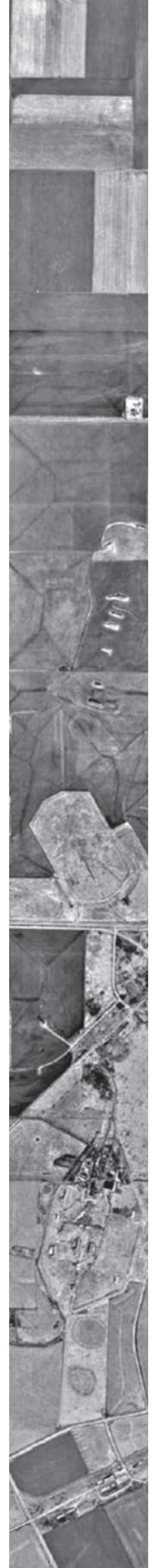
Baseline Human Health Risk Assessment Summary

Pantex Plant – Amarillo, Texas



ADMIN RECORD

AL-PX-SW-005686

Pantex Mission Statement

Pantex Plant, a United States Department of Energy/National Nuclear Security Administration (USDOE/NNSA) facility, has a long term mission to maintain the safety, security, and reliability of the nation's nuclear weapons stockpile. All work at Pantex is carried out under these overarching priorities: the security of weapons and information, the safety and health of workers and the public, and the protection of the environment.

BWXT Pantex, the management and operating contractor at Pantex, maintains, builds, and retires nuclear weapons in support of our nation's nuclear deterrent. The Environmental Projects and Operations (EP&O) Division is responsible for the investigation and cleanup of the corrective action units at Pantex Plant. The mission of the EP&O Division is: protecting people and the environment through responsible leadership, responsive cleanup actions, and innovative technology.

Additional information can be found at www.pantex.com.

National Nuclear Security Administration

USDOE - NNSA Pantex Site Office

BWXT Pantex

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Key Findings

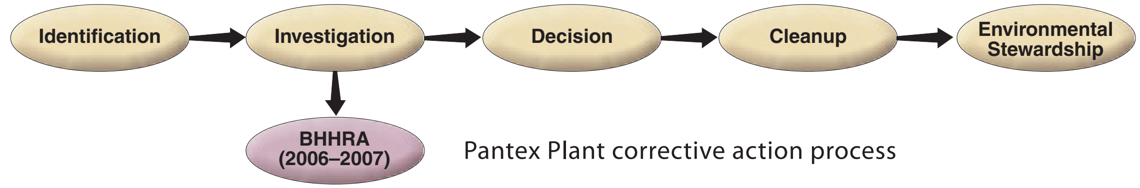
1. There is no current or imminent threat to human health from drinking water from the Ogallala Aquifer.
2. Potential future risks could occur offsite (to the east and on Texas Tech University property) in the absence of remediation, if a well is placed in the Ogallala Aquifer in that area in the future. These potential future risks are primarily related to predicted movement of RDX, a chemical explosive, that is already present in the perched groundwater because of historical releases to ditches and playas.
3. There is no current or imminent threat to human health from chemicals detected in the perched groundwater because perched groundwater is not used as drinking water.
4. Zones 10, 11, and 12; Landfills 1, 2 and 13; Firing Site 5; and the Burning Ground are the only onsite areas in which constituents in soil were identified to be above target risk levels based on direct exposure to onsite workers. Exposure to onsite workers will be reduced to safe levels through soil management practices. Chemicals in soil do not pose a current or future risk to offsite residents or farmers.
5. The United States Department of Energy/National Nuclear Security Administration intends to design and implement corrective measures to ensure that any potential future impacts to the Ogallala Aquifer are mitigated and exposures prevented. The focus of corrective measures at Pantex Plant will be on the control of RDX in perched groundwater.
6. Long-term monitoring and environmental stewardship will continue at Pantex Plant for the foreseeable future.

The United States Department of Energy/National Nuclear Security Administration (USDOE/NNSA) Pantex Plant, located in Carson County in the Texas Panhandle, is an active facility that maintains our nation's nuclear weapons stockpile. Although Pantex Plant is and will remain an active permitted facility, Pantex Plant is currently in a regulatory Corrective Action Process to investigate site conditions and decide upon long-term environmental cleanup actions. As part of this process, environmental investigations evaluated chemical and radionuclide impacts in soil, soil gas, surface water, perched groundwater, and the Ogallala Aquifer. Human health risk assessments have been conducted to look at potential health risks to onsite workers and Plant neighbors who may be exposed to impacted media as a result of past waste management activities at Pantex Plant. This Baseline Human Health Risk Assessment (BHHRA) Summary Report explains the methods and findings from the following Pantex Plant risk assessment reports:

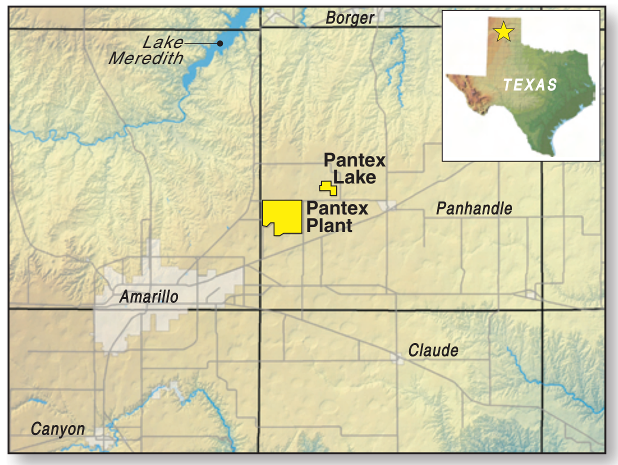
- Burning Ground Human Health Risk Assessment Report (September 2006)
- Nuclear Weapons Accident Residue Storage Unit (NWAR) Human Health Risk Assessment Report (August 2006)
- Baseline Human Health Risk Assessment Report for Zones 10, 11, and 12, Fire Training Area, Ditches and Playas, Independent Sites, and Groundwater (December 2006)
- Firing Site 5 Human Health Risk Assessment Report (May 2007)

These reports have been submitted for review to the Texas Commission on Environmental Quality (TCEQ) and the United States Environmental Protection Agency (USEPA).

The results of the risk assessments identify key constituents of concern and environmental media (soil, groundwater, etc.) that require further corrective action. The final regulatory phase will include use of long-term groundwater monitoring, focused remedial activities, and environmental stewardship to ensure that any potential future impacts to the Ogallala Aquifer, a significant and important source of groundwater for the Panhandle region, are mitigated and exposures prevented.



Pantex Plant corrective action process



Pantex Plant, about 17 miles northeast of Amarillo, Texas, consists of approximately 10,000 acres owned by the United States Department of Energy/National Nuclear Security Administration. The site includes about 9,000 acres in the main Plant area and 1,000 acres located 2.5 miles northeast of the main Plant known as Pantex Lake. Pantex Plant was constructed during World War II when a number of the Plant's areas were used to develop conventional ordnance and produce high explosive compounds such as TNT. Over time, new facilities were constructed for the manufacture of high explosives such as HMX and RDX for use in final assembly of weapons. Unlike other United States Department of Energy facilities, radioactive materials have not been processed at Pantex Plant. The current mission of Pantex Plant focuses on disassembly of weapons and storage of plutonium pits.

What is a Risk Assessment?

Over the past several years, the public has become increasingly aware of the presence of chemicals in our environment and has expressed concerns about how these substances might affect their health. Given these concerns, how can we determine which of these potential hazards really deserve attention and how can we best focus our efforts and resources to control these hazards?

Health risk assessment is a scientific tool designed to help answer these questions. Health risk assessments are used to determine if a particular chemical poses a significant risk to human health, and if so, under what circumstances. A risk assessment examines how people may be exposed, the predicted or measured levels of a chemical in the environment over time, and identifies those chemicals that may exceed acceptable health risk criteria. Findings from the risk assessment can also be used to help focus actions needed to reduce risk.

Importantly, a risk assessment does not measure the actual health effects that chemicals at a site may have on individual people. Risk assessments rely on estimates of hypothetical exposure that may occur rather than on measurement of actual exposure. In addition, conservative safety margins are built into a risk assessment to ensure protection of the public.

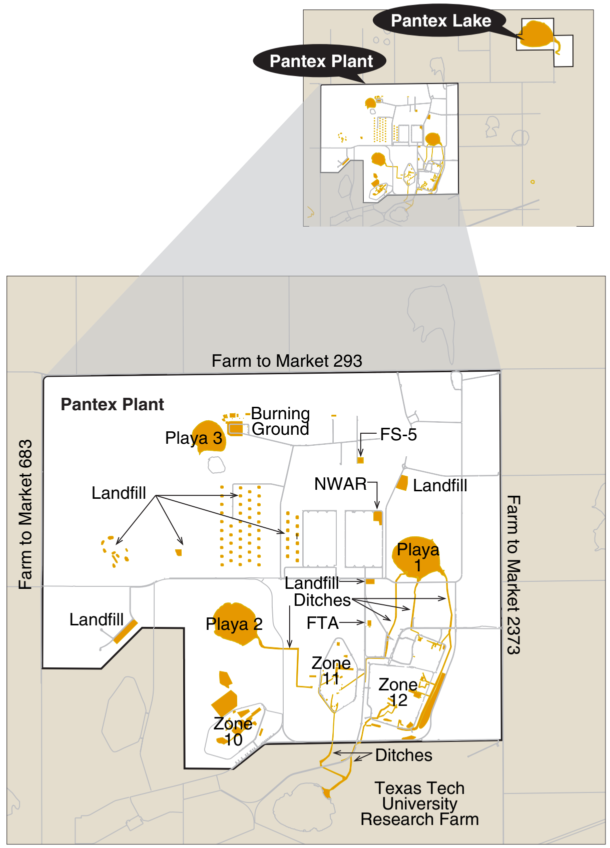
Site Description

Pantex Plant is bounded on the north by Farm to Market Road 293, on the east by Farm to Market Road 2373 and on the west by Farm to Market Road 683. Pantex Plant leases approximately 5,000 acres south of the Plant from Texas Tech University, for use as a safety and security buffer. The Texas Tech University Research Farm (TTU) manages the buffer zone for a variety of agricultural uses. Pantex Plant consists of several functional areas, commonly referred to as numbered zones. The locations of areas included in the risk assessment are shown in the figure to the right; a more detailed description of each unit is provided in the *Results* section of this report.

Zone 10, Zone 11, and Zone 12 are active operational areas. Facilities in these zones were originally built to manufacture conventional bombs during World War II, but were reconstructed after munition production ceased in 1945. These zones currently contain both active and inactive areas. Zones have been reconstructed to serve as assembly/disassembly areas, staging areas, and support areas for other facility functions.

Fire Training Area (FTA) was used for fire department training exercises; a portion of this area is still used by the fire department.

Playa 1, Playa 2, and Pantex Lake are three of five playas associated with Pantex Plant; Playa 1 and Playa 2 are located within the boundaries of Pantex Plant, whereas Pantex Lake is located 2.5 miles (4 km) northeast of the Plant boundary. Historically, these playas received treated and untreated industrial discharges.



Areas evaluated in human health risk assessment

Ditches are located in various areas at Pantex Plant. Ditches are associated with the playa drainage basins. Similar to the playas, these ditches historically received treated and untreated industrial discharges.

Landfills are inactive areas that are located in multiple areas at Pantex Plant. These landfills were used for general sanitary waste, construction debris, and demolition debris, including asbestos-containing materials and waste petroleum products.

Firing Site 5 (FS-5) is an inactive area previously used for research and development testing of high explosives. Explosives were detonated at a surface test pad or in a gravel pit to test the firing of high explosives with parts made of depleted uranium and other metals.

Burning Ground is an active operational area. The facility was historically used for the disposal of high explosive waste and contaminated materials. Current use includes thermal treatment of high explosive-contaminated wastes. Playa 3 is evaluated as part of the Burning Ground, because past operations at the Burning Ground contributed to surface-water runoff to Playa 3.

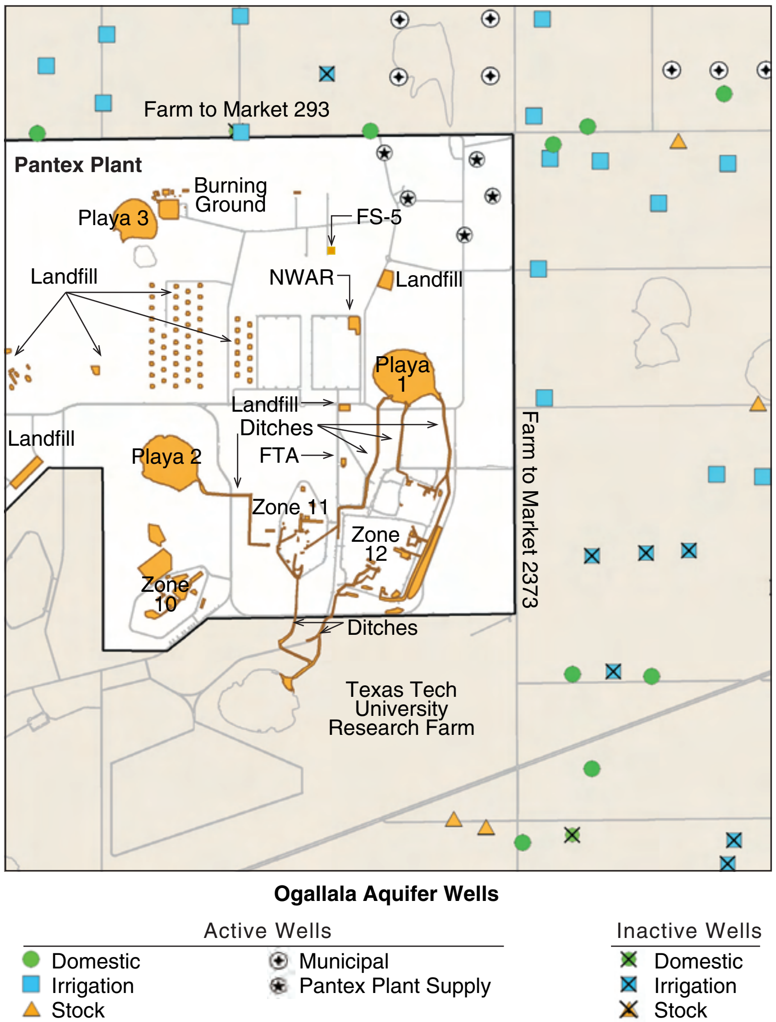
Nuclear Weapons Accident Residue Storage Unit (NWAR) was a retrievable radioactive materials storage unit. Wastes stored at NWAR included radioactive debris from military aircraft accidents, residue from Pantex Plant Firing Site test shots, and low-level radioactive wastes from Pantex Plant production lines. By 1986, all wastes were removed and site decontamination was completed.

What is a Playa?

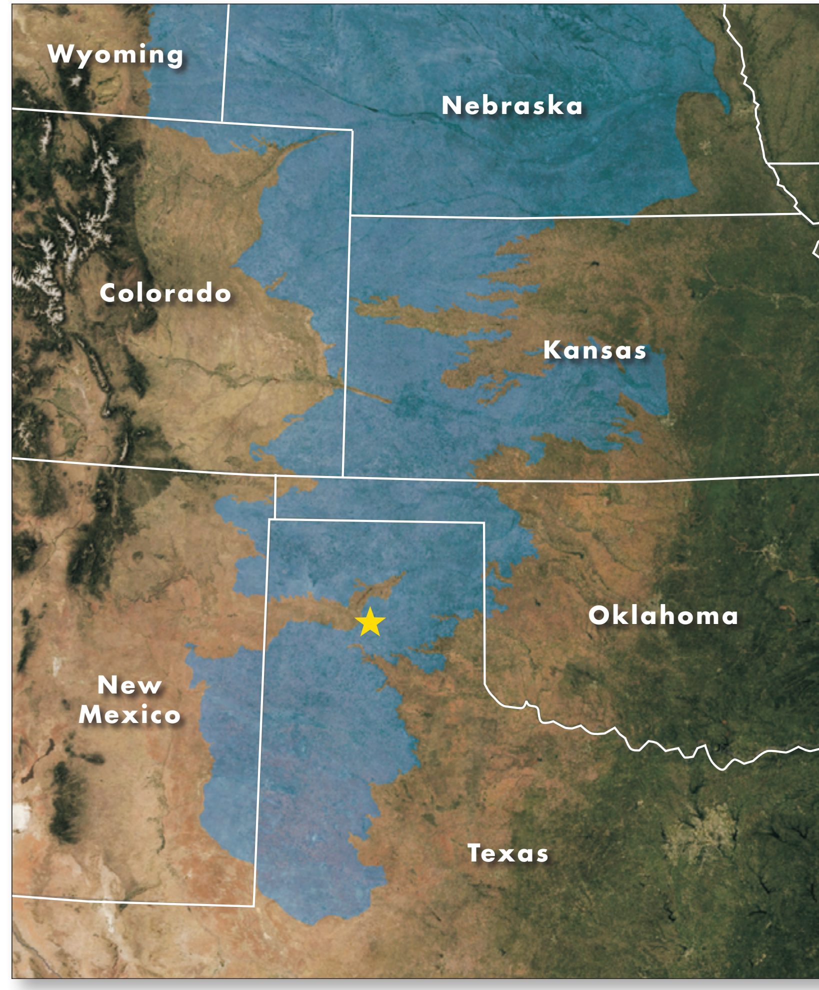
As one of the few surface-water sources on the High Plains, playas are desirable seasonal water bodies that often serve as cattle grazing areas. There are approximately 19,000 playas on the Texas plains. These seasonal lakes form in small depressions and serve as the primary source of recharge to groundwater in the Panhandle. In the past, the playas at Pantex Plant have been used as storage for industrial discharges; they continue to capture stormwater runoff from the Plant and surrounding land.

Groundwater at Pantex Plant

Two separate groundwater bodies are present under Pantex Plant at two different depths. The shallow one, called the "perched groundwater," is supported by a thin zone of "tight" soil (fine-grained zone) at an average depth of about 276 ft below ground surface. This water body is rather thin (average thickness is about 7 ft) and the areal extent is limited. The deeper water body, called the "Ogallala Aquifer," is supported by what is referred to as the red bed formation at depths ranging from about 350 ft to more than 800 ft below the ground surface. The Ogallala Aquifer is extensive and is significantly thicker (up to about 400 ft) than the perched groundwater.



Groundwater use north and east of Pantex Plant

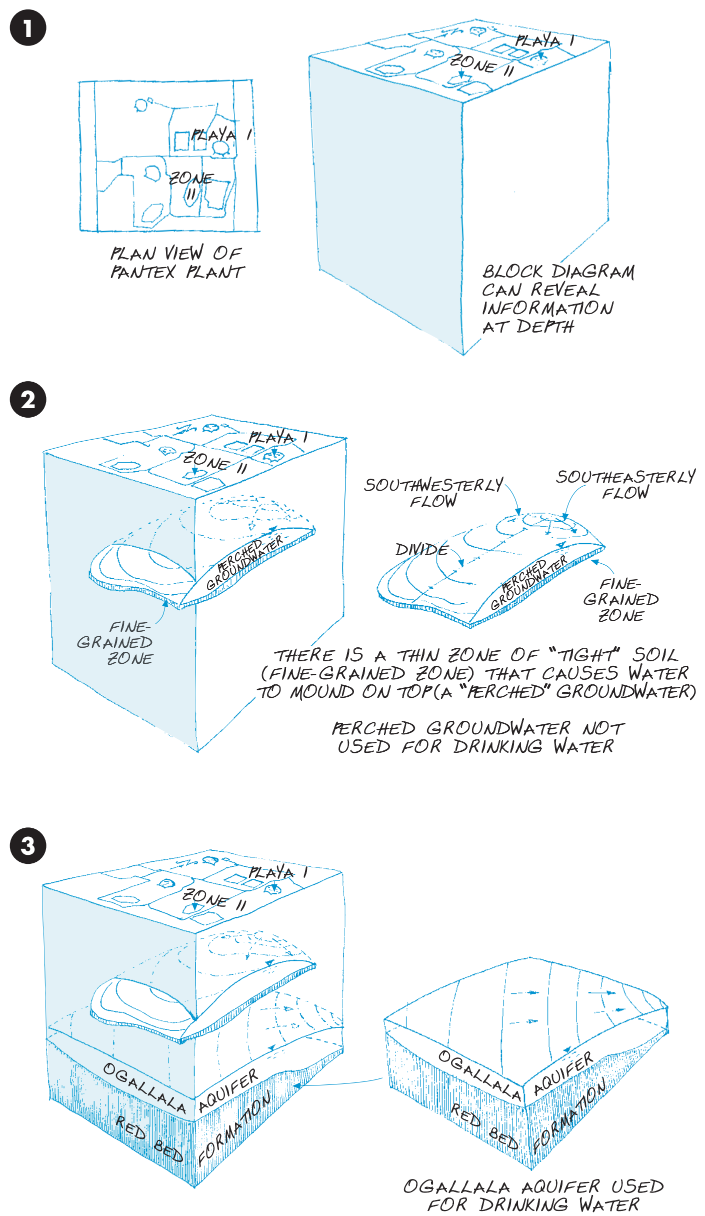


Areal extent of Ogallala Aquifer

Ogallala Aquifer

The Ogallala Aquifer stretches across eight states from Texas to South Dakota. It is the primary source of drinking and irrigation water in the region and for Pantex Plant. In Carson County, where Pantex Plant is located, 80% of the water obtained from the aquifer is used for irrigation. Water for Pantex Plant is supplied by 5 production wells; the City of Amarillo operates 39 wells in Carson County. In the vicinity of Pantex Plant, groundwater flows generally northeast. Water levels in the Ogallala Aquifer have been declining since about 1940, primarily because of heavy irrigation use. The thickness of the aquifer varies greatly near Pantex Plant, from more than 400 ft of water north of the Plant to less than 20 ft in some areas to the south. Currently there is a dry area on the eastern side of the Texas Tech University property. As water levels continue to decline, this dry area is expected to increase in size.

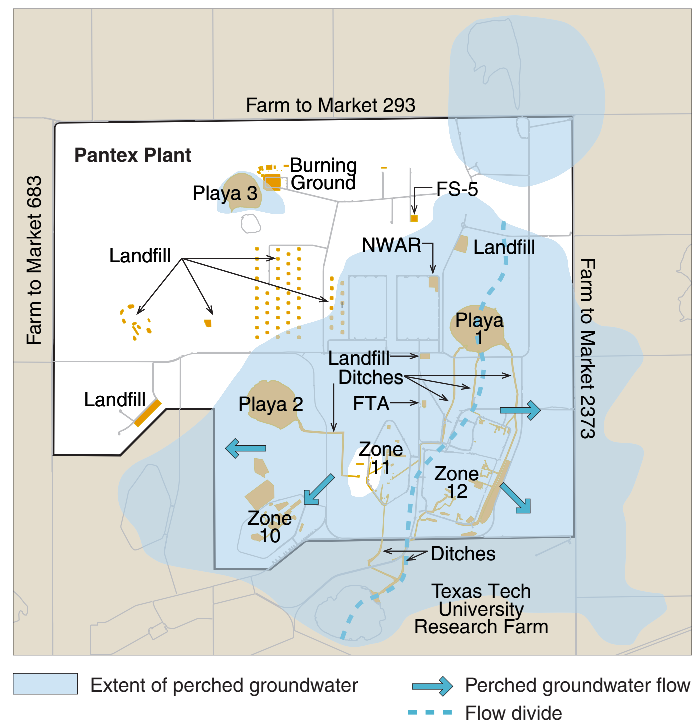
Site Hydrogeologic Model for Pantex Plant



Perched Groundwater

The perched groundwater is mostly contained under Pantex Plant, except for a small area to the east and the south where it extends a little beyond the Plant boundary. The area covered by perched groundwater is limited by the shape of the supporting fine-grained zone and by a balance between the amount of surface water that seeps in from the playas above and the amount of water that seeps out slowly through the fine-grained zone to the Ogallala Aquifer below. Because surface water seeps into perched groundwater only from the playas (rather than from the entire ground surface), the playas are considered to act as zones of "focused recharge" to the perched groundwater. Downward movement (or infiltration) of perched groundwater through the fine-grained zone to the Ogallala Aquifer varies from point to point, but increases toward the south and east near the edge of the perched groundwater.

Perched groundwater was present before Pantex Plant was built, at which time its size was about 8 to 12 billion gallons. Historical discharges from plant activities during the Cold War increased the volume of the perched groundwater to about 16 billion gallons. Although these discharges were discontinued in the 1990s, storm water runoff from the industrialized areas of the site and the surrounding land areas is captured by the playas and may move downward to the perched groundwater. The perched groundwater has formed a roughly north-south trending ridge called a groundwater "flow divide." West of the divide, the perched groundwater flows to the west and southwest, but does not extend to the Farm to Market 683 western Plant boundary. East of the divide, the perched groundwater flows mostly to the east and southeast beyond the Plant boundary.



Extent of perched groundwater at Pantex Plant

Site Characterization

Soil, soil-gas, surface-water, and groundwater samples were collected at Pantex Plant as part of multiple remedial investigations conducted at various areas across the site, as well as the site-wide radiological investigation and groundwater investigation. Additional samples were collected in some areas to obtain information on current conditions. Samples were analyzed for:

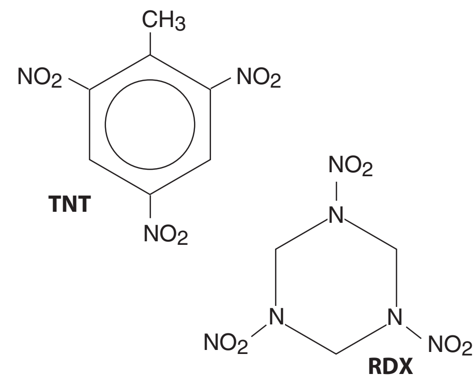
- high explosives
- volatile organic compounds
- semivolatile organic compounds (including polyaromatic hydrocarbons)
- pesticides
- PCBs
- dioxins/furans
- herbicides
- perchlorate
- metals (including hexavalent chromium)
- radionuclides

More than 18,000 soil samples and 500 soil-gas samples were collected. More than 400 groundwater samples were obtained from the Ogallala Aquifer from 31 monitoring, investigation, or plant production wells since 1999. Additionally, more than 1,300 perched groundwater samples were collected from 76 monitoring or investigations wells and 40 extraction wells since 1999.

Based on the results of these investigations, soils, soil gas, and perched groundwater in various areas of the site were impacted by most of the chemical groups analyzed. Soils in three small areas of the site were also impacted by radionuclides; however, these soils were remediated.

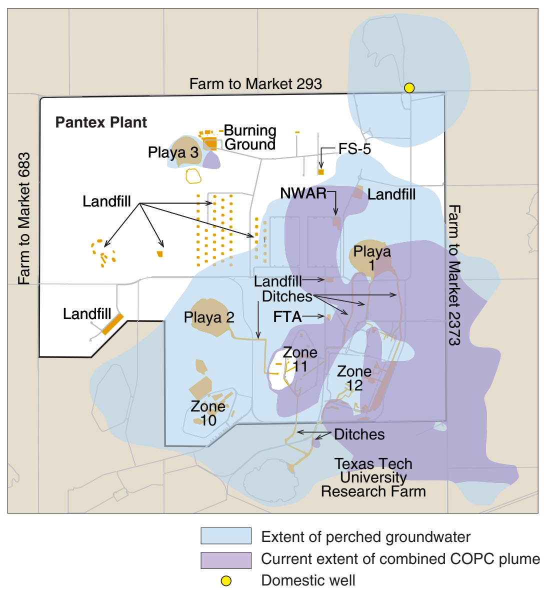
What are High Explosives?

High explosives are chemicals such as TNT, RDX, and dynamite that combust almost instantaneously when ignited by a spark, flame, or other impact.

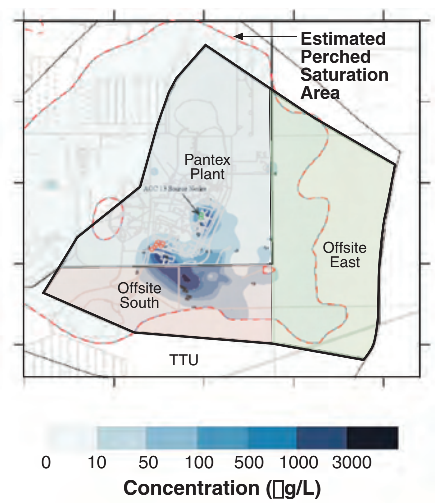


Current Conditions in the Perched Groundwater

- Currently there is only one domestic well placed into the perched groundwater. This well is north of Pantex Plant where the perched groundwater is clean.
- Constituents of potential concern (COPCs) have been detected primarily in the eastern and southern portion of the perched groundwater. Some of the impacted water extends beyond the Plant property.
  - High explosives, primarily RDX, and boron are present offsite east and south of Pantex Plant at concentrations exceeding regulatory levels.
  - TCE, hexavalent chromium, and perchlorate are present offsite south of Pantex Plant at concentrations exceeding regulatory levels.
  - Perchlorate and TCE concentrations exceeding regulatory levels were found in a small disconnected plume under the Burning Ground.



Extent of perched groundwater at Pantex Plant



Hexavalent chromium in perched groundwater (micrograms per liter [µg/L])

Cleanup Activities at Pantex Plant

Several types of cleanup activities have been and continue to be conducted at Pantex Plant to reduce potential exposures to current onsite workers and Plant neighbors to acceptable regulatory levels, and minimize the potential for impacts to the Ogallala Aquifer. Activities completed include soil removal, covering of landfills, deactivation and decommissioning of Plant facilities no longer needed, ditch lining, bioremediation pilot system installation and monitoring, soil vapor extraction, and the installation, expansion, and continuing operation of the perched groundwater pump and treat system.

In addition to these cleanup activities, Pantex Plant eliminated the release of discharges to the ditches and now only rarely discharges treated water to Playa 1. This reduction of discharge has stopped the movement of chemicals through ditches and Playa 1 soils, as well as eliminated the major force that caused expansion of the perched groundwater zone.

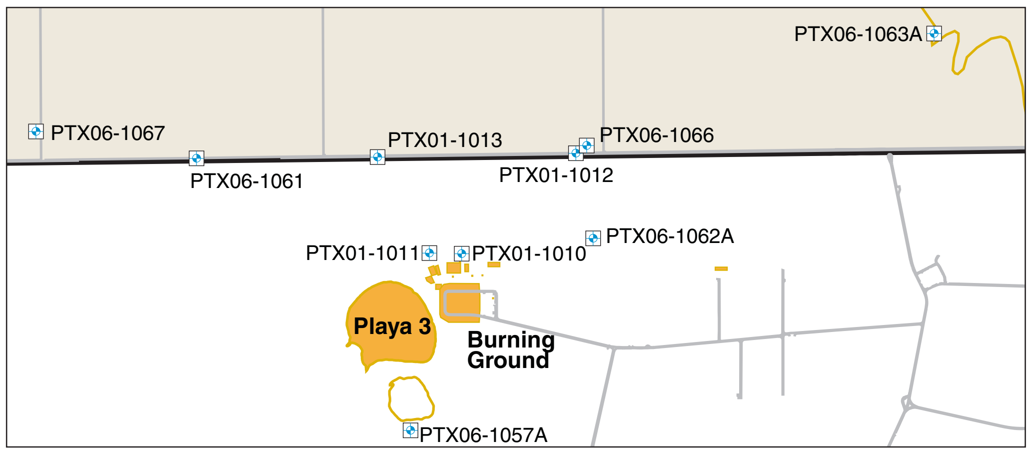
Excavation of ditch soils in Zone 11

Current Conditions in the Ogallala Aquifer

Pantex Plant has installed monitoring wells in the Ogallala Aquifer in the most suitable areas for detection of potential impacts from chemicals or radionuclides in source areas, playas, and perched groundwater. Historically, a few anomalous impacts were reported that have since been resolved.

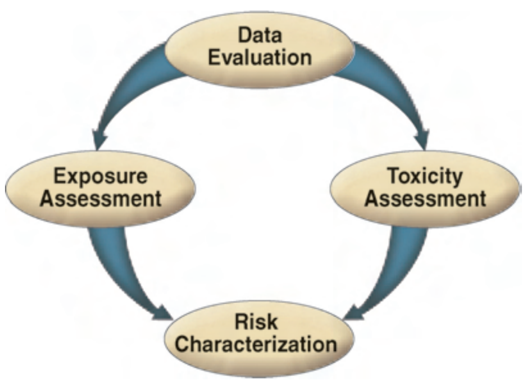
- TCE was detected in monitoring well PTX01-1003 at the Burning Ground from 1999 to 2001. Well integrity tests indicated a flaw in the well's construction that created a pathway for migration of TCE vapors from impacted soil at the Burning Ground to the Ogallala Aquifer. This well was plugged to eliminate the pathway, and subsequent measurements at nearby wells did not indicate that TCE was present.
- Volatile organic compounds were detected in a variety of monitoring wells that used multi-level sampling systems at the Burning Ground. Testing conducted by Pantex and verified by an external peer review team concluded that the materials used in construction of the sampling system were the source of volatile organic compounds. The problem was resolved after all multi-level sampling systems were removed.
- Two anomalous detections of uranium-238 were reported. One was found to be a reporting error, the second was a result of collection of a sample containing small particles of the soils that were inside the well. Naturally-occurring uranium in the soils caused the detection within the sample.

Recent groundwater samples collected from 10 monitoring wells in the vicinity of the Burning Ground in 2004-2005 were analyzed for high explosives, volatile organic compounds, and metals (see figure below). Groundwater concentrations were compared to background concentrations and regulatory screening levels such as TCEQ and USEPA residential groundwater standards. Although some isolated detections of chemicals have been found in recent data, review of these data indicate that there are no health concerns related to the detections. The data also indicate that there are no trends in the detections, meaning that there are no repeated detections in wells that would indicate the presence of a chemical plume in the Ogallala Aquifer. Pantex Plant continues to monitor these wells and will include this area in long-term monitoring.



Ogallala Aquifer monitoring well locations in the vicinity of the Burning Ground

The risk assessment process at Pantex Plant was used to identify those constituents that contributed most significantly to the overall risk estimates and that were above regulatory target risk levels so that focused actions can be taken to reduce potential risk to onsite workers or the surrounding community. This process consisted of the following four steps:



This process is consistent with the risk assessment process recommended by the United States Environmental Protection Agency. Each of these steps is described in the sections that follow.

What is a Radionuclide?

A radionuclide is an atom with an unstable nucleus (for example, uranium-238 [^{238}U]). Radioactivity is the property of some materials to undergo spontaneous nuclear transformations, referred to as decay, that result in the formation of new elements (for example, ^{238}U decays into thorium-234 [^{234}Th]). Radionuclides occur naturally, but can also be artificially produced.

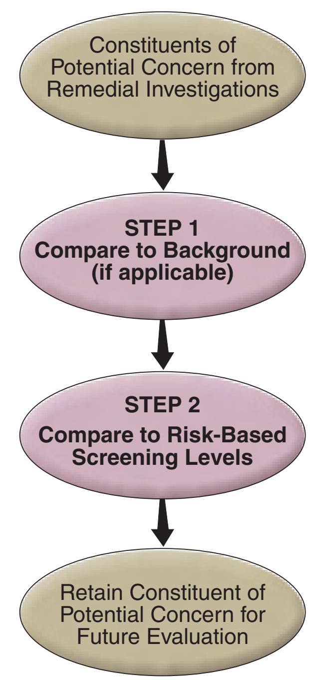
Data Evaluation

The purpose of the data evaluation is two-fold: 1) identify data collected as part of the site investigations to be included in the risk assessment, and 2) screen out those chemicals and radionuclides that are below levels of health concern to focus the risk assessment on the constituents that may require more cleanup for protection of human health.

As described previously, soil, soil-gas, groundwater, and surface-water data were collected in one or more areas across Pantex Plant. In general, all soil data were included in the risk assessment. Similarly, all soil-gas data were generally included in the risk assessment with two exceptions. In the Burning Ground, a soil vapor extraction system began operating in 2002. Soil-gas data collected in 2004 replaced earlier data that were collected before the soil vapor extraction system was constructed. Second, historical soil-gas data collected in the vicinity of the FTA were not included in the risk assessment, because the sampling and analytical methods were not equivalent to the more recent data. For perched groundwater, the most recent data from the beginning of 2002 through the end of 2003 (Burning Ground) or beginning of 2004 (all other areas with perched groundwater data) were included in the risk assessment. Finally, for the Ogallala Aquifer, data collected between 1999 and 2005 were included in the risk assessment.

At Pantex, a screening process was used to identify chemicals or radionuclides that have impacted the environment (called COPCs) that required further evaluation in the risk assessment. This process compared maximum detected concentrations to background (for naturally occurring constituents in soil and groundwater) and risk-based screening levels. If the maximum detected concentration of a naturally occurring constituent in soil (or groundwater) was less than the background concentration, then that constituent was not considered further in the risk assessment.

Risk-based screening levels are specific chemical and radionuclide concentrations for each environmental medium that are protective of human health assuming exposure over a lifetime. These values are intended to be conservative such that if the concentration of a constituent is below the risk-based screening level, then that constituent should not result in adverse health effects. At Pantex, risk-based screening levels were developed for soil, soil gas, and groundwater. For soil and groundwater, risk-based screening levels were based on existing regulatory screening levels (for example, Texas Commission on Environmental Quality risk-based screening levels, United States Environmental Protection Agency preliminary remediation goals). Regulatory screening levels were not available to evaluate the migration of soil gas to air or groundwater; therefore, site-specific risk-based screening levels for soil gas were developed in a manner consistent with the other regulatory screening levels.



Screening process

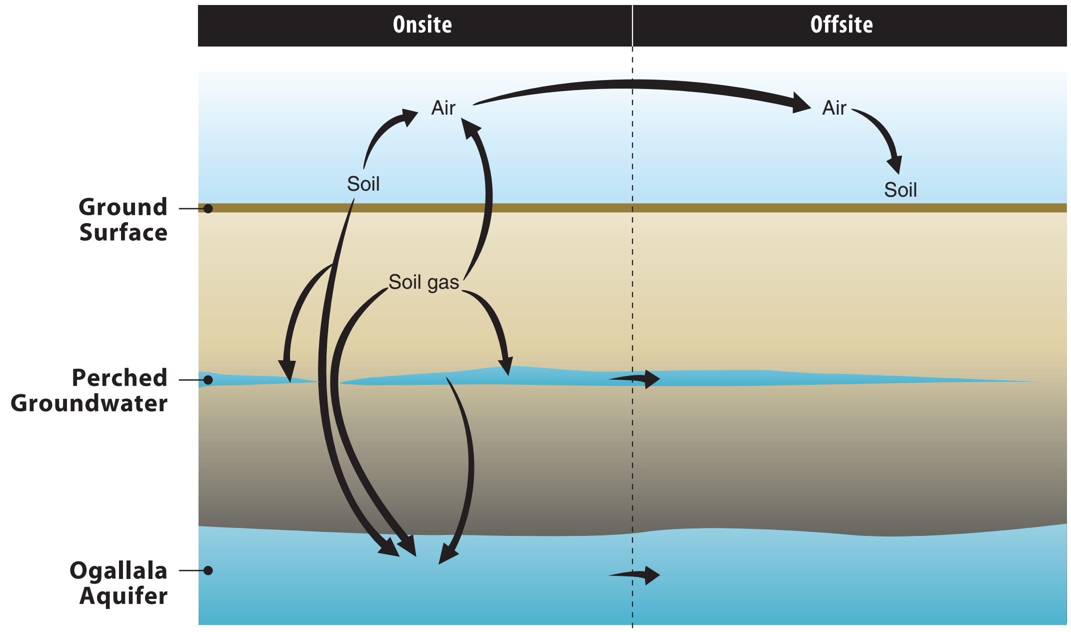
Exposure Assessment

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

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

Conceptual Site Model

To determine where people may be exposed, information is visually organized into a conceptual model to show how constituents in soil, soil gas, and groundwater may move through the environment. A general conceptual site model for Pantex Plant is shown in the figure on the right. Conceptual site models for specific areas may differ depending on area-specific considerations (for example, perched groundwater is not present beneath all of Pantex Plant).



Receptor	Industrial/Construction	Residential Farmer
Current Pathway	Soil – Ingestion – Skin contact – External radiation Air – Inhalation of vapors/dust – External radiation	Perched Groundwater – Ingestion – Inhalation while showering – Ingestion of crops/animals
Future Pathway	Ogallala – Ingestion – Inhalation while showering	Perched Groundwater and/or Ogallala – Ingestion – Inhalation while showering – Ingestion of crops/animals Air – Inhalation of vapors/dust – External radiation Soil – Ingestion of crops/animals – Skin contact – External radiation – Ingestion of crops/animals

Generalized conceptual site model for Pantex Plant

Land Use

As part of the exposure assessment, the land use at Pantex Plant and the surrounding area is evaluated to determine who will most likely be exposed to constituents that may move through the environment at the Plant.

Pantex Plant is an industrial facility and future land use is assumed to remain as industrial for the foreseeable future. Pantex Plant contains active operational areas and inactive areas. The inactive areas generally serve as safety and security buffers around the active operational areas.

Active Operational Areas

Of the areas included in the risk assessment, Zones 11 and 12 are active operational areas surrounded by high security fencing, and therefore, have restricted access. Most of the work in these areas is conducted inside industrial facilities. Zone 10, the FTA, and the Burning Ground are the only other active operational areas included in the risk assessment. Land use in active operational areas is industrial with occasional construction and excavation work.

Inactive Areas

Inactive areas are generally not used for industrial purposes, so industrial or construction workers have only limited contact with those areas. Inactive areas evaluated in the risk assessment include the landfills, FS-5, ditches, NWAR, and a portion of Zone 12 outside of the security fence.

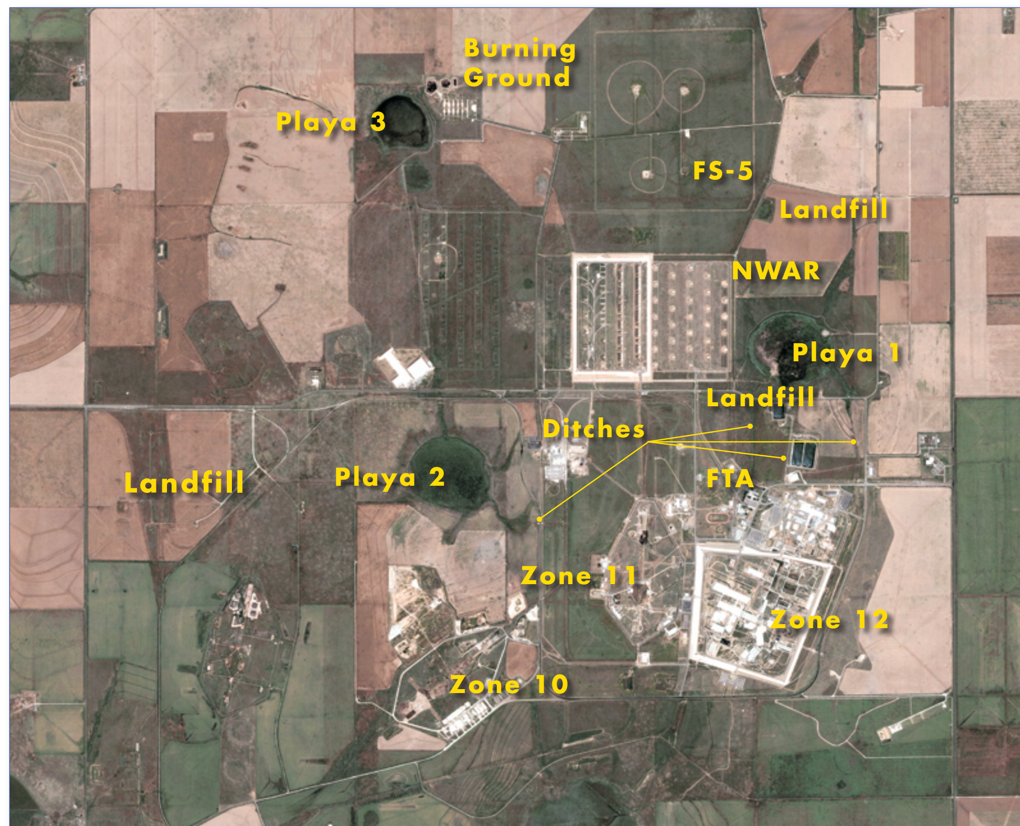
Other Areas

In addition to the active and inactive areas, Playa 1, Playa 2, Playa 3, and Pantex Lake were evaluated in the risk assessment. Playas 1, 2, and 3 are formally managed under the Playa Management Plan; infrequent cattle grazing is allowed in these areas to meet the objectives of this plan. These playas are accessed infrequently by sampling technicians, environmental scientists, and Texas Tech University personnel who use the area for cattle grazing. Pantex Lake is also used for cattle grazing and the United States Department of Energy lands outside of the playa basin are farmed by Texas Tech University.

The predominant land use immediately surrounding Pantex Plant and Pantex Lake is agricultural, including grazing and cultivation of crops. The property immediately to the south of Pantex Plant is owned by Texas Tech University and leased by Pantex Plant 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 Pantex Plant is assumed to remain agricultural.

Based on the onsite and offsite land use patterns, the following types of receptors were chosen to be evaluated for protection of onsite workers and offsite residents:

- Onsite industrial worker
- Onsite construction (excavation) worker
- Offsite resident farmer



Exposure Assumptions

To estimate exposure, assumptions need to be made regarding how the different types of receptors come into contact with impacted environmental media. The exposure assumptions for each of the three receptors are summarized below.

Onsite Industrial Worker

The onsite industrial worker is an individual who works outdoors while onsite and is assumed to have direct contact with constituents in surface soil by means of incidental ingestion, skin contact, and inhalation of vapors or dust. Future exposure pathways for onsite industrial workers include ingestion of water from the Ogallala Aquifer and contact during showering in the event that constituents migrate to the onsite production wells.

Regulatory agencies have developed default exposure assumptions for evaluating exposure to soil by industrial workers. These default assumptions were used in the risk assessment. For example, it was assumed that the industrial worker will be present outdoors at the impacted areas for 8 hours per day, 250 days per year, for 25 years. These assumptions are conservative because Pantex Plant does not have outdoor workers who work full-time in one outdoor location on a daily basis.

Onsite Construction Worker

The onsite construction worker is a site employee or subcontractor who is assumed to come into direct contact with constituents in surface and subsurface soil by means of incidental ingestion, skin contact, and inhalation of vapors or dust while doing construction or excavation work. Future exposure pathways for onsite construction workers include ingestion of water from the Ogallala Aquifer and contact during showering in the event that constituents migrate to the onsite production wells. For purposes of the risk assessment, it was assumed that the onsite construction worker will be present at the impacted areas 8 hours per day, 5 days per week, for a period of 12 weeks in a year.

Offsite Resident Farmer

The offsite resident farmer is an individual living on a family farm in the immediate vicinity of Pantex Plant. For current residents, the risk assessment evaluated the hypothetical exposure of a resident farmer assumed to come into direct contact with constituents in perched groundwater by means of ingestion and inhalation while showering. This exposure is hypothetical because impacted perched groundwater is not currently used by anyone, although impacted perched groundwater does extend offsite.

Future exposure pathways are the same as those described for current conditions, but also include potential exposure to contitutents in the Ogallala Aquifer, as well as exposure—by means of incidental ingestion, skin contact, and inhalation of vapors or dust—to constituents in soil transported offsite by wind.

Offsite resident farmers are also assumed to ingest agricultural products (crops or animals) impacted by constituents in soil (from deposition and uptake) and groundwater (from irrigation). The farmer is assumed to be present at one location 350 days per year for 40 years. Part of the farmer's lifetime is assessed as a child.

Exposure Area Determination for Onsite Workers

An exposure area is an area over which an individual may be exposed to chemicals in the environment. Within a particular exposure area, an individual is assumed to have an equal chance of being exposed to chemicals anywhere in the area. Exposure areas are often developed for large sites, such as Pantex Plant, where it is unlikely that an individual would be exposed to chemicals across large areas. The size and number of exposure areas is dependent on the overall size of the impacted area and the expected work patterns of individuals at Pantex Plant.

Pantex Plant encompasses more than 10,000 acres of land with distinct active and inactive areas, some of which are tens or hundreds of acres in size. In addition, an outdoor worker at the Burning Ground will be exposed differently than a maintenance worker who moves to different areas and does not routinely work in the same location. To determine the best way to evaluate each impacted area, worker patterns were observed and areas were broken into grids to correspond to how workers may use the area. At Pantex Plant, the worker with the highest potential for routine exposure to media impacted by chemicals and radionuclides is a worker at the Burning Ground. Work in this area is largely confined to a 6-acre area. Therefore, a 6-acre exposure area was used for the Burning Ground and was conservatively used for all active operational areas evaluated in the risk assessment (Zone 10, Zone 11, and Zone 12 [inside the security fence]), except for the FTA, which was evaluated as a single exposure area. Larger grid cells were used in areas that are not actively used for industrial purposes because workers rarely enter such areas. These areas included inactive landfills and areas outside of the active industrial zones (Zones 11 and 12).

The Burning Ground and Zones 10, 11, and 12 are much larger than 6 acres; therefore, multiple exposure areas were evaluated in each of the areas. The exposure areas were generally placed in a grid pattern across the site. Because the shape and placement of the grid cells affects the average constituent concentrations to which a worker within this area may be exposed, several different cell shapes and orientations were evaluated to ensure that potential health risks were not underestimated for onsite workers in these areas. The figure to the right shows just one of the grid placements evaluated to calculate exposure at the Burning Ground.

Exposure-Point Concentrations

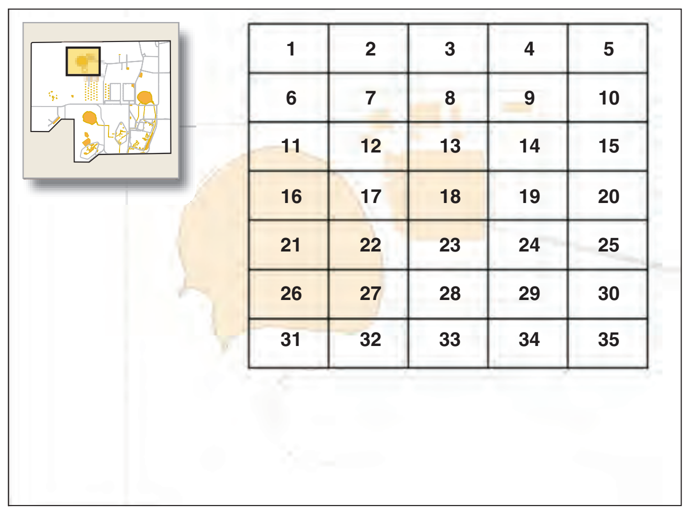
Exposure-point concentrations represent the chemical concentrations that a person is likely to contact over the period of assumed exposure. At Pantex, measured environmental data were used to estimate these concentrations for current exposure pathways. Fate and transport modeling, which uses mathematical equations to describe how a chemical is released and how it moves through surrounding environments, was used for future exposure pathways. The methods used to calculate exposure-point concentrations are described below; fate and transport modeling is described in the section that follows.

Current Exposure-Point Concentrations

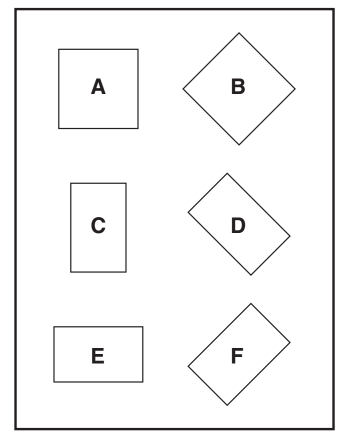
Current exposure-point concentrations were calculated for direct contact exposures to onsite soil and for hypothetical offsite exposures to perched groundwater. No current exposure-point concentrations were calculated for the Ogallala Aquifer onsite or offsite because no COPCs have been identified in the Ogallala Aquifer based on the current monitoring well network.

Soil

Current exposure-point concentrations for soil were calculated for two depth intervals: surface soil (0–2 ft), and surface and subsurface soil (0–15 ft), for the industrial worker and construction worker, respectively. The exposure-point concentration was equal to a statistical estimate of the average concentration for all sample locations within each exposure area, which is referred to as the 95 percent upper confidence limit (95% UCL). In some cases, the maximum detected concentration was used when the statistical average could not be calculated or was not appropriate for use.



Example exposure area grid

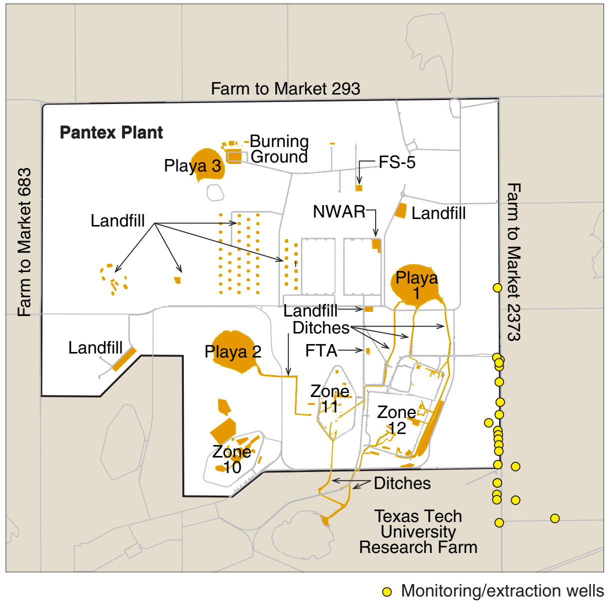


Evaluation of alternative exposure grid configurations

Groundwater

Current exposure-point concentrations for perched groundwater were calculated based on sampling data from monitoring wells and extraction wells located along the eastern Plant boundary and monitoring wells located east of the Plant. Separate exposure-point concentrations were calculated for Pantex Lake based on sampling data from one monitoring well in that area.

Data collected from these wells between 1999 and 2004 were evaluated for each COPC, to determine if there was an increasing or decreasing trend in measured concentrations. If so, then the most recently measured concentration was used as the exposure-point concentration for the offsite resident farmer. If not, then the 95% UCL or maximum detected concentration was used where appropriate.



Monitoring/extraction wells used for current exposure-point concentrations

What is a Detection Limit?

Environmental samples such as soil and groundwater collected at Pantex Plant are sent to a laboratory for a variety of chemical and radionuclide analyses. These analyses rely on analytical instruments to detect chemicals or radionuclides in the samples. The instruments cannot detect low concentrations reliably, so the lowest concentration that can be reliably detected in a sample is considered to be the detection limit.

Detection limits are estimates of concentrations at which we can be fairly certain that a constituent is present. Concentrations below this limit may not be detected or may be unreliably detected. Concentrations above this limit are almost certainly detected in the laboratory analysis. Detection limits depend on a number of factors, including the analytical method, type of instrument, and interference from other chemicals or radionuclides in the sample. Pantex Plant has a strong laboratory review program to achieve the most reliable and appropriate detection limits for samples.

Future Exposure-Point Concentrations

Soil

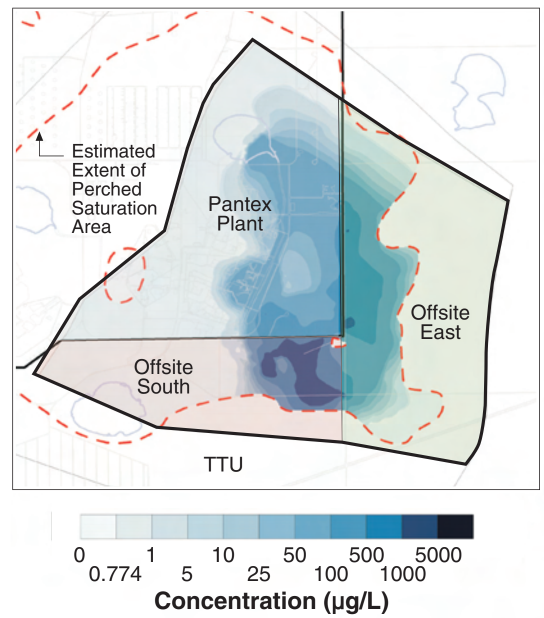
Future exposure-point concentrations were not calculated for soil because current soil concentrations are considered to represent worst-case exposures; concentrations in soil are not expected to increase in the future.

Groundwater

Future exposure-point concentrations in perched groundwater and the Ogallala Aquifer were calculated based on fate and transport modeling, which is discussed in the next section. In general, concentrations of COPCs were estimated over a 1,000-year period and the maximum predicted concentration at any location beyond the Plant boundary any time during that period was used as the exposure-point concentration for the offsite resident farmer. Future exposure to groundwater for onsite workers was evaluated based on the maximum predicted concentration at the existing Pantex Plant wells in the northeast corner of the Plant.

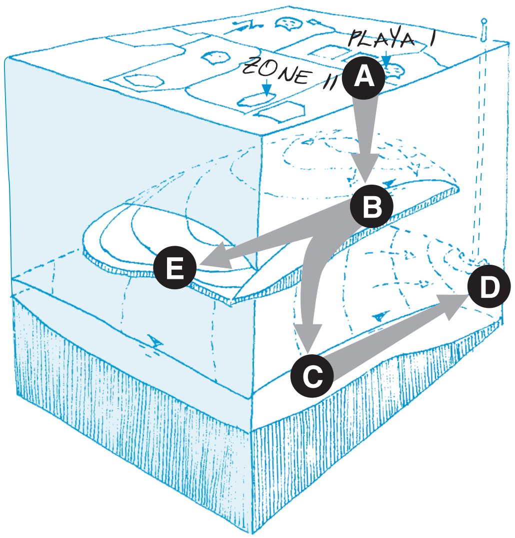
Air

A different fate and transport model was used to estimate offsite surface soil concentrations resulting from windblown dust. As with groundwater, the maximum predicted concentration was used as the exposure-point concentration. Detailed information regarding the fate and transport modeling is provided in the next section.



Example of modeled constituent concentrations in perched groundwater

Fate and Transport Modeling



Fate and transport modeling was used to evaluate the movement of constituents found in soil, soil gas, and perched groundwater at the site along various paths, with the goal of predicting concentrations in air and groundwater at locations where people may be exposed in the future. Different models were used to predict exposure-point concentrations in groundwater and air, as discussed in the following sections.

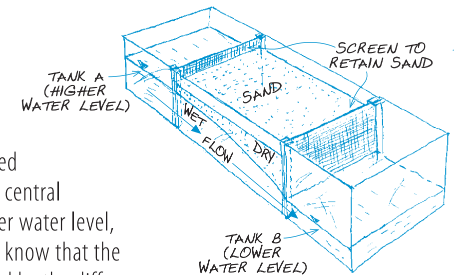
Groundwater Pathway

Pantex Plant is a large site with different source areas that may contribute chemicals and radionuclides to a complex subsurface environment. A fine-grained zone supports a thin layer of perched groundwater under portions of the property and small areas extending offsite to the south and east. The massive Ogallala Aquifer underlies the site at a greater depth and extends far beyond Pantex Plant.

Depending on the location of the source, constituents may reach various points in the subsurface through different routes. If the source is not located directly above the perched groundwater, constituents may never reach it. If a constituent does migrate from its discharge location (at or near ground surface) "A" through the vadose zone and reaches the perched groundwater "B," it will follow the direction that perched groundwater is moving depending on which side of the flow divide the constituent entered the perched groundwater.

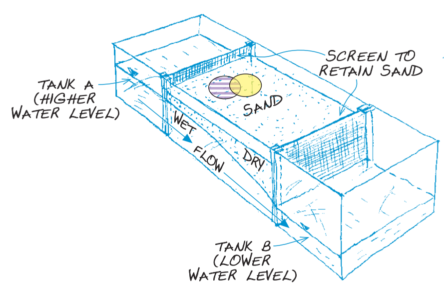
As perched groundwater moves over the fine-grained zone, some of it may seep through the fine-grained zone and move down through a second vadose zone to the Ogallala Aquifer "C." How quickly the perched groundwater seeps through the fine-grained zone varies from point to point because of changes in soil type and thickness of this layer. Once a constituent reaches the Ogallala Aquifer, it will follow the flow of the Ogallala groundwater to the northeast, the prevailing flow direction. Chemicals or radionuclides that reach the perched groundwater or Ogallala Aquifer must then travel with the groundwater to a location where a person may pump water for use before they are exposed "D" or "E." This combination of complex conditions warranted sophisticated modeling to understand the movement of constituents beneath the site and their ability to potentially migrate offsite.

Fate and Transport Models

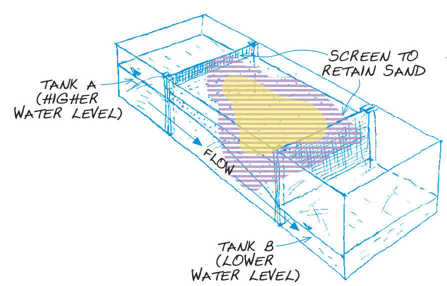


Groundwater fate and transport models are tools developed by scientists based on their understanding of how chemicals dissolved in groundwater will migrate from one point to another through a given porous medium (sand, silt, gravel, etc.) as a result of a difference in water levels and other driving mechanisms. As a first step, consider the enclosed glass tank to the right. It has two smaller tanks, one on each end, and a central section filled with sand. Water will flow from tank "A", which has a higher water level, through the sand, to tank "B". Based on actual measurements, scientists know that the rate at which water will flow through a given porous medium is governed by the difference in water levels and the length and properties of the porous material. For example, water flows more quickly through sand than through silt. Using this knowledge we can use a "flow model" to predict the rate at which water will move through different types of porous media rather than having to obtain actual measurements.

With that understanding, scientists have also studied how chemicals dissolved in groundwater move through the same system. For example, based on actual measurements, scientist know that if two chemicals are released in the same tank (one purple and one yellow), the chemicals will move through the tank differently based on their chemical properties. This understanding allows us to use models known as "transport models" to estimate the concentration of different chemicals at various locations in the subsurface environment over time.



Discharge at time "0"



Dispersed plumes at a later date

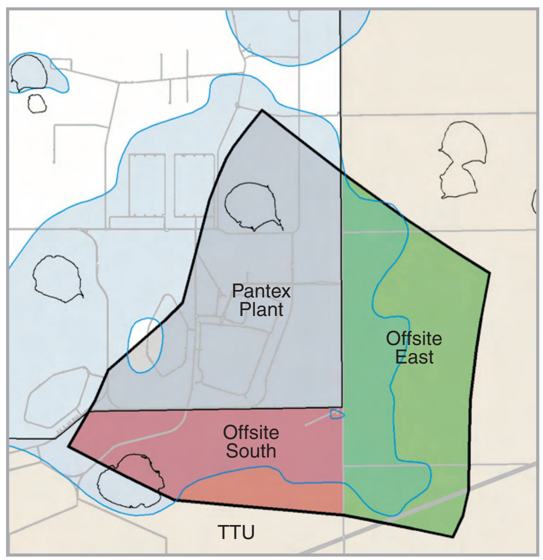
Saturated and Vadose Zones

As water infiltrates vertically downward in soil, it eventually encounters a tight layer where it "pools" because all the air spaces in the soil are completely filled with water. This region of pooled water, where all the pores are filled with water, is called a saturated zone. At Pantex Plant there are two saturated zones—the perched groundwater and the Ogallala Aquifer. The top of a saturated zone is called the "water table." The zone between the ground surface and the water table is unsaturated and called the vadose zone. At Pantex Plant, the zone between the bottom of the fine-grained zone and the top of the Ogallala Aquifer is also unsaturated.

Old Sewage Treatment Plant (OSTP) after deactivation and decommissioning

An initial modeling run was conducted to estimate the time it would take for a chemical in soil, soil gas, or perched groundwater to travel from a source area to a point of exposure for purposes of focusing more detailed modeling on areas and constituents that have a potential to impact offsite residents or offsite wells. If a chemical from a source was estimated to reach a potential receptor within 1,000 years at a concentration above a regulatory screening level, then that chemical from that source was included in the detailed fate and transport modeling. A period of 1,000 years was considered sufficient for this analysis, considering the uncertainties in the declining water levels in the Ogallala Aquifer and in modeling events over such a long period of time. The results of this analysis indicated that none of the COPCs would reach the existing Pantex Plant production wells (or further north) within the next 1,000 years. Hence, the detailed fate and transport modeling focused on areas east of the flow divide, where chemicals could potentially migrate offsite to the east and south (Texas Tech University) of Pantex Plant.

General findings from the detailed model simulations indicate that, of the three modeled input sources (soil, soil gas, and perched groundwater), the perched groundwater represents, by far, the most important potential source of chemicals to the Ogallala Aquifer, with minimal contributions from soil gas and essentially no contribution from soil.



Focused areas for detailed groundwater fate and transport modeling

Models Used at Pantex Plant

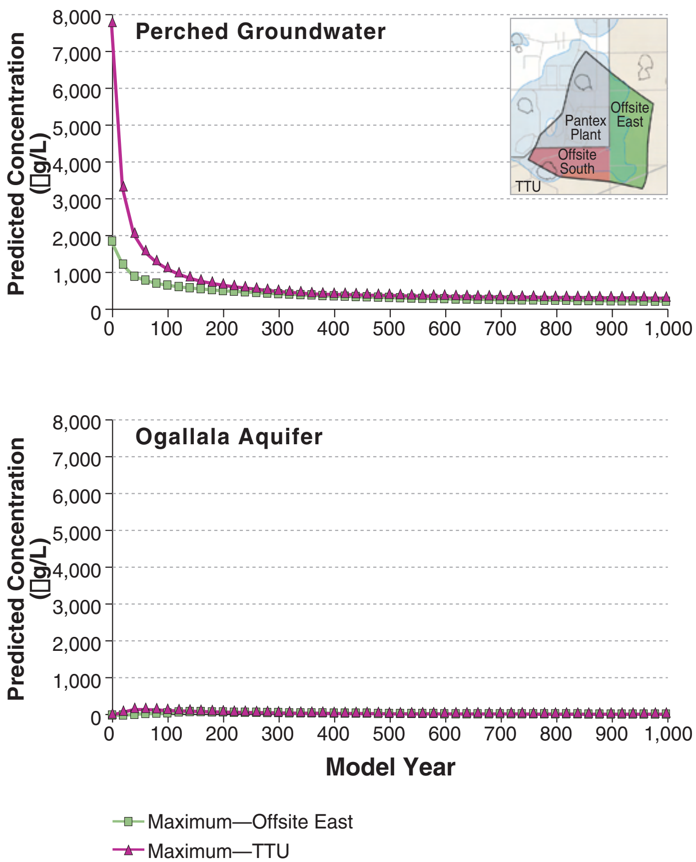
At Pantex Plant a single variably saturated "transport" model called BIOF&T3D was used. This computer model uses equations to estimate movement of chemicals throughout the system, accounting for dispersion (mixing and spreading), adsorption (adherence to soil particles), and biodegradation (breakdown of chemicals by microorganisms naturally present in the soil). Because all of the site-related radionuclides were detected only in upland areas (outside of the playas) where the recharge rate is very low, a special computer model particularly suited for that setting, FEHM, was used. FEHM was developed by the Los Alamos National Laboratory, which is located in an arid environment similar to Pantex Plant. Both BIOF&T3D and FEHM models have been rigorously validated.

Groundwater Pathway (continued)

Modeling results also indicate that concentrations in the perched groundwater decrease over time because major chemical sources to the perched zone have been removed (specifically, historical discharge of industrial process water to unlined ditches).

Air Pathway

Fate and transport models were also used to estimate the movement of chemicals detected in soil (as windblown dust) and soil gas (as vapors) to air.



Maximum predicted chemical concentration over time

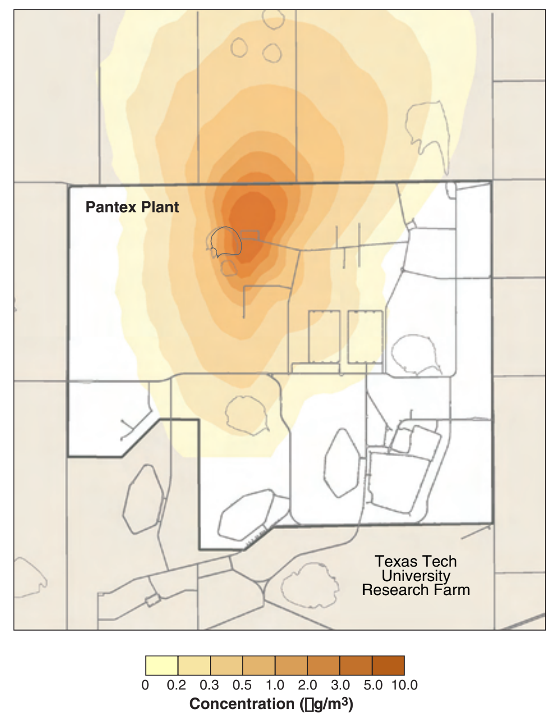
The figure on the top left is an example of how the model was used to predict maximum chemical concentrations in perched groundwater over time, east and south of Pantex Plant. Based on this information, the model is used to predict maximum chemical concentrations in the Ogallala Aquifer east and south of Pantex Plant over the same time period, as shown on the figure on the bottom left.

For purposes of the risk assessment, the model was run under what is referred to as "baseline" conditions. Specifically, the model was run under the assumption that no remediation will take place in the future that could reduce chemical concentrations in the perched groundwater. In addition, it was assumed that no chemical reactions or biodegradation will occur during transport that could also result in reduced concentrations in the perched groundwater or Ogallala Aquifer. This latter phenomenon is referred to as "non-reactive" transport. Modeling under these conditions resulted in a highly conservative scenario (erring to the side of greater rather than lesser risks). These baseline conditions were modeled to help determine where corrective measures should be focused and how much clean up is necessary to protect the Ogallala Aquifer.

Soil to Air

A different type of fate and transport model, referred to as an air dispersion model, was used to estimate offsite air concentrations associated with windblown dust from the Burning Ground. The model also estimated offsite soil concentrations resulting from deposition of windblown dust onto the ground. The Burning Ground area was modeled because it represents a "worst-case" scenario in terms of windblown dust for the following reasons: COPCs are present in surface soil at higher concentrations than in other areas at Pantex Plant, the Burning Ground is located near the northern plant boundary and is therefore closest to offsite receptors, and the predominant wind direction is to the north.

The model uses meteorological data (for example, wind speed, air temperature, precipitation), combined with information about



Example of predicted air concentrations

the "emission source" (for example, chemical concentrations in the soil, dimensions of the affected area, the amount of vegetation covering the soil) to predict future maximum air and soil concentrations at the Plant boundary.

The model was run for each exposure area in the Burning Ground, and the predicted maximum air and soil concentrations at the Plant boundary were used in the risk assessment to estimate potential health risks for an offsite resident farmer. The estimated health risks for each exposure area were then added to estimate the total potential health risk.

The results of the air dispersion modeling for the Burning Ground indicate that potential health risks associated with exposure to windblown dust are well below target risk levels, even though this area is considered to be a "worst-case" scenario for this transport pathway. The results from the Burning Ground were also used to evaluate potential health risks associated with exposure to windblown dust from other areas at Pantex Plant. This was done by comparing the distances to the Plant boundary for each area and the onsite concentrations of chemicals or radionuclides that could be carried offsite. Other areas of the plant are further from the Plant boundaries and chemical and radionuclide concentrations are similar or lower than those at the Burning Ground. The results of this analysis indicate that potential health risks associated with exposure to windblown dust from other areas at Pantex Plant are also well below target risk levels.

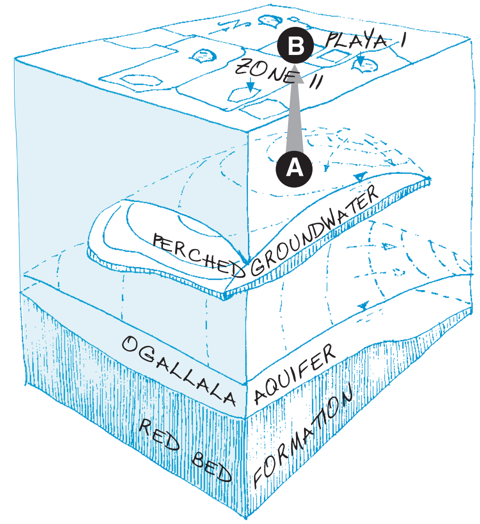
Soil Gas to Air

The same air dispersion model was also used to evaluate the movement of soil gas to air. In this case, the model was used to estimate soil-gas screening levels, which are compared to measured soil-gas concentrations. These soil-gas screening levels were developed to protect onsite workers who may be exposed to chemicals in soil gas while working in the impacted area. Similar to the modeling for the dust to air pathway, the Burning Ground was modeled to evaluate the movement of soil gas to air. Because the wind patterns at the Burning Ground are similar across Pantex Plant and a conservative model was used to estimate the amount of soil gas reaching the surface, the soil-gas screening levels estimated from this modeling effort were applied to the other areas of the Plant.

Comparison of the soil-gas screening levels to onsite soil-gas data indicates that concentrations to which onsite workers would be exposed are below health-based levels of concern. Because concentrations at the directly impacted areas are higher, offsite residents would also not be affected by soil gas that is released to the air. An additional soil gas to air model run was conducted for the Burning Ground because it is believed that a stable (not moving) nonaqueous-phase liquid (NAPL) is present in the subsurface soils. This is the only area at Pantex Plant where NAPL is suspected to be present. The NAPL consists almost entirely of toluene. Based on this modeling run, the estimated gas concentration of toluene evaporating from the NAPL is below the health-based screening level. Therefore, the soil gas to air pathway was not evaluated further in the risk assessment. As a precaution, Pantex Plant continues to operate a soil vapor extraction system at the Burning Ground to remove the NAPL.

Soil-Gas Screening Levels

Calculating the soil-gas screening levels was a multi-step process. First, the model was used to determine the rate at which soil gas "A" would be released to air at the ground surface "B." This information was then used to estimate onsite air concentrations above the soil gas source in the Burning Ground. Based on this modeling, the maximum predicted onsite air concentration was identified. The maximum predicted air concentration was then used with regulatory health-based levels to estimate soil-gas screening levels that protect workers at the ground surface.



Toxicity Assessment

Toxicity is a measure of how "toxic" or harmful a substance may be. In a toxicity assessment, data from animal and human studies are used to estimate how much of a substance it would take to cause some type of health effect. Health effects can be grouped into two broad types: short-term (acute) or long-term (chronic). Acute health effects are associated with a single large exposure, whereas chronic health effects are characterized by prolonged or repeated exposures over many days, months, or years.

Although risk assessments consider both short- and long-term health effects, the primary focus is on evaluating potential health effects associated with long-term exposure that may occur after years of exposure to constituents (that is, chemicals or radionuclides) in the environment (chronic effects). General types of chronic effects may include such things as cancer, nervous system disorders, liver disease, heart disease, or asthma.

Regardless of the type of health effect, an established principal of toxicology is that the amount of exposure (dose) affects the likelihood that health effects will occur. For example, when looking at acute effects, taking two aspirin is beneficial, 10 aspirin may cause an upset stomach, but 50 aspirin could be fatal. Similarly, there may be no immediate effects from ingesting low amounts of salt, but daily intake of large amounts of salt over several years (chronic exposure) may result in high blood pressure or heart disease.

The relationship between the exposure (dose) and effect (response) is referred to as "dose-response." Scientists use this relationship to understand how different levels of exposure can affect the occurrence and severity of health effects. Regulatory agencies such as United States Environmental Protection Agency and Texas Commission on Environmental Quality use dose-response information to develop toxicity criteria that are then used in the risk assessment.

Risk Characterization

The last step in the Pantex Plant risk assessment brings together exposure and toxicity information to calculate a risk for workers or Plant neighbors. If the calculated risk is greater than Texas Commission on Environmental Quality and United States Environmental Protection Agency target risk levels, it becomes a constituent of concern to be evaluated for further corrective measures. This risk assessment process is designed to be conservative, that is, to be protective of human health.

How are Risk Estimates Calculated and Used for Pantex Plant?

Regulatory agencies such as USEPA and TCEQ have established a process to estimate risk for populations who might be exposed to substances in the environment. The following simple equation demonstrates how risk is calculated:

Risk = Toxicity x Exposure

Risks are determined slightly differently for substances that cause cancer than for those that cause other kinds of health effects.

Non-Cancer Risks

Non-cancer health risks (for example, liver disease, heart disease, or asthma) are calculated by comparing the estimated exposure to a reference dose. The reference dose is what TCEQ and USEPA consider as a safe exposure level for individuals. If the estimated exposure in the Pantex Plant risk assessment is greater than the reference dose, there is a potential for a health effect and it is identified as a constituent of concern to be evaluated for further corrective measures.

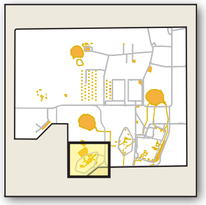
Cancer Risks

Cancer risk estimates are calculated as a probability (or chance) that an individual may develop cancer over a lifetime of exposure. Scientists use slope factors, developed by USEPA, which estimate possible cancer rates in humans, to calculate cancer risks in a risk assessment. The estimated cancer risks for the Pantex Plant risk assessment are then compared to risk levels that TCEQ and USEPA consider acceptable. Regulators have determined that a cancer risk of one case (or less) in a million is acceptable (that is, target risk levels) because the general cancer rates in the U.S. are one case for every four people. For Pantex Plant, if the estimated cancer risk level for a constituent exceeded one in a million, it was identified as a constituent of concern to be evaluated for further corrective measures.

More information about reference doses or slope factors can be found at www.epa.gov/iris and www.rais.ornl.gov.

Uncertainty Analysis

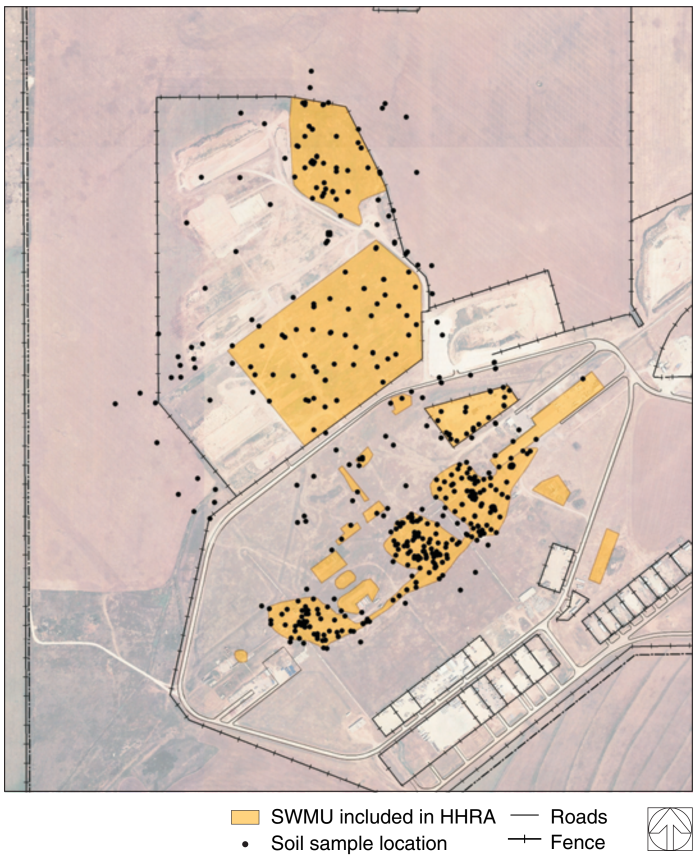
Uncertainty is inherent in many aspects of the risk assessment process. Uncertainty generally arises from a lack of complete knowledge of (1) site conditions, (2) toxicity and dose-response, and (3) the extent to which an individual may be exposed (if at all) to the COPCs. Because we are unable to collect a complete set of measurements for all of these factors, assumptions must be made based on the best available information presented in the scientific literature or on professional judgment. As a result, uncertainty may contribute to overestimation or underestimation of exposure and risk. Conservative assumptions were used throughout the risk assessment to compensate for uncertainties; thus, actual risks are more likely to be lower than predicted rather than higher. As additional protection for onsite workers and offsite residents, Pantex Plant has developed management strategies to address uncertainties in assumptions used in the risk assessment process. The results section provides the uncertainty management approach for specific areas of the Plant.



Zone 10

Zone 10 is in the south-central portion of Pantex Plant. Zone 10 facilities were originally built to manufacture conventional bombs. By 1945, Zone 10 production lines were deactivated and most buildings associated with the bomb production were demolished. After 1959, Zone 10 became a support area for operations carried out in other zones.

As part of the remedial investigation, soil, soil-gas, and perched groundwater samples were collected and analyzed for high explosives, volatile organic compounds, semivolatile organic compounds (including polyaromatic hydrocarbons [PAHs]), pesticides, PCBs, herbicides, perchlorate, metals (including hexavalent chromium), and radionuclides. A total of 1,566 soil samples and 19 soil-gas samples have been collected at multiple depths in Zone 10. Results of the investigation indicated soils were impacted by most of the chemical groups analyzed. Soil gas was impacted in the landfill area. Only the landfills were suspected to potentially contain radiological wastes. Sampling did not confirm the presence of any elevated radiological constituents. Perched groundwater samples collected near the landfills did not indicate that chemicals in soils moved to groundwater.



Several interim corrective measures have taken place within Zone 10, including soil removal and deactivation and decommissioning of areas.

Zone 10 includes both active and inactive areas and was divided into 39 exposure grid cells for purposes of the risk assessment.

Constituents of concern in soil were identified in two grid cells

Risk Assessment Conclusions

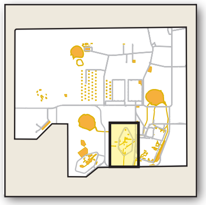
Onsite Soil (current/future): Several PAHs were identified as constituents of concern in two grid cells within Zone 10.

Onsite Groundwater (future): Subsurface transport modeling for constituents originating from Zone 10 indicates that exposure to onsite workers from groundwater is incomplete because constituents originating from soil and soil gas are not predicted to reach Pantex Plant production wells within 1,000 years. Subsurface transport modeling of perched groundwater beneath Zone 10 was not conducted because measured constituents were found to be at concentrations below background or risk-based screening levels.

Offsite Groundwater (future): Subsurface transport modeling for constituents originating from Zone 10 indicates exposure to offsite resident farmers from groundwater is incomplete because chemicals originating from soil and soil gas are not predicted to reach the Ogallala Aquifer within 1,000 years. Subsurface transport modeling of perched groundwater beneath Zone 10 was not conducted because measured constituents were found to be at concentrations below background or risk-based screening levels.

Pantex Management of Uncertainties

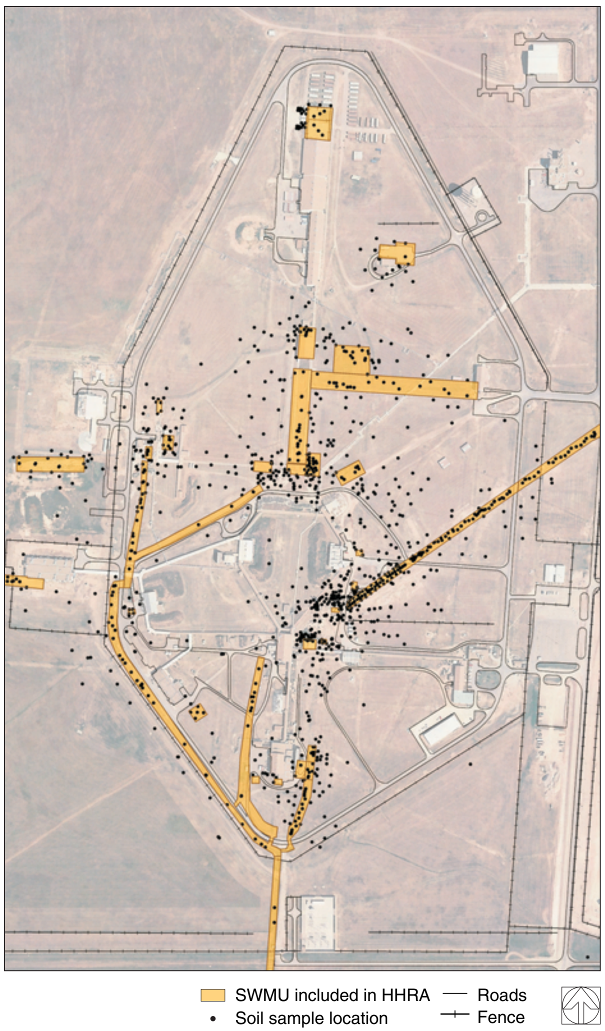
A higher level of uncertainty is associated with the analysis of potential groundwater migration to the south. To address this uncertainty, Pantex has committed to a long-term groundwater monitoring program that will include monitoring of perched groundwater to the south and west of Zone 10.



Zone 11

Zone 11 is in the south-central portion of Pantex Plant and encompasses approximately 180 acres. Zone 11 facilities were originally built to manufacture bombs during World War II. After all munitions production ceased in 1945, Zone 11 remained dormant from 1951–1959. Over time Zone 11 has became a support area for operations carried out in other zones.

As part of the remedial investigation, soil, soil-gas, and perched groundwater samples were collected and analyzed for high explosives, volatile organic compounds, semivolatile organic compounds (including PAHs), pesticides, PCBs, herbicides, perchlorate, metals (including hexavalent chromium), and radionuclides. A total of 3,202 soil samples and 210 soil-gas samples have been collected from multiple depths in Zone 11. Results of the investigation indicated soils were impacted by most of the chemical groups analyzed. Soil gas was impacted across the southwest portion of Zone 11. Zone 11 is not considered a potential radiological area based on historical usage as well as data collected during investigations. Perched groundwater beneath Zone 11 has been impacted by high explosives, volatile organic compounds, and perchlorate.



Several interim corrective measures have taken place within Zone 11, including soil removal, and the deactivation and decommissioning of buildings and areas. Additionally, a soil vapor extraction system was installed to reduce potential impacts from volatile chemicals in soil to groundwater.

Zone 11 is an active operational area and was divided into 30 exposure grid cells for purposes of the risk assessment.

Constituents of concern in soil were identified in one grid cell

Risk Assessment Conclusions

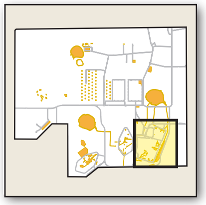
Onsite Soil (current/future): Two PAHs were identified as constituents of concern in one grid cell within Zone 11.

Onsite Groundwater (future): Subsurface transport modeling for constituents originating from Zone 11 indicates that exposure to onsite workers from groundwater is incomplete because constituents originating from soil, soil gas, and perched groundwater are not predicted to reach Pantex Plant production wells within 1,000 years.

Offsite Groundwater (future): Subsurface transport modeling for constituents originating from Zone 11 indicates that exposure to offsite resident farmers from groundwater is incomplete because constituents originating from soil, soil gas, and perched groundwater are not predicted to reach an offsite exposure point in the Ogallala Aquifer within 1,000 years.

Pantex Management of Uncertainties

The conclusion that constituents in perched groundwater at Zone 11 will not migrate south of Pantex is based on the influence of Playa 4 located on TTU property, which keeps groundwater from continuing to move southward toward TTU property. There is some uncertainty with this conclusion because of limited information about the perched groundwater influence from Playa 4. To ensure that potential pathways are eliminated and practices that could potentially contribute to migration of chemicals to the Ogallala Aquifer are controlled, Pantex Plant supplies all water to TTU property and USDOE/NNSA will continue this agreement with TTU.



Zone 12

Zone 12 is in the southeast portion of Pantex Plant and encompasses approximately 365 acres. Zone 12 facilities were originally built to manufacture bombs during World War II. Munitions production ceased in 1945, and by 1951 reconstruction began to prepare Zone 12 to serve as an explosive component and assembly plant. In the following years, numerous buildings were reconstructed, remodeled, or demolished.

As part of the remedial investigation, soil, soil-gas, and perched groundwater samples were collected and analyzed for high explosives, volatile organic compounds, semivolatile organic compounds (including PAHs), pesticides, PCBs, herbicides, perchlorate, metals (including hexavalent chromium), and radionuclides. A total of 5,592 soil samples and 145 soil-gas samples have been collected at multiple depths in Zone 12. Results of the investigation indicated soils were impacted by most of the chemical groups analyzed. Soil gas was impacted in three small areas of Zone 12. Zone 12 South was investigated for potential radiological concerns from past events. Only one area was confirmed to have evidence of depleted uranium, and the soils were removed. Perched groundwater beneath Zone 12 has been impacted by historical discharges to the ditches and playas. High explosives, volatile organic compounds, and metals have been found in perched groundwater.

Several interim corrective measures have taken place within Zone 12, including soil removal, deactivation and decommissioning of buildings and areas, lining of ditches, removal of an underground storage tank, and placement of a landfill cover to eliminate dust emissions and infiltration. Additionally, a perched groundwater pump and treat system is located east of Zone 12 that removes high explosives, hexavalent chromium, and volatile organic compounds from the perched groundwater through a network of 50 extraction and 5 injection wells. In addition, beginning in the late 1980s, the historical practice of discharging untreated industrial process wastewater from Zone 12 to the ditch system was eliminated. During the 1990s, the Plant began reducing the discharge of treated wastes to the ditches, and by 1999, all discharges to the ditches were discontinued.

Constituents of concern in soil were identified in thirteen grid cells

Zone 12 includes both active and inactive areas and was divided into 47 exposure grid cells for purposes of the risk assessment.

Risk Assessment Conclusions

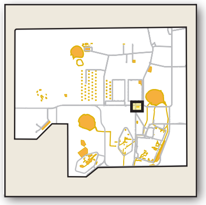
Onsite Soil (current/future): High explosives, PAHs, one metal, and one radionuclide were identified as constituents of concern in thirteen grid cells.

Onsite Groundwater (future): Subsurface transport modeling for constituents originating from Zone 12 indicates that exposure to onsite workers from groundwater is incomplete because constituents originating from soil, soil gas, and perched groundwater are not predicted to reach Pantex Plant production wells within 1,000 years.

Offsite Groundwater (future): Subsurface transport modeling for constituents originating from Zone 12 indicates that, in the absence of remediation, RDX and 2,4-dinitrotoluene in the perched groundwater are predicted to impact the Ogallala Aquifer in areas offsite to the east and south.

Pantex Management of Uncertainties

The predictions of potential future impacts to the Ogallala Aquifer were evaluated under baseline conditions that did not consider the effects of the current perched groundwater pump and treat system or naturally occurring degradation rates. Further discussions on Pantex Plant management of Zone 12 contributions to perched groundwater are discussed in the site-wide perched groundwater and Ogallala Aquifer results sections. Pantex Plant has adopted a proactive strategy consisting of long-term groundwater monitoring and environmental stewardship to ensure that any potential future impacts to the Ogallala Aquifer are mitigated and exposures prevented.



Fire Training Area (FTA)

The FTA is northeast of Zone 11 and covers an area of approximately 2 acres. The FTA was used for fire department training exercises. The tower and paved area within the FTA continue to be used. The burn pits, which were filled with fuels and waste solvents for fire training exercises, are no longer used. The FTA also includes Landfill 7, which is located just south of the burn pits.

As part of the remedial investigation, soil, soil-gas, and perched groundwater samples were collected and analyzed for high explosives, volatile organic compounds, semivolatile organic compounds (including PAHs), pesticides, PCBs, dioxins/furans, metals (including hexavalent chromium), and radionuclides. A total of 336 soil samples and 56 soil-gas samples have been collected at multiple depths in the FTA. Results of the investigation indicated soils were impacted by most of the chemical groups analyzed. Soil gas was impacted across the FTA. The FTA was investigated for potential radiological concerns, but no elevated radiological constituents were found. Perched groundwater beneath the FTA has been impacted by the soil-gas plume present at the FTA as well as by historical discharges to the ditches and playas in other areas of Pantex Plant. High explosives, volatile organic compounds, and perchlorate have been found in perched groundwater near the FTA.

Interim corrective measures have taken place within the FTA, including soil removal in the burn pit areas.

The FTA is an active operational area and was evaluated as a single exposure area for purposes of the risk assessment.

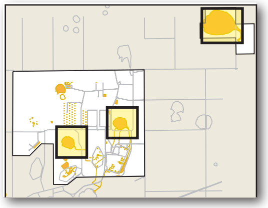
No constituents of concern in soil were identified in this area

Risk Assessment Conclusions

Onsite Soil (current/future): No constituents of concern were identified for the FTA. All evaluated constituents were found to be at concentrations below target risk levels for human health effects.

Onsite Groundwater (future): Subsurface transport modeling for constituents originating from the FTA indicates that exposure to onsite workers from groundwater is incomplete because constituents originating from soil, soil gas, or perched groundwater are not predicted to reach Pantex Plant production wells within 1,000 years.

Offsite Groundwater (future): Subsurface transport modeling for constituents originating from the FTA indicates that exposure to offsite resident farmers from groundwater is incomplete because constituents originating from soil, soil gas, or perched groundwater are not predicted to reach an offsite exposure point in the Ogallala Aquifer within 1,000 years.



Playas 1 and 2 and Pantex Lake

As one of the few surface-water sources on the High Plains, playas are desirable seasonal water bodies that often serve as grazing areas. These seasonal lakes form in small depressions and serve as the primary source of recharge to groundwater in the Panhandle. Five playas are associated with Pantex Plant. Playa 1 is in the eastern portion of Pantex Plant, Playa 2 in the southwestern portion, and Playa 3 in the northwestern portion (Playa 3 is evaluated in the Burning Ground area). Pantex Lake is located 2.5 miles northeast of the Plant boundary. The final playa, Playa 4, is located offsite south of Pantex Plant on Texas Tech University property and was not evaluated in the risk assessment because no closure decision has been made pending investigation by other parties and regulatory review.

Playas 1 and 2 contain a series of ditches that convey surface-water drainage. In the past, Playas 1 and 2 received storm water runoff from industrial areas (Zones 10, 11, and/or 12) and historical industrial discharges from Zones 11 and 12; Playa 1 also historically received treated and untreated wastewater. Currently, the ditches to these playas convey only storm water runoff. Playas 1 and 2 include cattle grazing and are formally managed areas under the Playa Management Plan. A new subsurface irrigation system was constructed and routine discharges to Playa 1 were eliminated. The reduction or elimination of discharge to the ditches and Playa 1 has eliminated the primary driving force for further movement of constituents through ditches and Playa 1 soils, as well as the driving force that caused the expansion of perched groundwater to its current extent.

Pantex Lake historically received treated sanitary and industrial waste from the old sewage treatment plant, which received wastewater from Pantex operations as well as the City of Amarillo and the former Amarillo Air Force Base. Currently, Pantex Lake receives only surface-water runoff from farm and ranch land surrounding the Lake.

As part of the remedial investigation, soil and perched groundwater samples were collected and analyzed for high explosives, volatile organic compounds, semivolatile organic compounds (including PAHs), pesticides, PCBs, herbicides, perchlorate, metals (including hexavalent chromium), and radionuclides. A total of 1,126 soil samples have been collected from multiple depths in Playas 1 and 2 and Pantex Lake. Results of the investigation indicated soils were impacted by most of the chemical groups analyzed. Pantex Lake was investigated for potential radiological concerns, but no elevated radiological constituents were found. Perched groundwater has been impacted by historical discharges from Plant operations beneath Playa 1. High explosives, volatile organic compounds, and metals have been found in perched groundwater beneath and to the southeast of Playa 1.

Playas 1 and 2 and Pantex Lake were evaluated as single exposure areas for purposes of the risk assessment.

No constituents of concern in soil were identified in these areas

Risk Assessment Conclusions

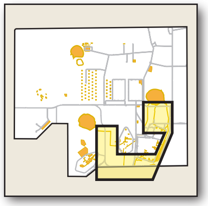
Onsite Soil (current/future): No constituents of concern were identified at Playas 1 and 2 and Pantex Lake. All evaluated constituents were found to be at concentrations below target risk levels for human health effects.

Onsite Groundwater (future): Subsurface transport modeling for constituents originating from Playa 1 and Playa 2 indicates that exposure to onsite workers from groundwater is incomplete because constituents originating from soil and perched groundwater are not predicted to reach Pantex Plant production wells within 1,000 years. Groundwater beneath Pantex Lake cannot contribute to Pantex Plant production wells, because groundwater does not flow from Pantex Lake toward the Plant.

Offsite Groundwater (future): Subsurface transport modeling for constituents originating from Playa 1 indicates that perched groundwater beneath Playa 1 is predicted to contribute to offsite perched groundwater impacts east of the Plant boundary, and may contribute to sitewide groundwater impacts. Subsurface transport modeling for constituents originating from Playa 2 indicates that exposure to offsite resident farmers from groundwater is incomplete because constituents originating from soil and perched groundwater are not predicted to reach an offsite exposure point in the Ogallala Aquifer within 1,000 years. For Pantex Lake, exposure to offsite resident farmers is also considered incomplete because no COPCs were identified for further evaluation in the risk assessment for this transport pathway.

Pantex Lake

No site-related constituents (for example, high explosives) were found in perched groundwater at Pantex Lake; however, nitrate and selenium were found in one well near a ditch that drains the surrounding agricultural area. Fertilizers and manure are common sources of nitrates in water. In the absence of site-related constituents, fertilizers and manure are the most likely sources of nitrate in perched groundwater at Pantex Lake. In addition, nitrate in groundwater has been shown to mobilize natural selenium from soil. Therefore, nitrate and selenium were not retained as constituents of concern.



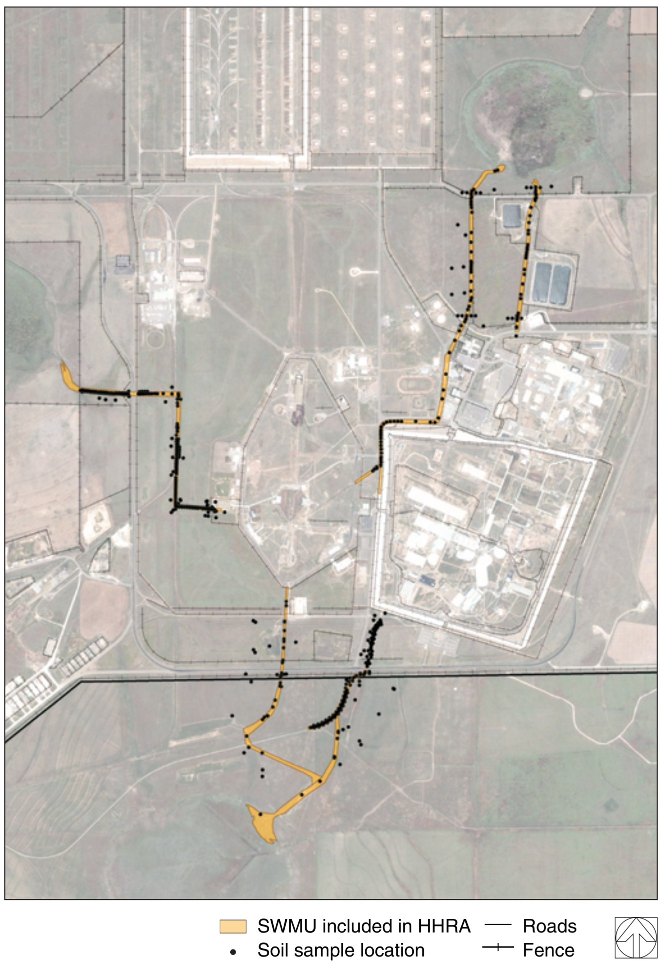
Ditches

The Ditches evaluated in the risk assessment are located in various areas of Pantex Plant. In the past, the Ditches received treated and untreated industrial discharges from Zones 11 and 12. The Ditches currently receive only storm water runoff. Ditches are associated with the Playa 1, Playa 2, and Playa 4 drainage basins.

As part of the remedial investigation, soil and perched groundwater samples were collected and analyzed for high explosives, volatile organic compounds, semivolatile organic compounds (including PAHs), pesticides, PCBs, herbicides, perchlorate, metals (including hexavalent chromium), and radionuclides. A total of 2,539 soil samples have been collected from multiple depths in the Ditches. Results of the investigation indicated soils were impacted in various areas by most of the chemical groups analyzed. The Ditches were investigated for potential radiological concerns, but no elevated radiological constituents were found. Perched groundwater has been impacted by historical discharges from Plant operations beneath ditches from Zones 11 and 12. High explosives, volatile organic compounds, perchlorate, and metals have been found in perched groundwater beneath the ditches north and south of Zones 11 and 12.

Focused soil excavations have occurred in various ditches over time.

The Ditches are inactive areas. Each ditch was evaluated as a single exposure area for purposes of the risk assessment.



No constituents of concern in soil were identified in these areas

Ditch lining in Zone 12

Risk Assessment Conclusions

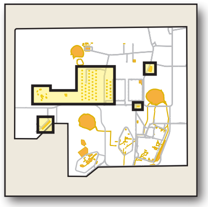
Onsite Soil (current/future): No constituents of concern were identified for the Ditches. All evaluated constituents were found to be at concentrations below target risk levels for human health effects.

Onsite Groundwater (future): Subsurface transport modeling for constituents originating from the Ditches indicates that exposure to onsite workers from groundwater is incomplete because constituents originating from soil and perched groundwater are not predicted to reach Pantex Plant production wells within 1,000 years.

Offsite Groundwater (future): Subsurface transport modeling for constituents originating from the Ditches indicates that exposure to offsite resident farmers from groundwater is incomplete because constituents originating from soil and perched groundwater are not predicted to reach an offsite exposure point in the Ogallala Aquifer within 1,000 years.

Pantex Management of Uncertainties

Perched groundwater has been impacted near ditches located south of Pantex Plant. To ensure potential pathways are eliminated and practices that could potentially contribute to migration of chemicals to the Ogallala Aquifer are controlled, Pantex Plant supplies all water to TTU property and USDOE/NNSA will continue this agreement.

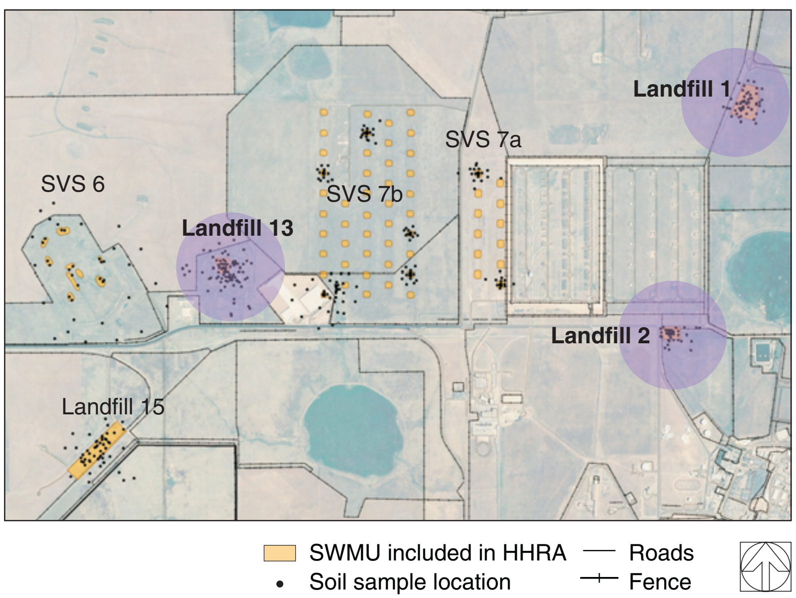


Landfills

The Landfills (Landfills 1, 2, 13, and 15, and Supplemental Verification Sites [SVS] 6, 7a, and 7b) are located in multiple zones at Pantex Plant. The Landfills were used as general purpose sanitary landfills or for construction debris. Landfill maintenance covers were placed on Landfills 1, 2, and 13 to prevent workers from coming into contact with the landfill contents and to prevent the infiltration of surface water to the groundwater.

As part of the remedial investigation, soil, soil-gas, and perched groundwater samples were collected and analyzed for high explosives, volatile organic compounds, semivolatile organic compounds (including PAHs), pesticides, PCBs, herbicides, perchlorate, metals (including hexavalent chromium), and radionuclides. A total of 1,502 soil samples and 16 soil-gas samples have been collected at multiple depths in the Landfills. Results of the investigation indicated soils were impacted in various areas by most of the chemical groups analyzed. Landfills 1, 2, and 13 were investigated for potential radiological concerns, but no elevated radiological constituents were found. Perched groundwater is not present beneath some of the landfills. Landfills 1, 2, and 13 have some perched groundwater present at depth. Perched groundwater has been impacted at Landfills 1 and 2, but is associated with the releases to Playa 1. High explosives and metals have been found in perched groundwater near Playa 1 and perchlorate has been found in perched groundwater along the ditches leading north from Zone 11 to Playa 1.

The Landfills are inactive areas. Each landfill was evaluated as a separate exposure area for purposes of the risk assessment.



Constituents of concern in soil were identified in Landfills 1, 2, and 13.

Risk Assessment Results

Onsite Soil (current/future): Lead was identified as a constituent of concern in Landfill 1. One or more PAHs were identified as constituents of concern in Landfills 2 and 13.

Onsite Groundwater (future): Subsurface transport modeling for constituents originating from the Landfills indicates that exposure to onsite workers from groundwater is incomplete because constituents originating from soil, soil gas, and perched groundwater are not predicted to reach Pantex Plant production wells within 1,000 years.

Offsite Groundwater (future): Subsurface transport modeling for constituents originating from the Landfills indicates that exposure to offsite resident farmers from groundwater is incomplete because constituents originating from soil, soil gas, and perched groundwater are not predicted to reach an offsite exposure point in the Ogallala Aquifer within 1,000 years.

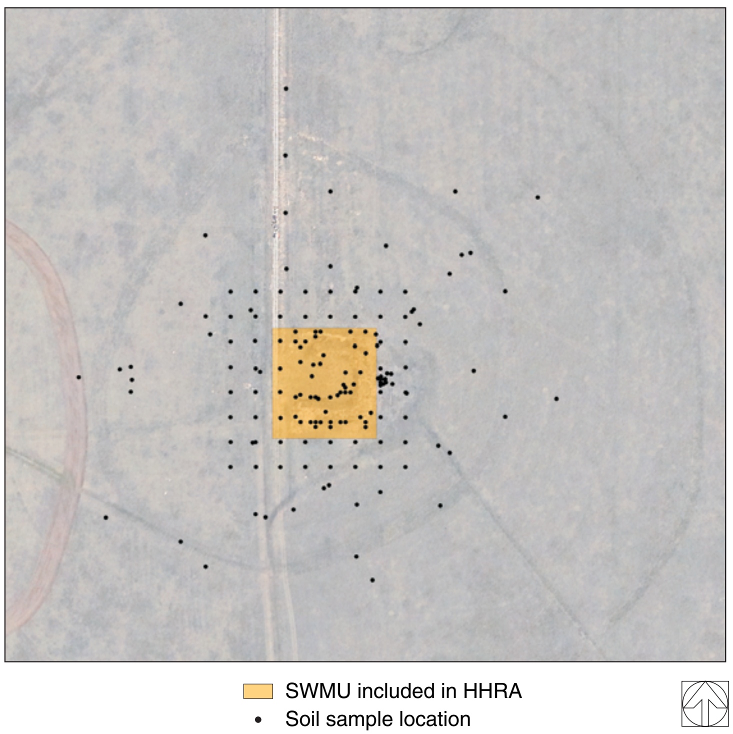
Pantex Management of Uncertainties

USDOE/NNSA agreed to install two additional perched groundwater wells in the vicinity of SVS 7a and SVS 7b to address uncertainties associated with the investigation. Wells were installed in August 2005. No perched groundwater was observed in either well.

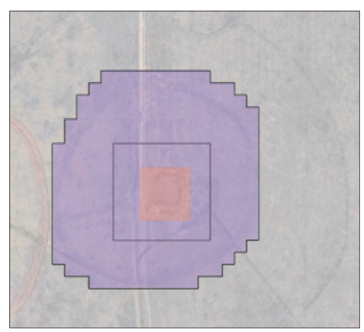
Firing Site 5 (FS-5)

FS-5 is in the northeastern portion of Pantex Plant and covers approximately 16 acres. FS-5 was built in 1953 and was used as an outdoor facility to test the behavior of weapon components when exploded. Depleted uranium was used in the test explosions to simulate the behavior of plutonium components used in actual weapons. An earthen berm surrounds the test firing area, and testing was performed on a metal-covered concrete pad or within a gravel pit in the center of the facility. All tests at the facility were stopped in 1984. Testing performed at FS-5 resulted in area-wide scattering of depleted uranium and other materials that were used in the test shots.

As part of the remedial investigation, soil samples were collected and analyzed for metals, high explosives, and radionuclides. A total of 1,099 samples were collected from multiple depths at FS-5. In addition, multiple field radiation surveys were conducted to identify depleted uranium fragments. Results of the investigation indicated that soils were impacted by metals, depleted uranium, and high explosives. An interim corrective measure was performed at FS-5 from 1996 to 1998 to remove the depleted uranium fragments and affected soils. All facilities were removed at FS-5, but the earthen berm remains at the site. Final soil samples collected from 171 locations at FS-5 in 1998 demonstrated that the remedial cleanup goals were met. A risk assessment performed following the cleanup (in early 1999) determined that the cleanup also met Texas Commission on Environmental Quality and United States Environmental Protection Agency acceptable risk criteria based on toxicity information available at that time.



The current FS-5 risk assessment was completed to update the toxicity information and to follow the approved final work plan for the human health risk assessments. FS-5 is an inactive area and was divided into two exposure areas (low anomaly area and high anomaly area/berm gravel pit) for purposes of the risk assessment.



Constituents of concern in soil were identified in both exposure areas

Risk Assessment Conclusions

Onsite Soil (current/future): Depleted uranium was identified as a constituent of concern in both exposure areas at FS-5.

Onsite Groundwater (future): Subsurface transport modeling for radionuclides originating from FS-5 indicates that exposure to onsite workers from groundwater is incomplete because radionuclides originating from soil are not predicted to reach Pantex Plant production wells within 1,000 years.

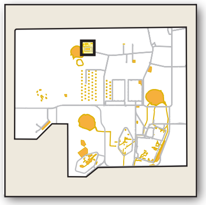
Offsite Groundwater (future): Subsurface transport modeling for radionuclides originating from FS-5 indicates that exposure to offsite resident farmers from groundwater is incomplete because radionuclides originating from soil are not predicted to reach an offsite exposure point in the Ogallala Aquifer within 1,000 years.

What is Depleted Uranium?

Depleted uranium is what is left over when most of the other radioactive types of uranium are removed for the production of enriched uranium. Depleted uranium contains greater than 99 percent uranium-238 (^{238}U) and is approximately 40 percent less radioactive than natural uranium. The amount of radiation emitted by depleted uranium is very low and it does not significantly add to the background radiation that we encounter every day.

Pantex Management of Uncertainties

FS-5 is in a controlled area of the Plant because test explosions are still conducted at nearby firing sites. Therefore, entry and use of FS-5 is restricted.

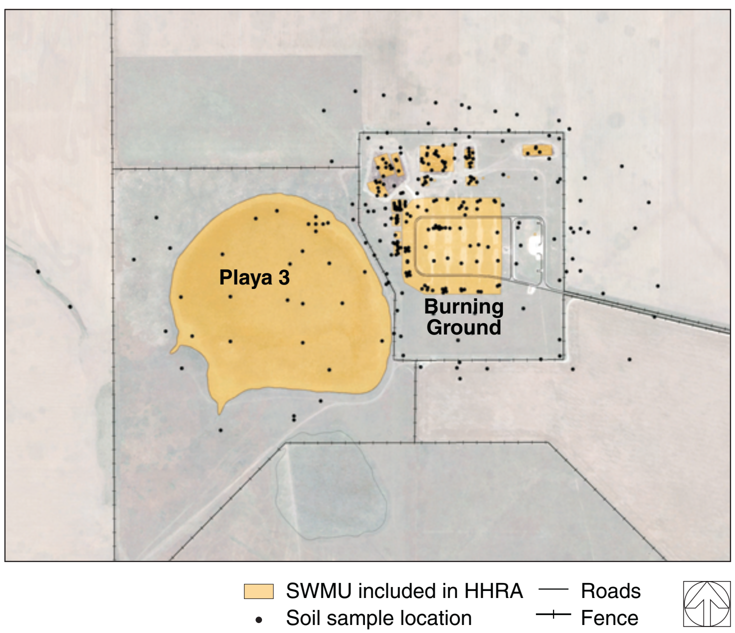


Burning Ground

The Burning Ground area is in the north-central portion of Pantex Plant and consists of the Burning Ground and Playa 3. The Burning Ground has been operating since 1952, and was historically used for disposal of high explosive waste, a practice that has been discontinued. Playa 3 is approximately 54 acres and receives storm water runoff from the surrounding area and agricultural fields. Playa 3 is formally managed under the Playa Management Plan.

As part of the remedial investigation, soil, soil-gas, and perched groundwater samples were collected and analyzed for high explosives, volatile organic compounds, semivolatile organic compounds (including PAHs), pesticides, PCBs, dioxins/furans, herbicides, perchlorate, metals (including hexavalent chromium), and radionuclides. A total of 1,999 soil samples and 120 soil-gas samples have been collected from multiple depths in the Burning Ground. Results of the investigation indicated soils were impacted by the chemical groups analyzed. Specific burn pads were investigated for radiological concerns, and depleted uranium was detected at concentrations above regulatory levels in one area. An interim corrective measure removed much of the depleted uranium at the burn pad. Perched groundwater is not present beneath most of the Burning Ground, but is present beneath Playa 3. A portion of the perched groundwater has been impacted by perchlorate and TCE.

Many permanent corrective and interim stabilization measures have already been performed at the Burning Ground, including soil removal, soil treatment by composting to reduce chemical concentrations, soil vapor extraction to reduce the soil-gas plume beneath the Burning Ground, backfilling of pit areas, and plugging of groundwater wells. A temporary administrative cover has been placed over one hot spot (area with high concentrations of chemicals).



The Burning Ground is an active operational area and was divided into 35 exposure grid cells for purposes of the risk assessment. Because Playa 3 is not an active industrial area, Playa 3 was evaluated as a single exposure area in the risk assessment.

Constituents of concern in soil were identified in six grid cells

Risk Assessment Conclusions

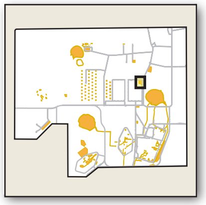
Onsite Soil (current/future): RDX, trinitrotoluene, and/or uranium-238 were identified as constituents of concern in six grid cells within the Burning Ground. The temporary administrative covers have been effective in protecting current workers, but more permanent measures need to be identified for those areas. No constituents of concern were identified for Playa 3.

Onsite Groundwater (future): Exposure to onsite workers from groundwater is incomplete because no COPCs were identified for further evaluation in the risk assessment for this transport pathway.

Offsite Groundwater (future): Exposure to offsite resident farmers from groundwater is also incomplete because no COPCs were identified for further evaluation in the risk assessment for this transport pathway.

Pantex Management of Uncertainties

Although risk assessment results indicate that residual contamination at the Burning Ground will not impact the Ogallala Aquifer, long-term monitoring will continue, to confirm these results and address uncertainties in the extent of chemicals, including the presence of NAPL in the soils at the Burning Ground.

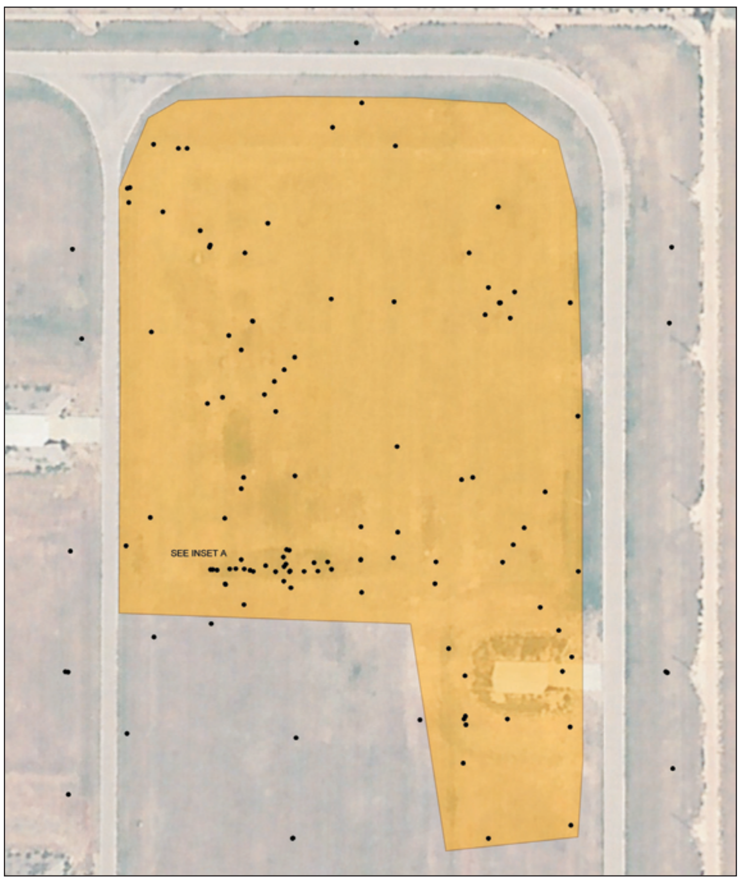


Nuclear Weapon Accident Residue Storage Unit (NWAR)

NWAR is in the northeast corner of Zone 4 and covers approximately 5 acres. From 1965 through 1986, the unit was a retrievable radioactive material storage site. Storage areas at NWAR consisted of 16 below-ground lined concrete cylinders and an earthen trench. Radioactive debris stored at NWAR included melted slag from weapons from five different military aircraft accidents, impacted soil from firing sites that contained low levels of depleted uranium, and low-level radiological waste from Pantex Plant operations. In 1979, the United States Department of Energy determined that all wastes stored at NWAR were to be retrieved and disposed. By 1986 all waste removal and site decontamination was completed, and all radioactive debris and low-level radioactive waste was shipped offsite for proper disposal.

The remedial investigation was conducted to verify that site decontamination and waste removal was protective of human health and the environment. As part of the remedial investigation, soil and perched groundwater samples were collected and analyzed for metals, high explosives, and radionuclides. A total of 286 soil samples were collected from multiple depths at NWAR. Results of the investigation indicated soils were impacted in various areas by metals. NWAR was investigated for potential radiological concerns. Depleted uranium and plutonium-239 (239Pu) were detected at elevated levels in limited soil areas. Perched groundwater is present beneath NWAR and was impacted by high explosives and boron, likely the result of historical discharges to Playa 1.

NWAR is an inactive area and was evaluated as a single exposure area for purposes of the risk assessment.



SWMU included in HHRA
• Soil sample location

No constituents of concern in soil were identified in this area

Risk Assessment Conclusions

Onsite Soil (current/future): No constituents of concern were identified for NWAR. All evaluated constituents were found to be at concentrations below target risk levels for human health effects.

Onsite Groundwater (future): Subsurface transport modeling for constituents originating from NWAR indicates that exposure to onsite workers from groundwater is incomplete because constituents originating from soil and perched groundwater are not predicted to reach Pantex Plant production wells within 1,000 years.

Offsite Groundwater (future): Subsurface transport modeling for constituents originating from NWAR indicates that exposure to offsite resident farmers from groundwater is incomplete because constituents originating from soil and perched groundwater are not predicted to reach an offsite exposure point in the Ogallala Aquifer within 1,000 years.

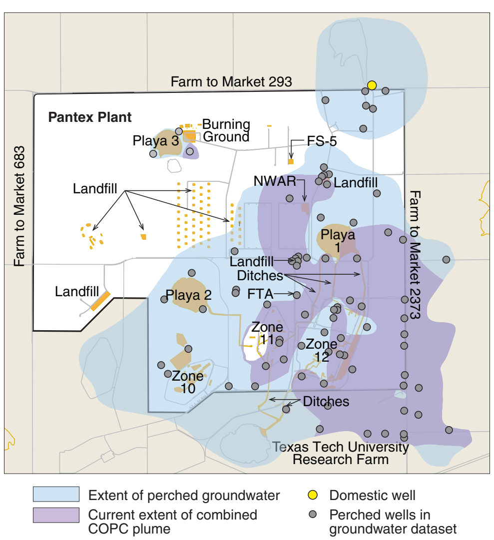
Pantex Management of Uncertainties

NWAR will be considered in a long-term monitoring network plan for groundwater because high explosives and boron are present in the perched groundwater beneath NWAR.

Site-Wide Perched Groundwater

The current conditions in perched groundwater are well understood because of extensive measurements from 1,305 samples collected from 76 monitoring or investigation wells and 50 extraction wells since 1999. The figure below shows the locations of the monitoring and investigation wells along with the current extent of the combined impacted plume. RDX, HMX, and boron have the most extensive plumes in the perched groundwater. Many of the individual chemical plumes are smaller than the combined plume (for example, hexavalent chromium, TCE, and perchlorate).

With the exception of one domestic supply well north of Pantex Plant, no public or private wells are completed in perched groundwater in the immediate vicinity of Pantex Plant. This one domestic well is not in an area of impacted perched groundwater. The impacted perched groundwater underlying Pantex Plant and extending to the south and east is not used. Therefore, exposure to chemicals in perched groundwater is not currently a complete pathway. Perched groundwater beneath Pantex Plant will not be used in the future because Pantex Plant will continue to control drilling and water usage.



Past activities such as discharges to ditches, playas, and other areas of focused recharge have ceased at Pantex Plant. A groundwater pump and treat system has been installed to the east and southeast of Zone 12, soils have been removed in source areas, ditches have been lined in some source areas to prevent further movement of chemicals to perched groundwater, and soil vapor extraction systems have been installed in Zone 11 and the Burning Ground to reduce potential future impacts to perched groundwater.

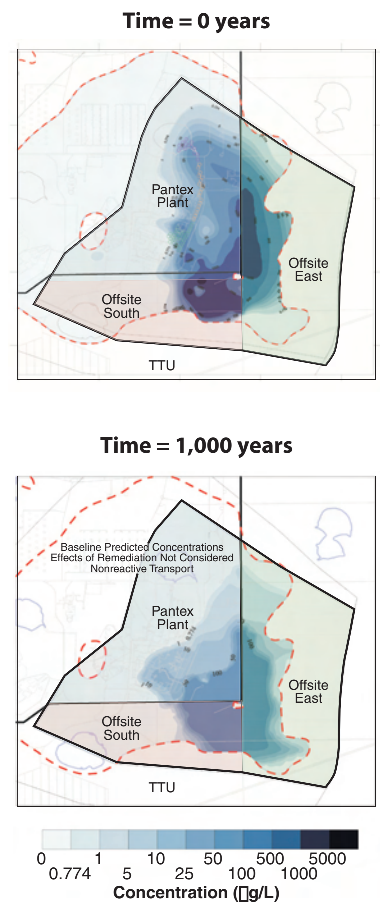
To identify constituents of concern, it was necessary to understand the highest anticipated perched groundwater concentration at the offsite exposure points. To estimate the highest concentrations over time, groundwater modeling was performed. For perched groundwater, the results indicate that current conditions constitute the highest concentrations. Impacts to perched groundwater will persist in the future as past industrial water remaining in vadose zone soils above the perched water table continues to drain over the next 50 to 100 years. Water levels will rise, but will not cause any increase in concentrations of the constituents of concern. This is primarily because the historical discharge practices from Plant activities have been discontinued.

Risk Assessment Conclusions

Offsite East of Pantex Boundary (current/future): Although no public or private water supply wells are currently completed in the perched groundwater east of Pantex Plant, development of a private well in the future could result in exposure to concentrations similar to those currently measured in monitoring wells in this area. Seven high explosives, one volatile organic compound, and boron were identified as constituents of concern. The primary source areas for these chemicals are Zone 12 and Playa 1.

Offsite South of Pantex Boundary (current/future): No water supply wells are completed in perched groundwater in this area. This pathway could become complete if a well is placed in this area in the future. However, the United States Department of Energy/National Nuclear Security Administration will continue the agreement with Texas Tech University to supply all future water to Texas Tech University Research Farm and will request that Texas Tech University place a formal restriction on the groundwater and future drilling in this area. Under current conditions, nine high explosives, boron, hexavalent and total chromium, perchlorate, TCE, and 1,2-dichloroethane were identified as constituents of concern. Under future conditions, 1,3,5-trichlorobenzene, chloroform, and tetrachloroethene were also identified as constituents of concern. The primary source areas for these chemicals are Zone 11 and Zone 12.

Offsite at Pantex Lake (current/future): Pantex Lake is located beyond the main perched groundwater extent; however, isolated perched groundwater does occur beneath Pantex Lake. Nitrate and selenium are the only two chemicals identified in the perched groundwater. Nitrate likely originated from the agricultural use of the area. Additionally, nitrate in groundwater can dissolve naturally occurring selenium from the soil. Therefore, these two chemicals are considered unrelated to activities at Pantex Plant and are not retained as constituents of concern.



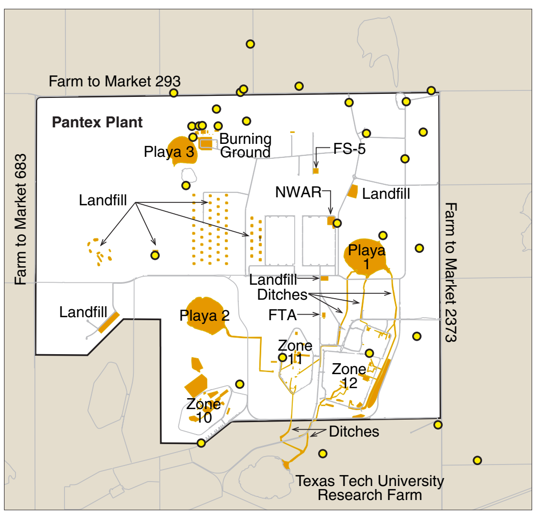
Predicted RDX concentration in perched groundwater at the start of the model and into the future

Site-Wide Ogallala Aquifer

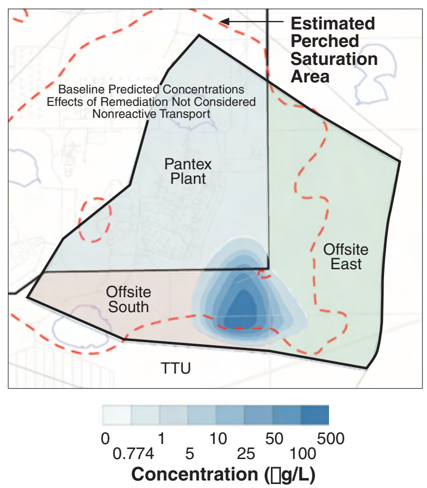
Since 1999, more than 400 groundwater samples have been collected from 31 monitoring or investigation wells in the Ogallala Aquifer. Although some Ogallala monitoring data indicate isolated detections of chemicals, review of the Ogallala data indicate there are no health concerns related to the detections. The data also indicate there are no trends in the detections, meaning there are no repeated detections in wells that would indicate the presence of a chemical plume in the Ogallala Aquifer. Therefore, there are no current risks or imminent threats to human health.

Future exposure would first require migration of constituents in soil, soil gas, or perched groundwater to reach the Ogallala Aquifer by moving downward through the fine-grained zone. Above the fine-grained zone, constituents will move southeast or southwest with the perched groundwater. Because the fine-grained zone is more permeable toward the southeast and because modeling indicates that the constituents would reach the highest concentrations in the southeast, the highest impact to the Ogallala Aquifer is expected to be at these southeasterly locations. Upon reaching the Ogallala Aquifer, the constituents then follow the prevailing Ogallala groundwater flow direction toward the northeast and must move to an offsite location used for drinking or agricultural supply before an offsite risk can occur.

Even though there are no current risks from the Ogallala Aquifer, groundwater modeling was conducted under a “baseline” condition to investigate whether contributions from the perched groundwater can pose any future risks. Specifically, the model was run under the assumption that no remediation would take place in the future that could reduce the constituent concentrations in the perched groundwater. In addition, it was assumed that no chemical reactions or biodegradation would occur during transport that could also result in reduced concentrations in perched groundwater or the Ogallala Aquifer. This latter phenomenon is referred to as “non-reactive” transport. Modeling under these conditions resulted in a highly conservative scenario (erring to the side of greater rather than lesser risks). These baseline conditions were modeled to help determine where corrective measures should be focused and how much cleanup is necessary to protect the Ogallala Aquifer.



Ogallala wells evaluated in the risk assessment



RDX predicted in the Ogallala Aquifer at 40 years if no corrective action is taken

Risk Assessment Conclusions

Onsite Production Wells and City of Amarillo municipal wells (current/future): Subsurface fate and transport modeling indicates that no constituents will reach Pantex Plant production wells within 1,000 years. Further, because all the City of Amarillo municipal wells are located further north, there are no current or future risks predicted for these wells because it would take longer for the chemicals to reach these wells.

Offsite East (current/future): The modeling identified the offsite area southeast of Pantex Plant in the Ogallala Aquifer as the most vulnerable for future risks. Currently, there are no production or domestic wells in this area. In the absence of any remediation, groundwater modeling identified two high explosives, 2,4-dinitrotoluene and RDX, as constituents of concern. Perched groundwater beneath and down-gradient of Zone 12 is the source of these constituents that may affect Ogallala groundwater in the future. Soil and soil gas at Zone 12 act only as minor sources to the perched groundwater and do not contribute to risk in the Ogallala Aquifer.

Offsite South (current/future): Several constituents of concern were also identified on Texas Tech University property. However, the United States Department of Energy/National Nuclear Security Administration currently supplies water to Texas Tech University. In addition, the United States Department of Energy/National Nuclear Security Administration is currently pursuing an agreement with Texas Tech University to restrict use of groundwater and future drilling in this area as part of the corrective measures for the perched groundwater.

Pantex Management of Uncertainties

USDOE/NNSA has adopted a proactive strategy to reduce the potential for chemicals in perched groundwater to reach the Ogallala Aquifer. This strategy includes interim measures such as the perched groundwater pump and treat system and various institutional controls. It is the goal of USDOE/NNSA to design and implement measures for the perched groundwater and comprehensive monitoring of the Ogallala Aquifer to ensure that any potential future impacts to the Ogallala Aquifer are mitigated and exposures prevented.

As part of the corrective action process for Pantex Plant, human health risk assessments were conducted to identify constituents of concern to be considered for further corrective measures. The risk assessments are based on data collected from numerous remedial investigations that evaluated impacts from chemicals and radionuclides in soil, soil gas, surface water, perched groundwater, and the Ogallala Aquifer. As part of the risk assessment, fate and transport modeling was conducted to evaluate if constituents in the soil, soil gas, or perched groundwater could migrate to the Ogallala Aquifer in the future, or if constituents in soil could migrate offsite as part of windblown dust. The risk assessment conclusions are as follows:

- There is no current or imminent threat to human health from drinking water from the Ogallala Aquifer. Potential future risks could occur if drinking water wells are placed offsite to the east or to the south, and if someone uses the water where future impacts are predicted. In the absence of any remediation, subsurface transport modeling identified 2,4-dinitrotoluene and RDX as future constituents of concern in the Ogallala Aquifer to the east and south.
- There is no current or imminent threat to human health from constituents detected in the perched groundwater because impacted perched groundwater is not used onsite or offsite. Potential future risks could occur if drinking water wells are placed offsite to the east or to the south, and if someone uses the water that is currently impacted or where future impacts are predicted. In the absence of any remediation, subsurface transport modeling indicates that some constituents present in perched groundwater may migrate to the Ogallala Aquifer. Numerous cleanup measures have been implemented to reduce potential future impacts to perched groundwater and the Ogallala Aquifer.
- Zones 10, 11, and 12; Landfills 1, 2, and 13; FS-5; and the Burning Ground are the only onsite areas in which constituents in soils were identified to be above health-based risk levels based on direct exposure to onsite workers. Exposure to onsite workers will be reduced to acceptable levels through soil management practices. Chemicals in soil do not pose a current or future risk to offsite residents or farmers.

OSTP before remediation

OSTP after remediation

It is the goal of the United States Department of Energy/National Nuclear Security Administration to design and implement measures for the perched groundwater and comprehensive monitoring of the Ogallala Aquifer to ensure that any potential future impacts to the Ogallala Aquifer are mitigated and exposures prevented. One such measure includes continuing to provide all water to Texas Tech University so that no well drilling occurs in areas where groundwater is impacted by chemicals. The United States Department of Energy/National Nuclear Security Administration will also request that Texas Tech University place a formal restriction on future well drilling and groundwater use for long-term protection of the area. In addition, remedial measures at Pantex Plant will focus on the control of RDX in the perched groundwater. Long-term monitoring and environmental stewardship will continue at Pantex Plant for the foreseeable future.

All risk assessment results reported in this Summary Report were based on baseline conditions (without consideration of future remediation). Permanent removals of constituents in soil (by excavation) or soil gas (by soil vapor extraction) were considered as a baseline condition in the risk assessment because these constituents are no longer present in soil or soil gas. However, even though a number of groundwater corrective measures are already in operation and several others are planned, the assessments did not incorporate any reduction in constituent concentrations in groundwater resulting from these corrective measures. Therefore, it is likely that any actual risks from exposures to constituents of concern will be lower than those predicted in the risk assessment. A Corrective Measures Study/Feasibility Study has been completed to look at options for cleanup of the constituents of concern identified in the human health risk assessment.

Zone 11 SVE system

Injection of soybean oil into perched groundwater to enhance bioremediation

Corrective Measures or Cleanup Actions

Current Operations at Pantex Plant

- Wastewater discharges and regular discharges to Playa 1 were eliminated to reduce recharge to the perched groundwater.
- Soil "hot spots" with constituents at concentrations above regulatory levels were excavated and removed offsite.
- Landfills 1, 2, 3, 12, and 13 and Burning Ground landfills are covered by administrative maintenance covers to reduce fugitive dust emissions and promote runoff rather than infiltration.
- Ditches in the southeast portion of Zone 12 have been lined to reduce migration of soil constituents to perched groundwater.
- A bioremediation pilot system was constructed in 2001 and is currently in operation to reduce the concentrations of high explosives in the vadose zone soils in the southeast portion of Zone 12.
- Full-scale soil vapor extraction systems were installed in the Burning Ground and Zone 11 to reduce concentrations of volatile organic constituents in the vadose zone.
- Originally installed in 1995 and after a series of upgrades, a pump and treat system consisting of 50 pumping wells and 5 injection wells is in operation southeast of Zone 12 to treat the perched groundwater. Currently, part of the treated water is injected back into the perched groundwater, although the majority of the treated water is now routed through the Wastewater Treatment Facility and then to an onsite subsurface irrigation system. The system treats approximately 7.5 million gallons of water per month.

Recommended Corrective Measures

The results of the risk assessment identified constituents of concern requiring further corrective measures and/or controls in some soils and perched groundwater. Therefore, Pantex Plant's remedial action objectives are:

- Prevent exposure to untreated perched groundwater onsite and offsite.
- Reduce movement of impacted perched groundwater toward the southeast.
- Increase effectiveness of perched groundwater and Ogallala Aquifer monitoring.

Additionally, Pantex Plant is also actively considering several additional corrective measures that include:

- Continue controlling exposure to onsite workers through proper personal protective equipment, restricted access, and deed restrictions.
- Continue operating the pump and treat system for 30 years but without injection of treated water.
- Installing additional perched groundwater extraction wells and adding field-scale *in situ* bioremediation and a permeable reactive barrier to help reduce constituent concentrations in perched groundwater to the southeast.
- Restricting the use of perched groundwater onsite and offsite through deed restrictions and other institutional controls.

These measures will continue Pantex Plant's mission of protecting people and the environment through responsive cleanup actions and innovative technology, and will ensure potential future impacts to the Ogallala Aquifer are mitigated and exposures prevented.

Preferred corrective measure will be described in the Proposed Plan, which will be issued for public review and comment according to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and the National Oil and Hazardous Substance Pollution Contingency Plan.

Additional Reading Material

BWXT Pantex/SAIC, 2003. ***Revised Final Baseline Risk Assessment Work Plan.*** Completed for the USDOE/NNSA, Pantex Site Office, Amarillo, Texas.

BWXT Pantex, 2004a. Final Pantex Plant Radiological Investigation Report. Completed for USDOE/NNSA, Pantex Site Office, Amarillo, Texas. January 2004.

BWXT Pantex, 2004b. ***Subsurface Modeling Report.*** Submitted for the USDOE/NNSA, Pantex Plant, Amarillo, Texas. September 2003.

BWXT Pantex, 2006a. ***Burning Ground Human Health Risk Assessment Report.*** Completed for USDOE/NNSA, Pantex Plant, Amarillo, Texas. May 2006.

BWXT Pantex, 2006b. ***Nuclear Weapons Accident Residue Storage Unit (NWAR) Human Health Risk Assessment Report.*** Completed for USDOE/NNSA, Pantex Plant, Amarillo, Texas. August 2006.

BWXT Pantex, 2006c. ***Baseline Human Health Risk Assessment Report for Zones 10, 11, and 12, Fire Training Area, Ditches and Playas, Independent Sites, and Groundwater.*** Completed for USDOE/NNSA, Pantex Plant, Amarillo, Texas. December 2006.

BWXT Pantex, 2007. ***Firing Site 5 Human Health Risk Assessment Report.*** Completed for USDOE/NNSA, Pantex Plant, Amarillo, Texas. May 2007.

Stoller, 1998. ***Final RCRA Facility Investigation Report/Interim Corrective Measure Addendum Report, Pantex Plant AL-PX-8, Ditches and Playas.*** ADS1216. Volumes 1 and 2, April 1998.

Stoller, 1999. ***RCRA Facility Investigation Report for Group II Landfills.*** Pantex Plant, Amarillo, Texas.

Stoller, 2002a. ***Burning Ground Waste Management Group, Final RCRA Facility Investigation Report.*** Pantex Plant, Amarillo, Texas. March 15, 2002.

Stoller, 2002b. ***Draft of the Final Group III Landfills RFIR.*** Prepared for the USDOE and BWXT Pantex Plant, Amarillo, TX. September 30, 2002.

Stoller, 2002c. ***Final FTA RCRA Facility Investigation Report.*** Prepared for the USDOE and BWXT Pantex Plant, Amarillo, TX.

Stoller, 2003a. ***Final Ditches and Playas RCRA Facility Investigation Report.*** Prepared for BWXT Pantex, LLC, Amarillo, Texas. September 2003.

Stoller, 2003b. ***Final Zone 10 RCRA Facility Investigation Report.*** Prepared for BWXT Pantex, LLC, Amarillo, Texas. Z10-003403, March 28, 2003.

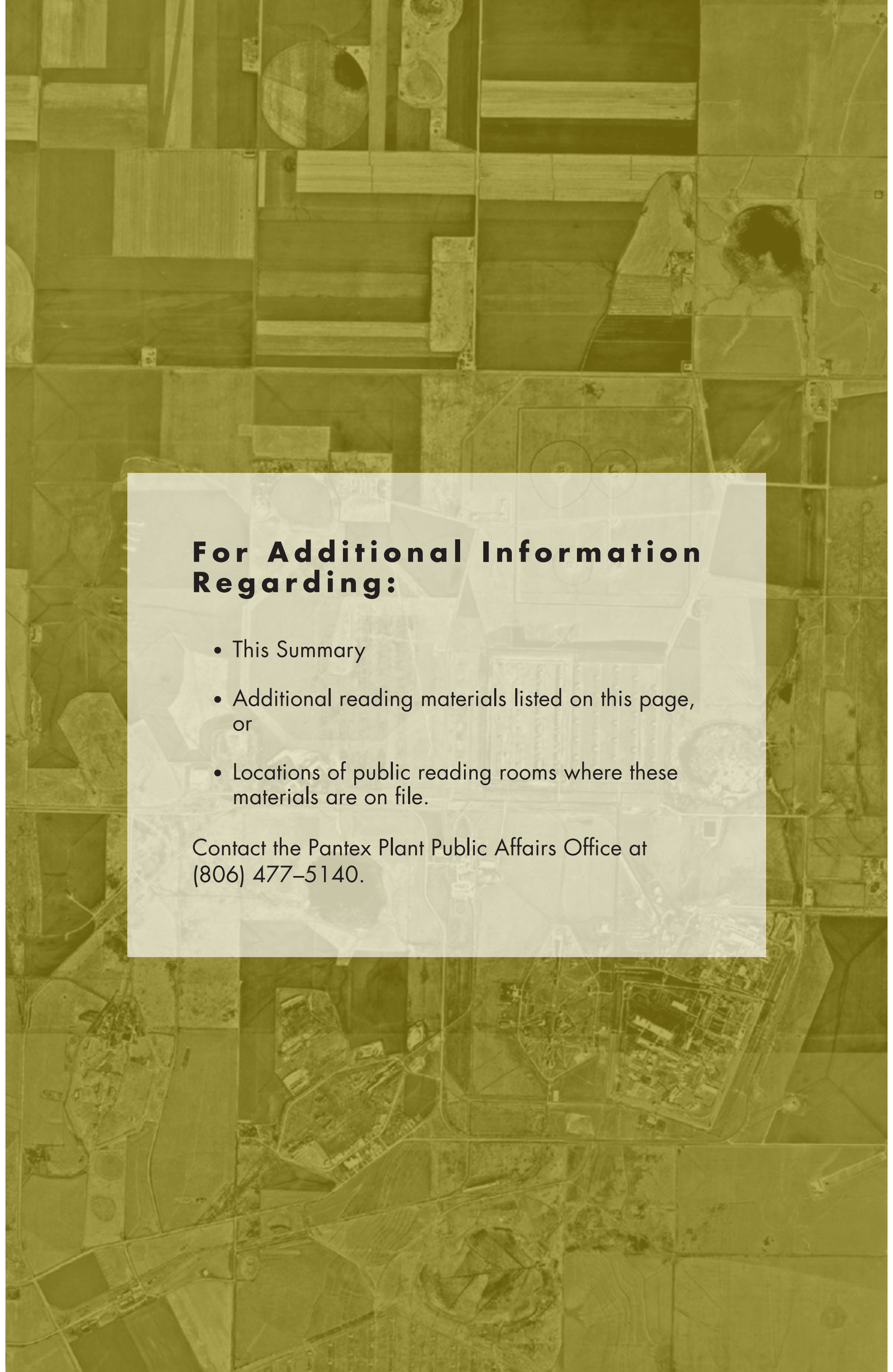
Stoller, 2003c. ***Final Zone 11 RCRA Facility Investigation Report.*** Prepared for BWXT Pantex, LLC, Amarillo, Texas. January 2003.

Stoller, 2003d. ***Final Zone 12 RCRA Facility Investigation Report.*** Prepared for BWXT Pantex, LLC, Amarillo, Texas. September 5, 2003.

Stoller, 2003e. ***Final Ditches and Playas RCRA Facility Investigation Report.*** Prepared for BWXT Pantex, LLC, Amarillo, Texas. September 2003.

Stoller, 2004a. ***Final Independent Sites RCRA Facility Investigation Report.*** Prepared for Pantex Plant, Amarillo, Texas. January 30, 2004.

Stoller, 2004b. ***Groundwater RCRA Facility Investigation Report.*** Prepared for Pantex Plant, Amarillo, Texas. March 15, 2004.



For Additional Information Regarding:

- This Summary
- Additional reading materials listed on this page, or
- Locations of public reading rooms where these materials are on file.

Contact the Pantex Plant Public Affairs Office at (806) 477–5140.

Glossary

Key Terminology

Constituent of concern – A chemical or radionuclide requiring further corrective measures and/or controls.

Constituent of potential concern – A chemical or radionuclide that was added to the environment and requires further evaluation in the risk assessment.

Depleted uranium – Contains greater than 99 percent uranium-238 because the more radioactive isotopes (^{235}U and ^{234}U) have been removed from natural uranium. Depleted uranium is about 40 percent less radioactive than natural uranium.

Environmental stewardship – Long-term commitment to ensure that appropriate investigation, cleanup, and monitoring of chemical and radionuclide releases is conducted to protect human health and the environment.

Flow divide – A ridge that forms at the top of a saturated zone such that groundwater on one side of the divide flows in one direction and groundwater on the other side of the divide flows in another direction.

Focused recharge – Seepage of surface water from a surface water body such as a lake or playa to the groundwater.

Perched groundwater – Groundwater that has mounded on top of a layer of fine-grained (“tight”) soil.

Playa – Natural depressions that are typically round, and capture runoff from the surrounding grasslands in the Texas Panhandle. The playas are usually dry during most portions of the year.

Radionuclide – An atom with an unstable nucleus (for example, uranium-238). Radionuclides occur naturally, but can also be artificially produced.

Saturated zone – A region of soil where all of the air spaces are filled with water.

Semivolatile organic compound – Compounds that evaporate slowly (for example, some PAHs such as naphthalene)

Vadose zone – A region of soil where the air spaces are not entirely filled with water.

Volatile organic compound – Compounds that readily evaporate (for example, solvents such as TCE).

Target risk levels – Risk levels that regulatory agencies such as TCEQ and USEPA consider acceptable.

Acronyms

95% UCL	95 percent upper confidence limit
BHHRA	Baseline Human Health Risk Assessment
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
COPCs	constituents of potential concern
FTA	Fire Training Area
FS-5	Firing Site 5
HMX	high melting explosive (cyclo-tetramethylene-tetranitramine)
NAPL	nonaqueous-phase liquid
NNSA	National Nuclear Security Administration
NWAR	Nuclear Weapon Accident Residue
OSTP	Old Sewage Treatment Plant
PAHs	polyaromatic hydrocarbons
PCBs	polychlorinated biphenyls
RDX	research development explosive (1,3,5-trinitro-1,3,5-triazine)
SVE	soil vapor extraction
SVS	supplemental verification site
SWMU	Solid Waste Management Unit
TCE	trichloroethene
TCEQ	Texas Commission on Environmental Quality
TNT	2,4,6-trinitrotoluene
TTU	Texas Tech University
USDOE	U.S. Department of Energy
USEPA	U.S. Environmental Protection Agency

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