 1990's, and EPA listed the site on the NPL in 1994. The RCRA

and CERCLA integration was formalized in the 1994 Memorandum of Agreement (MOA) between EPA and the State, which established roles and responsibilities for each Agency. The IAG was recently negotiated, effective February 2008, to further define roles from the Record of Decision (ROD) to construction to long-term operation and maintenance. It is important to note that the project has been accelerated through the efforts of a four-party Core Team comprised of the DOE, EPA, TCEQ, and the site operations and management contractor, B&W Pantex, which was formed in 2001. These integration efforts have maintained the independent authorities of the State and federal programs, while minimizing any duplication in the work needed to address the requirements of each program. While this was not emphasized during the presentation to the Board, this process has been effective in completing the investigations, the risk assessment, and the proposal of remedies.

As recommended, the ROD better clarifies the dual authority (CERCLA/RCRA) role for the Pantex Plant cleanup, and provides recognition of the interim responses taken under both the State's RCRA program and CERCLA. The interim responses provided for early action to mitigate risk and implement protective measures. The Selected Remedy in this ROD, including any interim responses, are based on the Administrative Record under Section 113(h) of CERCLA, and evaluated in the Feasibility Study against the nine criteria required by CERCLA in the Code of Federal Regulations (40 CFR §300.430(e)(9)(iii).

2. The Board believes that the remedial action objective (RAO) for the 11-square mile, 15-billion gallon perched aquifer should be restoration, consistent with the NCP expectation to restore ground water that is a potential drinking water source. Failure to identify restoration of the aquifer as a remedial action objective (RAO) makes the remedy as proposed (i.e., containment of ground water exceeding maximum contaminant levels (MCLs)) inconsistent with the NCP expectation that ground water be restored throughout the plume (40 CFR §300.430 (a)(1)(iii)(F)). Nothing presented to the Board suggests that potential future reliance on state-law based alternate concentration levels (ACLs) would ameliorate that inconsistency or could be done consistent with CERCLA. In addition, the use of point of compliance for this proposed remedy as presented to the Board was not consistent with the NCP and existing EPA guidance. Specifically, the preamble to the NCP states "that remediation levels should generally be attained throughout the contaminated plume or at and beyond the edge of the waste management area, when waste is left in place." (55 FR 8753, March 8, 1990).

   The Board believes that restoration of the perched aquifer is the best way to preserve the lower aquifer. Given that Texas considers all ground water to be potential drinking water, the perched aquifer should be considered a potential drinking water aquifer unless it does not have the potential to produce a minimum quantity of water of sufficient quality. If DOE determines that restoration is technically impracticable, then it may be appropriate to pursue a technical impracticability (TI) waiver for a portion of the plume that cannot be restored. This TI waiver should be based on sufficient data, as discussed in EPA's TI waiver guidance "Guidance for Evaluating Technical Impracticability of Ground-Water Restoration" (Directive 9234.2-25, September 1993). The Board recommends correcting this aspect of the proposed remedial strategy by reissuing the Proposed Plan to allow public comment on the change. A detailed cost estimate for this restoration alternative should be prepared for comparison against the other remedial alternatives presented as part of the Proposed Plan.

USDOE/NNSA Response:
USDOE/NNSA revised the perched groundwater remedial action objective to restoration. ACLs are no longer applicable to the Selected Remedy. This change does not change the scope, performance or cost of the preferred remedy and could have been reasonably anticipated, based on the information in the Proposed Plan and the Administrative Record. Relatively few comments were received on the Proposed Plan. USDOE/NNSA, as the Lead Agency, has flexibility to address this modification in the ROD, in accordance with 40 CFR 300.430 (f)(3)(ii)(A). Since this revised goal is more protective of human health and the environment than achieving drinking water standards in areas sensitive to vertical migration, the change has been identified in Section 2.10.1.3 of this Record of Decision and in this Responsiveness Summary. To inform the community of this more conservative approach USDOE/NNSA also provided a notice of the change to the more than 200 parties on its mailing list, including all recorded attendees of the March 31, 2008 public meeting on the Proposed Plan.

3. Based on information presented to the Board, the applicable or relevant and appropriate requirements (ARARs) for this site are not clear. The decision documents should describe how the preferred remedy will meet the ARARs for the site. Furthermore, the package presented to the Board indicated that at some point in the future, DOE and the State may seek to change the ground water cleanup levels and rely on state-law based ACLs. Assuming such state-law based ACLs can be used for a CERCLA remedial action, the decision documents should clearly state the cleanup levels to be achieved by the selected remedy and describe how the remedy will be protective of human health and the environment. If different cleanup levels are to be developed in the future, a ROD amendment would be needed. In addition, the Board notes that cleanup levels agreed to by DOE and the State for purposes of the State's cleanup program are not binding on EPA and do not impact how it carries out its statutory role under CERCLA Section 120 and the Federal Facility Agreement at this site to ensure protective cleanups. Generally, a site cannot be deleted from the National Priorities List unless it is protective under CERCLA.

USDOE/NNSA Response:
Comment noted. USDOE/NNSA revised the perched groundwater remedial action objective to restoration throughout the perched. Therefore, ACLs are no longer applicable to the Selected Remedy. Implementing a restoration objective for perched groundwater beneath the site should address the issues identified in this comment. Cleanup levels meet the CERCLA requirements and are consistent with State requirements.

4. The Board notes that the Region and DOE issued the Proposed Plan before presenting the remedy to the Board. Board procedures state that remedies subject to Board review should be presented to the Board prior to issuing the Proposed Plan, so that Board review can be integrated into the site schedule with minimal impact. The Board recommends that the Region carefully review the Proposed Plan in light of the Board's comments on the package.

USDOE/NNSA Response:
DOE, TCEQ, and EPA discussed how best to address the Board review within the context of the schedule negotiated in the February 22, 2008, Interagency Agreement. While we recognize that it was not a typical approach to have the review during the public comment period, we also understand that it was an important part of the review process for the project. To accommodate all parties, DOE opted to extend the public comment period to 45 days and to address any Board comments in the Responsiveness Summary and the ROD, as necessary. Discussions with the Board Chairman on January 28, 2008, confirmed that this approach, while not typical, was also not without precedent and would be acceptable. As

planned, the Board recommendations were considered and addressed as noted in this Responsiveness Summary.

5. In the materials given to the Board for review, it was difficult to discern what soil response work had already been completed and what soil response work would be done as part of this remedy. The RAOs in the package give the impression that all of the soil response work will be completed in the future. The Board recommends that the decision documents identify what soil response work remains to be done and be clear where no further action is planned because the RAOs have already been met.

USDOE/NNSA Response:
Comment noted. This ROD clarifies those actions that remain to be implemented, as well as those responses implemented as interim corrective measures

6. Related to Comment 5, the costs presented in the package appear to include the costs for previous early actions. In addition, the backup cost details for the various remedial alternatives were not provided, which limited the Board's ability to thoroughly review the cost effectiveness of the preferred alternative. The Board recommends that the decision documents clearly identify the remaining capital and detailed operation and maintenance (O&M) costs for the remedial actions that are proposed.

USDOE/NNSA Response:
Cost estimates were examined and revised for this Record of Decision to clarify the remaining capital costs and describe the operation and maintenance costs in greater detail.

7. The package presented to the Board stated that the preferred remedy for the southeast perched ground water includes pumping and treating contaminated ground water followed by MNA. However, it is not clear what conditions would trigger implementation of MNA. The remedy should clearly describe the set of conditions under which MNA will be implemented or whether MNA would be part of subsequent ground water remedy optimization. If MNA remains a part of the remedy, then the decision documents need to describe the mechanisms of MNA expected to be relevant to the site and provide the justification for its selection. The Board believes that the ROD should establish specific performance objectives for all aspects of the remedial action (including the pump and treat system) to properly evaluate system design, optimizing performance, effectiveness, and achievement of RAOs.

USDOE/NNSA Response:
Natural attenuation is an ongoing process that is part of the existing, perched groundwater system. Information collected from perched groundwater within the RDX plume, including measurements of oxidation-reduction potential and detections of RDX breakdown products (mono-, di-, and tri-nitrosamines), indicate that attenuation is occurring naturally. Additional information needs to be collected as components of the remedy are implemented to better understand and predict the effectiveness of the natural processes associated with this attenuation. Accordingly, references to MNA as part of the remedy are not included as part of the CERCLA Selected Remedy. Data will be collected and evaluated to determine if MNA should be formally considered at some point in the future.

8. The contaminated ground water in the perched aquifer is a primary threat to the contamination of the Ogallala, which is a critical sole source aquifer. The package presented to the Board indicated that, after 2005, wastewater has been managed by soil subsurface irrigation. The Board recommends that DOE should more fully evaluate the hydrogeology of the perched aquifer

system including the recharge rates, rates of withdrawal, impacts of soil irrigation and plant process water disposition. Specifically, DOE should evaluate the hydrogeologic effects on the Ogallala Aquifer to ensure that neither current nor future actions adversely affect the planned ground water remediation.

<u>USDOE/NNSA Response</u>:
USDOE/NNSA understands the importance of minimizing any recharge of the perched groundwater beneath the site. Wastewater from Pantex operations is managed to minimize the potential for future recharge, in accordance with applicable permits and regulations. Discharge to the subsurface irrigation system is authorized by a Texas Land Application Permit, which requires demonstration that the water is applied in a manner that results in effective capture at the root zone and use through plant uptake to prevent deep percolation. It is important to note that the remedial action proposed for perched groundwater establishes actions to further minimize the effects of past and present recharge, i.e. pump and treat systems. Minimizing recharge is a key component of the remedy and current operations at the site.

9. Based on the discussion at the meeting, the Board notes that the long-term monitoring network proposed for the Ogallala Aquifer is based on the current pumping regime for the production wells utilized by the City of Amarillo; changes to this ground water regime could affect the effectiveness of the proposed monitoring system. The Board recommends that if Amarillo makes significant changes involving these production wells, then the effectiveness of the monitoring network should be reassessed.

<u>USDOE/NNSA Response</u>:
Comment noted. Data collected during long-term monitoring, including water level measurements from monitoring wells in the Ogallala Aquifer, will be evaluated by the USDOE/NNSA, EPA and the State to determine if changes are needed in the future. The City of Amarillo has no plans in the foreseeable future (30-year plan) to decrease capacity of the water supply system to the north of Pantex Plant. Static and dynamic conditions of the aquifer were evaluated in the Sitewide groundwater model, and results indicate that the aquifer would respond gradually to significant changes in production, allowing time for evaluation and modification of the monitoring system. Any changes to the hydrologic system, either for the perched groundwater or the Ogallala aquifer, would be evaluated for short-term and long-term impacts.

10. The preferred alternative for the southeast perched ground water includes *in-situ* treatment for RDX and hexavalent chromium. The materials presented to the Board did not describe the rate and completeness of RDX degradation nor chromium reduction and immobilization. The Board recommends that treatment effectiveness be better documented in the decision documents.

<u>USDOE/NNSA Response</u>:
As noted the ROD will contain a more detailed discussion of the treatment effectiveness expected for RDX and hexavalent chromium through *in-situ* anaerobic bioremediation. The basis for this information is a pilot-scale in-situ treatability study conducted in 2006/2007 in Pantex perched groundwater near the ISB system installed as an early action. Results of this study demonstrated achievement of drinking water standards for both RDX and chromium within two years. Additional bench-scale studies are being performed to evaluate the permanence of chromium immobilization. In addition, the treatability studies for in-situ treatment with a range of amendments, including more detail and application

results, are included in the Administrative Record. The effectiveness of the field application will be evaluated through the groundwater monitoring program.

11. In the package presented to the Board, the preferred alternative for the Zone 11 perched ground water included targeted *in-situ* treatment, ICs, and MNA. Perchlorate and TCE were identified as the primary contaminants of concern (COCs). The package presented to the Board states that pilot studies have demonstrated that anaerobic *in-situ* biological (ISB) treatment is effective for some of the COCs found in Zone 11 but that additional studies would be needed to demonstrate its effectiveness for perchlorate. EPA has had mixed experience with ISB treatment for perchlorate. Active ex-situ biological treatment in a fluidized bed bioreactor is a proven effective perchlorate treatment technology. The Board recommends that DOE and the Region further evaluate and document the selection of *in-situ* biological treatment for perchlorate, or that the decision documents contain a contingency remedy for the Zone 11 perched ground water.

USDOE/NNSA Response:
While USDOE/NNSA is confident that anaerobic ISB will be effective for the observed perchlorate concentrations at the Pantex Plant (i.e. about 1 ppm), additional work is being pursued through the design phase of this project to ensure that this remedy will achieve RAOs. As recommended, this ROD also includes a contingency remedy, i.e., a pump and treat system that is described as Alternative 3 for the Zone 11 perched groundwater.

12. The package presented to the Board incorrectly describes physical barriers, long-term ground water monitoring, and maintenance of soil covers and ditch liners as ICs. The decision documents should correctly describe these elements as engineering controls or O&M requirements. The Board recommends that the ROD clearly identify any institutional controls necessary for the remedy and link the ICs to the RAOs to which they relate. Furthermore, the ROD should clearly describe the type of ICs and who will be responsible for enforcing them, including those necessary for the adjacent offsite property where ground water contamination has come to be located.

USDOE/NNSA Response:
Comment noted. This ROD clarifies these elements and identifies the parties responsible for implementing, maintaining, reporting on, and enforcing the ICs.

13. The package presented to the Board indicates that one of the RAOs is to "reduce the exposure risk to onsite industrial and construction/excavation workers through removal, treatment, or prevention of contact with COCs in the soil." The Board recommends that this RAO be clarified in the decision documents to make it clear that the workers addressed are those based on a typical industrial exposure scenario.

USDOE/NNSA Response:
The RAO was clarified in this ROD to recognize that the industrial exposure scenario was for a worker at an active site. The exposure scenario was not limited to the remedial activities.

14. The Board notes the absence of stakeholder input at the meeting; in particular, the State of Texas did not provide its views to the Board. The lack of state input was a critical factor in the Board's review for this site because of the complexity of the state's role and responsibility at this site; and it limited the Board's ability to clarify a number of issues, such as aquifer use and designations and cleanup goals (e.g., State ARARs).

<u>USDOE/NNSA Response</u>:
The State of Texas has been actively involved in the process as noted above in response to Comment 1. The State elected not to participate in the presentation, as they were involved in the preparation of the data provided to the Board.

3.1.2 Stakeholder Comments

The Pantex Plant Site-Wide Proposed Plan was issued on March 17, 2008 for public review and comment. A public meeting was held on March 31, 2008 to present the alternatives considered and explain the preferred remedy proposed by DOE/NNSA. Comments were received through April 28, 2008.

1. I think this is the first site I've ever worked with where the responsible party has acknowledged that it will take more than 100 years to fix the problem, the problem being contamination of the perched aquifer and the resulting threat to the Ogallala Aquifer. So I would like the DOE to address this issue of why does it believe that it's capable of conducting a program that will have to last 100 years or more.

   <u>USDOE/NNSA Response</u>:
   The Pantex Plant has and will retain an active mission for the foreseeable future. USDOE/NNSA is the agency presently responsible for management of the Pantex Plant, including implementation of this ROD. When and if this changes, the responsibility for the site will be transferred to either the DOE Office assuming the function of Long-Term Stewardship or the successor Federal Agency.

   The present conditions in perched groundwater beneath the site are the result of more than 50 years of contaminant fate and transport. While some compounds breakdown quickly in the environment or sorb to soils strongly, the primary risk driving contaminants in perched groundwater at the Pantex Plant (i.e., RDX) are much more recalcitrant. Site conditions restrict mass and fluid transport, which are two of the key factors that control the effectiveness of active remedies considered for implementation. It has been recognized that predictions of the fate and transport of RDX are highly dependent on its rate of degradation.

   Progress in achieving the cleanup may be quicker than the present modeling predictions indicate. Additional data will continue to be collected to better understand the RDX degradation process, as the CERCLA required 5-year reviews of the remedy are conducted. The overall remedial approach may be adjusted based on future information acquired through the long-term groundwater monitoring network, technological advances, and environmental studies.

2. I think DOE has rightly focused on the southeastern lobe of the perched aquifer. That probably represents the area where the Ogallala is most vulnerable. However, there may be other areas where the Ogallala is vulnerable that haven't been adequately addressed. One area is beyond the eastern boundary of the plant on private property. What we have here is highly contaminated groundwater flowing toward the edge of the perched aquifer. The other area is in the northern part of the perched aquifer where, once again, we have highly contaminated groundwater flowing to the edge of the perched aquifer.

USDOE/NNSA Response:
The preferred remedy includes a pump and treat system at Playa 1. Three of the extraction wells that are part of this system are along the northwest side of this playa. Several years of continuous operation of the Playa 1 Pump and Treat System is expected to achieve removal of some of the perched groundwater northwest of Playa 1. The fine-grained zone in the area northwest of Playa 1 exists as a competent clayey silt/silty clay (as demonstrated by test results for samples collected from the fine-grained zone when drilling monitoring wells PTX06-1050, PTX07-1O04, and PTX07-1O06 that exhibit a hydraulic conductivity less than 3E-07 cm/s). Also, information from wells in this area indicates that the FGZ is higher than beneath Playa 1. This feature aids in containing the perched contaminants, so the Ogallala Aquifer will be protected until sufficient data are available to determine the effects of the Playa 1 P&T System on the area of the perched groundwater northwest of Playa 1. This issue will be closely monitored through sampling and analysis while the preferred remedy is implemented and operated for a sufficient time to determine if contingencies need to be implemented to protect the Ogallala Aquifer.

Similarly, fate and transport predictions of vertical migration beneath property east of FM 2373 indicate that perched groundwater contaminants will not reach the Ogallala Aquifer. Recharge that resulted from historic industrial discharges to the drainage ditch east of Zone 12 led to an eastern component of flow in the past, but it has since dissipated. The flow of perched groundwater is now affected primarily by the mound of perched groundwater beneath Playa 1 and the shape of the surface of the FGZ, resulting in flow that is primarily to the south/southeast. Beneath most of the property east of FM 2373, perched groundwater is less than five feet thick. Along FM 2373, perched groundwater varies from 10 to 15 feet in thickness. Extraction wells along FM 2373 and within the area east of Zone 12 will reduce the volume of water present and result in a corresponding decrease in the head of water above the fine-grained zone. Some areas of the FGZ in the area east of FM 2373 exhibit hydraulic conductivities on the order of 1E-04 cm/s, but the vadose zone between the FGZ and the Ogallala Aquifer increases in thickness from the south boundary to the north boundary of the site, providing capacity for attenuation, as depicted in Figure 2-13 of this ROD. The pump and treat systems are expected to stabilize and decrease the vertical head of the perched groundwater on the fine-grained zone in the areas east of FM 2373. The perched groundwater in these areas will be closely monitored for increases in concentrations and thickness while the preferred remedy is implemented and operated for a sufficient time to determine if contingencies need to be implemented to protect the Ogallala Aquifer.

3. I've looked at the description of the Contingency Plan in the Proposed Plan, as well as in the CMS/FS document, and it's very vague. I think you could summarize the Contingency Plan probably in one sentence that says, "if something goes wrong, we're going to do something about it." I don't think that that's an adequate Contingency Plan. I think what the DOE needs to do is come up with objective criteria and steps that will be implemented if and when those criteria are met.

USDOE/NNSA Response:
Section 2.14.5.2 of this ROD describes the expected effects of each of the components of the preferred remedy and the contingent actions that could be implemented if unexpected conditions are observed. USDOE/NNSA will be preparing a more detailed contingency plan as part of the remedial design package to be submitted after issuance of this ROD, in accordance with Article 8.5 of the Interagency Agreement.

4. I know that DOE has considered the possibility of purchasing property to the east of Pantex. I don't know whether or not it's actually going to buy that property, but if that property is bought, it could be used -- you could install remediation measures on that property, and you could prevent the use of that water. So I think the DOE should tell the public whether or not it intends to buy that property.

USDOE/NNSA Response:
USDOE/NNSA has reached purchase agreements with all but one of the owners of land east of FM 2373 underlain by contaminated perched groundwater. Some sales have been completed and others are in progress. If purchase of the remaining parcel of land is not successful, USDOE/NNSA will enter into negotiations with the landowner to reach agreement to restrict use of the perched groundwater and drilling to depths of the perched zone. Agreements for access to the property for constructing remedies would be pursued as necessary.

5. The DOE used to post the water quality data on its website, as well as a lot of documents. It no longer does that, and this makes it more difficult for the public to figure out what is going on at Pantex. So I would just encourage the DOE to go back to its old policy and post the data and the documents on its website.

USDOE/NNSA Response:

USDOE/NNSA is providing information regarding the environmental cleanup on its website, including electronic data associated with the semi-annual progress reports submitted to TCEQ and EPA.

6. DOE has not expressed plans to remove contaminants in the perched aquifer in some areas that pose threats to the Ogallala Aquifer – some of these areas are (a) the northern part of the perched aquifer, (b) in the vicinity of Playa One (e.g., southwest of Playa One), and (c) at the Burning Ground.

USDOE/NNSA Response:
a) The preferred remedy includes a pump and treat system at Playa 1. Three of the extraction wells that are part of this system are along the northwest side of this playa. Several years of continuous operation of the Playa 1 Pump and Treat System is expected to achieve removal of some of the perched groundwater northwest of Playa 1. The fine-grained zone in the area northwest of Playa 1 exists as a competent clayey silt/silty clay (as demonstrated by test results for samples collected from the fine-grained zone when drilling monitoring wells PTX06-1050, PTX07-1O04, and PTX07-1O06 that exhibit a hydraulic conductivity less than 3E-07 cm/s). Also, information from wells in this area indicates that the FGZ is higher than beneath Playa 1. This feature aids in containing the perched contaminants, so the Ogallala Aquifer will be protected until sufficient data are available to determine the effects of the Playa 1 P&T System on the area of the perched groundwater northwest of Playa 1. This issue will be closely monitored through sampling and analysis while the preferred remedy is implemented and operated for a sufficient time to determine if contingencies need to be implemented to protect the Ogallala Aquifer.

b) The perched groundwater southwest of Playa 1 will also be indirectly affected by the Playa 1 P&T System. The fine-grained zone in this area exists as a competent clayey silty sand (as supported by test results for samples collected from the fine-grained zone when drilling monitoring wells PTX07-1P04 and PTX07-1P06 that exhibit a hydraulic conductivity less than

2E-07 cm/s), so the Ogallala Aquifer will be protected until sufficient data are available to determine the effects of the Playa 1 P&T System on this area of the perched groundwater.

c) Perched groundwater beneath the Burning Grounds exhibited concentrations of TCE and perchlorate in excess of drinking water standards in 2002/2003, but these concentrations peaked and subsequent data indicate that this perched groundwater does not presently exceed drinking water standards. Also, the potential for this perched groundwater to impact the underlying Ogallala Aquifer was assessed as part of the groundwater fate and transport evaluation presented in the Burning Ground Human Health Risk Assessment and it was determined that it did not poses a risk that requires mitigation. Both perched and Ogallala groundwater will be monitored beneath and downgradient of the Burning Ground to reaffirm this decision in the future.

7. DOE has not investigated the contamination of the perched aquifer associated with Pratt Lake. The reason that this perched aquifer is a concern is that stormwater runoff from the surface area of the Pantex Firing Sites – the surface of which has been contaminated for decades with depleted uranium and other contaminants – flows to ditches to the north and crosses the highway through culverts, destined for Pratt Lake. This area of perched groundwater threatens the City of Amarillo's municipal water supply field that is completed in the Ogallala Aquifer – some of which is beneath the Pratt Lake perched aquifer. Although DOE has investigated its onsite perched wells, it has not considered that water flowing into the Pratt Playa may have resulted in the largest concentrations of contaminants reaching the perched aquifer associated with the Pratt Lake offsite, rather than within the boundary of the Pantex Plant. The ramifications of this oversight may be problematic to the City of Amarillo and to the households the City of Amarillo serves. This seems to me to be a serious deficiency in the plan.

<u>USDOE/NNSA Response</u>:
USDOE/NNSA has investigated the perched groundwater near Pratt Playa. Data collected from perched groundwater wells in the northeast corner of the Pantex Plant property are not indicative of the presence of contaminant plumes, especially high explosive or volatile organic compounds. Also, Pantex Solid Waste Management Units with the potential for storm water runoff to Pratt Playa, including soil samples collected from the ditches draining from the Firing Sites and the Old Sewage Treatment Plant, have been evaluated. Surface water sampling results collected from the ditches draining toward Pratt Playa were evaluated during the investigation phase. None of this information supports that high concentrations of contaminants were conveyed to Pratt Playa or to the perched ground water beneath it. Perched ground water in the northeast corner of the Pantex Plant is monitored and will continue to be monitored as part of the long-term ground water monitoring network to reaffirm this conclusion in the future.

8. DOE has not adequately investigated the perched aquifer and the Ogallala Aquifer at Pantex Lake.

<u>USDOE/NNSA Response</u>:

USDOE/NNSA installed, sampled, and continues to monitor three perched groundwater wells at Pantex Lake. Data collected from these wells has not indicated an impact from the Plant historical discharge of treated wastewater from the Old Sewage Treatment Plant. These three perched groundwater wells will continue to be monitored in the future.

9. How does DOE plan to compensate the public for its lost groundwater resources during the more than 100 years during which groundwater is compromised and unusable?

   <u>**USDOE/NNSA Response**</u>**:**

   The body of perched groundwater impacted with Pantex contaminants meets criteria for classification as a potential drinking water source (i.e., low total dissolved solids content and sufficient yield). Before constructing and operating the existing pump and treat system, this body of perched groundwater at the Pantex Plant was not used. USDOE/NNSA is pursuing purchase of the properties east of Farm-to-Market Road 2373 that are underlain by perched groundwater impacted by the Pantex Plant operations to provide ready access to monitor the perched and Ogallala groundwater and to implement additional contingency actions as needed.

   Also, USDOE/NNSA will continue to evaluate options for use of the treated perched groundwater in ways that would replace current demands on the Ogallala Aquifer. If such a use is identified that is practical, it would achieve the benefit of reserving several billion gallons of water in the Ogallala Aquifer for future use by residents of the region, while reducing contaminants in the perched groundwater with the goal of eventually restoring it for drinking water use.

10. DOE has not yet provided a contingency plan that provides objective criteria and responses that may be warranted in the future.

    <u>**USDOE/NNSA Response**</u>**:**

    Section 2.14.5.2 of this ROD describes the expected effects of each of the components of the preferred remedy and the contingent actions that could be implemented if unexpected conditions are observed. USDOE/NNSA will be preparing a more detailed contingency plan as part of the remedial design package to be submitted after issuance of this ROD, in accordance with Article 8.5 of the Interagency Agreement.

11. Will the EPA and TCEQ be sufficiently involved in the future to assure the public that the monitoring plan is working and the public's groundwater resource is protected?

    <u>**USDOE/NNSA Response**</u>**:**
    Both EPA and TCEQ will continue to be involved with cleanup at the Pantex Plant.

12. Will the EPA and TCEQ allow the DOE to extend its promises to clean up the perched and Ogallala aquifers at the Pantex boundary to the "new" boundaries, should it purchase adjacent neighboring lands that have contaminated groundwater underneath?

    <u>**USDOE/NNSA Response**</u>**:**
    USDOE/NNSA is purchasing the properties east of FM 2373 that are underlain by perched groundwater impacted by Pantex operations. At the request of EPA, USDOE/NNSA has revised the remedial action objective in this ROD to restoration of the perched groundwater.

    Data collected from the Ogallala Aquifer investigative wells indicate that there are non-trending sporadic detections of constituents at low, non-actionable concentrations below regulatory screening levels. Stated another way, these data indicated that water in the Ogallala Aquifer beneath the Pantex Plant is currently safe for drinking water use and no repeated

detections that would indicate the presence of a contaminant plume in the Ogallala Aquifer have occurred.

13. For soil remedies, stakeholders should be notified when:

- The soil covering/cap is compromised by an event (e.g. grass fire) or persistent condition (e.g. extended drought) which damages vegetative covering, creating a risk of erosion;
- Any activity, natural or human, which compromises the integrity of liners.

For groundwater remedies, stakeholders should be notified when:

- There is an increase in contamination levels of 10% or more in one or more monitoring wells;
- There is a change in detection limits of one or more monitored constituents;
- A certain number of samples (e.g. 15%) fails to meet quality standards in any one monitoring cycle;
- Wells are planned to be added to the network;
- There is detection in any sentinel or Ogallala well;
- Contamination levels reach drinking water standards at any offsite well.

Such notification could be by letter, public meeting, dedicated link on the Pantex web site, or some other agreed on means. There should also be an agreed schedule for timeliness of notification.

USDOE/NNSA Response:
USDOE/NNSA regularly communicates with Plant neighbors and stakeholders through several different methods, as documented in the Pantex Plant *Environmental Restoration Project Community Involvement Plan, December 2007.* USDOE/NNSA provides updates on ER Project status, including remediation progress and any issues or challenges that might arise.

USDOE/NNSA is required to submit semi-annual progress reports containing the information identified in this comment, in accordance with the Article 16.4 of the Interagency Agreement and Section VII of Compliance Plan No. 50284. These reports have been available to the public since 2003 through the Administrative Record file and in the Pantex Reading Room at Amarillo College and the Carson County Library. USDOE/NNSA recently began posting these reports on the website at pantex.com.

Also, details of the long-term monitoring network and the sampling & analysis plan will be presented in the remedial design submittal package, that will be completed and submitted after issuance of this ROD, in accordance with Article 8.5 of the Interagency Agreement.

With regard to the timeliness of notifications, sampling data will be managed to enable prompt notification of EPA and TCEQ upon receipt of preliminary data or analysis exhibiting a threat of endangerment or actual endangerment to the Ogallala Aquifer, in accordance with Article 18 of the Interagency Agreement.

3.2 Technical and Legal Issues

No technical or legal issues were identified for discussion.