For Calendar Year 2022

Annual Site Environmental Report

Pantex Plant

CNS | consolidated nuclear security, llc
PANTEX PLANT | Y-12 NATIONAL SECURITY COMPLEX

NNSA
National Nuclear Security Administration

CNS | consolidated nuclear security, llc
PANTEX PLANT | Y-12 NATIONAL SECURITY COMPLEX

It is the CNS environmental policy to protect the environment, prevent pollution, comply with applicable requirements, and continually take actions to conserve and improve our natural environment within which we perform our missions. The CNS Environmental Management System:

- Implements appropriate controls and actions to minimize environmental impacts caused by our activities, products, and services;
- Seeks continual improvement in protection of the environment through sustainability, pollution prevention/source reduction, recycling/reuse, and housekeeping excellence;
- Advances strict compliance with relevant environmental laws, regulations and other requirements;
- Provides the framework for setting and reviewing environmental objectives and targets; and
- Documents conformance to each element of the International Organization for Standardization (ISO), *Environmental Management Systems – Requirements with Guidance for Use (ISO 14001)*.

Richard J. Tighe
Chief Executive Officer

On the cover: An American Avocet grasping its prey at Pantex Lake; the frog promptly escaped.

Site Environmental Report
Pantex Plant 2022

September 2023

Prepared for
U.S. Department of Energy/National Nuclear Security Administration Production Office

Prepared by
Environmental Compliance Department
Waste Operations Department
and the Environmental Projects Department

Consolidated Nuclear Security, LLC (Pantex)
Amarillo, Texas 79120-0020

https://pantex.energy.gov

Acknowledgments

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The results presented in this report are from samples collected by the Environment, Safety, and Health Division's Environmental Projects Department. Many other staff members in the environmental departments worked on validating data, conducting quality checks, and making the data available electronically. The 2022 *Annual Site Environmental Report* for Pantex was reviewed for classification issues and it was determined to be unclassified.

Help Us Make This Site Environmental Report More Useful for You!

We want this summary to be easy to read and useful. To help continue this effort, please take a few minutes to let us know if this annual report meets your needs. Please print out this page and mail or fax it:

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1. How do you use the information in this summary? Please circle.

To become more familiar with Pantex monitoring
To help me make a decision about moving to the Texas Panhandle
To send to others outside the Texas Panhandle
To prepare for public meetings
Other (please explain)

2. What parts of the summary do you use? Please circle.

Pantex overview/mission
Site management
Environmental compliance
Environmental monitoring
Quality assurance
Regulatory oversight
Current issues and actions

3. Does this guide contain?

Enough detail Too much detail Too little detail

Comments:

4. If you could change this report to make it more readable and useful to you, what would you change?

What is your affiliation? Please circle.

Pantex contractor
State agency
Public interest group
Member of Native American Nation
University
Other Comments:

DOE
Federal agency
Member of the public
Local government
Industry

Thank you!

Annual Site Environmental Report for Pantex Plant

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AEC	Atomic Energy Commission
ALARA	as low as reasonably achievable
AQMR	air quality management requirement
ASER	Annual Site Environmental Report
BCG	biota concentration guide
CAA	Clean Air Act
CCL	Contaminant Candidate List
CEQ	Council on Environmental Quality
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFE	carbon pollution-free electricity
CFR	Code of Federal Regulations
CNS	Consolidated Nuclear Security
CO	Carbon Monoxide
COC	Contaminants of Concern
CY	calendar year
DBP	disinfectant by-product
DCS	Derived Concentration Standard
DOE	U.S. Department of Energy
DOECAP	DOE Consolidated Audit Program
DOT	Department of Transportation
DQO	data quality objective
EA	Environmental Assessment
ECD	Environmental Compliance Department
EMS	environmental management system
EO	Executive Order
EPA	U.S. Environmental Protection Agency
FGZ	fine-grained zone
FM	farm-to-market road
FY	fiscal year
GHG	greenhouse gas
GPS	Global Positioning System
GWPS	Groundwater Protection Standard
HAP	hazardous air pollutant
HE	high explosive
IAEA	International Atomic Energy Agency
IAG	interagency agreement
ICRP	International Commission on Radiological Protection
ISB	in-situ bioremediation
ISO	International Organization for Standardization
IWQP	inland water quality parameter
JCDC	John C. Drummond Center
LTM	long-term monitoring
M&E	material and equipment
MBTA	Migratory Bird Treaty Act
MCL	maximum contaminant level
MDA	minimum detection activity
MDL	method detection limit
MEI	maximally exposed individual

MRaD	Multimedia Radiochemistry
MSGP	Multi-Sector General Permit
NAPL	non-aqueous phase liquid
NCRP	National Council on Radiation and Protection Measures
NEPA	National Environmental Policy Act
NHPA	National Historic Preservation Act
NNSA	National Nuclear Security Administration
NPO	National Nuclear Security Administration Production Office
NRF	NEPA Review Form
NWS	National Weather Service
O&M	operation and maintenance
OSSF	on-site sewage facility
P1PTS	Playa 1 Pump-and-Treat System
P2	pollution prevention
PA/CRMP	Programmatic Agreement/Cultural Resources Management Plan
PBR	Permits by Rule
PCB	polychlorinated biphenyl
PE	performance evaluation
PFAS	per- and polyfluoroalkyl substances
PQL	practical quantitation limit
PREP	Pantex Renewable Energy Project
PST	petroleum storage tank
PTE	potential-to-emit
PWS	Public Water System
QA	quality assurance
QC	quality control
RAO	remedial action objective
RCRA	Resource Conservation and Recovery Act
RDX	Royal Demolition Explosive
RER	replicate error ratio
ROD	Record of Decision
SAP	Sampling and Analysis Plan
SARA	Superfund Amendments and Reauthorization Act
SDWA	Safe Drinking Water Act
SEPTS	Southeast Pump-and-Treat System
SHPO	State Historic Preservation Office
SME	subject matter expert
SMP	Site Management Plan
SOW	Statement of Work
SPD	Sustainability Performance Division
SSP	Site Sustainability Plan
SVE	soil vapor extraction
SWEIS	Site-Wide Environmental Impact Statement
SWMU	solid waste management unit
TAC	Texas Administrative Code
TCEQ	Texas Commission on Environmental Quality
TDSHS	Texas Department of State Health Services
TTHM	Total Trihalomethanes
TLAP	Texas Land Application Permit
TLD	thermoluminescent dosimeter
TPDES	Texas Pollutant Discharge Elimination System

TPH	total petroleum hydrocarbon
TPW	Texas Parks and Wildlife
TPWD	Texas Parks and Wildlife Department
TPY	tons per year
TSCA	Toxic Substances Control Act
TSS	total suspended solids
TTU	Texas Tech University
UIC	underground injection control
U.S.	United States
USACE	U.S. Army Corps of Engineers
USC	U.S. Code
USFWS	U.S. Fish and Wildlife Services
VOC	volatile organic compound
VMF	Vehicle Maintenance Facility
WWII	World War II
WWTF	wastewater treatment facility
WWWRC	Wild West Wildlife Rehabilitation Center
Y-12	Y-12 National Security Complex

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EXECUTIVE SUMMARY

The Pantex Plant (Pantex) is the nation's primary nuclear weapons manufacturing facility. The U.S. Department of Energy (DOE) through the NNSA Production Office (NPO) oversees Pantex operations. Consolidated Nuclear Security, LLC (CNS) is the managing and operating contractor of the Pantex under Contract No. DE-NA0001942. Like all manufacturing facilities, the Pantex has the potential to release a variety of contaminants through its primary and supporting operations. CNS manages the environmental aspects of these operations in a manner consistent with integrated safety management, applicable environmental regulations, and best management practices.

PURPOSE

The *2022 Annual Site Environmental Report* (ASER) summarizes Pantex's status, data, and efforts for the environmental compliance, protection, and restoration programs. It has been prepared in accordance with DOE O 231.1B, *Environment, Safety and Health Reporting*, and DOE O 458.1, *Radiation Protection of the Public and the Environment*. These orders outline the requirements for environmental protection programs at DOE facilities to ensure that programs fully comply with applicable federal, state, and local environmental laws and regulations, executive orders, and DOE policies.

MAJOR SITE PROGRAMS

The Pantex Plant site encompasses approximately 17,129 acres, with most operations conducted on approximately 2,000 acres of land. As the nation's primary nuclear weapons manufacturing facility, it assembles, dismantles, modifies, and maintains the nation's stockpile of nuclear weapons. Pantex also supports the weapons stockpile through the development, testing, and fabrication of high explosives components. In addition, Pantex maintains its own steam-generating plant, drinking water treatment plant, and wastewater treatment plant. All work at Pantex is conducted under three overarching priorities: the safety and health of workers and the public, the security of weapons and information, and the protection of the environment.

ENVIRONMENTAL MANAGEMENT AND MONITORING

The CNS environmental policy defines a comprehensive environmental management system (EMS) that focuses on protecting the environment, preventing pollution, strict compliance with all regulatory requirements, and continual improvement, supported by environmental monitoring conducted by Pantex and the State of Texas, program audits, and stakeholder input.

Data obtained from various monitoring programs in past years are summarized in previous ASERs. Those reports are available in the DOE Information Repositories at the Amarillo Public Library Downtown Branch, in Amarillo, Texas and at the Carson County Library in Panhandle, Texas. The monitoring data, as well as the ASERs since 2011, are available on Pantex website at http://pantex.energy.gov. Copies of previous years of Pantex ASER can be acquired by contacting Pantex Communications at public_communications@cns.doe.gov.

The purpose of the environmental monitoring component of Pantex's EMS is to provide indicators of the potential impact to human health and the environment and to demonstrate compliance with applicable regulatory limits. The environmental monitoring program monitors air, groundwater, drinking water, surface water, wastewater, soil, vegetation, and fauna. Pantex also operates a meteorological monitoring program that supports several of these requirements. Samples for 2022 were routinely collected at diverse locations, and 20,119 analyses were performed for substances including explosives, metals, organic chemicals, inorganic chemicals, radionuclides, and water quality indicators.

Pantex EMS provides the foundation to administer sound stewardship practices that protect natural and cultural resources while cost-effectively demonstrating compliance with environmental, public health and

resource protection laws, regulations, and DOE requirements. Notable accomplishments in 2022 relating to the Pantex EMS are listed below.

- Continued promotion of sustainable acquisition and procurement to the maximum extent practicable, ensuring bio-preferred and bio-based provisions and clauses are included in 95 percent of applicable contracts.
- The Sustainable Acquisition team received the DOE Green Buy Award in 2022 for Pantex's efforts leading to purchasing six Priority Products in four different categories. This is the third time Pantex was recognized for achieving the Silver Level for demonstrating excellence in Sustainable Acquisition. Approximately 95 percent of all electronics procured have met criteria for being environmentally sustainable, for which Pantex won the Electronic Product Environmental Assessment Tool Purchaser Award in 2022.
- Diversion of approximately 43 percent of municipal solid waste, and approximately 86.2 percent construction and demolition material/debris originally from landfills to alternate pathways for beneficial reuse.
- Achievement of sufficient energy savings that enable meeting clean and renewable electric energy targets and being able to transfer enough renewable energy credits to Y-12 National Security Complex to meet its sustainability goal.

As required by DOE O 436.1, *Departmental Sustainability*, Pantex EMS is audited every three years to determine the level of conformance with the *ISO 14001 Environmental Management Systems – Requirements with Guidance for Use*. The last audit conducted at Pantex was during fiscal year (FY) 2022, and was performed by a qualified party outside the control or scope of Pantex EMS program. The outcome of the audit indicated that Pantex continues to implement an EMS program that conforms to ISO 14001 standards. The next validation audit is scheduled to be performed in FY 2025.

Radiation Dose

In 2022, the calculated annual radiation dose from releases to the atmosphere generated by Pantex operations was 2.20E-04 mrem/yr for a hypothetical, maximally exposed member of the public (Table ES.1.). This annual dose continues to be several orders of magnitude below the U.S. Environmental Protection Agency's (EPA's) standard for the air pathway of 10 mrem/yr above background and is consistent with those of previous years. No unplanned radionuclide releases occurred at Pantex in 2022. The ambient air-monitoring results for 2022 were generally similar to those from previous years. All results were below the applicable DOE Derived Concentration Standard. Fig. ES.1. provides a comparison of radiation doses from multiple exposure categories.

Table ES.1. Pantex Radiation Dose for 2022 Compared to Regulatory Dosage Allowances

Pantex Radiation Dose (mrem)	EPA Standard Air Pathway (mrem)	DOE Standard All Pathways (mrem)
2.20E-04	10	100

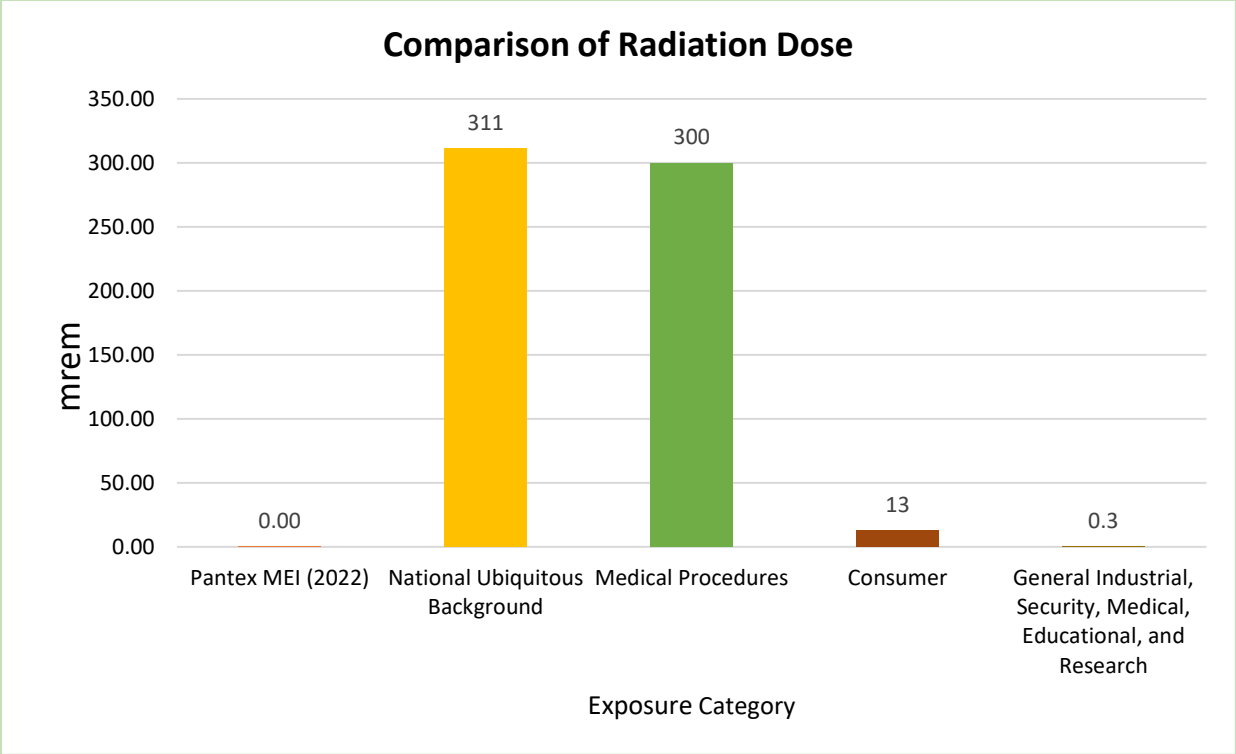

Fig. ES.1. Comparison of Radiation Dose

Drinking Water Monitoring

Results from routine drinking water compliance monitoring in 2022 confirmed that the drinking water system at Pantex met water quality regulatory requirements. All analytical results for bacteria, chemical compounds, and disinfection by-products were below regulatory limits, and adequate levels of disinfectant were maintained in the distribution system. The Pantex Public Water System was last inspected by the Texas Commission on Environmental Quality (TCEQ) in November 2021 with no compliance issues noted and continues to be recognized by the TCEQ as a "Superior" supply system, the highest rating assigned by the state.

Wastewater Monitoring

During 2022, Pantex discharged approximately 93 million gallons of treated wastewater to the on-site playa lake. Major repairs to the on-site subsurface irrigation system were completed in 2021 and additional repairs are continuing. These repairs will support beneficial reuse of wastewater through this subsurface irrigation system.

Pantex had two overflows of untreated wastewater from the sanitary sewer system. The TCEQ was notified and both instances were remediated as required.

Storm Water Monitoring

Sampling of storm water runoff from industrial areas at Pantex was conducted in accordance with Texas Pollutant Discharge Elimination System Multi-Sector General Permit No. TXR050000. Monitoring conducted during 2022 was consistent with past monitoring results. All sample results were within effluent limitations established by the general permit.

Environmental surveillance monitoring was conducted at the playas as a best management practice. Results obtained during 2022 were similar to past monitoring results. The playa data continues to support the position that operations at Pantex are not negatively affecting the water quality of the playas.

Soil Monitoring

Results of soil monitoring conducted at Pantex Burning Ground in 2022 were within established background comparison values. Results of soil monitoring conducted at the subsurface irrigation sites were consistent with previous years' results.

Flora and Fauna Monitoring

Flora and fauna surveillance is complementary to air, soil, and water monitoring in assessing potential short- and long-term effects of operations at Pantex on the environment. Animals at Pantex were sampled to determine whether Pantex activities had an impact on them. Black-tailed prairie dogs and cottontail rabbits were the species selected for sampling because they interact with both primary (air, water) and secondary (vegetation) environmental media also being analyzed. All analyses of black-tailed prairie dogs and cottontail rabbits were below minimum detection activity. Native vegetation and crops were sampled and results were consistent with results from previous years and at control locations.

Quality Assurance

Due to its unique mission and service to the country, Pantex must strive to become a High Reliability Organization. High reliability includes robust quality assurance (QA) that ensures all environmental monitoring data provides definitive evidence of regulatory compliance and protection of human health and the environment. The complexity of analytical chemistry and radiochemistry performed to support environmental monitoring programs necessitates that Pantex maintain an unparalleled QA and Quality Control (QC) Program that meets the need for high reliability.

Environmental Remediation

Historical waste management practices at Pantex resulted in impacts to on-site soil and perched groundwater. High explosives, solvents, and metals were found in the soil in the main operational areas, the Burning Ground, and in the perched groundwater beneath Pantex. Groundwater data collected in 2022 demonstrated that current remedial actions continue to progress toward cleanup of perched groundwater contaminants and that drinking water resources are safe. One well in the drinking water aquifer was found to have a constituent above the cleanup standards established for Pantex Remedial Action. The well is distant from water resources, and other monitor wells indicate there is no concern for nearby drinking water resources or irrigation use in the area. Pantex is planning to begin installation of more wells to verify whether a plume is developing in the drinking water aquifer.

Pantex has completed investigations and soil cleanup of all solid waste management units, with the exception of units that remain in an active status. This allowed Pantex to transition to long-term stewardship in 2009. A *Record of Decision for Groundwater, Soil, and Associated Media* was issued by the EPA in September 2008 that described the final remedial actions for all investigated units (Pantex Plant and Sapere Consulting 2008).

As part of the transition to long-term stewardship, Pantex operated and maintained the groundwater remediation systems, monitored the systems to determine effectiveness of the remedy, and maintained the soil remedies. Pantex installed two types of perched groundwater remediation systems: four in-situ bioremediation and two pump-and-treat systems. Monitoring results indicate that the groundwater systems are effectively treating contamination and reducing saturated thickness in the perched aquifer as designed. The systems will continue to be monitored to determine the effectiveness of the remedy and to determine if changes to the systems will be required over time to ensure the continued success of remedial actions. Soil remedies were also inspected, maintained, or scheduled for maintenance during 2022. The soil vapor

extraction system located at the Burning Ground continued to operate during 2022 and extracted approximately 58 pounds of volatile organic compounds. Based on data collected through 2022, the soil vapor extraction has met cleanup objectives and will be requested for shutdown in 2023.

Pollution Prevention

Efforts to reduce and eliminate waste from routine operations at Pantex have resulted in significant waste reductions over the past 30 years. The reduction of waste is even more important considering Pantex population and workload has increased as waste amounts have decreased. During 2022, Pantex successfully recycled over 4.6 million pounds of materials including over 69,000 pounds of electronics.

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CHAPTER 1 - INTRODUCTION

Pantex Plant site, consisting of 17,129 acres (ac), is located 17 miles (mi) northeast of Amarillo, Texas, in Carson County. Pantex was a World War II munitions factory and was converted to a nuclear weapons assembly facility in 1951. Today, it is the nation's primary assembly/disassembly facility supporting the nuclear weapons arsenal. Included within this chapter are brief discussions of Pantex location, history and mission, and facility description, followed by the climate, geology, hydrology, seismology, land use, and population of the area around Pantex.

1.1 SITE LOCATION AND ENVIRONMENTAL SETTING

Pantex Plant site is located in Carson County in the Texas Panhandle, north of United States (U.S.) Highway 60, approximately 17 mi northeast of downtown Amarillo (Fig. 1.1). The area is part of the Llano Estacado (staked plains) portion of the Southern Great Plains, and sits at an elevation of approximately 3,500 feet (ft). The topography is relatively flat, characterized by rolling grassy plains and numerous natural playa basins. The term "playa" is used to describe ephemeral shallow lakes, mostly less than 0.6 mi in diameter. The region is semi-arid and primarily agricultural; however, several industrial facilities are located near Pantex.

Pantex is centered on a site that is approximately 17,129 ac. The site consists of land owned and leased by the U.S. Department of Energy (DOE). The DOE owns 11,329 ac of the site, including the following:

- 8,726 ac - Pantex area,
- 1,526 ac - Four tracts east of Farm-to-Market (FM) 2373 near Pantex area, and
- 1,077 ac - Pantex Lake, located approximately 2.5 mi northeast of Pantex area.

There are no government industrial operations conducted at the Pantex Lake property. The remaining 5,800 ac are located south of the main Pantex area and are leased from Texas Tech University (TTU) for a safety and security buffer zone.

1.2 FACILITY HISTORY AND MISSION

Pantex is a government-owned, contractor-operated facility. DOE oversees the operation of Pantex through the NNSA Production Office (NPO). At the end of 2022, approximately 6,119 persons (including Pantex contracted employees, federal employees, and subcontracted employees) were employed at Pantex. Mason & Hanger Corporation was the operations and maintenance (O&M) contractor of Pantex from 1956 through May 1999 when the contractor became a subsidiary of Day & Zimmermann, Inc. Mason & Hanger Corporation (Day & Zimmermann, Inc.) was replaced as contractor by BWX Technologies, LLC on February 1, 2001. BWXT Pantex combined elements of BWXT Technologies, Honeywell, and Bechtel. Effective in January 2008, the name of the company was officially changed to Babcock & Wilcox Technical Services, LLC. On July 1, 2014, Consolidated Nuclear Security, LLC (CNS) became the O&M contractor of Pantex.

From 1942 to 1945, the U.S. used the Pantex Ordnance Plant for loading conventional artillery shells and bombs. In 1951, the Atomic Energy Commission (AEC) arranged to begin rehabilitating portions of the original Pantex and constructing new facilities for nuclear weapons operations. In 1974, the Energy Research and Development Administration replaced the AEC and took responsibility for the operation of Pantex, and in 1977, the Energy Research and Development Administration was replaced by the DOE. In 2000, the DOE created and designated the National Nuclear Security Administration (NNSA) to manage the nuclear weapons facilities and laboratories.

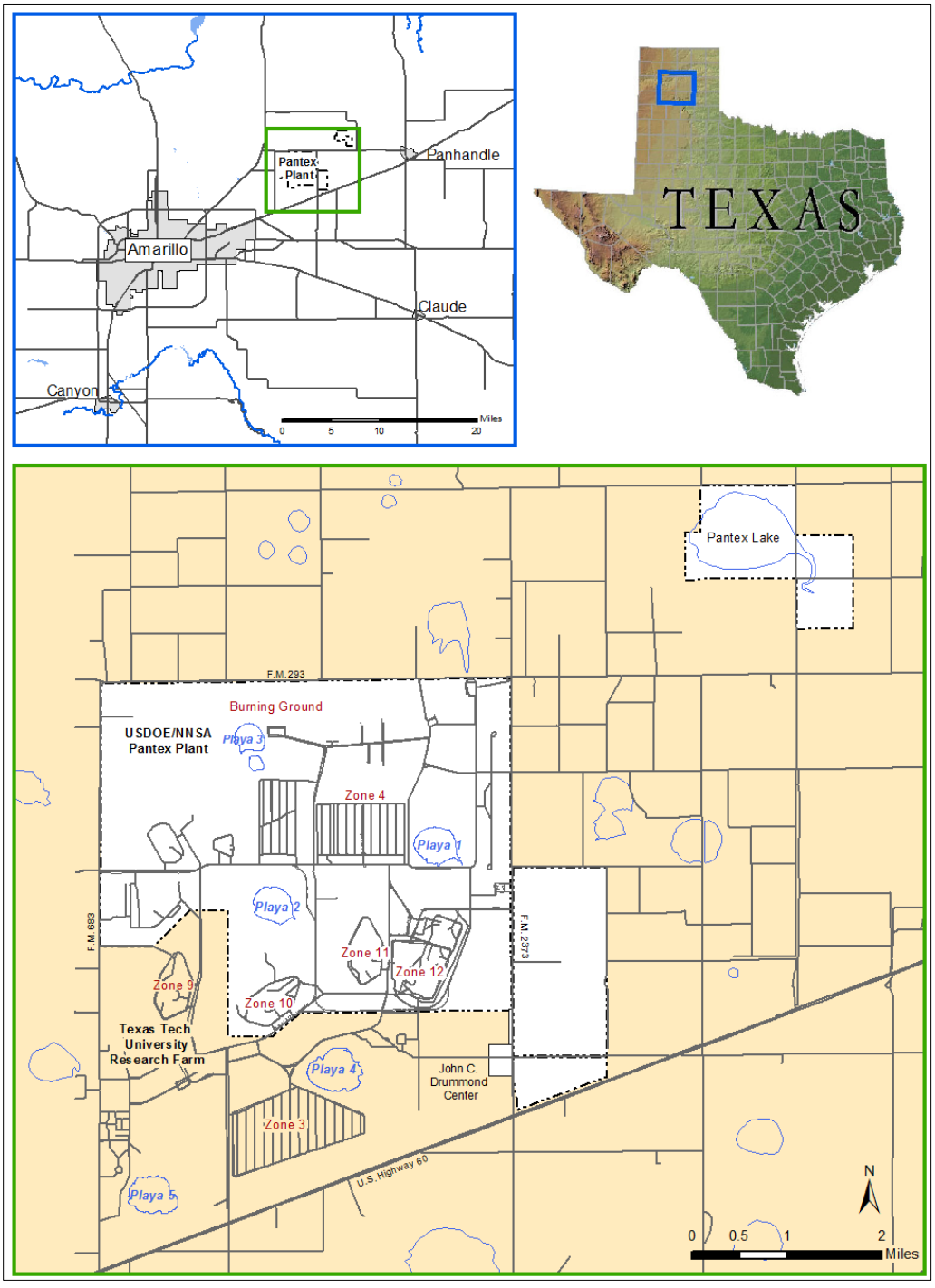

Fig. 1.1. Pantex Site Location and Zones

The primary missions of Pantex are as follows:

- Provide a nuclear deterrent for the nation and allies as the nation's primary site for assembly, modification, and disassembly of nuclear weapons for the nation's stockpile.
- Ensure the stockpile is strong and viable by evaluating, repairing, and retrofitting the nuclear weapons in the stockpile.
- Reduce the total nuclear weapons in the stockpile through the dismantling of retired weapons and dispositions of various components and materials.
- Support the stockpile as the High Explosives Center of Excellence that develops, tests, and fabricates high explosive (HE) components for nuclear weapons and to support DOE initiatives.

Weapon assembly, disassembly, maintenance, and evaluation activities involve short-term handling (but not processing) of encapsulated tritium, uranium, and plutonium, as well as a variety of nonradioactive hazardous or toxic chemicals. In addition, environmental restoration of the facility is an integral part of the DOE environmental management's mission to clean up its sites.

1.3 FACILITY DESCRIPTION

Pantex is composed of several functional areas, commonly referred to as numbered zones (refer to the lower portion of Fig. 1.1). Included within the zones are a weapons assembly/disassembly area, a weapons staging area, an area for experimental explosives development, a drinking water treatment plant, a sanitary wastewater treatment facility (WWTF), a vehicle maintenance facility, and administrative areas. Other functional areas include a utilities area for steam and compressed air, an explosives test-firing facility, a Burning Ground for thermally processing (i.e., burning or flashing) explosive materials, pump-and-treat groundwater remediation facilities, several agricultural tracts which are irrigated via a subsurface fluid distribution system, and landfills. Overall, there are approximately 518 buildings at Pantex.

The weapons assembly/disassembly area covers approximately 200 ac and contains more than 100 buildings. In this area, nuclear weapons can be assembled from nuclear components, parts received from other DOE plants, chemical explosive components, and metal parts fabricated at Pantex. The weapons can also be disassembled in this area.

Zone 4 is used for general warehousing and temporary holding (or staging) of weapons and weapon components awaiting movement to another area for modification, repair, or disassembly; for shipment to other DOE facilities for reworking; for shipment to a facility for sanitization; or for shipment to the military. The warehouse area is also used for interim storage of plutonium components from disassembly operations.

The explosives development area consists of facilities for synthesizing, formulating, and characterizing experimental explosives. This zone is under construction to become Pantex Center of Excellence for HEs.

The explosives test-firing facility (commonly called "firing sites") includes several test-shot stands and small-quantity test-firing chambers for measuring detonation properties of explosive components. The firing sites also include support facilities for setting up test-shots, interpreting results, and sanitizing components.

The Burning Ground is used for processing explosives, explosive components, and explosives-contaminated materials and waste by means of controlled open burning and flashing.

The land disposal area, north of Zone 10, is divided into two landfill sites. One currently receives non-hazardous solid wastes, primarily construction debris. The other receives non-hazardous solid waste management unit debris. Before 1989, Pantex's domestic solid waste was sent to an on-site sanitary landfill for disposal. Since then, this waste has been processed to remove recyclable materials. The non-recyclable material is sent to an off-site landfill. Practices preclude disposal of hazardous materials in on-site landfills; therefore, hazardous materials are transported off-site for disposal in accordance with applicable regulations.

Wastewater generated at Pantex is routed through a wastewater collection system to a WWTF. On October 6, 2003, the Texas Commission on Environmental Quality (TCEQ) issued Pantex a Texas Land Application Permit (TLAP) that authorizes beneficial reuse of the treated wastewater for the purpose of agricultural irrigation via a subsurface fluid distribution system. Construction of the subsurface distribution system was completed prior to the end of 2004. During 2017, major filter leaks developed and use of the system was temporarily discontinued. Repairs were completed in 2021 so that the treated effluent from the WWTF and from the perched aquifer pump-and-treat systems will once again be beneficially reused through this subsurface irrigation system. Pantex is also authorized to discharge wastewater to an on-site playa lake pursuant to Texas water quality permit, WQ000229600 (Texas Commission on Environmental Quality 2020).

The drinking water system, common to many zones, consists of production wells, water treatment/pumping facilities, storage tanks, and associated distribution lines. This system also supplies water to the high-pressure fire protection system.

Land east of FM 2373 has not been assigned a formal zone designation; however, wind turbines for the generation of electrical power and associated support equipment have been installed for generation of renewable electricity. Center-pivot irrigation is under construction on this land to further support the beneficial reuse of treated wastewater for irrigation of agricultural crops.

1.4 CLIMATOLOGICAL DATA

The area's climate is classified as semi-arid. It is characterized by hot summers and relatively cold winters. It experiences large variations in daily temperatures, low relative humidity, and irregularly spaced moderate rainfall. According to the National Weather Service's website, the average annual precipitation is 19.71 inches (in.) (Department of Commerce 2016). Approximately 70 percent of the average annual rainfall occurs from April to September. This is considered growing season precipitation and is commonly associated with thunderstorm activity. The average annual snowfall is 17.9 in. (Department of Commerce 2016). Snow typically melts within a few days after it falls. Heavier snowfalls of 10 in or more, usually with near-blizzard conditions, average once every five years and with snow mass generally remaining less than two to three days. The estimated potential gross lake surface evaporation in the area is about 55 in (Bomar 1995) or 280 percent of the average annual precipitation.

The Amarillo area is subject to extreme and rapid temperature changes, especially during the fall and winter months when cold fronts from the northern Rocky Mountain and Plains states sweep across the area. Substantial temperature drops within a 12-hour period are common (Department of Commerce 2016).

Humidity averages are low, occasionally dropping below 20 percent in the spring. Low humidity moderates the effect of summer afternoon high temperatures and permits evaporative cooling systems to be very effective. Severe local storms are infrequent throughout the cool season, but occasional thunderstorms with large hail, lightning, and damaging wind occur during the warm season, especially during the spring. These storms are often accompanied by heavy rain, which can produce local flooding in low-lying areas.

Pantex is located in an area with a relatively high frequency of tornadoes, convective wind events, and hail. An average of 17 tornadoes occurred each year in the 20 counties of the Texas Panhandle and the adjacent three counties of the Oklahoma Panhandle during the period between 1950 and 2022 (Department of Commerce 2017). While the threat of tornadoes is real, tornado occurrences in Amarillo are generally rare. Tornadoes are most common from April to June. There was a total of six tornadoes reported in the Texas and Oklahoma Panhandles during 2022 (Department of Commerce 2017).

The frequencies of wind direction and wind speed during 2022 near Pantex, at the National Weather Service (NWS) Amarillo located approximately 13.2 mi SW of Pantex, are illustrated by the windrose in Fig. 1.2. The figure indicates that, as in most previous years, a large percentage (approximately 55 percent) of the winds blew from southerly directions.

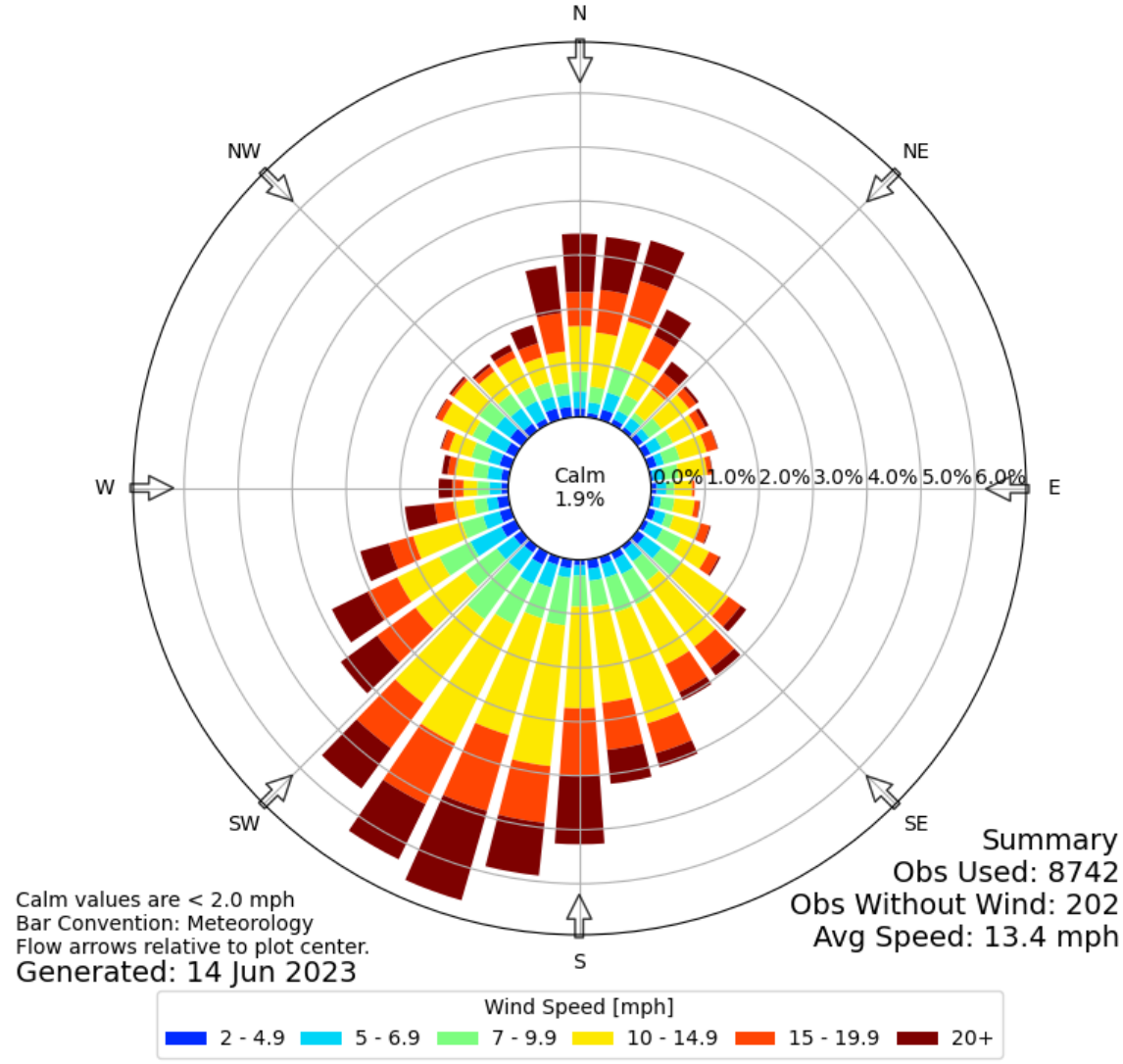

Fig. 1.2. Pantex Annual Windrose for 2022 (Iowa Environmental Mesonet)

Based upon monthly climatological data forms published by the NWS Forecast Office for Amarillo (located at Rick Husband International Airport), the mean temperature at the official NWS location during 2022 was 59.2 degrees Fahrenheit (°F), slightly above the normal annual mean temperature in Amarillo of 58.7°F. During 2022, the official NWS rain gauge recorded 16.43 in. of precipitation (Department of Commerce 2016). Table 1.1 is a compilation of climatological data [temperature, relative humidity, precipitation (including the water equivalent of any snowfall), and wind speed] for 2022 from Amarillo Airport NWS meteorological instrumentation. The range of mean monthly temperatures and the monthly precipitation totals as measured at the Amarillo Airport NWS site are shown in Figs. 1.3 and 1.4.

Table 1.1. Pantex 2022 Climatological Data by Month

Month	Temperature (°F)			Mean Relative Humidity (percent)	Precipitation[a] (inches)	Wind Speed (mph)	
	Maximum	Minimum	Mean Monthly			Mean	Maximum
January	73	7	37.6	58.5	0.34	12.8	29.5
February	76	0	36.1	60.6	0.14	13.6	31.3
March	87	16	48.5	53	1.51	14.4	38.2
April	93	31	60.2	44.9	0.01	16.5	40.6
May	104	37	69.8	67	1.4	16.3	34.3
June	106	51	78.1	57.9	2.25	14.8	40.7
July	108	63	83.8	61.5	4.4	11.4	37.9
August	98	58	77.9	54.7	1.54	9.6	30.8
September	94	52	74.2	46.8	1.57	12	23.3
October	86	34	59.5	45.7	2.8	10.4	28.3
November	77	14	43.6	42.9	0.33	13.5	29.5
December	74	-2	40.8	33.9	0.14	13.8	55.3
Annual			**59.2**	**52.28**	**16.43**	**13.3**	**55.3**

[a] Includes water equivalent of snowfall.

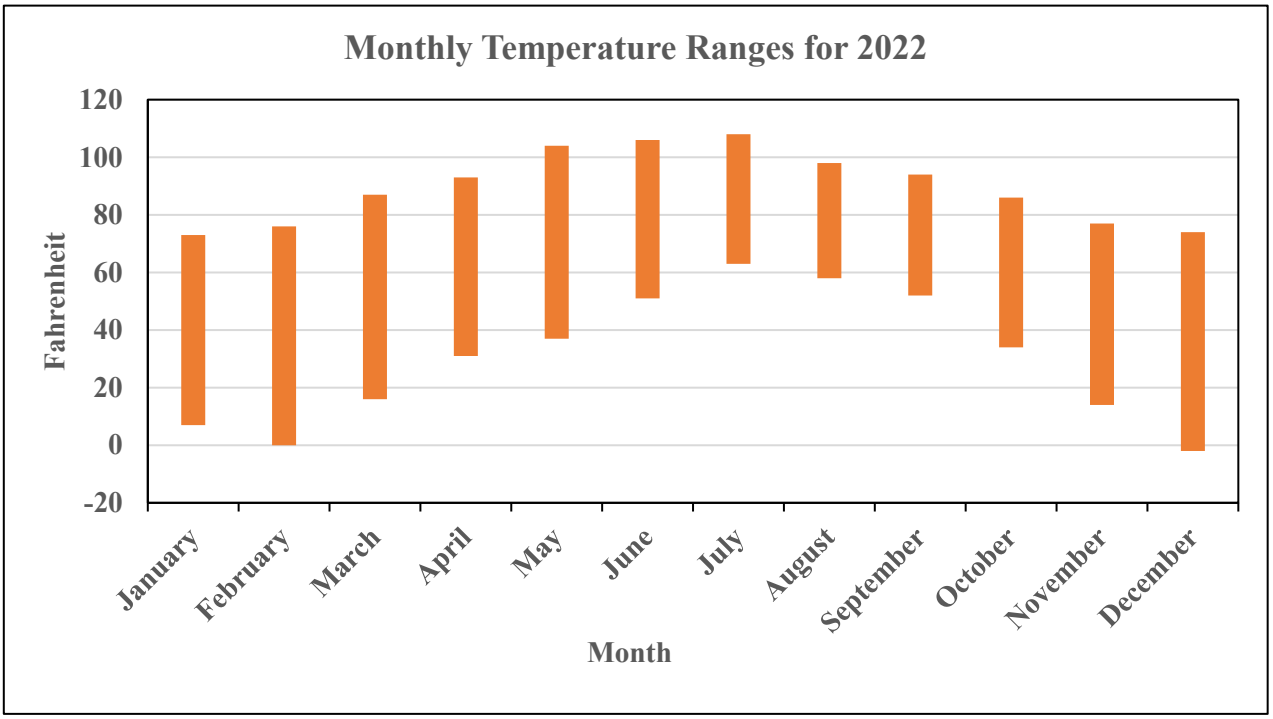

Fig. 1.3. Pantex Monthly Temperature Range During 2022

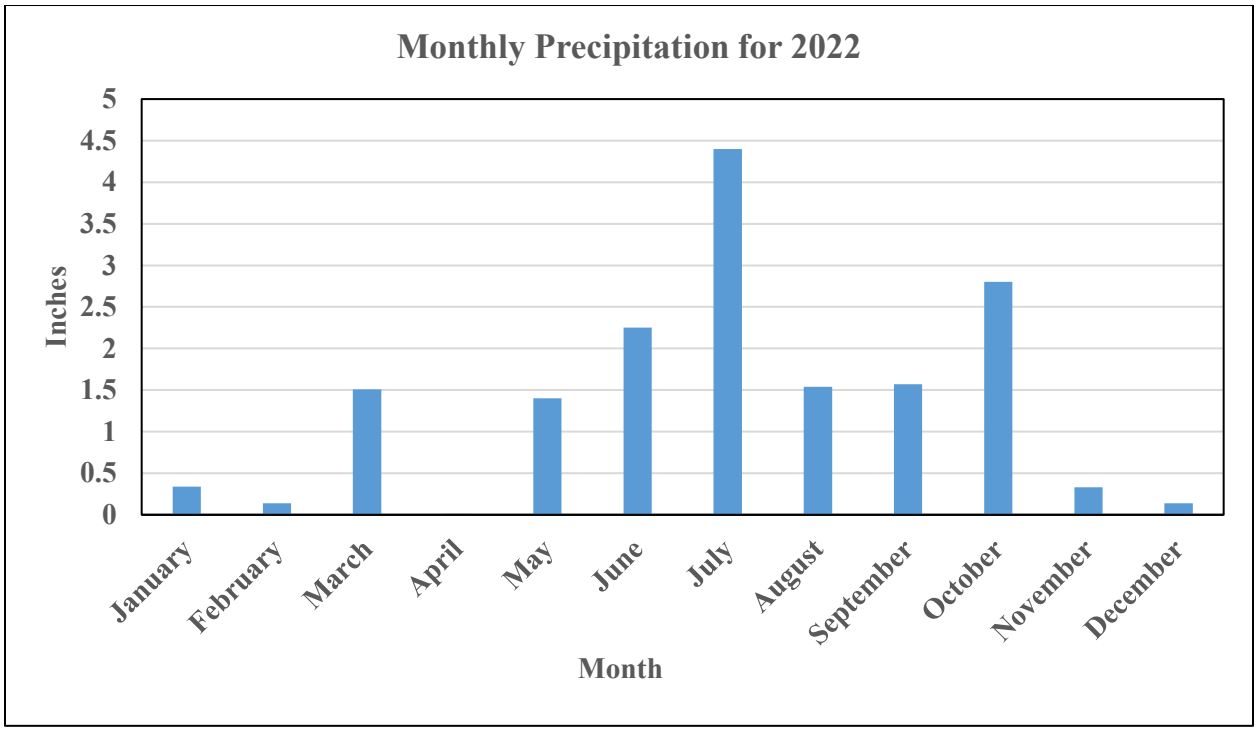

Fig. 1.4. Pantex Precipitation During 2022

Pantex maintains a meteorological monitoring station on the northeast corner of Pantex. The data from Pantex's meteorological tower are compared with those obtained from the Amarillo Airport NWS site, located approximately 10 mi to the west-southwest, to determine if the instrumentation is operating correctly. On a monthly basis, data outliers are identified and, when necessary, eliminated from the meteorological data set. The meteorological tower includes temperature/humidity sensors located at a height of 33 feet for plume modeling purposes. Pantex also has a Texas Tech West Texas MesoNet site, located just across from the John C. Drummond Center (JCDC) and FM 2373. Data from this site can be accessed at https://www.mesonet.ttu.edu/latest-obs. The MesoNet site has official meteorological instrumentation that includes a temperature/humidity sensor at five feet, which is the official height for the NWS. The NWS observes our MesoNet data and has deemed it as "meteorologically official" due to the standardized height of the instrumentation. Pantex added a second MesoNet site at the Texas Tech Research Farm, located half a mile north of the Killlgore Facility and along FM 683 in 2022; the site will be operational in 2023.

1.5 GEOLOGY

The primary surface deposits at Pantex are the Pullman and Randall soil series, which grade downward to the Blackwater Draw Formation. This formation consists of about 50 ft. of interbedded silty clays with caliche and very fine sands with caliche.

Underlying the Blackwater Draw Formation, the Ogallala Formation consists of interbedded sands, silts, clays, and gravels. The base of the Ogallala Formation is an irregular surface that represents the pre-Ogallala topography. As a result, depths to the base of the Ogallala vary. At Pantex, the vertical distance to the base of the Ogallala varies from 300 ft. at the southwest corner to 720 ft. at the northeast corner of the property (Purtymun and Becker, 1982). Underlying the Ogallala Formation is the Dockum Group, consisting of shale, clayey siltstone, and sandstone. Radon released from the underlying granitic rocks in the deep geology (>4,000 ft.) below Pantex has a major influence on the natural radiation environment.

1.6 HYDROLOGY

The closest riverine water feature on the Southern High Plains is the Canadian River approximately 17 mi north of Pantex, which flows southwest to northeast. Surface waters at Pantex do not drain into this system, but for the most part discharge into on-site playas. Storm water from agricultural areas at the periphery of Pantex drain into off-site playas. From the various playas, water either evaporates or infiltrates the soil. Two principal subsurface water-bearing units exist beneath Pantex and adjacent areas: the Ogallala Aquifer and the underlying Dockum Group Aquifer. The perched aquifer lies within the vadose, or unsaturated, zone above the Ogallala Aquifer. The vadose zone consists of as much as 500 ft. of sediment that lies between the land surface and the Ogallala Aquifer.

1.6.1 Perched Aquifer

The perched aquifer sits within the Ogallala Formation. It is present in the vadose zone, above the main zone of saturation, and is discontinuous. Perched aquifers form above clayey layers that have low permeability. Depths from the surface to the perched aquifer range from 209 to 279 ft. Data collected from wells at Pantex indicate that the zone of saturation in the perched aquifer varies in thickness by as much as 50 to 80 ft.

1.6.2 Ogallala Aquifer

The main Ogallala Aquifer lies beneath the perched aquifer. Depth to the main Ogallala Aquifer ranges from 335 to 500 ft. The saturated thickness varies from 39 to 400 ft. (Panhandle Groundwater Conservation District 1980). The aquifer is defined as the basal water-saturated portion of the Ogallala Formation, and is a principal water supply on the Southern High Plains. The regional gradient of the Ogallala Aquifer beneath Pantex trends from the southwest to the northeast, where the zone of saturation is thickest. Pantex's production wells are located in this northeast area. The City of Amarillo's Carson County Well Field is located north and northeast of Pantex's well field.

1.6.3 Dockum Group Aquifer

The Dockum Group Aquifer lies under the Ogallala Formation at Pantex. Water contained in sandstone layers within the Dockum Group supplies domestic and livestock wells south and southeast of Pantex. Other wells reaching the Dockum Group Aquifer are located 10 mi south and west of Pantex. The aquifer may be semi-confined with respect to the overlying Ogallala Aquifer because of lateral variations in the Ogallala and shale layers within the Dockum Group.

1.6.4 Water Use

The Canadian River flows into the man-made Lake Meredith approximately 25 mi north of Pantex. Many local communities use water from Lake Meredith for domestic purposes, when the water depth is sufficient. The major groundwater source near Pantex is the Ogallala Aquifer. It is used as a domestic source by numerous municipalities and industries in the High Plains. Historical groundwater withdrawals, and long-term pumping from the Ogallala Aquifer in Carson County and the surrounding eight-county area, have exceeded the natural recharge rate of the Ogallala Aquifer. These overdrafts have removed large volumes of groundwater from recoverable storage, and have caused substantial water-level declines.

The large demands of the Amarillo area, which are primarily agricultural, are responsible for the drop in the water table. From 1988 to 1997, the average change in “depth to water” from 1,209 Ogallala Aquifer observation wells in the Panhandle was 1.49 ft. Groundwater withdrawals from the Ogallala Aquifer in Carson County have averaged approximately 39 billion gallons (gal.) over the last several years. This groundwater withdrawal rate is more than 10 times greater than the estimated annual recharge rate of 358 million gal. Groundwater withdrawal rates are expected to decline each decade to approximately 21 billion gal. by 2060 (Crowell, 2007).

The City of Amarillo is the largest municipal user of Ogallala Aquifer water in the area. It pumps water for public use from the Carson County Well Field, located north and northeast of Pantex. Pantex obtains water from five wells in the northeast corner of the site. In 2022, Pantex pumped approximately 130 million gal of water from the Ogallala Aquifer. Most of the water used at Pantex is for domestic purposes. Through an agreement with TTU, Pantex provides water to the adjacent TTU research farm properties for domestic and livestock uses.

Pantex reviews emerging contaminants to potentially add to sampling lists when a contaminant could be of concern. Emerging contaminants have been detected in drinking water supplies around the U.S., and may pose a risk to the environment or human health; however, risk factors are not fully known. Per- and polyfluoroalkyl substances (PFAS) are a group of man-made chemicals that have been in use since the 1940s, and are (or have been) found in many consumer products like cookware, food packaging, and stain repellants. PFAS manufacturing and processing facilities, airports, and military installations that use firefighting foams are some of the main sources of PFAS (EPA/240/R-02/00). Pantex currently has contracts with two labs for PFAS analysis capabilities. Here at Pantex, development of regulations is being monitored, historical use of PFAS chemicals has been documented, and samples from our drinking water system have been analyzed by multiple external laboratories with the results indicating zero detections of PFAS.

1.7 SEISMOLOGY

Seismic events of low magnitude have occurred infrequently in the region. The stress conditions at the site are such that the possibility of high-order seismic events is extremely unlikely. A qualitative understanding of the present conditions at Pantex indicates that anticipated seismic activity is well below the level that is necessary to cause significant damage to structures at Pantex. The potential for local or regional earthquakes (with a magnitude great enough to damage structures at the site to the degree that hazardous materials would be released) is extremely low (McGrath, 1995).

1.8 LAND USE AND POPULATION

The land around Pantex is used mainly for winter wheat and grain sorghum farming, for ranching, and for drilling for oil and gas. Although dryland farming is dominant, some fields are irrigated from the Ogallala Aquifer or, less commonly, from local playas. Ranching in the region consists of cow-calf and yearling operations. The economy of the rural Panhandle region depends primarily on agriculture, but diversification has occurred in the more populated counties of the region to include manufacturing, distribution, food processing, and medical services. Nationally known businesses that are major employers in the greater Amarillo area include Bell Helicopter; Tyson Foods (a single rail beef-slaughtering operation); Pantex; Owens-Corning Fiberglass (a fiberglass reinforcement plant); American Smelting and Refinement Company (a large silver and copper refiner); and Cactus Feeders (one of the largest cattle-feeding operations in the world). Conoco-Phillips Petroleum and Xcel Energy are also major industrial presences in the Panhandle region.

A land-use census of the residential population surrounding Pantex showed that most of the population is located west-southwest of Pantex in the Amarillo metropolitan area. Population data from the 2020 census were used to generate Fig. 1.5 (U.S. Census Bureau 2022), showing the population distribution at 5-mi intervals within 50 mi of Pantex. According to the 2020 census, the total population within 50 mi of Pantex is 332,688 people.

The total population of the 20-county area (defined as the Texas Panhandle) surrounding Pantex is 398,904. The population of the City of Amarillo (200,904 in 2020) represents approximately 49 percent of the counties' population. Approximately 32 percent of the population lives in other incorporated cities, and approximately 19 percent reside in unincorporated areas. The communities of Pampa, Borger, Hereford,

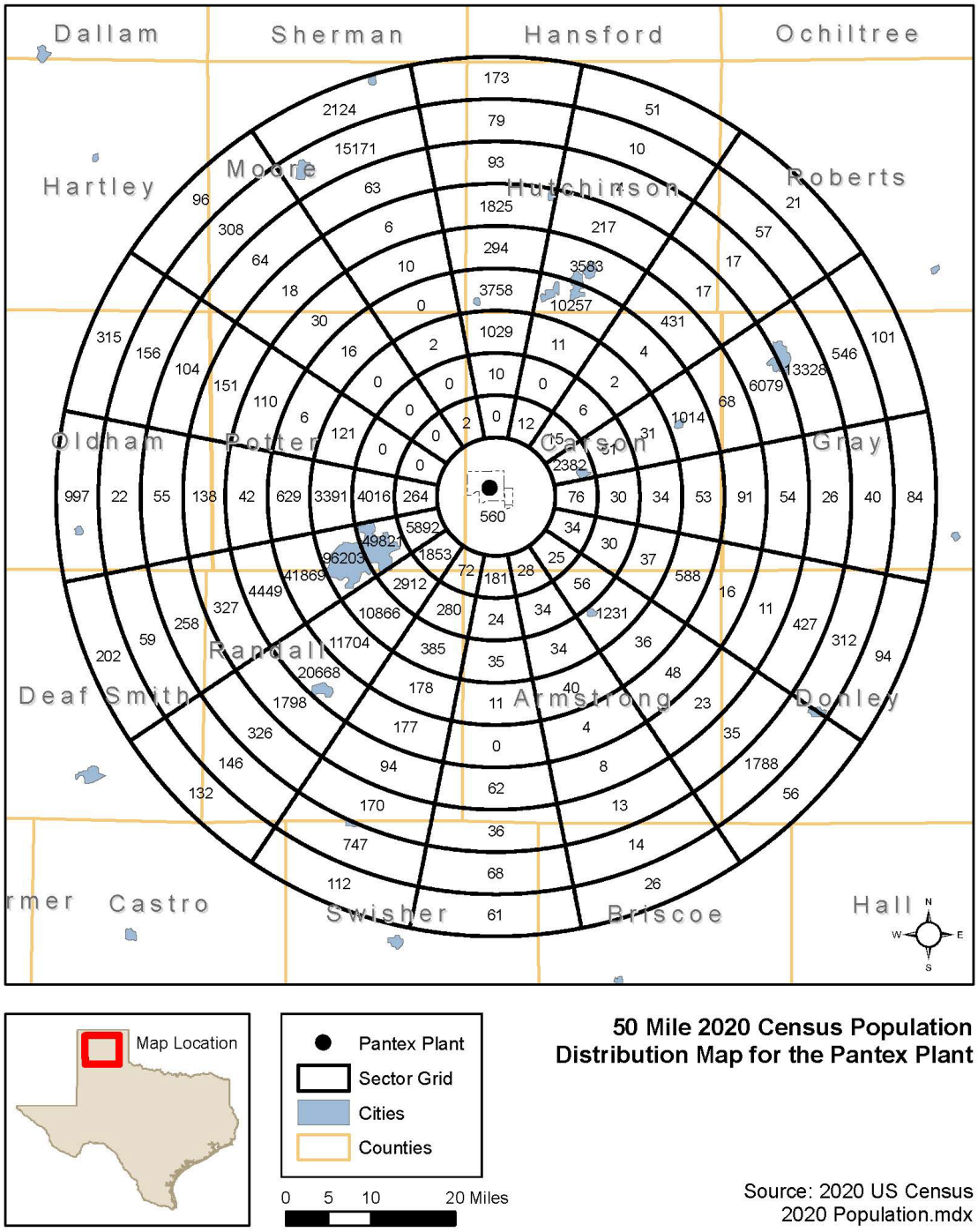

Fig. 1.5. Population Distribution within 50 Miles of Pantex (2020)

The communities of Pampa, Borger, Hereford, Dumas, and Canyon each have populations between 13,000 and 18,000. The 20-county areas can be described as sparsely populated, with Potter and Randall counties being the exception. Excluding Potter and Randall counties, the general population density of each county ranges from 12 to 154 persons per square mile. Potter, Randall, Carson, and Armstrong Counties make up the Amarillo Metropolitan Statistical Area. Hutchinson County (in which Borger is located) and Gray County (in which Pampa is located) are now classified as micropolitan statistical areas (U.S. Census Bureau 2022). Hartley, Moore, Roberts, Oldham, Deaf Smith, Donley, Dallam, Sherman, Hansford, Ochiltree, Lipscomb, Hemphill, Wheeler, and Collingsworth are the remaining counties of the defined area. The populations contained in the northerly portions of Castro, Swisher, and Briscoe Counties are also included in the 50 mi population estimate described above.

1.9 ORGANIZATION OF THE REPORT

The remainder of this report is organized into twelve chapters and nine appendices as follows:

Chapter 2 discusses regulatory requirements for environmental compliance during 2022 and describes Pantex's compliance-related issues and activities. It presents results of various regulatory inspections and environmental activities and lists the environmental permits issued to Pantex.

Chapter 3 provides a brief summary of the environmental programs that are conducted at Pantex. Overviews are provided for environmental management, pollution prevention (P2), natural and cultural resources management, environmental restoration, and sustainability initiatives.

Chapter 4 describes the environmental radiological monitoring program, which deals with the potential exposure of the public and the environment to radiation resulting from Pantex operations. Also discussed are results of the environmental thermoluminescent dosimetry program and other radiological monitoring programs for various environmental media (i.e., air, groundwater, surface water, plants, and animals).

Chapters 5 through 11 discuss radiological and non-radiological monitoring and surveillance programs for individual environmental media. Chapter 5 discusses the air-monitoring program. The groundwater, drinking water, wastewater, and surface water monitoring programs are discussed in Chapters 6, 7, 8, and 9, respectively. Chapter 10 describes the soil monitoring program. Fauna and flora monitoring are discussed in Chapter 11. Each of these chapters includes a description of the monitoring program for the specific medium and an analysis of radiological and non-radiological data for the 2022 samples.

Chapter 12 reviews Pantex's Quality Assurance program for environmental monitoring efforts, as initiated in response to 10 CFR 830.120, *Nuclear Safety Management*, “Scope,” and DOE O 414.1D, *Quality Assurance*. The chapter also includes an analysis of quality control (QC) samples collected during 2022 and a data validation summary.

Appendix A lists all of the birds sighted at Pantex.

Appendix B provides the 2022 drinking water sampling analytical results.

Appendix C lists all of the analytes for which environmental analyses were conducted.

Appendix D provides the 2022 soil sampling analytical results.

Appendix E is a glossary that lists and defines key terms used in this report.

Appendix F lists relevant elements and chemicals and the respective abbreviations and formulas.

Appendix G lists the relevant units of measure and the respective abbreviations.

Appendix H provides helpful conversion information.

Appendix I provides references.

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CHAPTER 2 - COMPLIANCE SUMMARY

Pantex policy is to conduct all operations in compliance with applicable environmental statutes, regulations, and the requirements of the various authorizations issued to Pantex. This chapter describes and reviews current issues, initiatives, and cleanup agreements in place, regulatory authorizations issued to Pantex, and measures to support the DOE environmental performance indicators. It also summarizes the compliance status of Pantex for 2022.

Chapter Highlights

- Pantex tracked emissions from 30 different processes at specific locations and grouped sources across the site. Total Pantex emissions were less than 30 percent of the certified and authorized potential-to-emit levels for each of the pollutants tracked.
- Pantex is compliant with all provisions of the applicable regulations and issued permits.
- The annual Resource Conservation and Recovery Act waste site inspection was conducted by the Texas Commission on Environmental Quality on June 21-22, 2022. It concluded with no findings or issues identified.

2.1 ENVIRONMENTAL REGULATIONS

Various government entities have regulatory authority over and environmental interests in the operations at Pantex. Table 2.1 presents environmental regulations applicable to operations at Pantex.

Table 2.1. Major Environmental Regulations Applicable to Pantex

Regulatory Description	Authority	Codification	Status
CLEAN AIR ACT (CAA)	Federal: Environmental Protection Agency (EPA)	Federal: 40 CFR 50-82	Pantex complies with permits and Permits by Rule issued or promulgated by the Texas Commission on Environmental Quality to authorize releases of pollutants to the atmosphere.
CAA and the Texas Clean Air Act, through their implementing regulations, control the release of regulated emissions to the atmosphere and provide for the maintenance of ambient air quality.	State: Texas Commission on Environmental Quality (TCEQ) Texas Department of State Health Services	State: Title 30 of the Texas Administrative Code (TAC), Chapter 101 through Chapter 122 (30 TAC 101-122) and 305 25 TAC 295 (Asbestos only)	Pantex complies with the applicable requirements codified in the CFR and TAC (including those dealing with emissions of radionuclides at DOE facilities) (40 CFR 61, Subpart H).
CAA		Pantex is a self-certified "Minor" emission source under the Federal Operating Permit Program.	

Table 2.1. Major Environmental Regulations Applicable to Pantex

Regulatory Description	Authority	Codification	Status
ARCHAEOLOGICAL RESOURCE PROTECTION ACT (ARPA) ARPA provides for the protection of archaeological resources and sites located on public and Native American lands.	Federal: Advisory Council on Historic Preservation State: State Historic Preservation Office	Federal: Title 36 CFR Part 79 (39 CFR 79) 43 CFR 7	All archaeological surveys and testing at Pantex conformed to ARPA standards.
COMPREHENSIVE ENVIRONMENTAL RESPONSE, COMPENSATION, AND LIABILITY ACT The Comprehensive Environmental Response, Compensation, And Liability Act provides the regulatory framework for the remediation of releases of hazardous substances and cleanup of inactive hazardous substance disposal sites. Section 107 provides for the protection of natural resources on publicly owned property through designation of Natural Resource Trustees.	Federal: EPA	Federal: 40 CFR 300, 302, 355, and 370	Pantex has been on the National Priorities List since 1994. The EPA, TCEQ, and National Nuclear Security Administration Production Office have signed an Interagency Agreement concerning the conduct of the remediation at Pantex. A Record of Decision was issued and approved in 2008 and Pantex was added to the Construction Completion List in 2010. Interested Co-Trustees have been involved in the planning and completion of the Ecological Risk Assessment for Pantex, and selection of the final remedy. The Agency for Toxic Substances and Disease Registry published its final report *Public Health Assessment-Pantex* in September 1998.
ENDANGERED SPECIES ACT Endangered Species Act prohibits any entity or person from taking any action that would jeopardize the continued existence of endangered or threatened species or result in the destruction or adverse modification of a critical habitat.	Federal: U.S. Fish and Wildlife Service (USFWS)	Federal: 50 CFR 10; 50 CFR 17; Title 16 of the United States Code, Chapter 153 (16 USC 153), et seq.	Ongoing and proposed actions are assessed as to their potential adverse effects on threatened and endangered species.
PROTECTION of ENDANGERED SPECIES (STATE)	State: Texas Parks and Wildlife Department (TPWD)	State: Texas Parks and Wildlife (TPW) Code, 68	Ongoing and proposed actions are assessed as to their potential adverse effects on threatened and endangered species.

Table 2.1. Major Environmental Regulations Applicable to Pantex

Regulatory Description	Authority	Codification	Status
FEDERAL INSECTICIDE, FUNGICIDE, AND RODENTICIDE ACT Federal Insecticide, Fungicide, and Rodenticide Act governs the manufacture and use of biocides, specifically the use, storage, and disposal of all pesticides and pesticide containers and residues.	Federal: EPA State: Texas Department of Agriculture; Structural Pest Control Board	Federal: 40 CFR 170-171 State: 4 TAC 7.1-7.71; Structural Pest Control Act (Art. 135b-5)	State-licensed personnel apply pesticides in accordance with applicable regulations. Pantex implemented a land-applied chemical use plan in 1996. The plan was updated in 2022.
FEDERAL WATER POLLUTION CONTROL ACT / CLEAN WATER ACT The Texas Water Code, through its implementing regulations, regulates the quality of water discharged to waters of the State of Texas.	Federal: EPA State: TCEQ	Federal: 40 CFR 120-136, and 40 CFR 300 - 583 State: 30 TAC 205-299, 305, 309, 317, and 319	As currently defined, Pantex does not discharge its wastewaters to 'Waters of the United States'. Pantex discharges its industrial wastewaters pursuant to Permits WQ0002296000, WQ0004397000, and Underground Injection control 5W2000017. Pantex has coverage under the Texas Pollutant Discharge Elimination System (TPDES) Construction General Permit, for storm water via Permit No. TXR150000. Pantex complies with the requirements of the permit whenever applicable to a project. Pantex operates under the TPDES Multi-Sector General Permit for Discharges of Storm Water from Industrial Sources via Permit No. TXR05CD31.
MIGRATORY BIRD TREATY ACT (MBTA) Under the MBTA, it is unlawful "by any means or manner to pursue, hunt, take, capture, or kill" any migratory birds except as permitted by regulation.	Federal: USFWS	Federal: 50 CFR 10 pursuant to 16 USC 704-707 and 712	Actions being considered at Pantex are reviewed through the National Environmental Policy Act (NEPA) process, which considers impacts to migratory species. Nuisance and other bird conditions are managed within compliance of the MBTA.

Table 2.1. Major Environmental Regulations Applicable to Pantex

Regulatory Description	Authority	Codification	Status
PROTECTION OF MIGRATORY BIRDS (STATE)	State: TPWD	State: TPW Code 64 (2-5, 7, and 26-27)	Actions being considered at Pantex are reviewed through the NEPA process, which considers impacts to migratory species. Nuisance and other bird conditions are managed within compliance of state regulations.
MEDICAL WASTE	Federal: U.S. Department of Transportation (DOT) State: Texas Department of State Health Services	Federal: 49 CFR 173 State: 30 TAC 330.1201-1221	Pantex manages medical waste in accordance with applicable regulations.
Executive Order 13186: Responsibilities for Federal Agencies to Protect Migratory Birds (2001) Establishes commitment to migratory bird protection, management, research, and outreach on federal properties. The order reaffirms relationship between the USFWS and other federal agencies.	Federal: DOE	Volume 66 Federal Register, page 3853 (66 FR 3853), 2001	Actions being considered at Pantex are reviewed through the NEPA process, which considers impacts to migratory species. This Executive Order adds additional language beyond the MBTA to consider impacts to habitat. It encourages partnerships, research, and outreach, dealing with migratory birds.
NEPA NEPA establishes a broad national policy to conduct federal activities in ways that promote the general welfare of the environment. NEPA procedures must ensure that environmental information is available to public officials and citizens before decisions are made and before actions are taken.	Federal: DOE; Council for Environmental Quality	Federal: 10 CFR 1021, 40 CFR 1500-1508	In 2022, eight Standard NEPA Review Forms, 22 Internal NEPA Review Forms, and three amendments were prepared.
PROTECTION OF BIRDS, NONGAME SPECIES, AND FUR-BEARING ANIMALS Requires the protection of all indigenous birds and ring-necked pheasants, nongame species, and fur-bearing animals except where exceptions are stated in the TPWD code.	Federal: USFWS State: TPWD	Federal: 50 CFR 10 State: TPWD Code 67 and 71	Actions being considered at Pantex are reviewed through the NEPA process, which considers impacts to all protected species.
SAFE DRINKING WATER ACT Safe Drinking Water Act and the Texas Water Code govern public water supplies.	Federal: EPA State: TCEQ	Federal: 40 CFR 141-143 State: 30 TAC 290	Pantex operates a non-transient, non-community public water supply system (No. 0330007). The system is recognized as a Superior

Table 2.1. Major Environmental Regulations Applicable to Pantex

Regulatory Description	Authority	Codification	Status
			Public Water System by the TCEQ.
Resource Conservation and Recovery Act Resource Conservation and Recovery Act and the Texas Solid Waste Disposal Act govern the generation, storage, handling, treatment, and disposal of solid waste, including hazardous waste. These statutes and regulations also regulate underground storage tanks and spill cleanup.	Federal: EPA State: TCEQ	Federal: 40 CFR 260-280 State: 30 TAC 305, 327, and 335 State: 30 TAC 334	Pantex is defined as a large-quantity generator. Permit HW-50284 authorizes the management of hazardous wastes in various storage and processing units at Pantex. HW-50284 addresses corrective action requirements at Pantex. Pantex operates five regulated underground storage tanks and one regulated above-ground storage tank.
TOXIC SUBSTANCES CONTROL ACT Toxic Substances Control Act requires the characterization of toxicity and other harmful properties of manufactured substances and regulates the manufacture, distribution, and use of regulated materials.	Federal: EPA	Federal: 40 CFR 700-766, and 10 CFR 850	Pantex manages polychlorinated biphenyl, asbestos, beryllium, and chemicals in compliance with applicable regulations.

2.2 CLEAN AIR ACT

Most requirements of the federal Clean Air Act (CAA) in Texas are implemented under the Texas Clean Air Act, which is administered by the TCEQ, as approved by the EPA through the Texas State Implementation Plan. The exceptions to this delegation of authority from the EPA include 40 CFR 61, *Protection of the Environment,* "National Emission Standards for Hazardous Air Pollutants," Subpart H, "Emissions of Radionuclides Other Than Radon from Department of Energy Facilities"; 40 CFR 61, Subpart M, "National Emissions Standard for Asbestos"; and regulations dealing with stratospheric ozone protection and greenhouse gases. The primary regulatory authority for 40 CFR 61, Subpart M, is delegated to the Texas Department of State Health Services (TDSHS).

2.2.1 Emissions of Radionuclides Other Than Radon from DOE Facilities

According to the standard established in 40 CFR 61.92, "Standard," emissions of radionuclides to the ambient air from DOE facilities shall not exceed those amounts that would cause any member of the public to receive an effective dose equivalent of 10 millirem per year (mrem/yr.) or 0.10 millisievert per year (mSv/yr.). Based upon evaluations using the most conservative assumptions about the emissions of radionuclides from several Pantex locations that have the potential-to-emit radioactive materials, Pantex has determined that the maximum effective dose equivalent that any member of the public received in 2022 was 2.20 E-04 mrem/yr (2.20E-06 mSv/yr). Accordingly, Pantex is in compliance with the EPA standard. Continuous emission monitoring, as described in 40 CFR 61.93, "Emission Monitoring and Test Procedures," is not required of any source at Pantex, based on each source's emission potential. Pantex performs periodic confirmatory measurements and modeling to assure compliance with 40 CFR 61 Subpart H regulations.

In accordance with 40 CFR 61.96, "Applications to Instruct or Modify," all new construction projects and activities (or modifications to existing structures or activities) that have the potential-to-emit radioactive materials are evaluated to determine if the effective dose equivalent, caused by all emissions, is less than one percent of the 40 CFR 61.92 standard (i.e., is less than 0.1 mrem/yr. [0.001 mSv/yr.]). During 2022, none of the evaluations resulted in the identification of exceedances of this reduced standard. Accordingly, there was no need to make an application for approval or notifications of start-up to the EPA under the provisions of 40 CFR 61.96.

2.2.2 National Emissions Standard for Asbestos

Each year, Pantex files a *Notification of Consolidated Small Operations Removing Asbestos-Containing Material* with the TDSHS for maintenance activities to be conducted by Pantex in the next calendar year (CY). To verify that operations are consistent with the notification, Pantex keeps a log of all its affected maintenance activities to track quantities of material disturbed.

Subcontractors at Pantex are required to prepare separate notifications for work that qualifies as "demolition" or "renovation" as defined in 40 CFR 61, Subpart M, and 25 TAC 295.61, "Applications," which implements the Texas Asbestos Health Protection Act. Separate notifications are also required for jobs conducted by Pantex personnel that involve amounts that would require job-specific notifications. Pantex maintains the required certifications for the personnel who plan, oversee, and conduct these efforts. By filing the required forms and maintaining the described records, Pantex demonstrates that it is in compliance with 40 CFR 61, Subpart M.

2.2.3 Chemical Accident Prevention

Pantex has established and maintains controls on the introduction of new chemicals to any area of the plant. Through this process, Pantex continues to demonstrate that it has control of the chemicals in use. Pantex continues to track chemical inventories and ensure that the quantities of chemicals at any location are below the threshold quantities stated in 40 CFR 68, "Chemical Accident Prevention Provisions," exempting Pantex from having to perform risk management planning.

2.2.4 Ozone Depleting Substances

At Pantex, licensed technicians install and maintain stationary and motor vehicle air conditioning systems. Technicians use approved recycling devices as needed when conducting these efforts. Pantex maintains records of training and maintenance activities to demonstrate compliance with these regulations (40 CFR 82).

2.2.5 Air Quality Permits and Authorizations

Pantex operates under several TCEQ air quality authorizations for processes and activities conducted at Pantex. These include a New Source Review permit issued under 30 TAC 116 (Permit No. 84802), de minimis activities as authorized under 30 TAC 116.119, and authorizations issued under 30 TAC 106 [Permits by Rule (PBR)].

2.2.6 Federal Operating Permit Program

The Title V Federal Operating Permit Program is administered and enforced by the EPA Region 6 Office and the TCEQ. During 2022, Pantex maintained documentation demonstrating compliance as a synthetic minor source, as defined by the Federal Operating Permit Program.

2.2.7 Air Quality Investigation

The TCEQ did not perform an air quality-related compliance inspection of Pantex during 2022.

2.2.8 Emission Tracking and Calculation

Pantex is subject to the federal Clean Air Act and the state of Texas regulations under 30 TAC Chapters 101, 106, 111, 112, 113, 116, 117, 118, and 122. The main scope or function of Pantex's air emission

tracking system is to monitor and quantify process emissions to (a) maintain the facility designation of "Synthetic Minor" under the federal Title V program, and (b) demonstrate compliance with the National Ambient Air Quality Standards and with the authorizations issued to Pantex. Pantex initiated a comprehensive system for tracking emissions from specific sources (facilities) in September of 1999, and has continued to update the tracking process to comply with changing regulations and best management practices. Pantex processes that have emissions are conducted under the authority of various regulations and authorizations (permits, standard exemptions, and PBR). Table 2.2, below, identifies the tracked emission sources at Pantex and their authorizations.

Table 2.2. Tracked Emission Sources at Pantex

Process:	Authorization / Permit #	Standard Exemption	Permit By Rule
High Explosives (HE) Synthesis Facility	Permit 84802		
HE Fabrication	Permit 84802		
Firing Site Activities	Permit 84802		
Boiler House	Permit 84802		
Stationary Standby Emergency Engines	Permit 84802		
Boiler House, Diesel Storage	Permit 84802		
Burning Ground Activities	Permit 84802		
Hazardous Waste Storage	Permit 84802		
Hazardous Waste Processing	Permit 84802		
Welding and Cutting		SE 39	
Dual Chamber Incinerator	Permit 84802		
Plastics Shop	Permit 84802		
Machining		SE 41	PBRs 106.432, and 106.452
Vehicle Maintenance Facility (VMF) Fueling Operations	Permit 84802		
Pantex Site-wide Cooling Towers	Permit 84802		
Hazardous Waste Treatment and Processing Facility Liquid Processing Facility	Permit 84802		
Stationary Standby Emergency Engines	Permit 84802		
Painting Facilities	Registration 32674, 52638, 167514	SE 75	PBR 106.433
Burning Ground-Soil Vapor Extraction	Registration 70894		PBR 106.533
Miscellaneous Chemical Operations: e.g., Emissions of hazardous air pollutants from laboratories, small coating operations and fugitive sources.		SE 34	PBR 106.122, PBR 106.433, de minimis
Chemical Transfer Operations	Registration 72373		PBR 106.262, 106.472, and 106.473
Drum Management Operations	Registration 92876		PBR 106.261, 106.262, and 106.512
HE Pressing Facility	Registration 145558		PBR 106.261, 106.262
Emergency Water Pump	Registration 87270		PBR 106.512
Printed Wire Assembly	Registration No. 43702		PBR 106.227

2.2.9 Program Structure and Requirements

Pantex is categorized as a Synthetic Minor Air Emission Source. To remain in this category, the following threshold limits cannot be exceeded: 25 tons per year of any combination of hazardous air pollutants (HAPs); 10 tons per year of any single HAP; or 100 tons per year of any non-HAP air pollutant. Under this designation, a facility is not required to declare its emissions every year to the TCEQ; however, 30 TAC 122.122 requires a certification of potential-to-emit (PTE) when significant changes of emissions take place. The PTE, once submitted to the TCEQ, becomes a federally enforceable document for allowable emissions. Essentially, the PTE establishes emission limits that are administratively set by Pantex and authorized/enforceable by the TCEQ and the EPA.

Pantex maintains a tracking process to verify compliance with certified emissions limits. This tracking process is implemented through air quality management requirement (AQMR) documents, which are placed into the everyday operational procedures/activities that have either point source or fugitive emissions. AQMRs are management-driven documents that outline regulatory requirements for operators to follow based upon process activities and the requirements of the federal and state air emissions regulations. The approved AQMRs incorporate sections of the authorization that outline the internal reporting and recordkeeping requirements for process operators. Operational data are gathered by process operators and then input on a monthly basis into commercial, off-the-shelf computer software. The software uses emission factors from source tests, manufacturer's data, and EPA documentation to calculate hourly, CY, and rolling 12-month emissions.

2.2.10 Types and Tracking of Emissions

During 2022, Pantex tracked the emissions from 30 different processes at both specific locations and grouped sources across Pantex. Pantex personnel responsible for air program compliance gathered facility data on emissions of common air pollutants including nitrogen oxides, carbon dioxide (CO_2), volatile organic compounds (VOCs), sulfur oxides (SOx), particulate matter, and HAPs. The data, once gathered, are compiled into a monthly report that compares the cumulative past 12-month emissions for Pantex, to the annual limits set in the authorized PTE.

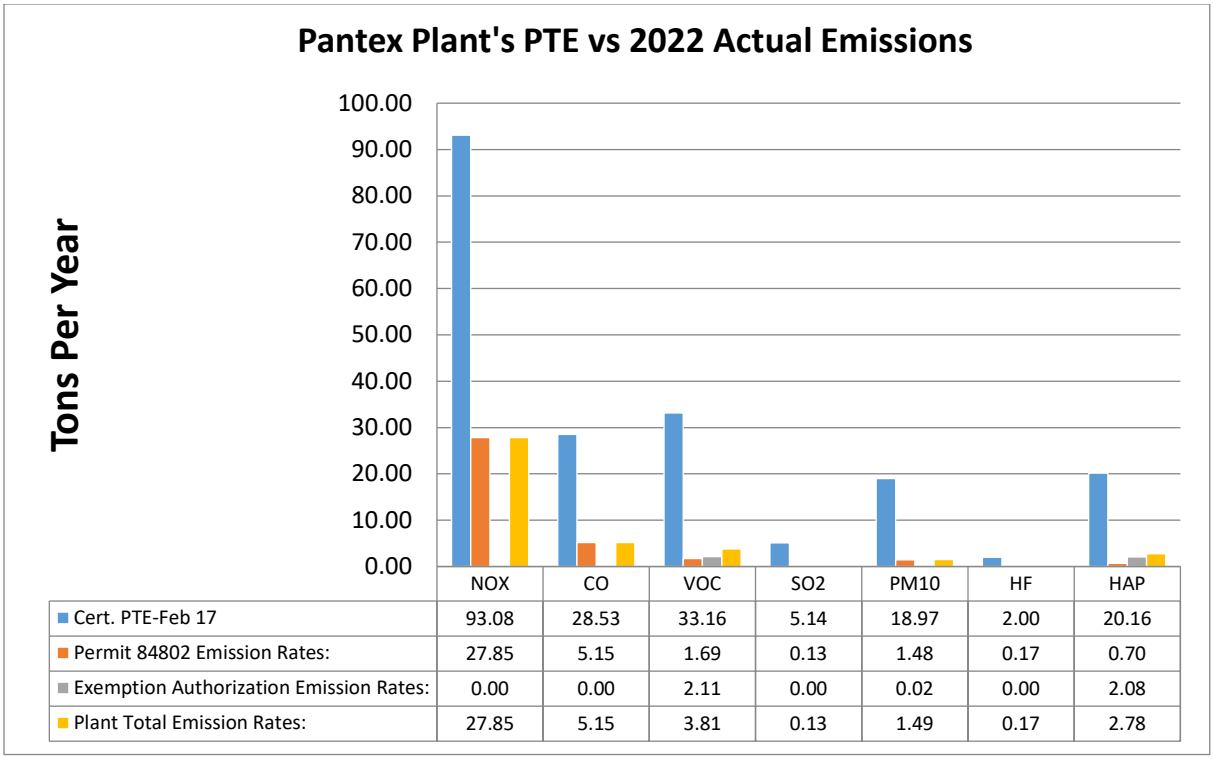
2.2.11 Conclusions of Air Emission Tracking for 2022

Over the 12 months of air emission tracking for 2022, operations at Pantex remained well below the certified and authorized PTE levels for each of the pollutants tracked. Fig. 2.1 is a graphic presentation of the emission information gathered from January through December 2022, expressed in relation to the PTE certification in tons per year (TPY). It provides a demonstration that Pantex continues to meet the requirements of the Title V program for the designation as a Synthetic Minor Source.

2.3 COMPREHENSIVE ENVIRONMENTAL RESPONSE, COMPENSATION, AND LIABILITY ACT

Because Pantex is listed on the National Priorities List, Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), Section 107 (Title 42 of the USC, Chapter 9607) is applicable. Section 107 provides for the designation of federal and state trustees who are responsible for assessing damages, for injury to, destruction of, and loss of natural resources. As Pantex's primary Natural Resource Trustee [per 40 CFR 300.600(b)(3)], the DOE is responsible for encouraging the involvement of designated federal and state trustees. To meet this responsibility, DOE held meetings with state and federal agencies. DOE and EPA jointly issued an interagency agreement (IAG) in December 2007 in conclusion of negotiations between DOE, Pantex, EPA, and TCEQ. This agreement became effective in February 2008.

Pantex submitted the Site Management Plan (SMP), a primary document required by Article 7.2 of the IAG in November 2008.



	NOX	CO	VOC	SO2	PM10	HF	HAP
Cert. PTE-Feb 17	93.08	28.53	33.16	5.14	18.97	2.00	20.16
Permit 84802 Emission Rates:	27.85	5.15	1.69	0.13	1.48	0.17	0.70
Exemption Authorization Emission Rates:	0.00	0.00	2.11	0.00	0.02	0.00	2.08
Plant Total Emission Rates:	27.85	5.15	3.81	0.13	1.49	0.17	2.78

Fig. 2.1. Pantex's PTE vs January – December 2022 Actual Emissions

The SMP is a schedule with deadlines and timetables for completion of all primary documents and additional work identified pursuant to the IAG. The SMP is submitted annually to update schedules for the five-year review and the Final Remedial Action Completion Report. No additional work has been identified for inclusion in the SMP.

Accordingly, Pantex was added to the Construction Completion List, signifying the start of the O&M phase of the remedy. Progress reports are prepared and submitted to EPA and TCEQ quarterly to communicate the status and accomplishments of the remedial action systems. Also, an annual report is prepared to document a more thorough evaluation, and five-year reviews are conducted to ensure periodic comprehensive analyses of the protectiveness of the selected remedy. The first and second five-year reviews were completed in 2013 and 2018, respectively. Conclusions and recommendation from the third five-year review are currently in draft, with the final document scheduled for completion in August 2023.

2.4 ENDANGERED SPECIES ACT

Pantex provides habitat for several species protected by federal and state endangered species laws. In 1992, Pantex began a program to assess its natural resources (See Chapter 3). Each year, wildlife observations are recorded and state and federal rare species lists are examined for changes. These observations include data collected by subcontractors working on wildlife projects at Pantex. The current status of endangered or threatened species, as well as species of concern, known to appear on or near Pantex (Carson and Potter counties) is summarized in Table 2.3. Pantex is in compliance with the applicable provisions of the Endangered Species Act.

Table 2.3. Endangered, Threatened and Candidate Species, and High Priority Species of Concern[a] Known to Appear on or Near Pantex

Common Name		Scientific Name	Present in 2022	Federal Status	State Status
Birds	Bald eagle	*Haliaeetus leucocephalus*	Yes	Delisted	Concern
	Franklin's gull	*Leucophaeus pipixcan*	-	-	Concern
	Interior least tern	*Sterna antillarum athalassos*	-	Delisted	Endangered
	Lesser prairie chicken	*Tympanuchus pallidicinctus*	-	-	Concern
	Mountain plover	*Charadrius montanus*	-	-	Concern
	Western burrowing owl	*Athene cunicularia hypugea*	Yes	-	Concern
	White-faced ibis	*Plegadis chihi*	-	-	Threatened
	Whooping crane	*Grus americana*	-	Endangered	Endangered
Mammals	Black bear	*Ursus americanus*	-	-	Threatened
	Black-tailed prairie dog	*Cynomys ludovicianus*	Yes	-	Concern
	Plains spotted skunk	*Spilogale putorius interrupta*	-	-	Concern
	Prairie vole	*Microtus ochrogaster*	-	-	Concern
	Swift fox	*Vulpes velox*	-	-	Concern
Reptiles	Texas horned lizard	*Phrynosoma cornutum*	Yes	-	Threatened

[a] Texas Parks and Wildlife Department (S1/S2 ranking, recently proposed.)

Several species listed as Threatened or Endangered for Carson County or surrounding counties, but not included in Table 2.3 because of their dependence on habitat not found on Southern High Plains soils, include the following:

Endangered

- N/A

Federal and State - Threatened

- Arkansas River shiner (*Notropis girardi*)
  - Only expected in streams on or flowing into the Canadian River floodplain

State - Threatened

- Palo Duro mouse (Peromyscus truei comanche)
  - Resident of slopes of steep-walled canyons and along escarpments, habitat not found on Pantex
- Common black-hawk (Buteogallus anthracinus)
  - Sightings in the High Plains are extremely rare
  - Nesting habitat is cottonwood-lined watercourses far to the south in South Texas and the Trans-Pecos region
- Peppered chub (Macrhybopsis tetranema)
  - Only expected in streams on or flowing into the Canadian River floodplain

2.5 FEDERAL INSECTICIDE, FUNGICIDE, AND RODENTICIDE ACT

The Federal Insecticide, Fungicide, and Rodenticide Act regulates the manufacture and use of pesticides. The EPA has federal jurisdiction pursuant to 40 CFR 150-189, and the Texas Department of Agriculture and the Structural Pest Control Board have state jurisdiction pursuant to Title 4 TAC 7. Regulations promulgated under Federal Insecticide, Fungicide, and Rodenticide Act govern the use, storage, and

disposal of pesticides and pesticide containers. State-licensed personnel, in accordance with federal and state regulations, apply pesticides needed for operations at Pantex.

2.5.1 Pesticide Use in 2022

Texas Tech Research Farm submitted seven agricultural spray requests during the 2022 growing season; however only five applications were made. All seven agricultural spray requests were reviewed and approved by the Environmental Compliance Department and Safety & Industrial Hygiene Department. Multiple Pantex organizations and the NNSA Production Office reviewed the approved requests for information and awareness. Pantex's Maintenance Department made 29 applications during 2022. The majority of these applications were for weed control in Zone 4, Zone 11, Zone 12, and the associated Perimeter Intrusion Detection and Surveillance beds. The second most frequent pesticides used were insecticides for spiders and mosquitoes. Contractors submitted 33 spray requests to control or suppress weeds and prairie dogs, as specified in the contract work completed at Pantex in 2022. Table 2.4 shows the number of pesticide applications conducted at Pantex since 2017.

Table 2.4. Number of Pesticide Applications Conducted at Pantex

Year of Pesticide Applications	Texas Tech Research Farm	Maintenance Department	Contractors	Total
2017	18	59	0	77
2018	10	35	4	49
2019	17	27	9	53
2020	9	35	12	56
2021	8	29	19	56
2022	5	29	33	67

2.6 FEDERAL WATER POLLUTION CONTROL ACT AND TEXAS WATER CODE

Pantex does not discharge wastewaters into or adjacent to waters of the United States; thus, Pantex is not subject to the Federal Water Pollution Control Act (Clean Water Act). Pantex is subject to the requirements of the Texas Water Code. All discharges must be done in compliance with the requirements of the Texas Water Code and its implementing regulations.

During 2022, Pantex disposed of most of its treated industrial and domestic wastewaters via discharge to an on-site playa lake as authorized by WQ0002296000. Pantex is authorized by Permit WQ0004397000 (TLAP) and underground injection control (UIC) Authorization 5W2000017 to discharge treated wastewater through surface or subsurface fluid distribution systems. Combined, these authorizations support the production of approximately 400 ac of crops. The TLAP was amended to provide authorizations for the disposal of treated wastewaters through a surface or subsurface irrigation area when covered by vegetation. The UIC authorization allows the application of limited quantities of treated wastewater to the subsurface irrigation area during periods when the agricultural fields are fallow.

During 2017, major filter leaks developed in the subsurface fluid distribution system, and use of the system was temporarily discontinued. After June 2017, all treated industrial and domestic wastewaters were discharged via a surface water outfall into Playa Lake 1, per WQ0002296000. Repairs are ongoing so that treated effluent from the wastewater treatment facility and from the perched aquifer pump-and-treat systems can once again be discharged to the subsurface fluid distribution system. During 2022, testing was conducted, but operations were not fully restored. Efforts are underway to establish a surface irrigation system (pivot) to provide additional opportunities for beneficial reuse of treated wastewater for crop irrigation. This system is expected to be operational during 2023.

Pantex operates under the Texas Pollutant Discharge Elimination System (TPDES) Multi-Sector General Permit (TXR05CD31) for the discharge of storm water related to industrial activities.

Pantex also obtains coverage as needed under the TPDES Storm Water General Permit for Construction Activities (Permit TXR150000). The Notices of Intent filed for large construction projects during 2022 are listed with other Pantex environmental authorizations and permits in Table 2.5.

At seven of its more remote buildings, Pantex operates on-site sewage facilities (OSSFs), or septic tank systems, to dispose of domestic wastewaters from these buildings. Newer OSSFs have been approved by the TCEQ via permits. However, several of the systems were installed prior to the promulgation of applicable regulations and are not currently registered. As unregistered OSSFs are replaced, permits authorizing the upgrading or installation of the new system will be acquired from the TCEQ.

2.6.1 Wastewater Discharge Permit Inspections

The TCEQ did not conduct a Comprehensive Compliance Investigation of Permit WQ0002296000 during CY 2022. Pantex had two separate sanitary sewer over-flow events which were reported to the TCEQ and mitigated.

2.7 MEDICAL WASTE

Medical waste at Pantex is regulated by the Department of Transportation (DOT), the State of Texas, and associated Pantex requirements. Pantex remains in compliance with applicable requirements.

2.8 NATIONAL ENVIRONMENTAL POLICY ACT

NEPA establishes requirements that federal agencies must meet to make well-informed decisions on proposed activities. The decisions must be based on alternatives that consider detailed information concerning potential significant environmental impacts. To minimize environmental impacts from operations at Pantex, proposed activities are reviewed for NEPA requirements.

Table 2.5. Permits Issued to Pantex

Building or Activity	Permit Number	Issuing Agency	Effective Date	Expiration Date
Air				
Air Quality Permit	84802	TCEQ	03/29/2019	03/29/2029
All other small sources	Standard Exemptions, De Minimis authorizations, and Permit by Rules	TCEQ	Various dates	When changes occur to the process that modify the character or nature of the air emission, or modify the process so that the PBR may no longer be used.
Clean Air Act Title V Declaration, 30 TAC 122	N/A	TCEQ	05/22/2000 (first filing)	None
Solid Waste				
Solid Waste Registration Number	TX4890110527 30459	EPA TCEQ	10/30/1980 10/30/1980	None None
Industrial and Solid Waste Management Site Permit; RCRA Compliance Plan	HW-50284	TCEQ	05/30/2014	05/30/2024
UIC TLAP associated	5W2000017	TCEQ	11/29/2004	When cancelled.

Table 2.5. Permits Issued to Pantex

Building or Activity	Permit Number	Issuing Agency	Effective Date	Expiration Date
UIC- Environmental Restoration Program	5X2600215	TCEQ	10/23/2001	When cancelled.
Water				
Texas Water Quality Permit	WQ0002296000	TCEQ	08/27/2020	08/26/2025
TLAP	WQ0004397000	TCEQ	08/11/2020	08/10/2030
TPDES Multi-Sector (Industrial) Storm Water Permit	TXR05CD31	TCEQ	08/14/2021	08/14/2026
TPDES Storm Water General Permit for Construction Activities	TXR150000	TCEQ	03/05/2023	03/05/2028
Natural Resources				
Scientific Permit	SPR-1296-844	TPWD	12/05/2011	12/31/2023
Letter of Authorization: Trap and Release Fur-bearing Animals	None	TPWD	07/28/2000 (Initial)	Renewed annually.

At Pantex, the NEPA process is initiated by completing a NEPA Review Form (NRF). The NRF includes a description of the proposed action. Subject matter experts (SMEs) review the actions for potential environmental concerns. NEPA documentation ranges from internal reviews that tier off previously approved NEPA documents, categorical exclusions, environmental assessments (EAs), and environmental impact statements (EIS). *Implementation Guidance for DOE Policy on Documentation and Online Posting of Categorical Exclusion Determinations: NEPA Process Transparency and Openness*, October 16, 2009, mandates that all determinations for categorical exclusions involving classes of actions listed in Appendix B to Subpart D of the DOE's NEPA regulations, 10 CFR 1021, be published online.

In 2022, four Standard NRFs (Categorical Exclusion determinations), 22 Internal NRFs, and four amendments were prepared and approved. Categorical Exclusion determinations for nine Standard NRFs were posted on Pantex's website.

At least every five years DOE is required to evaluate whether the *Final Environmental Impact Statement for the Continued Operation of the Pantex Plant and Associated Storage of Nuclear Weapon Components* [referred to as the Pantex Site-Wide Environmental Impact Statement (SWEIS)] remains adequate, if a new SWEIS is warranted, or if the existing SWEIS should be supplemented. DOE/NNSA performs this evaluation through the preparation of a Supplement Analysis (SA) as provided in 10 CFR 1021.314, *Supplemental Environmental Statements*. The analysis conducted in the 2018 SA indicated that continued operations at Pantex, including changes expected to occur through approximately 2023, would be similar in nature and would not be expected to differ significantly from those NNSA identified and analyzed in the SWEIS. At the time of this report, ongoing analysis of the Pantex SWEIS is being performed in accordance with 40 CFR 1021.330(d).

2.9 NATIONAL HISTORIC PRESERVATION ACT, ARCHAEOLOGICAL RESOURCE PROTECTION ACT, AND NATIVE AMERICAN GRAVES PROTECTION AND REPATRIATION ACT

In October 2004, NPO, Pantex, State Historic Preservation Office (SHPO), and the President's Advisory Council on Historic Preservation (Advisory Council) completed execution of a Programmatic Agreement and Cultural Resource Management Plan (PA/CRMP) (2004).

This PA/CRMP ensures compliance with Sections 106 and 110 of the National Historic Preservation Act (NHPA), providing for more efficient and effective review of Pantex projects having the potential to impact prehistoric, World War II era, or Cold War-era properties. In addition, the PA/CRMP outlines a range of preservation activities planned for Pantex's compliance program. The PA/CRMP provides for the systematic management of all archaeological and historic resources at Pantex under a single document.

Compliance with the Archaeological Resource Protection Act requirements for site protection and collections curation is addressed in the PA/CRMP. Even though Native American mortuary remains or funerary artifacts have not been found at Pantex, compliance with the Native American Graves Protection and Repatriation Act is also addressed in the plan. Both archaeological and natural resources at Pantex are closely concentrated around six playa lakes. These playa and floodplain areas have been reserved for comprehensive ecosystem management, resulting in preservation of many of Pantex's archaeological sites.

Fulfilling Pantex's cultural resource management obligations under Section 106 of the NHPA, 28 projects were evaluated in 2022 under the PA/CRMP. Of these projects, 16 did not involve either National Register-eligible properties or possible adverse effects. For the remaining six projects, a prior notification and a walkdown prior to start-up was required to avoid impacts to the National-Register-eligible properties.

2.10 RESOURCE CONSERVATION AND RECOVERY ACT

2.10.1 Active Waste Management

The types of wastes generated at Pantex include the following:

- Hazardous waste
- Universal waste
- Non-hazardous industrial solid waste
- Waste regulated by the Toxic Substances Control Act (TSCA)
- Low-level radioactive waste
- Mixed low-level radioactive waste
- Sanitary waste.

Table 2.6 summarizes wastes generated from the operation, maintenance, and environmental cleanup at Pantex in CY 2022. Overall, the amount of waste generated in 2022 decreased 27.0 percent from 2021. This is due primarily to decreased waste generation volumes in the environmental restoration projects and the deactivation and decommissioning of excess facilities and construction projects.

During 2022, 876.2 cubic meters (m^3) of hazardous waste was generated at Pantex. The following were typical hazardous wastes generated:

- Explosives-contaminated solids
- Spent organic solvents
- Solids contaminated with spent organic solvents, metals, and/or explosives

Hazardous wastes were managed in satellite accumulation areas (less than 55-gal waste accumulation sites), central accumulation areas, or permitted waste management units. Some hazardous wastes, such as explosives, were processed on-site before the process residues were shipped off-site for final treatment and

disposal. Environmental restoration projects, construction projects, and deactivation and decommissioning of excess facilities contributed 26.3 percent of the total hazardous waste generated. For 2022, 221 m^3 of the hazardous wastes from environmental restoration projects, construction projects, and deactivation and decommissioning of excess facilities were Resource Conservation and Recovery Act (RCRA) exempt hazardous scrap metal. Hazardous wastes and residues from hazardous waste processing are shipped to commercial facilities authorized for final treatment and disposal or, as applicable, recycling.

Pantex generated 6,773.3 m^3 of non-hazardous industrial solid waste in 2022. Generated non- hazardous industrial solid wastes were characterized as either Class 1 non-hazardous industrial solid waste or Class 2 non-hazardous industrial solid waste, as defined by 30 TAC 335. Class 1 non-hazardous industrial solid wastes generated at Pantex were managed in a similar manner as hazardous waste, including shipment to off-site treatment and/or disposal facilities. Some Class 2 non-hazardous industrial solid wastes (inert and insoluble materials such as bricks, concrete, glass, dirt, and certain plastics and rubber items that are not readily degradable) were disposed in an on-site Class 2 non-hazardous industrial solid waste landfill. Other Class 2 non-hazardous industrial solid wastes, generally liquids, were shipped to commercial facilities for treatment and disposal.

Pantex's environmental restoration projects, construction projects, and deactivation and decommissioning of excess facilities contributed 55.3 percent of the total non-hazardous industrial solid waste generated during 2022. In addition, 927.3 m^3 of sanitary waste (cafeteria waste and general office trash) was generated at Pantex. Sanitary wastes were also characterized as Class 2 non-hazardous industrial solid wastes and disposed of at authorized off-site landfills.

Pantex generated 16.9 m^3 of waste regulated by TSCA during 2022. These wastes include asbestos, asbestos-containing material, and materials containing or contaminated by polychlorinated biphenyls (PCBs). During the year, environmental restoration projects, construction projects, and deactivation and decommissioning of excess facilities contributed to 90.5 percent of the total TSCA waste generated. All TSCA wastes were shipped off-site for final treatment and disposal.

Table 2.6. Waste Volumes Generated at Pantex (in cubic meters)

Waste Type	1993	2019	2020	2021	2022	Percent Increase or (Decrease) from 1993	Percent Increase or (Decrease) from 2021
Non-hazardous Industrial Solid Waste	10,885	6,621.9	8,860.7	9,453.8	6,773.3	(37.8)	(28.4)
Sanitary Waste	612	794.9	681.3	927.3	927.3	51.5	0
Hazardous Waste	369.6	935.1	1,441.1	1,282.5	876.2	137.1	(31.7)
Low-Level Waste	287	17.8	16.8	12.1	31.7	(89.0)	162
Mixed Waste	37.5	1.1	0.02	0.23	0.23	(99.4)	0
Toxic Substances Control Act	112.9	138.6	171.6	148.0	16.9	(85.0)	(88.6)
Universal Waste[a]	-	15.1	9.0	12.1	13.8	-	14.0
Total	12,304	8,524.5	11,180.5	11,836.0	8,639.4	(29.8)	(27.0)

[a] In 2001, Pantex began managing some hazardous waste under the Universal Waste Rules.

During 2022, 13.8 m^3 of waste that were managed as universal wastes were generated at Pantex. Universal wastes are defined as hazardous wastes that are subject to alternative management standards in lieu of

regulation, except as provided in applicable sections of the TAC. Universal wastes include batteries, pesticides, paint and paint-related waste, and fluorescent lamps. During the year, wastes from environmental restoration projects, construction projects, and deactivation and decommissioning of excess facilities are shipped off-site for final treatment, disposal, or, as applicable, recycling. Pantex generated 31.7 m^3 of low-level radioactive waste during 2022. The low-level radioactive wastes were generated by weapons-related activities.

Assembly and disassembly of weapons can result in some wastes that include both radioactive and hazardous constituents, which are referred to as "mixed waste." The hazardous portion of the mixed waste is regulated by the TCEQ pursuant to RCRA regulations. The radioactive portion is regulated pursuant to the Atomic Energy Act. During 2022, 0.23 m^3 of mixed waste was generated at Pantex.

2.10.2 Hazardous Waste Permit Modifications

Pantex Hazardous Waste Permit HW-50284 sometimes requires modification to address new information, changes in facility, or changes in regulatory requirements. The three classes of modifications consist of minor modifications (Class 1 and Class 2) and major modifications (Class 3). No modifications were completed for Pantex Permit HW-50284 during the CY 2022.

2.10.3 Annual Resource Conservation and Recovery Act Inspection

The annual RCRA waste site inspection was conducted by the TCEQ on June 21-22, 2022. This year the investigation concentrated on all satellite accumulation areas and universal waste sites in Zone 12 Protected Area, including the Zone 12 Material Access Area, all central accumulation areas, and all hazardous waste permitted facilities at Pantex. A total of 43 waste sites were visually inspected during the investigation. The inspection also included a comprehensive records review to ensure compliance with Pantex hazardous waste permit and the applicable requirements from the CFR and the TAC. This year's inspection concluded with no findings or issues identified, and Pantex received a general compliance letter from the TCEQ dated July 5, 2022.

2.10.4 Release Site and Potential Release Site Investigation, Monitoring, and Corrective Action

Progress reports, required by Table VII of HW-50284 (Texas Commission on Environmental Quality 2014) and Article 16.4 of Pantex, were submitted to both the TCEQ and EPA in 2022. The annual report contained a full reporting of all monitoring information for 2022. Quarterly progress reports were also submitted in 2022 in accordance with the schedule in the approved sampling and analysis plan (SAP) and Table VII of Permit HW-50284. These reports focused on continued operation of remedies and on monitoring results from key groundwater wells.

2.10.5 Petroleum Storage Tanks

Pantex operated six regulated petroleum storage tanks (PSTs) during 2022. Of these tanks, five are underground PSTs utilized for vehicle refueling and emergency generator fuel storage. One PST is incorporated into an aboveground emergency generator package. The fuel types stored on-site include gasoline, diesel, and a gasoline–ethanol mix (E-70). Additionally, the TCEQ performed a regulatory inspection during 2022 and no issues were identified.

2.11 SAFE DRINKING WATER ACT

Pantex operates a non-community, non-transient public drinking water system, which is registered with the TCEQ. This category of systems identifies private systems that continuously supply water to a small group of people; i.e., schools and factories. Pantex obtains its drinking water from the Ogallala Aquifer through five wells located at the northeast corner of the plant.

2.11.1 Drinking Water Inspection

In September 2022, a TCEQ contractor collected routine water samples from Pantex Public Water System (PWS). The report generated from this event indicated that Pantex met or exceeded all requirements for operating a PWS. The TCEQ did not conduct a comprehensive compliance investigation during 2022.

2.11.2 Drinking Water System Achievements

On December 17, 2009, the TCEQ notified Pantex that its PWS had achieved a "Superior Rating." Organizations receiving the Superior PWS rating are recognized for their overall excellence in all aspects of operating a PWS. Pantex maintained its Superior PWS rating during 2022.

2.12 TOXIC SUBSTANCES CONTROL ACT

The major objective of the TSCA is to ensure that the risk to humans and the environment posed by toxic materials has been characterized and understood before the chemicals are introduced into commerce. The goal is to regulate chemicals that present unreasonable risk to human health or the environment. Of the materials regulated by TSCA, those containing asbestos, beryllium and materials and parts containing, contaminated by, or potentially contaminated by PCBs are managed at Pantex.

As a user of chemical substances, Pantex complies with applicable regulations issued under the Act, refrains from using PCBs, except as allowed by EPA regulations, and refrains from using any chemical substance that Pantex personnel know, or have reason to believe, has been manufactured, produced, or distributed in violation of the Act. As of December 31, 1996, all new parts and equipment that contain PCBs, used at Pantex, have PCBs that are in concentrations of less than 50 parts per million.

2.13 EMERGENCY PLANNING AND COMMUNITY RIGHT-TO-KNOW ACT

The Emergency Planning and Community Right-to-Know Act, which was enacted as part of the Superfund Amendment and Reauthorization Act of 1986 (SARA), requires that the public be provided with information about hazardous chemicals in the community; and establishes emergency planning and notification procedures to protect the public in the event of a release. In order to accomplish these goals, the Emergency Planning and Community Right-to-Know Act and Executive Order (EO) 12856 require that Pantex file several annual reports with the EPA (Table 2.7) and participate in Local Emergency Planning Committee activities. Pantex remains in compliance with provisions of this statute.

Table 2.7. 2022 Activities for Compliance with the Emergency Planning and Community Right-to-Know Act

Requirement	Applicable	Comment
Planning Notification [Superfund Amendments and Reauthorization Act (SARA 302-303)]	Yes	Three chemicals defined as "Extremely Hazardous Substance" by SARA 302-303 were stored at Pantex in quantities above the threshold planning quantities in 2022.
Extremely Hazardous Substance Notification (SARA 304)	Yes	There were no accidental releases of "Extremely Hazardous Substance" as defined by SARA 304 that exceeded quantity limits in 2022.
Material Safety Data Sheet/Chemical Inventory (SARA 311-312)	Yes	This requirement was satisfied by the Texas Tier II Report[a]. Twenty-three chemicals were listed in the report for 2022.
Toxic Chemical Release Inventory Reporting (SARA 313)	Yes	A Toxic Chemical Release Inventory Report was required for CY 2022.

[a] Report submitted annually to the Chief, Hazard Communication Branch, Occupational Safety and Health Division, Texas Department of Health, the Local Emergency Planning Committee, and the local Fire Department.

2.14 FLOODPLAINS/WETLANDS ENVIRONMENTAL REVIEW REQUIREMENTS

Floodplain management is taken into account when surface water or land-use plans are prepared or evaluated. The U.S. Army Corps of Engineers (USACE), Tulsa District, completed a floodplain delineation report in January 1995 (U.S. Army Corps of Engineers 1995), revising an earlier delineation. In CY 2022, all proposed activities at Pantex were evaluated during the NEPA process for potential impacts on floodplains and wetlands and other criteria required by 10 CFR 1022, *Energy,* "Compliance with Floodplain and Wetland Environmental Review Requirements."

CHAPTER 3 - ENVIRONMENTAL MANAGEMENT INFORMATION

To implement sound stewardship practices that are protective of the air, water, land, and other natural and cultural resources impacted by Pantex operations, a comprehensive EMS has been implemented. Pantex EMS is a major component of the Integrated Safety Management System and contributes to sustaining Pantex imperatives of Safety, Security, Zero Defects, and Deliver as Promised. The Integrated Safety Management/EMS applies to all personnel whether permanent or temporary, and to subcontractors working within the boundaries of Pantex.

Chapter Highlights

- Pantex exceeded clean energy targets set forth by the Sustainability Performance Division of DOE.
- Water intensity at Pantex has decreased approximately 10.1 percent from the 2008 baseline year.
- Approximately 95 percent of all electronics procured have met criteria for being environmentally sustainable, for which Pantex won the Electronic Product Environmental Assessment Tool Purchaser Award.
- Pantex diverted 43 percent of non-hazardous solid waste and 86.2 percent of construction and demolition debris from being disposed in landfills in 2022.
- In 2022, Pantex pump-and-treat systems and the soil vapor extraction system combined removed greater than 510 pounds of contaminants from the perched aquifer.

3.1 ENVIRONMENTAL MANAGEMENT SYSTEM

Pantex EMS meets the requirements of DOE O 436.1 *Departmental Sustainability* and is modeled on the International Organization for Standardization (ISO) 14001, *Environmental Management Systems – Requirements with Guidance for Use*, (2004). The EMS provides for systematic planning, integrated execution, and evaluation of programs for:

- Public health and environmental protection,
- Environmental sustainability,
- P2,
- Recycling, and
- Compliance with applicable environmental protection requirements.

Pantex EMS includes policies, procedures, and training to identify activities with significant environmental impacts; manage, control, and mitigate the impacts of these activities; and assess performance and implement corrective actions where needed. Environmental aspects and impacts are reviewed annually, and measurable environmental objectives and specific targets are developed for implementation. DOE O 436.1 requires that contractors must integrate the site sustainability goals into the EMS. The Site Sustainability Plan (SSP) is prepared annually by the Environmental Compliance Department (ECD). The SSP reports the site's performance status and planned actions for meeting DOE's SSP goals. The EMS provides a business management system to ensure compliance with environmental regulations; to ensure support for the achievement of DOE sustainability goals; and to ensure controls are set to accomplish effective waste management, natural and cultural resource management, pollution prevention/source reduction, recycling/reuse, environmental remediation, sustainable acquisition and design principles, energy management/efficiency, fleet management, and water conservation.

A team of senior management personnel at Pantex leads the review, approval, promotion, and provision of human and physical resources to support the EMS. The EMS Senior Management Team helps guide achievement of environmental objectives, DOE sustainability goals, continual improvement of Pantex's EMS, and conformance with ISO 14001. Through communication of the following Pantex commitments to pollution control, team members strive to increase awareness of the CNS *Environmental Policy* (E-POL-1024) within their organizations across Pantex through communication of our commitments to P2C2, i.e.,

- **P**rotect the environment,
- **P**revent pollution,
- **C**omply with environmental requirements, and
- **C**ontinually improve Pantex's environmental stewardship programs.

The environmental objectives for fiscal year (FY) 2022 and past EMS objectives are listed below in Table 3.1. By using the DOE sustainability goals as the site's environmental aspects, Pantex is in the unique position to work on multi-year objectives on the site and quantify the big projects in terms of environmental impacts. As a result, most of the initial objectives from FY 2020 have continued into following years.

Table 3.1. Pantex Objectives and Targets for 2022

Objective	Target(s)	Status/Comments
Reduce water consumption and intensity throughout Pantex	Repair and expand the Texas Land Application Permit fields to beneficially reuse Pantex wastewater instead of discharging to Playa 1	Completed
	Continue to work on repairing leaking, old infrastructure to make the system more efficient and to reduce number of leaking areas	Ongoing
	Repair the high-pressure fire loop water leaks	Ongoing
Increase the amount of clean/renewable energy used from the Pantex Renewable Energy Project production	North Substation/ Pantex Renewable Energy Project Interconnection Project	Ongoing
Reduce Scope 1 and 2 (Direct) Greenhouse Gas emissions	Energy Independence and Security Act energy audit evaluations	Ongoing
	Installation of electric vehicle chargers for the fleet	Ongoing
	Begin the process to install building level energy meters on covered buildings	Ongoing
Grow the general Pantex population's environmental awareness in accordance with the mission	Determine Pantex's International Organization for Standardization 14001 Compliance – third party audit	Completed
	Conversion to the International Organization for Standardization 14001:2015	Ongoing
Waste Management	Installation of water bottle filler stations in the John C, Drummond Center building	Completed
Climate Change Resilience	Create a site-specific vulnerability assessment and resiliency plan per U.S. Department of Energy guidance	Completed

3.1.1 Environmental Management System Accomplishments for 2022

In accordance with the current DOE O 436.1, Pantex continues to implement and maintain a formal EMS using the ISO 14001 Standard as the platform for site implementation. To meet the intent of this DOE

Order, on five occasions Pantex EMS has been the subject of required formal triennial audits by qualified auditors, outside the control or scope of the EMS, and was successfully identified as conforming to ISO 14001 at each audit, the last one occurring in FY 2022.

Opportunities for continuous improvement are the emphasis of regularly scheduled building environmental walkdown surveillances. These surveillances focus on EMS principles, energy and water conservation, environmental sustainability, recycling, safety, and P2.

Notable accomplishments of the environmental programs at Pantex include, but are not limited to, the following:

- Continued promotion of sustainable acquisition and procurement to the maximum extent practicable, ensuring bio-preferred and bio-based provisions and clauses are included in 95 percent of applicable contracts.
- The Sustainable Acquisition team received the DOE Green Buy Award in 2022 for Pantex's efforts leading to purchasing six Priority Products in four different categories. This is the third time Pantex has been recognized for achieving the Silver Level for demonstrating excellence in Sustainable Acquisition. Approximately 95 percent of all electronics procured have met criteria for being environmentally sustainable, for which Pantex won the Electronic Product Environmental Assessment Tool Purchaser Award in 2022.
- Diversion of approximately 43 percent of municipal solid waste, and approximately 86.2 percent construction and demolition material/debris originally from landfills to alternate pathways for beneficial reuse.
- Achievement of sufficient energy savings that enable meeting clean and renewable electric energy targets and being able to transfer enough renewable energy credits to Y-12 National Security Complex (Y-12) to meet its sustainability goal.

3.1.2 Energy

In the remainder of this section, the goals established by the DOE Sustainability Performance Division (SPD) are expressed in FYs from DOE determined baselines. Pantex reported progress towards meeting these goals in a SSP produced after the completion of FY 2022. For the purpose of this document, the progress during CY 2022 is also reported where applicable. Success in reducing energy use at Pantex has historically been realized from energy savings activities such as the following:

- Utilization of the Energy Management Control System to implement and maintain night, weekend, and holiday setbacks
- Installation of occupancy sensors to control lighting in areas in several facilities with low occupancy rates (conference rooms, break rooms, restrooms)
- Installation of new or retrofitted advanced meters that are integrated with a communication network and dedicated server that stores the meter readings for use with the Energy Star Portfolio Manager building benchmarking system
- Procurement of equipment such as Energy Star products that are more energy efficient
- Continuous and retro-building commissioning

In 2022, Pantex continued to use an alternate work schedule, which has helped reduce energy consumption for a large number of administrative personnel. Pantex has implemented a permanent teleworking procedure that varies by department requirement. Another major source of reductions in energy intensity has been the installation of the Pantex Renewable Energy Project (PREP) consisting of five 2.3-megawatt Siemens wind turbines (see Fig. 3.1) in the summer of 2014.

In 2016, DOE SPD provided guidance requiring a 25 percent reduction in energy intensity by FY 2025 from a FY 2015 baseline. Pantex had a 3.6 percent decrease in energy intensity from the 2015 baseline as

the energy intensity decreased from 164.9 energy per square foot per year (kBtu/ft^2/year) for FY 2015 to 159.1 kBtu/ft^2/year for FY 2022.

Fig. 3.1. Pantex Renewable Energy Project

The decrease in energy intensity is primarily attributable to the continued work of reducing the number of buildings that were vacated to occupy the JCDC and the number of employees that were able to telework with the implementation of the permanent telework guidance. As demolition of vacated buildings continues and with the renewable energy production from PREP, Pantex expects to see continued decreases in energy intensity.

During CY 2022, the PREP supplied 38,815 MWh of electricity to Pantex and the local electrical grid. Pantex exceeded clean energy targets set forth by the SPD and was able to provide Y-12 with enough renewable energy credits to meet that site's clean energy goals.

In December 2021, EO 14057 was issued. This EO incorporated the requirements for carbon pollution-free electricity (CFE) for federal sites. DOE published implementing instructions for EO 14057 in August 2022. However, on July 26, 2022, a memorandum from the DOE secretary implemented a Carbon Pollution-Free Electricity Roadmap and required all departmental elements responsible for facilities to develop CFE implementation plans. NNSA began this process with a data call to the sites. Pantex provided the requested information via data call and a meeting to NNSA in September 2022 including projected electrical loads; planned site efficiency, demand response and electrification projects; on-site CFE generation and storage projects; and CFE procurement plans. NNSA used the Pantex projections as part of its contribution to the DOE Carbon Pollution-Free Electricity Plan. EO 14057 also established other new sustainability goals, including the following,

- 100 percent zero-emission light-duty vehicle acquisitions by 2027
- 100 percent CFE on a net annual basis by 2030, including 50 percent 24/7 CFE
- A 65 percent reduction in scope 1 and 2 greenhouse gas (GHG) emissions from federal operations by 2030 from 2008 levels
- 100 percent zero-emission vehicle acquisitions by 2035
- A net-zero emissions building portfolio by 2045, including a 50 percent emissions reduction by 2032

- Net-zero emissions from federal procurement, including a Buy Clean policy to promote use of construction materials with lower embodied emissions (no date given)
- Climate resilient infrastructure and operations (no date given) and
- A climate- and sustainability-focused federal workforce (no date given).

3.1.3 Greenhouse Gases

Guidance from SPD has expanded upon the energy reduction and environmental performance requirements indicated in DOE O 436.1 by setting requirements in several areas, including the management of GHGs. The guidance requires a 50 percent reduction of electricity-related and natural gas GHG emissions and 25 percent reduction of other indirect GHG emissions by FY 2025 from their respective FY 2008 baselines.

The largest component of the GHG emissions accredited to Pantex are those from federally owned or controlled sources such as the combustion of natural gas used to produce steam on-site and the use of petroleum fuels in fleet and other vehicles and equipment as well as fugitive emissions from refrigerants and wastewater treatment operations. These emissions and those generated through the purchase and use of electricity generated off-site yielded more than 73,970 metric tons CO_2 equivalent ($MtCO_2e$) of GHG in 2008.

During FY 2022, the operation of Pantex emitted a total of 65,437 $MtCO_2e$. Of this total, 19,749 $MtCO_2e$ of emissions were from the combustion of natural gas, 20,337 MtCO2e off-site electricity and 24,670 $MtCO_2e$ was due to other indirect GHG emissions. These emissions are illustrated in Fig. 3.2.

The operation of the PREP during CY 2022 reduced the amount of purchased electricity and electricity-related GHG emissions of Pantex compared to baseline year (FY 2008) levels. In addition, reducing energy consumption by the means discussed in Section 3.1.2, Pantex has concurrently reduced the generation of electricity-related GHGs. Pantex also continued efforts to reduce GHG emissions by improving operations of its vehicle fleet, reducing petroleum fuel use, zero-emission vehicle use, using alternative fuel vehicles and ensuring the fleet is of a proper size for mission work. Future reductions in the generation of electricity-related GHGs are anticipated to occur as operation of the PREP continues.

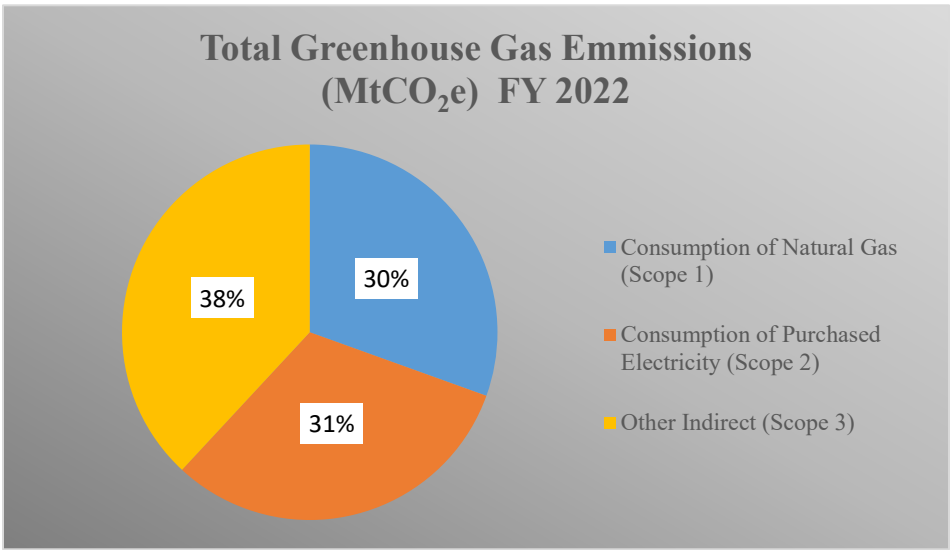


Fig. 3.2. Total 2022 Greenhouse Gas Emissions

Pantex saw an increase in other indirect GHG emissions compared to the FY 2008 baseline due to work related travel restarting as well as a large increase of number of new employees. During FY 2022

approximately 12 percent of the Pantex population continued to telework in some capacity. However, Pantex hired approximately 400 new employees and had more construction subcontractors than in previous years, all of which added to the increase in indirect emissions.

3.1.4 Water

Since 2008, the DOE requires Pantex to reduce water intensity relative to the baseline of Pantex's water consumption in 2007 of approximately 129 million gallons. Pantex continues to develop and implement initiatives based upon requirements in DOE O 436.1 to reduce annual use and meet sustainability goals integrated into the SSP.

During 2022, water consumption was approximately 128 million gal. Despite an 11.1 percent increase in square footage since the baseline year, water intensity has decreased about 10.1 percent from the baseline year.

Five on-site water wells provide all of Pantex's potable water supply from the Ogallala Aquifer. There are approximately 50 mi of aging distribution lines suppling cooling towers, the steam plant, and domestic uses such as restrooms, showers, ice machines, and cafeterias. Some of Pantex's weapons processes require water for testing and quality control. In addition to the traditional distribution lines, there are over 17 mi of a high-pressure fire loop suppression system maintained for Pantex, with high-risk production areas prioritized. Fire suppression systems are tested on a rigorous schedule throughout the year, which is a main contributor to total water consumption. Pantex also provides water to the adjacent and on-site TTU operations for domestic and livestock use through an agreement with TTU. The majority of water lost is through leaks in the aging distribution system.

In FY 2022, four of the eight identified leaks in the traditional distribution lines were repaired; however, as repairs were made, many lines developed new leaks due to the aging infrastructure. The domestic water distribution system is currently undergoing major renovations in a multi-year plan to greatly reduce the number of leaks.

Underneath Pantex, there is a perched aquifer that is currently the focus for on-site environmental restoration activities. Water from the perched aquifer is collected, treated, and transferred to an authorized on-site storage lagoon intended for beneficial reuse. This non-potable water is combined with Pantex's treated wastewater. The combined water is discharged via a permitted wastewater outfall to an on-site playa or used beneficially for a subsurface irrigation system. In 2017, the irrigation system failed and all water was diverted to the playa. In FY 2022, projects were completed to repair 75 percent of the irrigation system which reinstates the potential of beneficial reuse of the water. Water is distributed through manifold pipes to individual zones located within four 100-ac tracts of irrigated land. A project for additional beneficial reuse water irrigation through center-pivot sprinklers was underway in FY 2022 on the land east FM 2373. Irrigation is expected to start in the spring of 2023. The irrigated land is agriculturally farmed by TTU for crops including, but not limited to, winter wheat, sorghum, soybeans, triticale, cotton, corn, and oats.

3.1.5 Environmental Justice

Pantex is committed to addressing environmental justice in disadvantaged communities and other targeted populations that are close to the site, by managing environmental impacts on and beyond Pantex's property. The nearest economically disadvantaged communities are Hutchinson County and Gray County, which are located approximately 19 mi and 26 mi respectively from the Pantex boundary. The following are criteria for an economically disadvantaged county:

- Below average per capita taxable property value,
- Below average per capita income,
- Above average unemployment rate, or
- Met the standard criteria within the last 6 years and has been included in no less than five federally declared disasters.

Outreach efforts to surrounding environmental justice communities are numerous and include the following: annual public meetings on environmental remediation efforts, coordination with Carson County for Emergency Response drills and activities, local job fairs, communications to the public on permit modifications or floodplain assessments, academic contests such as the annual Science Bowl, the NHPA Programmatic agreement, and the annual ASER. These provide many opportunities for education, awareness, and public involvement.

3.2 OVERSIGHT

3.2.1 Federal Agencies

Chapter 2 of this document discusses the results of compliance inspections and/or other oversight activities conducted by the EPA in 2022.

3.2.2 State of Texas

Chapter 2 of this document discusses the results of compliance inspections and/or other oversight activities conducted by various state agencies. In 1989, the secretary of energy invited the host State of each DOE facility to oversee the evaluation of environmental impacts from facility operations as an additional oversight mechanism. As a result, the DOE entered into a five-year Agreement in Principle with the State of Texas in August 1990. It was renegotiated in 1995, 2000, 2005, 2010, 2015 and 2021. The current agreement is in effect through 2026. Six state agencies are involved: the Governor's Office (acting through the State Energy Conservation Office), the Texas Attorney General's Office, the TCEQ, the Texas Department of Public Safety, Division of Emergency Management, the TDSHS-Radiation Control, and the Texas Bureau of Economic Geology. The agreement focuses on general cooperation with all state agencies, including emergency management and environmental sampling and surveillance by the TDSHS.

The agreement also provides for joint emergency planning with Carson, Armstrong, and Potter counties, and the City of Amarillo. A number of meetings between DOE and these agencies were held in 2022. In addition, DOE provided information to the State of Texas, as required, and the State conducted its own environmental sampling and research, and participated in joint emergency exercises and drills with Pantex and local jurisdictions. The TDSHS regularly collects soil, water, air, and dosimeter data from on and near Pantex.

3.3 POLLUTION PREVENTION

Activities in support of the P2 Program are waste elimination, material substitution, waste minimization, recycling, and energy and water conservation. Team members are continually searching and seeking new and innovative initiatives to further the advancement of P2 principles, the philosophy of sustainable acquisition, and the proper management and disposition in the life cycle of all materials and items acquired by Pantex.

In accordance with DOE O 436.1, Pantex has continued an active recycling program, which reduces the waste disposal volumes and saves taxpayers' money. Results of ongoing recycling initiatives in FY 2022 are shown in Table 3.2.

Table 3.2. Pantex Site-wide Recycling for 2022

Fiscal Year 2022 Totals		
Recycled Material	**Pounds**	**Kilograms**
Batteries	107,582	48,798
Computers and Other Electronics	69,390	31,475
Concrete and Asphalt	3,387,260	1,536,435
Corrugated Cardboard	101,920	46,230
Engine Oils	34,780	15,776
Fluorescent Bulbs	3,633	1,648
Newspapers/Magazines/Phonebooks	4,112	1,865
Non-Suspension Scrap Metals	862,040	391,015
Office and Mixed Paper	26,100	11,839
Oil Filters	1,750	794
Plastic	5,460	2,477
Tires/Scrap Rubber	26,700	12,111
Wooden Pallets	10,660	4,835
Total	**4,641,387**	**2,105,298**

In 2022, Pantex diverted 86.2% of construction and demolition debris. Contracts have been maintained with off-site vendors to recycle concrete waste generated from construction projects. As a result, more than 3,387,260 pounds of concrete were recycled. Pantex also diverted 1,097,700 pounds of non-hazardous solid waste, excluding construction and demolition debris.

During 2022, Pantex continued a partnership with Y-12 to reuse and repurpose 12 metal containers received from the Oak Ridge facility. Transfer, reuse, and repurposing of these containers will continue throughout the remainder of a five-year plan and beyond.

Pantex continued to use non-lead bullets during Security Force live fire exercises, when possible, avoiding 1,477.1 pounds of lead usage during 2022. Additionally, Pantex sent 862,007.4 pounds of scrap metals including lead from industrial sources for recycling.

Through these ongoing efforts Pantex has demonstrated an environmentally friendly approach to lifecycle management and stewardship of all processes while ensuring the protection of national security resources and assets entrusted to Pantex by the citizens of this country.

3.4 NATURAL RESOURCES

3.4.1 Flora and Fauna

Across most of the Southern High Plains, cultivation and other developments have reduced the acreage of native habitat and caused fragmentation of the habitat that does remain. These types of reductions and fragmentations have also occurred at Pantex. The remaining areas of near- native habitat at Pantex are small and include wetlands and shortgrass prairie uplands located near the playas.

A biological assessment at Pantex, completed in 1996, addressed the impacts from continuing Pantex operations to endangered or threatened species and species of concern that may occur in or migrate through the area. The U.S. Fish and Wildlife Service approved the assessment and concurred with the conclusion that continued Pantex operations would not be likely to adversely affect any federally listed threatened or endangered species (AL-PX-SW-005006). This was reaffirmed in subsequent Supplement Analyses [*Final Supplemental Analysis For The Final Environmental Impact Statement For The Continued Operation Of*

The Pantex Plant And Associated Storage Of Nuclear Weapon Components, (DOE/EIS-0225/SA-03, 2003, DOE/EIS-0225/SA-04 2008, DOE/EIS-0225-SA-05, 2012, and DOE/EIS-0225-SA-06, 2018)] for the SWEIS. Lists of threatened and endangered species, species of concern, and information regarding designations of critical habitat are monitored regularly for changes in status. Results of animal and plant sampling are discussed in Chapters 11.

3.4.2 Mammals

When including feral cats (*Felis sylvestris*), at least 17 species of mammals were recorded at Pantex in 2022 during field activities, spotlight surveys, and nuisance animal responses (Table 3.3). The all-time mammal list for Pantex includes 46 species; no previously unrecorded species sightings were reported for the year. In 2022, annual spotlight surveys continued and three surveys were performed approximately 2-3 weeks apart starting in mid-November.

Table 3.3. Mammals Identified at Pantex During 2022

Common Name	Scientific Name
Badger	*Taxidea taxus*
Black-tailed jackrabbit	*Lepus californicus*
Black-tailed prairie dog	*Cynomys ludovicianus*
Bobcat	*Lynx rufous*
Cottontail	*Sylvilagus spp*[a].
Coyote	*Canis latrans*
Deer Mouse	*Peromyscus maniculatus*
Domestic dog	*Canis familiaris*
Feral Cat	*Felis sylvestris*
Gray fox	*Urocyon cinereoargentus*
Mule deer	*Odocoileus hemionus*
Pronghorn	*Antelocapra americana*
Raccoon	*Procyon lotor*
Red Fox	*Vulpes vulpes*
Striped skunk	*Mephitis mephitis*
Virginia opposum	*Didelphis virginiana*
White-tailed Deer	*Odocoileus virginianus*

[a] Desert (*S. audubonii*) and eastern (*S. floridanus*) cottontails could occur on Pantex.

In 2022, a survey of black-tailed prairie dog colonies conducted with the assistance of Global Positioning System (GPS) equipment revealed that the colonies occupied about 571 ac at Pantex (including Pantex Lake: Figs. 3.3 and 3.4). Prairie dogs are occasionally controlled where they have spread into operational areas of concern. Prairie dog control was conducted in landfill and security buffer areas just west of Zone 4, along the east side of Zone 5 where the colony was encroaching on landfill areas, the 12-36 colony where it was encroaching on landfill and security areas and parts of the Playa 2 colony where it had expanded outside of Playa 2 and was encroaching on the tactical training facility and other landfill areas.

3.4.3 Birds

Migratory birds are an important part of Pantex's natural resources. K. D. Seyffert compiled a bird checklist for Pantex. It indicates the species and their abundances expected in Pantex area during various seasons of the year, based on habitat types and knowledge of migrations through the local area (Seyffert 1994). *The Integrated Plan for Playa Management at Pantex Plant and Wildlife Management at Pantex* (2021)

provides for monitoring of birds across Pantex. The all-time bird list for Pantex includes 209 species, a result of systematic transect and plot surveys, intensive research projects by university collaborators, trail camera photos, casual observations, and nuisance animal (bird) response.

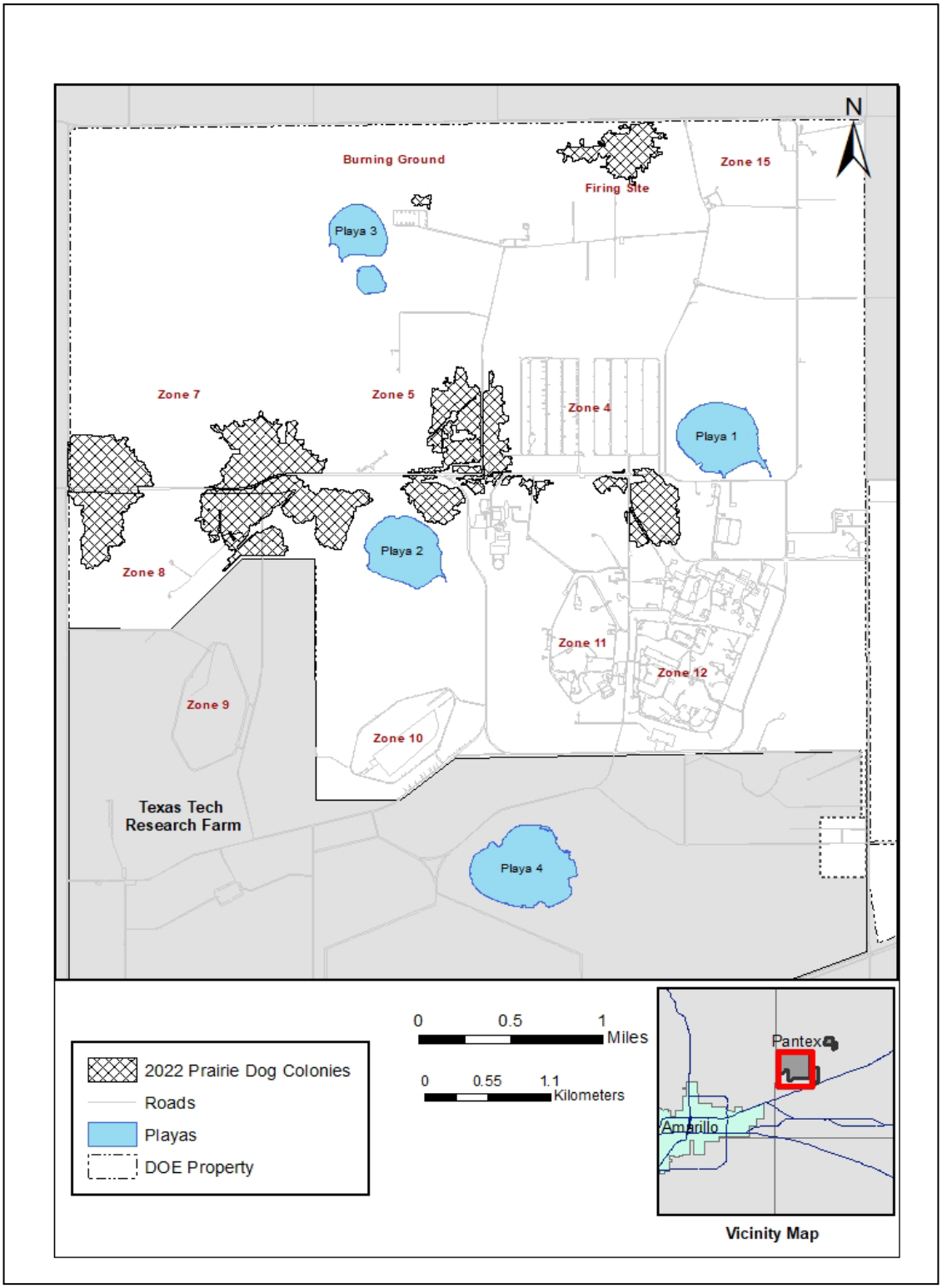


Fig. 3.3. Locations of Prairie Dog Colonies at Pantex, 2022

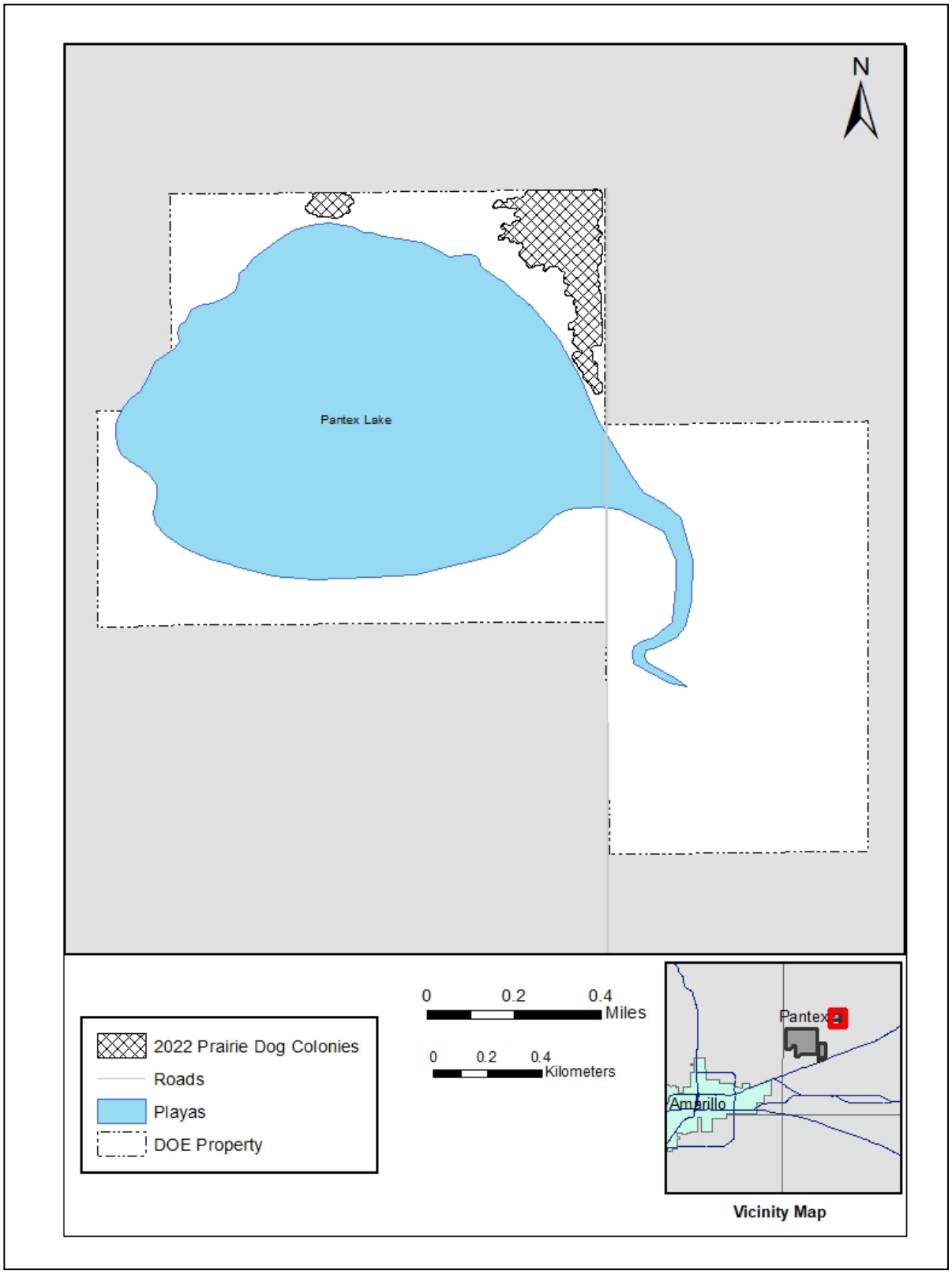


Fig. 3.4. Location of Prairie Dog Colonies at Pantex Lake, 2022

Currently, birds are recorded during work activities thus the distribution of sightings across Pantex is determined by staff field activity and work locations. During CY 2022, 59 species of birds were recorded across Pantex (Appendix A). The common poorwill (*Phalaenoptilus nuttallii*) was added to the all-time birds list in 2022. Security police officers spotted this bird in a high traffic area. They were concerned for the bird's safety, and reported it to the ECD's wildlife biologist who confirmed the sighting and checked on the health of the bird.

Pantex collaborates with York University, University of Manitoba, and the Purple Martin Conservation Association and maintains a study site for deployment of geolocator and GPS data-loggers on eastern purple martins (*Progne subis subis*) as part of an international collaboration studying this declining songbird. GPS technology has confirmed roost locations and habitat throughout the migrations and winter.

During CY 2022, Pantex and collaborators continued research into purple martins. Results from studies are routinely shared through various journal article, wildlife magazines, and presentations. These are acknowledged by USDOE as important contributions to federal migratory bird initiatives.

3.4.4 Amphibians and Reptiles

Seven species of reptiles and amphibians were recorded at Pantex in 2022 during field activities and nuisance animal responses (Table 3.4). The all-time amphibian and reptile list for Pantex includes 28 species.

Table 3.4. Amphibians and Reptiles Identified at Pantex During 2022

Common Name	Scientific Name
Bullsnake	*Pituophis melanoleucus sayi*
Checkered garter snake	*Thamnophis marcianus marcianus*
Desert kingsnake	*Lampropeltis getula splendidad*
Great plains skink	*Plestiodon obsoletus*
Great plains toad	*Bufo cognatus*
Prairie rattlesnake	*Crotalus viridis viridis*
Texas horned lizard	*Phrynosoma cornutum*

3.4.5 Pollinators

In 2022, ECD staff identified and monitored various locations across Pantex property for vegetation beneficial to pollinators, primarily the several species of milkweeds found on the property. These plants provide key habitat for the monarch butterfly (*Danaus plexippus).* The butterfly will lay its eggs on the milkweed plants, when these eggs hatch the larvae will feed on the milkweed as they grow. The toxins from the milkweed are deposited into the tissues of the larvae which provide protection from predation as the toxins generally taste bad to most insectivores and will make them sick if they eat the monarch butterfly or its larvae. Due to the importance of these plant species in the life cycle of the monarch butterfly, which is an important pollinator species that is in decline, ECD staff make efforts to protect these stands of milkweed whenever they are identified.

3.4.6 Nuisance Animal Management

In 2022, ECD staff addressed 148 nuisance animal situations. These included over 19 wildlife species. Twelve striped skunks were trapped and released to Wild West Wildlife Rehabilitation Center (WWWRC) by ECD. WWWRC is a non-profit, licensed wildlife rehabilitator operating in the Amarillo area and serving the entire Texas Panhandle. The center monitors the skunks for rabies and other diseases, provides vaccines

and necessary veterinary services then relocates the animals to suitable habitats once cleared. WWWRC also assisted ECD staff by providing assistance with two injured raptors that were found on Pantex property in 2022.

ECD staff had one skunk euthanized when it exhibited strange behavior; this animal was submitted to the State of Texas for rabies testing, which came back negative. Additionally, one cottontail rabbit also had to be euthanized and submitted for testing after exhibiting neurological symptoms consistent with rabbit hemorrhagic disease, which is an invasive, non-native disease that infects only rabbit species. The spread of this disease is being tracked across the country by the U.S. Department of Agriculture. Test results for rabbit hemorrhagic disease were negative leading ECD staff to believe that some kind of internal injury or endemic disease was the cause of these symptoms.

3.5 CULTURAL RESOURCES

Cultural resources identified at Pantex include archaeological sites from prehistoric Native Americans; standing structures that were once part of the World War II (WWII)-era Pantex Ordnance Plant (1942 – 1945); and buildings, structures, and equipment associated with Pantex's Cold War operations (1951 – 1991). In addition, many artifacts and historical documents have been preserved which are valuable sources for interpreting prehistoric and historic human activities at Pantex. Some of these cultural resources are eligible for inclusion in the *National Register of Historic Places* (*National Register*), thus requiring protection and preservation under the NHPA and related cultural resource management requirements. Pantex's cultural resource management program ensures compliance with all applicable state and federal requirements.

The goal of the cultural resources management (CRM) program is to manage Pantex's cultural resources efficiently and systematically, taking into account both Pantex's continuing mission and historic preservation concerns. This goal is achieved through coordination with Pantex's project review process for compliance with the National Environmental Policy Act (NEPA), and through consultation with the SHPO and the President's Advisory Council on Historic Preservation (Advisory Council). In October 2004, DOE, Pantex, the Texas SHPO, and the Advisory Council completed execution of a PA/CRMP (Pantex 2004). The PA/CRMP provides for the systematic management of all archaeological and historic resources at Pantex under a single document. It ensures compliance with Section 106 of the NHPA, providing for more efficient and effective review of Pantex projects having the potential to impact prehistoric, WWII-era, and Cold War-era properties, objects, artifacts, and records. In addition, the PA/CRMP outlines a range of preservation activities planned for Pantex's compliance program. No changes were made to the program in 2022. NPO and Pantex Cultural Resources staff began consultation with the Texas SHPO, Advisory Council, Native American tribes, and interested parties to revise and update the PA/CRMP. A signed and approved document is expected in 2023.

3.5.1 Archaeology

Pantex lies within the southern Great Plains archaeological province; specifically, it is within the High Plains Ecological Region of the Texas Panhandle. Approximately half of the DOE-owned and leased land at Pantex has been systematically surveyed for archaeological resources. Based upon those surveys, a site-location model was developed. In 1995, a 2,400-ac survey confirmed that prehistoric archaeological sites at Pantex are situated within approximately 0.25 mile of playas or their major drainage locations. Conversely, such sites do not occur in inter-playa upland areas (Largent, 1995).

Sixty-nine archaeological sites have been identified at Pantex consisting of 57 Native American prehistoric sites, represented by lithic scatters of animal bone artifacts, and 12 Euro-American farmstead sites, represented by foundation remains and small artifact scatters. In consultation with the SHPO, Pantex determined that the 12 historic sites are not eligible for inclusion in the *National Register*. Pantex and the SHPO concluded that two of the 57 prehistoric sites (41CZ66 and 41CZ23) are potentially eligible for the *National Register* but that additional field work would be required to make a final eligibility determination.

Pantex will continue to protect these two sites and monitor them on a regular basis, as though they are eligible. If additional features are exposed and found, excavation will proceed if they cannot be adequately protected in-situ. These exposed features will be analyzed, mapped, collected and excavated by appropriate archaeological methods. All archaeological reports, records, photographs, maps and artifacts will be archived at Pantex in accordance with applicable federal regulations. In addition, 22 of the prehistoric sites are protected within playa management units surrounding the four DOE-owned playas.

In the fall of 1996, Pantex personnel monitoring for erosion discovered a number of large bones belonging to a bison. An emergency excavation was completed under the supervision of a qualified archaeologist. The bones were identified, preserved, and placed in a permanent exhibit within the Pantex Access Control Facility.

In 2022, staff members monitored archaeological sites on four separate occasions. Staff members found zero artifacts during the year.

3.5.2 World War II

In 1942, the U.S. Army Ordnance Department chose this site for construction of a bomb-loading facility. The 16,000-ac industrial Pantex Ordnance Plant, designed and constructed in only 9 months, sprang up in the middle of a traditional rural farming and ranching community, bringing with it great social and demographic change. It was constructed by the USACE and operated by the Certain-teed Products Corporation to produce bombs and artillery shells.

The WWII-era historical resources of Pantex consist of 118 standing buildings and structures, all of which have been surveyed and recorded. In consultation with the SHPO, Pantex has determined that these properties are not eligible for inclusion in the *National Register* within a WWII context. The WWII-era buildings and structures have been preserved to some extent through survey documentation, photographs, individual site forms, and oral histories.

The Pantex Records Operation Center continues to maintain and store historical records and a variety of different media for preservation purposes. Records include facility maps, aerial maps and additional Cold War as-built drawings, as well as Pantex layout plans of former zones. In addition, a collection of Cold War-era photographs, written material, and other items have been collected and stored.

3.5.3 Cold War

The NHPA typically applies only to historic properties that are at least 50 years old unless they are of "exceptional importance" (NPS Bulletin 15). One hundred eighty-one facilities used during the Cold War are eligible for inclusion in the *National Register* under the Cold War context. Many properties at Pantex are associated with the Cold War arms race and are of exceptional importance. As a final assembly, maintenance, surveillance, and disassembly facility for the nation's nuclear weapons arsenal, Pantex lies at the very heart of Cold War history.

The period of Cold War operations at Pantex date from 1951 to September 1991. In 1951, the AEC reclaimed Pantex as part of the expansion of the nuclear weapons complex. In September 1991, Pantex mission changed from one of nuclear weapon assembly to one of disassembly when President, George H.W. Bush addressed the nation, directing the dismantlement of a portion of the nation's nuclear weapon stockpile. The Cold War-era historical resources of Pantex consist of approximately 590 buildings and structures and a large inventory of process-related equipment and documents. The historical resources of this period are among Pantex's most significant, and offer a valuable contribution to the nation's cultural heritage.

Pantex 25-Year Master Site Plan (2021), specifically lists improvements and preservation of buildings listed in the PA/CRMP for in-situ preservation (Pantex 2004). The ten facilities designated for in-situ preservation are additionally included in all NEPA reviews. Cultural resources management personnel review NEPA documentation to identify adverse effects on historical structures, objects, and archaeological sites. Historical equipment, tooling, trainers, and other components have been and continue to be acquired,

inventoried, and moved into a historical facility. Preservation activities continue through the identification and evaluation of facilities; maintenance of an unclassified historical exhibit and railcar displays; collection of artifacts and records; monitoring of archaeological sites; educational outreach; and other preservation activities. Sixty-eight outreach activities for Pantex history occurred in CY 2022, including history presentations to newly hired staff members, students, and community leaders. Due to the COVID-19 pandemic, outreach opportunities were limited in 2022. These projects strengthen continued use of the historical facilities, and confirm Pantex pledge for implementing preservation activities.

3.6 EDUCATIONAL RESOURCES AND OUTREACH OPPORTUNITIES

Pantexans donated their time and talent to area schools by speaking to students about the various careers available at Pantex. National Engineers Week and Introduce a Girl to Engineering in February help stimulate students' interest in science, technology, engineering, and math. For 30 years, the Pantex Regional Science Bowl has given middle school and high school students across the Texas Panhandle a chance to compete for the opportunity to advance to the National Science Bowl. In addition, Pantex supported area schools with its robotics programs.

For many years ECD staff have been a part of a research partnership in which eastern purple martins are banded and tagged with GPS locators at an off-site study location, maintained by a local wildlife biologist and bird enthusiast. In 2022, staff members assisted in several "deployment" days in which natural resources and biology program students as well as members of the public are invited to come out and participate in banding purple martins; as well as affixing the GPS locator backpacks to suitably aged birds. This provides valuable experience to the students to help round out the training and skill they are acquiring in their studies of the life sciences. It also introduces children and members of the general public to a key aspect of bird conservation and promotes active "citizen science" in the community.

Many events were held virtually this year because COVID protocols were required. Pantexans continue to show their ability to be flexible and help make each one a success. With all the challenges that the community faced this year, Pantexans showed their support by continuing to give to the United Way of Amarillo and Canyon.

3.7 ENVIRONMENTAL RESTORATION

Historical waste management practices at Pantex resulted in impacts to on-site soil and perched groundwater. These historical practices included disposal of spent solvents in unlined pits and sumps, and disposal of HE wastewater and industrial wastes into unlined ditches and playas. As a result, HEs, solvents, and metals were found in the soil at solid waste management units (SWMUs) at Pantex and in the uppermost (perched) groundwater beneath Pantex. Pantex and regulatory agencies identified 254 units for further investigation and cleanup. Investigations that identified the nature and extent of contamination at SWMUs and associated groundwater were submitted to the TCEQ and EPA in the form of RCRA Facility Investigation Reports. Those investigation reports closed many units through interim remedial actions and No Further Action determinations. Other units were evaluated in human health and ecological risk assessments to identify further remedial actions necessary to protect human health and the environment. Fig. 3.5 depicts the location and status of the units. The 15 units still in active use will be closed in accordance with CERCLA and RCRA permit provisions when they become inactive, are determined to be of no further use, and funding is obtained for investigation, cleanup, and closure of the site. One of these units is now inactive and funding has been requested to address the formerly active site.

Those units requiring further remedial actions were assessed in a Corrective Measures Study to identify and recommend final remedial actions. A detailed summary of actions for the 254 units can be found in the *Record of Decision for Groundwater, Soil and Associated Media*, (Pantex Plant and Sapere 2008). The final approved remedial actions are detailed in the Record of Decision (ROD). Ongoing remedial actions focus on the following:

- Cleanup and removal of perched groundwater to protect the underlying drinking water aquifer,
- Removal of soil gas and residual non-aqueous phase liquid (NAPL) in the soil at the Burning Ground for future protection of groundwater resources,
- Institutional controls to protect workers, control perched groundwater use, and control drilling into and through perched groundwater
- Maintenance of soil remedies (ditch liner and soil covers) for groundwater protection.

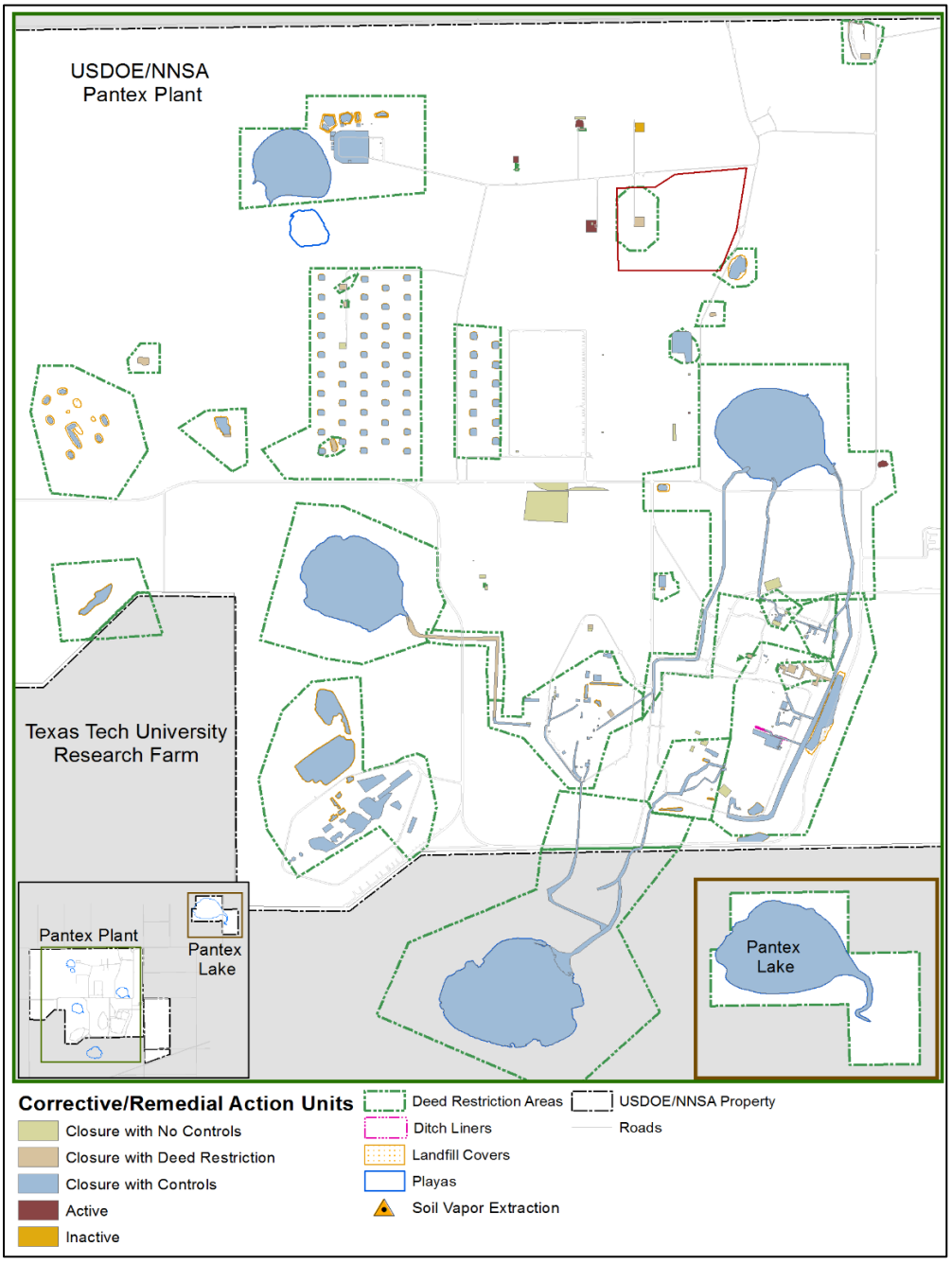


Fig. 3.5. Location and Status of Solid Waste Management Units

3.7.1 Environmental Restoration Milestones

During 2022, Pantex completed several milestones under the continued long-term stewardship (LTS) of environmental units. LTS includes the long-term operation and maintenance (O&M) of the remediation systems, monitoring of the systems to ensure that cleanup goals established in the ROD and Pantex Hazardous Waste Permit will be met, maintenance of soil remedies and institutional controls, and reporting of that information to regulatory agencies and the public. Major Milestones for the 2022 remedial actions are shown in Fig. 3.6 and Remedial Action Systems at Pantex are depicted in Fig. 3.7.

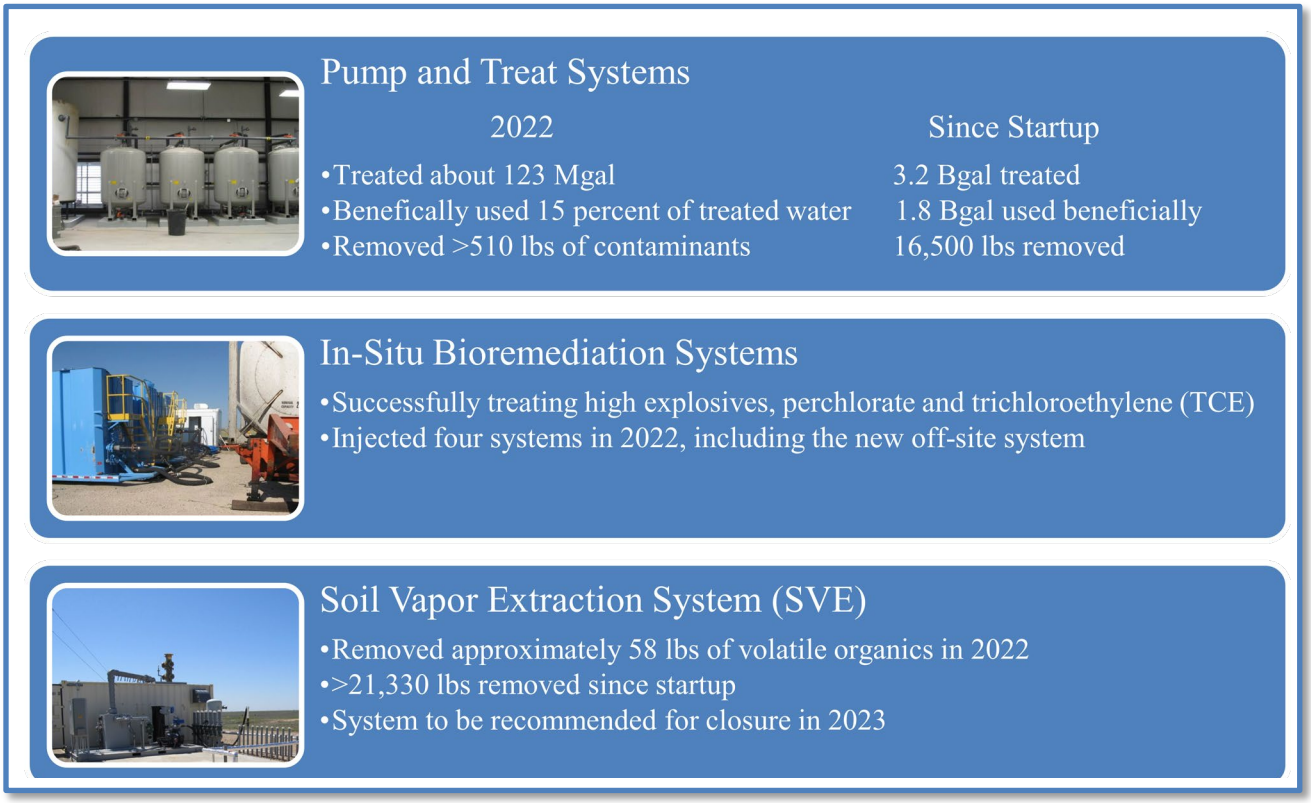
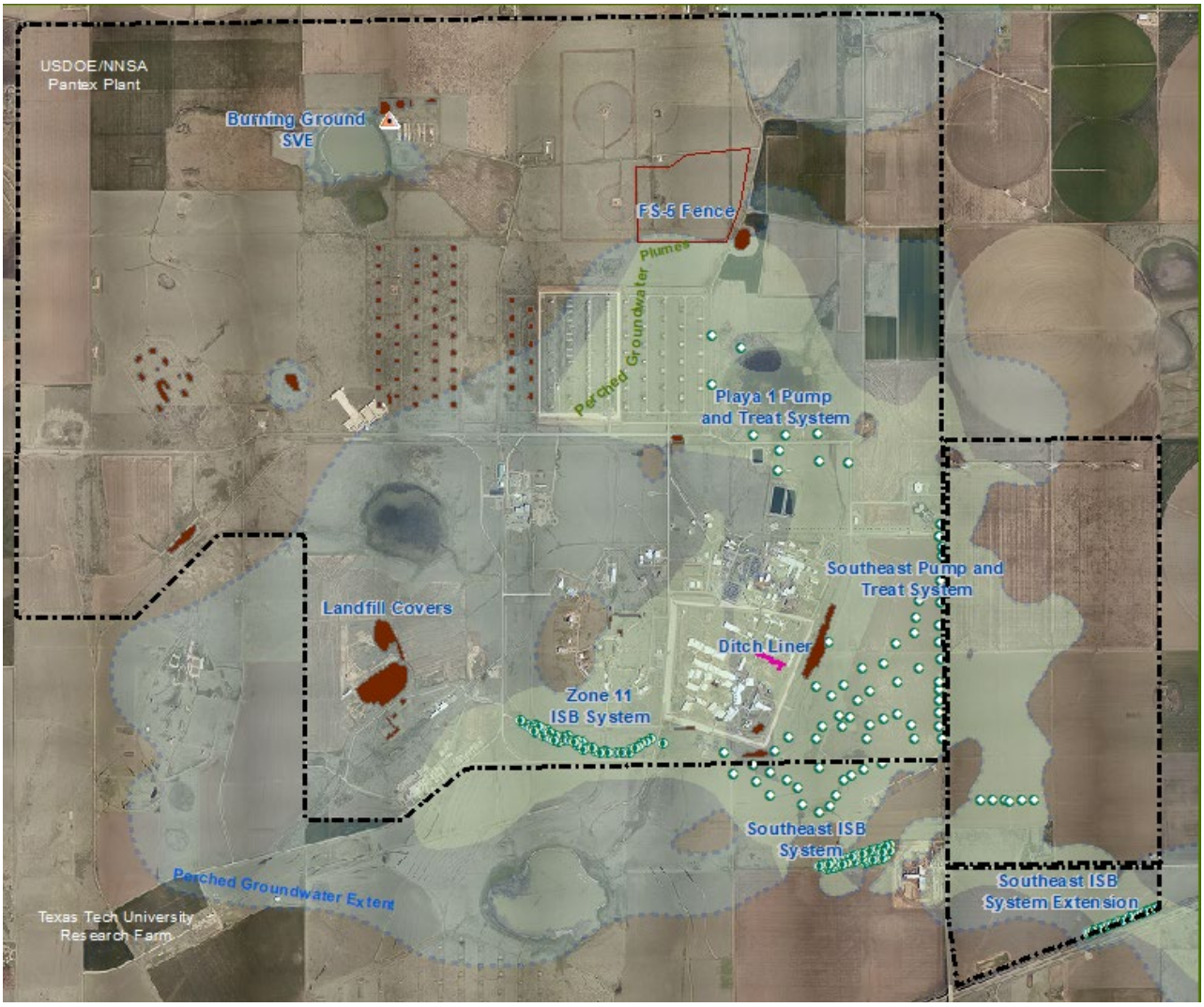


Fig. 3.6. Major Milestones for 2022 Remedial Actions

To reach the goal of reducing saturated thickness, the pump-and-treat systems have a goal of operating 90 percent of the time and at 90 percent of treatment capacity if the wastewater treatment facility and irrigation system can receive all of the treated water. Pantex revised the goals during 2014 to prioritize treatment and use of the water to align operation with the goal of reducing saturated thickness. During 2022, only fifteen percent of the treated water was beneficially used due to the shutdown of the subsurface irrigation system resulting from the filter bank break that occurred in 2017. The two pump-and-treat systems were managed to maximize capture of the HE plumes to control movement of the groundwater plumes. Performance of the pump-and-treat systems for 2022 is depicted in Figs. 3.8, 3.9, and 3.10.

The filter bank break has been repaired, but work continues to repair the subsurface irrigation system due to impacts from an extended shutdown. Because the subsurface irrigation system was not available in 2022, treated water continues to be discharged to Playa 1 or injected into the perched groundwater when in-situ bioremediation (ISB) injection is not needed. Due to expansion of the high explosive plume to the southeast, Pantex managed the two systems in 2022 to improve capture of the HE plumes. This required the Playa 1 Pump-and-Treat System (P1PTS) to be shut down during most of 2022, with operation only occurring once

quarterly to ensure continued operability of the system. P1PTS operation was also affected by the tie-in to the new irrigation system, requiring a continuous shutdown in the last half of 2022. The Southeast Pump-and-Treat System (SEPTS) was operated during the year to improve capture of the plumes.



Groundwater Remedies:

- 2 Pump & Treat Systems
  - Playa 1 Pump and Treat
  - Southeast Pump and Treat
- 3 In-Situ Bioremediation (ISB) Systems
  - Zone 11 ISB
  - Southeast ISB
  - Southeast ISB Extension
- Institutional Controls

Soil Remedies:

- Ditch Liner
- Soil Covers on Landfills
- Fencing at FS-5 to control use/access
- Institutional Controls
- Soil Vapor Extraction (SVE) System
- Institutional Controls

Fig. 3.7. Remedial Action Systems at Pantex

Injection was used at one well to improve output at SEPTS; however, permit restricted water release to Playa 1 required reduced output at the SEPTS during the year unless ISB injections were occurring.

To reduce the need for release to Playa 1 or injection into perched aquifer wells, Pantex contracted for the design and construction of a surface irrigation system on Pantex property east of FM 2373 in 2021.

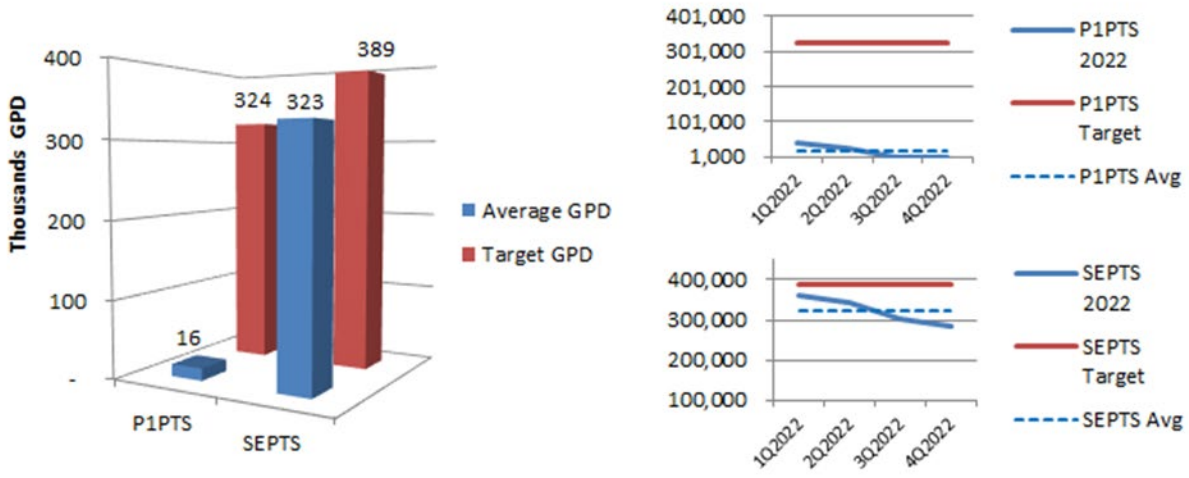
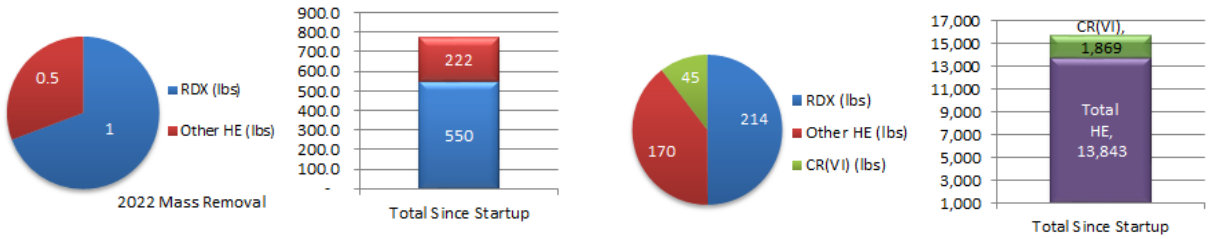


Fig. 3.8. 2022 Pump-and-Treat Systems Performance



P1PTS Mass Removal **SEPTS Mass Removal**

Fig. 3.9. 2022 Pump-and-Treat Systems Operation and Mass Removal

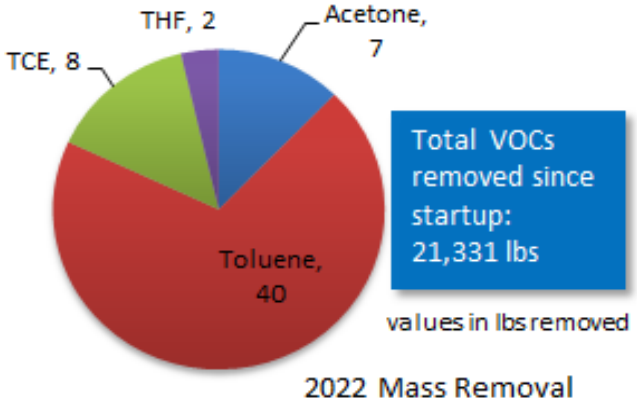


Fig. 3.10. 2022 SVE Mass Removal

The system design was complete in May 2021. Construction of the irrigation system began in late 2021 and will be completed in summer 2023.

In addition to removing impacted water from the perched aquifer, the pump-and-treat systems remove contaminant mass from the groundwater that is extracted from the aquifer. The P1PTS primarily removes the HE Royal Demolition Explosive (RDX) and the SEPTS primarily removes RDX and hexavalent chromium. Fig. 3.9 provides the mass removal for HEs and chromium for 2022, as well as totals since start-up of the systems. The SEPTS has been operating longer, and the greatest concentrations of HEs are found in the SEPTS extraction well field, so mass removal is higher at that system. P1PTS throughput and mass removal was also affected by shutdowns in 2022.

3.7.2 In-Situ Bioremediation Systems

Four ISB systems (Zone 11 ISB, Southeast ISB, Southeast ISB Extension, and Off-site ISB) are in operation at Pantex where pump-and-treat technology is not effective. These on-site systems are designed with closely spaced wells to set up a treatment zone in areas of the perched groundwater to control plumes migrating off-site, to TTU property south of Zone 11, or where the area is sensitive to vertical migration of contaminants of concern (COCs) to the underlying aquifer. The new system was designed to cleanup COCs that have moved to off-site areas. Amendment is injected into the treatment zone to provide a food source for naturally occurring bacteria that break down the COCs. Monitoring wells were installed down-gradient

of the groundwater flow from the treatment systems to monitor whether the system is effectively degrading the COCs. A discussion of treatment zone effectiveness and down-gradient performance monitoring well information is included in Chapter 6. Pantex started injecting into the available wells at the new off-site ISB Extension in 2021. Full installation of the off-site ISB is planned for completion in 2023.

3.7.3 Burning Ground-Soil Vapor Extraction

A soil vapor extraction (SVE) system was installed and has been operating at the Burning Ground since February 2002. After a large-scale system remediated a significant area at the Burning Ground, a small-scale activated carbon system was installed in late 2006 after the large-scale system became inefficient at continued removal of non-aqueous phase liquid (NAPL). The current system, consisting of a small-scale catalytic oxidizer and wet scrubber, was installed in early 2012 to replace the activated carbon system. The system was modified in 2017 to increase air flow through the soils to increase remediation and evaluate the system for closure. The current system continues to focus on treating residual soil gas and NAPL at a single well (SVE-S-20) where soil gas concentrations continue to remain high. Pantex began actively pulsing the system in 2020 to gain information relating to closure. Data collected in 2021 and 2022 indicates the NAPL source is nearly depleted and that shutdown of the system is viable in the near future. As depicted in Fig. 3.10, the SVE system removed about 58 pounds of VOCs during 2022.

3.7.4 Soil Remedies and Institutional Controls

Institutional controls are required as part of the LTS of soil remedial action units at Pantex. Deed restrictions have been placed on all soil units with the exception of the active units. All SWMUs at Pantex are restricted to industrial use. To support the deed restrictions, Pantex maintains long-term control of any type of soil disturbance in SWMUs to protect human health and to prevent spread of contaminated soils.

Pantex also regularly inspects and maintains soil covers on landfills to prevent infiltration of water into the landfill contents and migration of impacted water to groundwater. The ditch liner is also regularly inspected and maintained to prevent infiltration of water through soils that have been impacted by past releases.

3.7.5 Second Five-Year Review

The five-year review is conducted to ensure that remedial actions for soils and groundwater at Pantex remain protective of human health and the environment. Pantex started the second five-year review in May 2017 and regulatory approval for the final report was received in September 2018. The results of the review indicate that the selected remedy is performing as intended and is protective of human health and the environment in the short-term because there are no completed exposure pathways to human or environmental receptors for soil or perched groundwater. In order to achieve long-term protectiveness of human health and the environment, O&M of the remedial action systems must continue and enhancements to existing systems and institutional controls need to be evaluated, planned, and implemented. Pantex completed the action items included in the approved five-year review in 2022. The next five-year review began in fourth quarter 2022 and is scheduled for completion in 2023.

3.7.6 Long-Term Groundwater Monitoring

Pantex transitioned to the long-term monitoring (LTM) network in July 2009. The groundwater monitoring network was developed to evaluate the effectiveness of the remedial actions. The evaluation is conducted to ensure that the remedial system is effective in stabilizing plumes and meeting cleanup goals, to detect any new COCs from source areas or in the drinking water aquifer, and to evaluate the presence and amount of natural attenuation that may be occurring in the groundwater plumes. The monitoring information collected is evaluated and reported in annual and quarterly progress reports and is summarized in Chapter 6 of this report. The quarterly and annual reports can be found at www.pantex.energy.gov.

3.8 ENVIRONMENTAL MONITORING

DOE O 458.1 *Radiation Protection of the Public and Environment* requires the performance of monitoring that is integrated with the general environmental surveillance and effluent monitoring programs in order to do the following:

- Assess impacts
- Characterize exposures and doses to individual members of the general public, to the population, and to biota in the vicinity of Pantex
- Detect, characterize and respond to releases from DOE activities
- Demonstrate compliance with applicable regulatory and permit limits

The monitoring program with its associated planning, implementation, and assessment phases was designed based upon the system described in the *EPA QA/G-1, Guidance for Developing Quality Systems for Environmental Programs*. Another document useful in the continuous improvement of the design of Pantex monitoring program was Report No. 169, *Design of Effective Radiological Effluent Monitoring and Environmental Surveillance Programs*, published by the National Council on Radiation Protection and Measurements (2010). Although this document specifically addresses radiological effluent monitoring and surveillance, the authors note that many of the concepts described are appropriate for non-radiological contaminants that must also be monitored.

Planning for the environmental monitoring program begins with the development of (or revision of previously existing) monitoring requirements by the various environmental SME (for environmental media including but not limited to air, water, soil, and biota) by a process based upon that described in *EPA QA/G4, Guidance for Data Quality Objective Process* (2006). When planning sample collection locations and frequencies for various environmental media, SME must consider several factors including the following:

- Purpose of the monitoring program
- Trend of historical results from previous sampling
- Predominant wind direction
- Presence of a sufficient quantity of a target species for analysis

Through permits issued to Pantex, specifications for sampling locations and frequencies by a regulatory body (such as TCEQ or EPA) have also been used in the development of certain monitoring programs. When feasible, sample plans include taking samples at the same geographical location for several environmental media to allow an individual media scientist to compare results from other media and determine the usability of the data.

The implementation of these plans begins with the collection of samples by technicians using procedures contained within an Environmental Sampling and Analysis Manual. In addition to procedures common to all environmental media (such as those associated with completion of sampling logs and Chain-of-Custody forms), the manual contains procedures specific to each different environmental media. These specific procedures are based upon the collection protocols included in different national consensus standards. The majority of the analyses of Pantex environmental samples are completed by independent laboratories under a scope of work that requires the analysis of Pantex samples be conducted by protocols that are equivalent to those in consensus standards. A limited number of analyses including those for preliminary analysis of certain water samples are performed on-site. In addition, Radiation Safety Department personnel perform analyses of the environmental TLDs discussed later in Chapter 4. In some instances, analysis results were not available due to drought conditions, electrical power failures during sample collection, or laboratory errors during analysis.

Data assessment processes were employed by Pantex to verify that the data collected for the monitoring programs met the specified data acceptance criteria. These processes included evaluation of sampling quality assurance (QA), laboratory technical performance and QA, and data verification and validation. Chapter 12 in this document contains a discussion of the program used to ensure that the environmental monitoring data meet the appropriate data quality requirements.

The results of the data assessment processes described above and management reviews performed for the monitoring programs were then used as feedback for periodic revisions of the monitoring requirements. The revisions may include changes to the analytes being monitored, as wells as locations and frequencies of sample collection.

Media-specific descriptions of the sampling locations and the results of the monitoring program for samples collected during 2022 are contained in Chapters 4-11 of this report.

CHAPTER 4 - ENVIRONMENTAL RADIOLOGICAL PROGRAM

Pantex's environmental radiological monitoring program is conducted according to DOE Order 458.1, Radiation Protection of the Public and the Environment. The program involves measuring radioactivity in environmental samples in addition to calculating the potential radiological dose to the off-site public. The program monitors for the principal radionuclides in air, groundwater, drinking water, surface water, flora, and fauna samples associated with Pantex operations: tritium, uranium-234 (U-234), uranium-238 (U-238), and plutonium-239 (Pu-239). The radionuclides U-234, U-238, and Pu-239 emit primarily alpha particles although gamma radiation emissions from these radionuclides were also monitored and evaluated. Tritium emits beta particles.

Chapter Highlights

- Monitoring results for the environmental radiological pathways in 2022 indicated levels substantially below relevant standards, similar to results from previous years, and consistent with background conditions.
- There were no unplanned releases of radioactive material during 2022.

4.1 RADIOLOGICAL DISCHARGES AND DOSES

DOE O 458.1 requires radiological activities be conducted in a manner so that exposure to members of the public from ionizing radiation from all DOE sources and exposure pathways shall not cause, in a year, a total effective dose greater than 100 millirem (mrem) (1 milliSiervert [mSv]). At Pantex, demonstration of compliance with this limit is documented by a combination of measurements and calculations including the comparison of concentrations of radioactive material in air and water to Derived Concentration Standards (DCSs) listed in DOE-STD-1196-2021, *DOE Derived Concentration Technical Standard*. The DCS values are derived in accordance with dose limitation systems recommended by the International Commission on Radiological Protection in its several publications (2007). These standards are used by the Environmental Protection Agency (EPA), the Nuclear Regulatory Commission, and other regulatory bodies including DOE in establishing regulatory limits for radiological protection. These regulatory limits are purposely set at levels well below those known to cause any adverse effects on the public and/or the environment.

4.1.1 External Radiation Pathways

DOE O 458.1 requires evaluations to demonstrate compliance with the dose limits described in Section 4.1, above. It is DOE and Pantex policy that radiological activities at Pantex are designed to ensure that any dose above that due to background radiation is as low as reasonably achievable (ALARA). Evaluations consider several exposure pathways including direct external radiation from sources located on-site, external radiation from airborne radioactive material, and external radiation from radioactive material deposited on surfaces off-site. At Pantex, external gamma radiation is measured at several locations at or near the site to determine the magnitude of any dose from these pathways. Additionally, external radiation dose is measured at numerous locations around the perimeter of Pantex by the TDSHS Laboratory Services Section (TDSHS 2022). Measurements of external radiation, collected by Pantex and the State of Texas, continue to indicate that activities at Pantex do not contribute significantly to the exposure of workers, members of the public, or the environment to ionizing radiation.

4.1.2 Air Pathway

DOE O 458.1 further requires that internal doses to members of the public from inhalation of airborne effluents be evaluated using the EPA's Clean Air Act Assessment Package -1988 (CAP-88-PC) model (or

another EPA-approved model or method) to demonstrate compliance with applicable subparts of Title 40 of the Code of Federal Regulations (CFR), Chapter 61, *National Emission Standards for Hazardous Air Pollutants*. Compliance with the limit for emissions to the airborne pathway of radionuclides, other than radon established by the EPA in 40 CFR 61.92, is demonstrated at Pantex by calculating the effective dose equivalent received by a maximally exposed individual (MEI) using the CAP-88-PC model (EPA 402-B-92-001). The MEI is a theoretical person who resides near Pantex, and who would receive, based on assumptions about lifestyle, the maximum exposure to radiological emissions and therefore, the highest effective dose equivalent from Pantex operations.

Meteorological data used in this modeling effort was obtained from the meteorological tower from the Amarillo NWS station at the Rick Husband International Airport. The source term for releases to air was calculated based on process knowledge of the releases of radionuclides from the routine operations at Pantex (e.g., calibration of radiation detection instrumentation and operations at the Burning Ground and Firing Sites), the number of operations conducted during the year, and other modifying factors. In estimating the emissions, conservative assumptions concerning the form of the radioactive material and the presence or absence of engineering controls such as high-efficiency particulate air filters are made to ensure that maximum potential emissions are modeled. A small percentage (less than 0.001 percent) of these calculated emissions is due to emissions of U-238 and other radionuclides from various routine Pantex activities, while the balance is due to emissions of tritium. These emissions are summarized in Table 4.1 below.

Table 4.1. Pantex Radiological Atmospheric Emissions in Curies (Bq)

Tritium	Total Uranium	Total Plutonium	Total Other Actinides	Other
7.369E+00 (2.727E+11)	2.839E-07 (1.051E+04)	7.529E-13 (2.786E-02)	4.882E-09 (1.806E+02)	None

Based on the 2022 operational data, the results of the CAP-88-PC modeling indicate that the MEI for 2022 located approximately 2.3 km northeast of Zone 12 would have received a dose of 2.20E-04 mrem/year (2.20E-06 mSv/yr). This dose is significantly below the EPA's maximum permissible exposure limit to the public of 10 mrem/yr. specified in 40 CFR 61, Subpart H. The indicated dose is also equivalent to 2.20E-03 percent of the DOE Public Dose Limit for all pathways. Based upon the same CAP-88-PC modeling results, the collective population dose equivalent received by those living within 80 km (50 mi) of Pantex would have been 1.10E-03 person-rem/year (1.10E-05 person-Sievert/year) in 2022. The majority of this collective population dose equivalent is contributed by tritium.

As in previous years, the effective dose equivalent for the MEI is substantially less than 0.003 percent, i.e., less than three one-thousandths of one percent, of the regulatory limit. Effective dose equivalents for the last five years are shown in Table 4.2 below. Variation in the doses between years is due to changes in the emissions of tritium and isotopes of uranium associated with different operations such as instrument calibration, processing of certain HE components, and waste treatment operations during the different years. As part of Pantex's overall efforts to continuously improve the ALARA program, a more protective assumption was made for the CAP88 modeling of the site's dose for 2022. This administrative change led to the model calculating a dose that, while numerically higher from previous years, is still extremely low, i.e., less than 0.003 percent of the regulatory limits. The collective population dose equivalent for the same years is also substantially less than 0.003 percent of the regulatory limit.

Table 4.2. Effective Dose Equivalent for Maximally Exposed Individual Member of General Public during CYs 2018-2022

Year	Maximally Exposed Individual Dose (mrem)	Population Dose (Person-rem/yr.)
2018	1.70E-06	2.41E-06
2019	7.24E-08	1.50E-07
2020	1.27E-07	7.23E-07
2021	4.11E-08	2.17E-07
2022	2.20E-04	1.10E-03

4.1.3 Water Pathway

In addition to promulgating the dose limit mentioned above, DOE O 458.1 requires operators of DOE facilities discharging or releasing liquids containing radionuclides from DOE activities to conduct such activities in such a manner as to:

- Protect groundwater resources;
- Not cause private or public drinking water systems to exceed the drinking water maximum contaminant limits outlined in 40 CFR 141, *National Primary Drinking Water Regulations*; and
- Comply with other limitations as applicable.

Current Pantex policy does not allow the discharge of radioactive material in liquid effluent discharges to groundwater or to sanitary sewers, thus eliminating any future potential impact to groundwater from those sources. Compliance with 40 CFR 141.66 maximum contaminant level (MCL) limitations for individual radionuclides potentially released from Pantex activities, with the exception of tritium, is demonstrated by comparing measured concentrations of radionuclides in drinking water to four percent of the DCS values for ingested water. The current average annual concentration of tritium tabulated in 40 CFR 141.66 which is assumed to produce the same four mrem dose equivalent is 20,000 pCi/L. The results of these measurements as well as those for other water monitoring programs did not indicate releases to any water pathway and thus no contribution to the total effective dose from Pantex activities during 2022.

4.1.4 Other Pathways

Pantex has considered doses, which might arise from radioactive materials ingested with food from terrestrial crops, animal products, and aquatic food products (including plant and animal species). The results of the faunal monitoring measurements and monitoring of native vegetation and crops did not indicate releases to either pathway from Pantex activities during 2022.

As will be discussed in more detail below, the current program concerning the release of property containing residual material has been designed to ensure that such releases are ALARA. Public doses from this pathway are negligible.

4.1.5 Public Doses from All Pathways

The dose equivalent received by the MEI during 2022, the 2022 collective population dose, and the 2022 natural background population dose are presented in Table 4.3. Because there were no releases from Pantex to the water or other pathways, the air pathway dose represents the public dose from all pathways.

Table 4.3. Pantex Radiological Doses in 2022

Dose to Maximally Exposed Individual from Pantex Operations mrem (mSv)	Percent of DOE 100-mrem Limit	Estimated Population Dose from Pantex Plant Operations person-rem (person-Sv)	Population within 80 km (50 mi)	Estimated Naturally Occurring Radiation Population Dose at Pantex (person-rem)
2.20E-04 (2.20E-06)	2.20E-04	1.10E-03 (1.10E-05)	360,000	100,800

4.2 RELEASE OF PROPERTY CONTAINING RESIDUAL RADIOACTIVE MATERIAL

DOE O 458.1 provides requirements for the clearance of potentially contaminated material and equipment (M&E) from Pantex to the public. The order distinguishes real property (land and structures) from personal or non-real property (any materials not land and structures) in its discussion of clearance. To implement the requirements of the Order, DOE requires that the property that has been or is suspected of being contaminated with radioactive material be adequately surveyed (radiologically characterized) to ensure that the property meets pre-approved DOE authorized limits prior to clearance to the public. DOE O 458.1 specifically indicates that previously approved guidelines and limits (such as those developed for compliance with DOE O 5400.5) may continue to be applied and used as pre-approved authorized limits until they are replaced or revised by pre-approved authorized limits issued under the new order. Clearance of potentially radioactive contaminated M&E to the public is managed with the consistent and appropriate application of one set of clearance criterion based upon the surface activity guidelines established in DOE O 5400.5.

Since 1993 Pantex's clearance process, as stated in the *Pantex Radiological Control Manual* (MNL-RS0001), requires the Radiation Safety Department's evaluation of any potentially contaminated M&E using process and forms including:

- Radiation Safety Department's approval for M&E that is to be excessed,
- PX-4008, *Waste Operations Department Scrap Metal Disposition Form*, for disposition of any scrap metal (in compliance with former DOE Secretary Richardson's moratorium on recycling certain metals);
- PX-2643, *Material Evaluation Form*, for release of all waste,
- PX-691, *Shipment Request*, for release of outbound non-weapon shipments,
- PX-2189, *Radiation Safety Material Clearance*, for M&E not covered by one of the preceding method, and/or
- PX-3134, *Process Knowledge*, for nonradioactive M&E having no potential for radioactive contaminated surfaces.

The application of Pantex clearance process has resulted in no releases of personal property with surface contamination in excess of the indicated levels.

DOE O 458.1 requires that personnel independent of contractor personnel conducting property clearance activities perform verification. At Pantex, a Waste Certification Official who is independent from organizations producing, accumulating, transporting, or performing radiological characterizations and/or surveys of weapons components and certain categories of mixed low-level waste destined for burial at the Nevada National Security Site, performs the verification.

The volume of radiological waste generated at Pantex during 2022 is discussed in Chapter 2. As there were no releases of real property containing residual radioactive material during 2022 those values represent the quantities of personal property released from Pantex in 2022.

4.3 RADIATION PROTECTION OF BIOTA

DOE O 458.1 contains no specific limits for radiation doses to aquatic animals, terrestrial plants, and terrestrial animals. However, it requires the use of DOE-STD-1153-2019, *A Graded Approach for Evaluating Radiation Doses to Aquatic and Terrestrial Biota*, or equivalent methodologies, to demonstrate that radiological activities are conducted in a manner that protects these populations from adverse effects due to radiation and radioactive material released from DOE operations. This requirement has the effect of limiting the dose to 1 rad/day (10 milligray [mGy]/day) for aquatic animals and terrestrial plants and to 0.1 rad/day (1 mGy/day) for terrestrial animals (NCRP Report No. 109, International Atomic Energy Agency).

During 2022, there was sufficient precipitation near Playa 1, in addition to discharge from the wastewater treatment facility, for the collection of surface water and sediment samples. These samples were analyzed for tritium, U-234, U-235, U-238, and Pu-239/240. To implement the DOE-STD-1153-2019, the radionuclide concentrations obtained were entered into the DOE calculation tool (RAD-BCG) with the standard and compared to biota concentration guide (BCG) limits for aquatic and terrestrial systems in the technical standard.

Estimated concentrations of the indicated radionuclides in the sediment were obtained by multiplying the measured aqueous concentrations by isotope-specific solid/solution distribution coefficients tabulated for the measured radionuclides in the standard. The value for each radionuclide was automatically divided by the BCG for that radionuclide to calculate a partial fraction for each nuclide for each medium. Partial fractions for each medium were added to produce a sum of fractions.

The dose limit for aquatic animals would not be exceeded if the sum of fractions for the water medium plus that for the sediment medium is less than 1.0. Similarly, the dose limits for both terrestrial plants and animals would not be exceeded if the sum of fractions for the water medium plus that for the soil medium is less than 1.0. The maximum site concentrations for each medium, applicable BCGs, partial fractions, and sums of fractions are listed in Tables 4.4a and 4.4b.

Table 4.4a. Evaluation of Dose to Aquatic Biota in 2022

Nuclide	Measured Water Concentration (pCi/L)	BCG (Water) (pCi/L)	Partial Fraction (Water)	Measured Sediment Concentration (pCi/g)	BCG (Sediment) (pCi/g)	Partial Fraction (Sediment)	Sum of Fractions (Water and Sediment)
Tritium	≤62.40	265 E+08	2.36E-07	≤0.270	3.74.E+05	7.21E-07	9.57E-07
U-234	1.320	2.02E+02	6.54E-03	0.556	5.27.E+03	1.06E-04	6.65E-03
U-235	0.060	2.17E+02	2.76E-04	0.028	3.73.E+03	7.52E-06	2.84E-04
U-238	0.731	2.23E+02	3.27E-03	0.577	2.49.E+03	2.32E-04	3.51E-03
Pu-239	0.0114	1.87E+02	6.11E-05	0.005	5.86.E+03	8.53E-07	6.19E-05
Sum of Fractions			**1.02E-02**			**3.47E-04**	**1.05E-02**

Table 4.4b. Evaluation of Dose to Terrestrial Biota in 2022

Nuclide	Measured Water Concentration (pCi/L)	BCG (Water) (pCi/L)	Partial Fraction (Water)	Measured Sediment Concentration (pCi/g)	BCG (Soil) (pCi/g)	Partial Fraction (Soil)	Sum of Fractions (Water and Soil)
Tritium	≤62.40	2.31E+08	2.70E-07	≤0.270	1.71E+05	1.58E-06	1.85E-06
U-234	1.320	4.04E+05	3.26E-06	0.556	5.13E+03	1.08E-04	1.12E-04
U-235	0.060	4.19E+05	1.43E-07	0.028	2.83E+03	9.88E-06	1.00E-05
U-238	0.731	4.06E+05	1.80E-06	0.577	1.58E+03	3.66E-04	3.68E-04
Pu-239	0.0114	2.00E+05	5.69E-08	0.005	6.11E+03	8.18E-07	8.75E-07
Sum of Fractions			**5.53E-06**			**4.86E-04**	**4.92E-04**

As the sum of fractions for the aquatic system and the terrestrial system are 1.05E-02 and 4.92E-04 respectively, applicable BCGs were met for both evaluations. Therefore, it can be concluded that populations of aquatic and terrestrial biota on and near Pantex are not being exposed to doses in excess of the existing DOE dose limits.

4.4 UNPLANNED RELEASES

No unplanned releases of radioactive material occurred at Pantex during 2022.

4.5 ENVIRONMENTAL RADIOLOGICAL MONITORING

With the exception of the environmental dosimetry program discussed in this chapter, media-specific descriptions, as well as the results of any radiological surveillance monitoring for samples collected during 2022, are contained in Chapters 5-11 of this report.

4.5.1 Environmental Dosimetry

The environmental dosimetry program uses thermoluminescent dosimeters (TLDs) to measure gamma radiation on and around Pantex. This program has been conducted at several locations in parallel with monitoring conducted by the TDSHS since the early 1980s. The TDSHS uses optically stimulated luminescence dosimeters devices similar in function to the TLDs used by Pantex. Fig. 4.1 shows the locations of Pantex and the TDSHS dosimeters during 2022. Additionally, dosimeters are placed each quarter at multiple locations across the industrial portion of Pantex as part of the personnel dosimetry program. These dosimeters provide additional documentation that dose from current operations is kept ALARA.

Pantex's TLDs are generally placed at the same locations where Pantex operates air monitors, as discussed further in Chapter 5. Pantex's TLDs are analyzed and replaced at the end of each calendar quarter. This data provides the cumulative radiation exposure received while exposed to the environment over approximately 90 days of uninterrupted deployment at each location. This exposure includes ubiquitous background (i.e. cosmic radiation) as well as that from Pantex operations. The State of Texas has a robust Quality Assurance/Quality Control program, and historically State of Texas monitoring data has closely aligned with Pantex monitoring data.

Table 4.5 lists results for 2022 and reflects the dose that an individual would have received at the dosimeter location if the person were present continuously for a full quarter. The average quarterly dose for all Pantex on-site locations during 2022 was approximately 35.1 mrem. For TDSHS on-site locations the average quarterly dose was approximately 38.3 mrem.

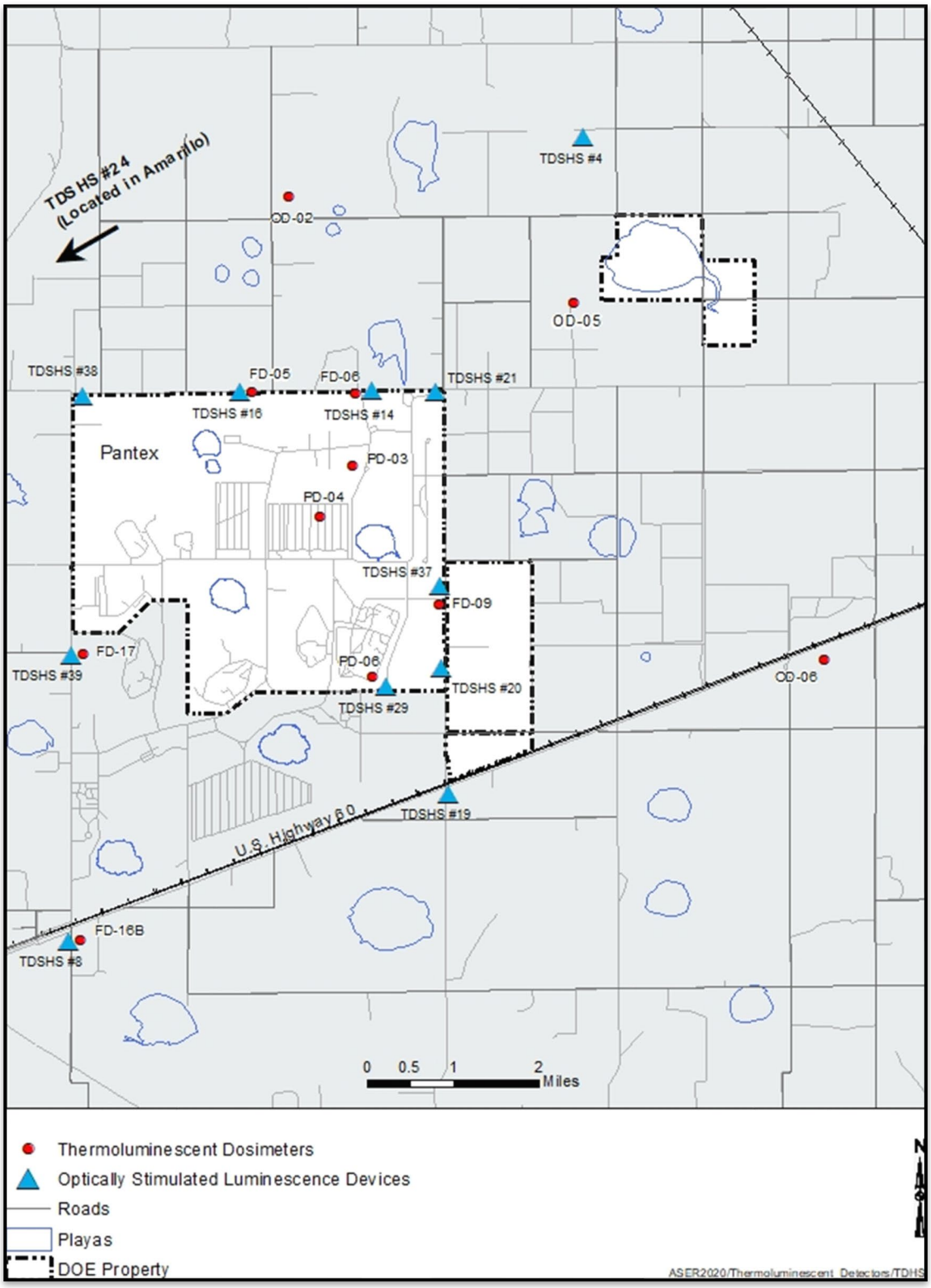


Fig. 4.1. Locations of Pantex TLDs

Table 4.5. Average Quarterly Dose Measured in Millirem by Environmental Dosimeters

Location	Q1	Q2	Q3	Q4
Locations On or Near Pantex Operations				
On-site				
Pantex (PD-03, 04, & 06)	40	33	32	33
TDSHS (#20)	32	37	44	39
TDSHS (#29)	32	37	46	39
Fence Line				
Pantex (FD-05, 06, & 09)	41	35	33	34
TDSHS (#8, 14, 16, 19, 21, 37, 38, & 39)	33	38	44	39
Off-site				
Pantex (OD-02, 05, & 06)	42	38	34	34
TDSHS (#4)	34	39	45	40
Control Locations				
Pantex (FD-16B & 17)	38	35	35	35
TDSHS (#24)	29	34	43	37

4.5.2 Future Radiological Monitoring

Media-specific subject matter experts (SMEs) periodically make revisions to the Pantex Environmental Monitoring Program based on technological advancements, process changes, and potential impacts. The SMEs develop or revise monitoring requirements using a process based upon EPA guidance documents and consider potential releases from current DOE activities at the site. However, the SMEs also consider planned new activities identified in the NEPA process discussed in Chapter 2. Based upon pathway analyses the SMEs make adjustments to the monitoring program for their individual environmental media.

4.6 CONCLUSIONS

The environmental radiological monitoring program at Pantex continues to document the doses produced by current operations at Pantex are a small fraction of relevant limits set by EPA and DOE. Pantex's monitoring results for the environmental radiological pathways in 2022 indicated levels below relevant standards, similar to results from previous years, and consistent with background conditions.

Measured and calculated doses to the public, workers, and the environment from Pantex operations are a minute fraction of the 320 mrem dose estimated to be received from naturally occurring sources each year.

CHAPTER 5 - AIR MONITORING

Some operations at Pantex are sources or potential sources of airborne emissions. Monitoring, sampling, and tracking to detect possible airborne emissions of radiological or hazardous pollutants at Pantex is conducted at on-site and off-site locations as a part of a comprehensive environmental surveillance program. Air monitors at fixed locations operate continually, sampling for radiological material to ensure operations are not having an impact on ambient air quality. Additionally, the TDSHS conducts air monitoring at a location on the northern boundary of Pantex.

Chapter Highlights

- All of the radiological air-monitoring data for 2022 indicated that results were below relevant Derived Concentration Standards set by regulatory agencies. In fact, all radionuclide measurements were below 0.1 percent of these comparison standards.
- Data from radiological air monitoring conducted by Pantex indicate that operations are not releasing radiological material that would have detrimental effects on the on or off-site environments, workers, or the public.

5.1 NON-RADIOLOGICAL AIR MONITORING

Emissions from Pantex operations are strictly limited by Air Quality Permit 84802, State of Texas regulations, and the Clean Air Act. Emissions to the air from operations are tracked, documented, and reported based on the amounts of chemicals used and process knowledge.

5.2 RADIOLOGICAL AIR MONITORING

Current operations at Pantex involve various radioactive materials including tritium (a radioactive isotope of hydrogen), plutonium, uranium, and miscellaneous sources (e.g., thorium, cobalt, and cesium) that may be present in the components of nuclear weapons being managed. Rigorous operational controls, safety standards, and the physical form of the material reduce the potential for release of these radioactive materials to the environment, Pantex personnel, or the public. As mentioned in Chapter 4 (Table 4.1), the majority of radionuclide releases at Pantex are tritium. Very small amounts of tritium escape as gas or vapor during normal operations. Additionally, some tritium is released from the structural materials of a building where an accidental release of tritium occurred in 1989 [as described in the *Environmental Information Document* (1998)].

During 2022, Pantex operated ten air-monitoring stations. The location of these monitoring stations is shown in Figs. 5.1 and 5.2. Two monitoring stations operated on-site, designated as PA-AR-XX; six stations operated along the boundary fence line, designated as FL-AR-XX; and two stations operated at off-site locations, designated as OA-AR-XX.

On-site air-monitoring stations are located near operating areas (Fig. 5.1). Station PA-AR-04 is located in an area so that it is able to monitor the ambient air associated with shipping and receiving operations conducted at Pantex, since the predominant wind direction is from the southwest, south, and southeast. Station PA-AR-06 is located near an operations area where nuclear material may be present.

Fence line monitoring stations are located along Pantex perimeter (Fig. 5.1). The perimeter is defined as the perimeter that existed prior to the purchase of the property east of FM 2373 in the latter part of 2008. Two stations are located along the northern fence line, two stations are located along the eastern fence line, and two stations are located along the western fence line. Stakeholders were considered in establishing the locations of the stations.

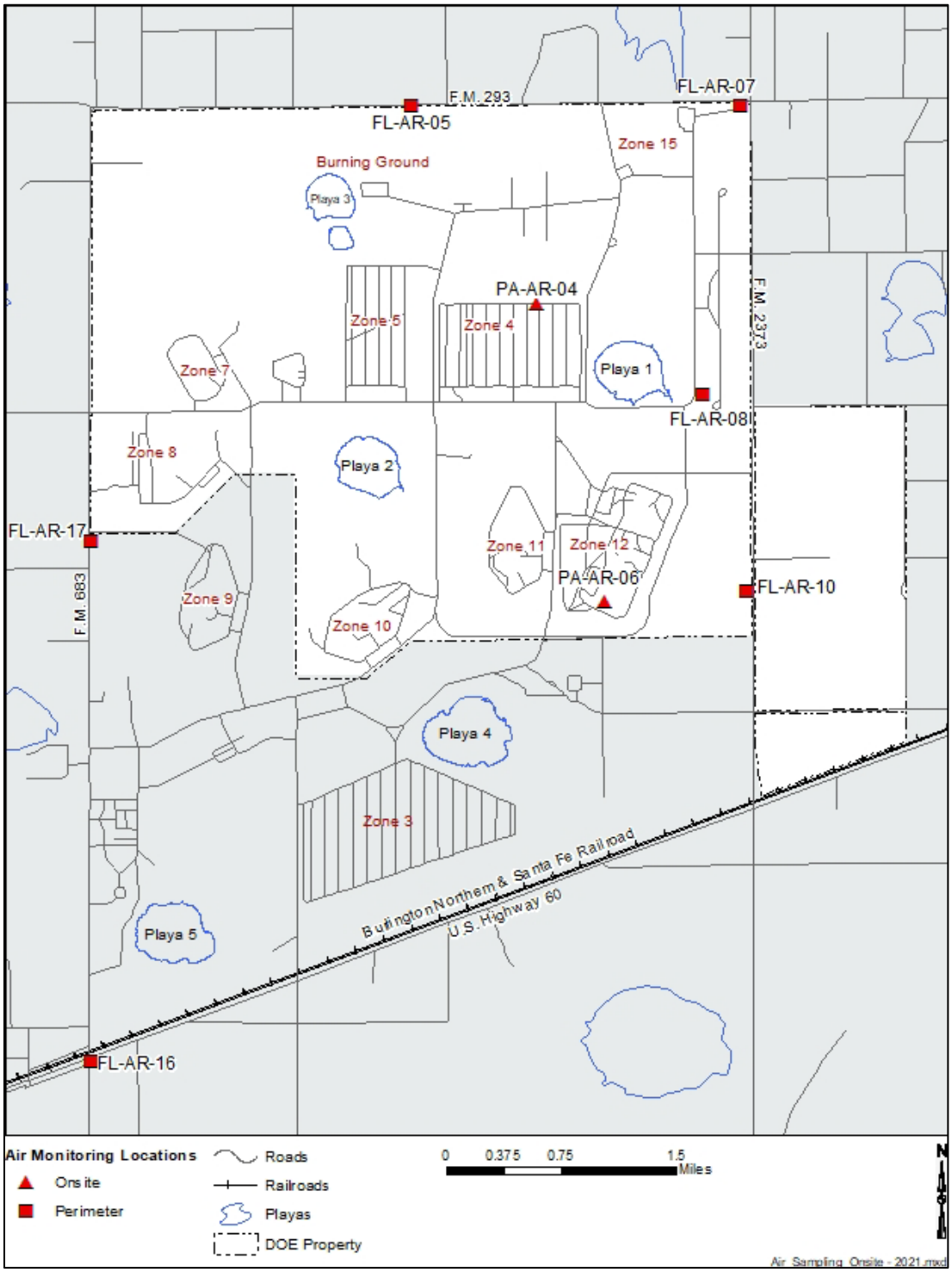


Fig. 5.1. Locations of On-site and Fence Line Air-Monitoring Stations

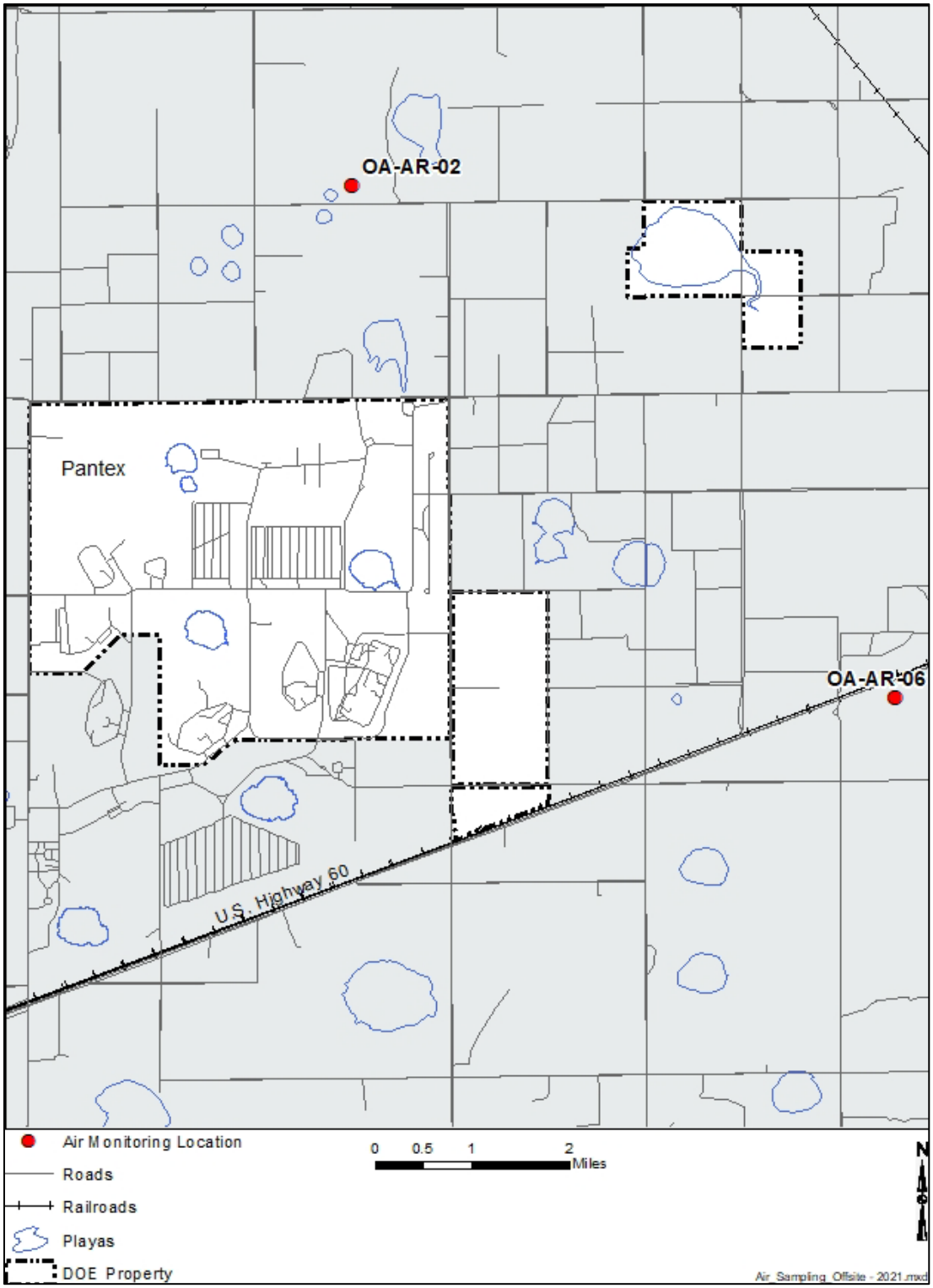


Fig. 5.2. Locations of Off-site Air-Monitoring Stations

Off-site stations, OA-AR-02 and OA-AR-06, are approximately five miles from the center of Pantex (Fig. 5.2).

Stations FL-AR-05, FL-AR-07, FL-AR-08, FL-AR-10, OA-AR-02, and OA-AR-06 are all located in the predominant downwind direction from Pantex operations (i.e., the direction that radiological material would most likely be expected to travel). Monitoring stations FL-AR-16 and FL-AR-17 are located upwind of Pantex, opposite the predominant wind directions. Station FL-AR-16 is used as a background location due to its distance from the center of Pantex and being located upwind of Pantex operations.

5.2.1 Collection of Samples

Each air-monitoring station has a high-volume air sampler designed to collect solid particles on a filter and a low-volume air sampler designed to collect water vapor in silica gel. In Fig. 5.3, the high-volume sampler is located on the left. These high-volume samplers collect solid particles by pulling air through a filter, much like a vacuum cleaner. The "doghouse" containing the low-volume sampler is on the right in Fig. 5.3. Fig. 5.4 shows the internal equipment for the low-volume air sampler; the U-shaped tube in the front of the equipment contains silica gel that collects water vapor from the air pulled through the tube. Samplers run continuously unless the equipment malfunctions or electric service is interrupted. Samplers are inspected, and filters or silica gel samples are scheduled to be collected on a weekly basis. Sampling technicians record sample collection period, beginning and ending flow rates, sample run time, initial and final sample volume weights (for silica gel samples), as well as notes for any anomalies (loss of power, low sample run times, low sample weights, equipment replacement or failure, etc.,) in the associated sample log book.

The high-volume samplers operate at a flow rate of approximately 30 cubic feet per minute (ft^3/min or more commonly cfm). During a seven-day run period, particles from approximately 302,400 ft^3 of air are collected on 8×10-inch filters. Filters are collected approximately weekly, and all weekly filter samples for a given month are composited into one sample for analysis of uranium-234 (U-234), uranium-238 (U-238), and plutonium-239 (Pu-239) by an off-site radiological analysis laboratory.

Airflow through the low-volume air samplers is 1.5 ft^3/min. The silica gel in the U-shaped tube acts as a desiccant, removing water vapor from air as it flows through the sampler. The silica gel samples are collected at the same time as the individual particle filters from the high-volume samplers. Water vapor present in the sampled air and absorbed in the silica gel is recovered and analyzed for tritium by a radiological analysis laboratory.

5.2.2 Sample Analysis Results

All analytical results obtained from the laboratory were converted to concentrations in air by dividing the quantity of radionuclides collected in the sample by the volume of air sampled. This quantity was calculated using the operational characteristics recorded. Table 5.1 summarizes the concentration values for tritium, U-234, U-238, and Pu-239 measured in samples collected from on-site, off-site, downwind, and upwind (control) monitoring stations. The values indicated are the mean plus-minus the standard deviation, the maximum value plus-minus its associated counting error, and the historical background concentration measured at a control location near Bushland, Texas during 2013, 2014, and 2015. This historical background value is the upper confidence limit for a population consisting of all data for the specified radionuclide from the control location during the period from 2013-2015.

Fig. 5.3. Typical Air-Monitoring Site

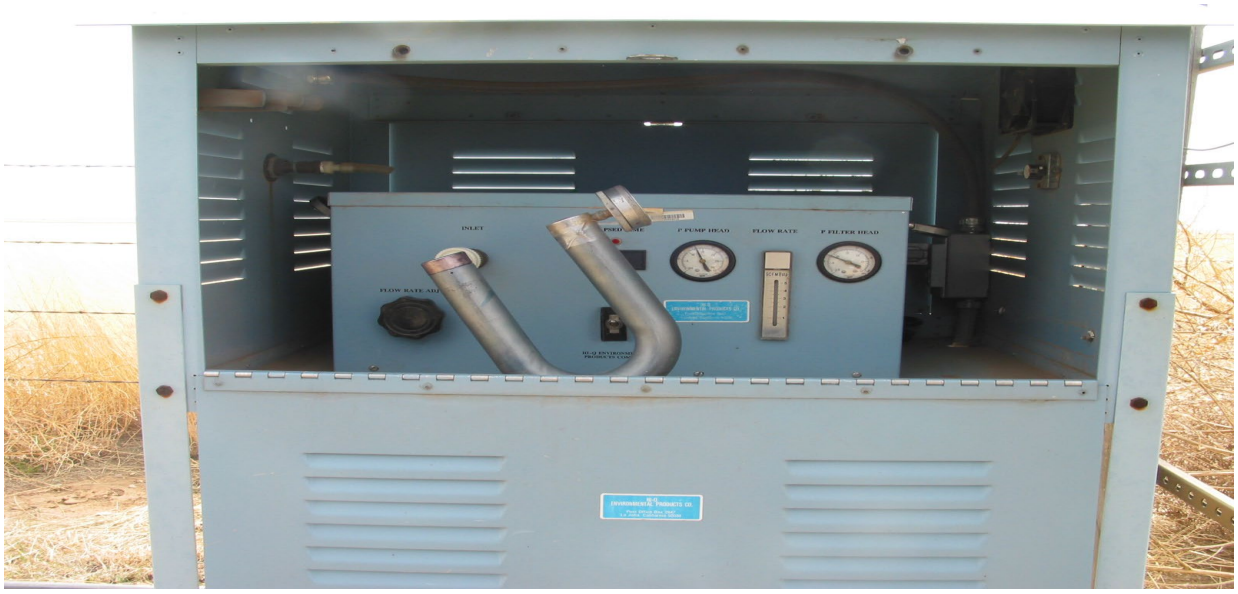


Fig. 5.4. Low-Volume Sampling Apparatus

Additionally, the mean and maximum concentrations are compared to the DCS. DCS values represent the concentration of a given radionuclide in either water or air that results in a member of the public receiving 100 millirem (mrem) effective dose following continuous exposure for one year for either the ingestion of water, submersion in air, and air inhalation pathways. The DCS value for each radionuclide is referenced from DOE-STD-1196-2022, *DOE Derived Concentration Technical Standard*. These comparison standard values are derived in accordance with dose limitation systems recommended by the ICRP in its several publications (International Atomic Energy Agency 1992) and used by the EPA, the Nuclear Regulatory Commission, and other regulatory agencies including DOE in establishing standards for radiological protection.

These regulatory comparison standards are purposely set at levels well below those known to cause any adverse effects on the public and/or the environment.

Table 5.1. Concentrations of Radionuclides in Air for 2022 at On-site, Off-site, Downwind Upwind Locations

Radionuclide	Number of Samples Analyzed (Planned)	Mean[c] ±Std. Dev.	Max ± Counting Error	Historical Background, at Control Location	DCS, Regulatory Comparison Value
On-site Locations, PA-AR-04 and PA-AR-06					
Tritium[a]	88 (102)	6.081 ± 19.54	149.173 ± 19.08	1.320	130,000
U-234[b]	22 (22)	0.662± 0.291	1.189 ± 0.161	30.400	160,000
U-238[b]	22 (22)	0.663 ± 0.262	1.084 ± 0.169	28.960	180,000
Pu-239[b]	22 (22)	0.017± 0.020	0.075 ± 0.093	0.930	120,000
Off-site Locations, OA-AR-02 and OA-AR-06					
Tritium[a]	91 (102)	0.329 ± 4.112	12.312 ± 9.716	1.320	130,000
U-234[b]	22 (22)	0.746 ± 0.329	1.499 ± 0.211	30.400	160,000
U-238[b]	22 (22)	0.726 ± 0.336	1.442 ± 0.207	28.960	180,000
Pu-239[b]	22 (22)	-0.013 ±0.015	0.053 ± 0.031	0.930	120,000
Downwind Locations, FL-AR-05, FL-AR-07, FL-AR-08, and FL-AR-10					
Tritium[a]	180 (204)	0.087 ± 4.030	11.435 ± 19.005	1.320	130,000
U-234[b]	44 (44)	0.875 ± 0.390	1.760 ± 0.237	30.400	160,000
U-238[b]	44 (44)	0.867 ± 0.395	1.841 ± 0.223	28.960	180,000
Pu-239[b]	44 (44)	0.011 ± 0.013	0.045 ± 0.032	0.930	120,000
Upwind Locations, FL-AR-16 and Fl-AR-17					
Tritium[a]	93 (102)	-0.249 ± 3.822	12.281 ± 8.408	1.320	130,000
U-234[b]	22 (22)	0.737 ± 0.305	1.368 ± 0.192	30.400	160,000
U-238[b]	22 (22)	0.736 ± 0.313	1.343 ± 0.190	28.960	180,000
Pu-239[b]	22 (22)	0.011 ± 0.011	0.035 ± 0.039	0.930	120,000

[a] Units in all tables are $\times 10^{-18}$ µCi/mL (or yCi/mL) for tritium.
[b] Units in all tables are $\times 10^{-18}$ µCi/ft^3 (or yCi/ ft^3) for α-emitting radionuclides (U-233/234, U-238, and Pu-239/240)
[c] Negative values indicate that the average result of the analysis was below detectable levels

During 2022, air sampling equipment ran continuously collecting greater than 90 percent of the samples planned for all locations. Intermittent power losses or motor failures caused a few of high-volume and low-volume samples to be missed or resulted in non-representative sampling volumes. Additionally, there were a couple of instances of analytical errors by the contract lab used for analysis which resulted in those samples not being included in the dataset.

5.2.3 Data Interpretation

During 2022, the maximum measurements for the U-234, U-238, and Pu-239 occurred during periods when high wind speeds were observed at Pantex. This most likely caused an increase in the re-suspension of dust into the atmosphere. The relative maxima were observed to be occurring both upwind and downwind of Pantex, indicating that many of the maximum measurements represent the collection of increased quantities of naturally occurring radioactive material in local soil during these periods.

Statistical comparisons of the 2022 U-234 and U-238 sample data for the location categories (on-site, upwind, and downwind) indicate that all results are of the same magnitude, thus indicating that areas potentially affected by Pantex operations are not distinguishable from background. The analysis laboratory indicated that nine percent of the Pu-239 measurements were above the minimum detection activity (MDA). However, the concentrations were so close to the MDA that when the counting error is subtracted from these results all but one fall below the MDA. Average concentrations for all three alpha-emitting radionuclides are a minute fraction of levels that would cause a 100 mrem effective dose.

The ratio of the activities of U-234 and U-238 indicates radiological equilibrium between both radionuclides and suggests the absence of uranium discharges during Pantex operations. The ratio of measured values of Pu-239 to its DCS are indistinguishable from zero, thus emissions of this isotope to ambient air are not indicated.

Variations in mission activities over the last several years may have resulted in various rates of emission of tritium and resulted in the apparent variations in measured concentrations of tritium during the period from 2017 through 2022. No tritium concentration in ambient air during 2022 (or any of the indicated years) exceeded the DCS. No measured concentration of tritium, uranium, or plutonium in ambient air exceeded the applicable DCS, or even 0.1 percent of this comparison value despite revised DCS values issued in 2021.

5.3 CONCLUSIONS

Data from radiological air monitoring conducted by Pantex continue to indicate that operations at Pantex are not releasing radiological material that would have detrimental effects on the on-site or off-site environments.

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CHAPTER 6 - GROUNDWATER MONITORING

Groundwater monitoring at Pantex began in 1975 when the first investigative wells were installed. Pantex completed its investigations in 2005 with the identification of contaminant plumes in the perched groundwater beneath Pantex and TTU property. Monitoring wells in the perched groundwater are being used to monitor two remedial actions: two pump-and-treat systems, with 76 operating extraction wells and four injection wells, and four ISB systems consisting of 194 active treatment zone wells. Pantex also monitors 27 wells in the deeper drinking water aquifer (Ogallala Aquifer) to verify the remedial actions remain protective of this resource.

Chapter Highlights

- Groundwater data collected in 2022 demonstrated that current remedial actions continue to progress toward cleanup of perched groundwater contaminants and that drinking water resources are safe. One deeper well in the drinking water aquifer was found to have a constituent above the cleanup standards established for Pantex Remedial Action. The well is distant from water resources and other monitor wells indicate there is no concern for nearby drinking water resources or irrigation use in the area. Pantex is planning to begin installation of more wells to verify whether a plume is developing in the drinking water aquifer.
- All major contaminants of concerns [trichloroethylene (TCE), hexavalent chromium, perchlorate, and RDX] have declining trends for all areas under the influence of an active remedial action in perched groundwater.

6.1 GROUNDWATER AT PANTEX

Groundwater beneath Pantex and vicinity occurs in the Ogallala and Dockum Formations at two intervals (Fig. 6.1). The first water-bearing unit below Pantex in the Ogallala Formation is a discontinuous zone of perched groundwater located at approximately 200 to 300 feet (ft.) below ground surface and 100 to 200 ft. above the drinking water aquifer. A zone of fine-grained sediment (consisting of sand, silt, and clay) that created the perched groundwater is found between the perched groundwater and the underlying drinking water aquifer. The fine-grained zone (FGZ) acts as a significant barrier to downward migration of contaminated water. The perched groundwater ranges in saturated thickness from less than a foot at the margins to more than 75 ft. beneath Playa 1. Perched groundwater forms by surface water in the playas that initially migrates down to the FGZ. It then flows outward in a radial manner away from the playa lakes and becomes influenced by the regional south to southeast gradient. The largest area of perched groundwater beneath Pantex is associated with natural recharge from Playas 1, 2, and 4, treated wastewater discharge to Playa 1, historical releases to the ditches draining Zones 11 and 12, and storm water runoff that drains to the unlined ditches and playas. Two hydraulically separate, relatively small, perched zones occur around Playa 3 (near the Burning Ground in the north central portion of Pantex) and near the Old Sewage Treatment plant in the northeast corner of Pantex.

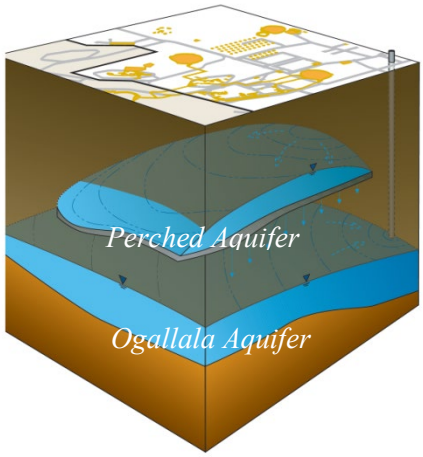


Fig. 6.1. Groundwater Beneath Pantex

The second water-bearing zone, the Ogallala Aquifer, is located below the FGZ in the Ogallala and Dockum Formations. The Ogallala Aquifer is a primary drinking and irrigation water source for most of the High

Plains. The groundwater surface of the Ogallala Aquifer beneath Pantex is approximately 400 to 500 ft. below ground surface with a saturated thickness of approximately one to 100 ft. in the southern regions of Pantex and approximately 250 to 400 ft. in the northern regions. At Pantex, the primary flow direction of the Ogallala Aquifer is north to northeast due to the influence of the City of Amarillo's well field located to the north of Pantex.

Historical operations at Pantex resulted in contamination of the larger perched groundwater area. The contaminant plume has migrated past Pantex boundaries and beneath the adjacent property to the south and east. Most of the impacted property to the east was purchased in 2008 to allow better access for monitoring and control of perched groundwater. The primary COCs in the perched aquifer are the explosives RDX and related breakdown products, perchlorate, hexavalent chromium, and TCE (Fig. 6.2). With the exception of one domestic well north of Pantex, no public or private water supply wells are completed in the perched groundwater in the immediate vicinity of Pantex. The domestic well north of Pantex is in an area that has not been impacted by historic operations.

Perched groundwater is not used for industrial purposes at Pantex; however, the treated perched groundwater is routed through the wastewater treatment facility (WWTF) and is beneficially used for subsurface irrigation of crops. Because concentrations of contaminants in the perched groundwater beneath Pantex's property and off-site to the south and east currently exceed drinking water standards, the water is not safe for domestic or industrial use. Pantex restricts on-site use of perched groundwater. TTU and three off-site property owners to the east have placed a deed restriction on their property to control use of perched groundwater and restrict drilling through the perched groundwater in areas that are impacted. Due to the expansion of the plumes to the southeast, Pantex worked with landowners in 2022 to place deed restrictions on use of groundwater beneath the property while remediation continues at those locations.

6.2 LONG-TERM MONITORING NETWORK

The purpose of the LTM network is to ensure that remedial action objectives (RAOs) are being achieved. The RAOs and the corresponding LTM Network Monitoring Objectives are provided in the highlight box below.

Remedial Action Objectives	LTM Network Monitoring Objectives
❖ Reduce risk of exposure to perched groundwater through contact prevention ❖ Achieve cleanup standard for perched COCs ❖ Prevent growth of perched groundwater contaminant plumes ❖ Prevent COCs from exceeding cleanup standards in the drinking water aquifer	❖ Remedial action effectiveness ❖ Plume stability ❖ Uncertainty management ❖ Early detection

To ensure the achievement of the RAOs, wells and monitoring information were chosen with respect to specific objectives developed for the LTM network. The objectives are applied to perched and drinking water aquifer wells, as appropriate.

Pantex developed a *Long-Term Monitoring System Design Report* (AL-PX-SW-8419) and a *Sampling and Analysis Plan* (AL-PX-SW-8418) to detail the LTM network and monitoring. The network monitoring information is evaluated quarterly, annually, and on a 5-year basis. Evaluations increase in detail and complexity for each type of report.

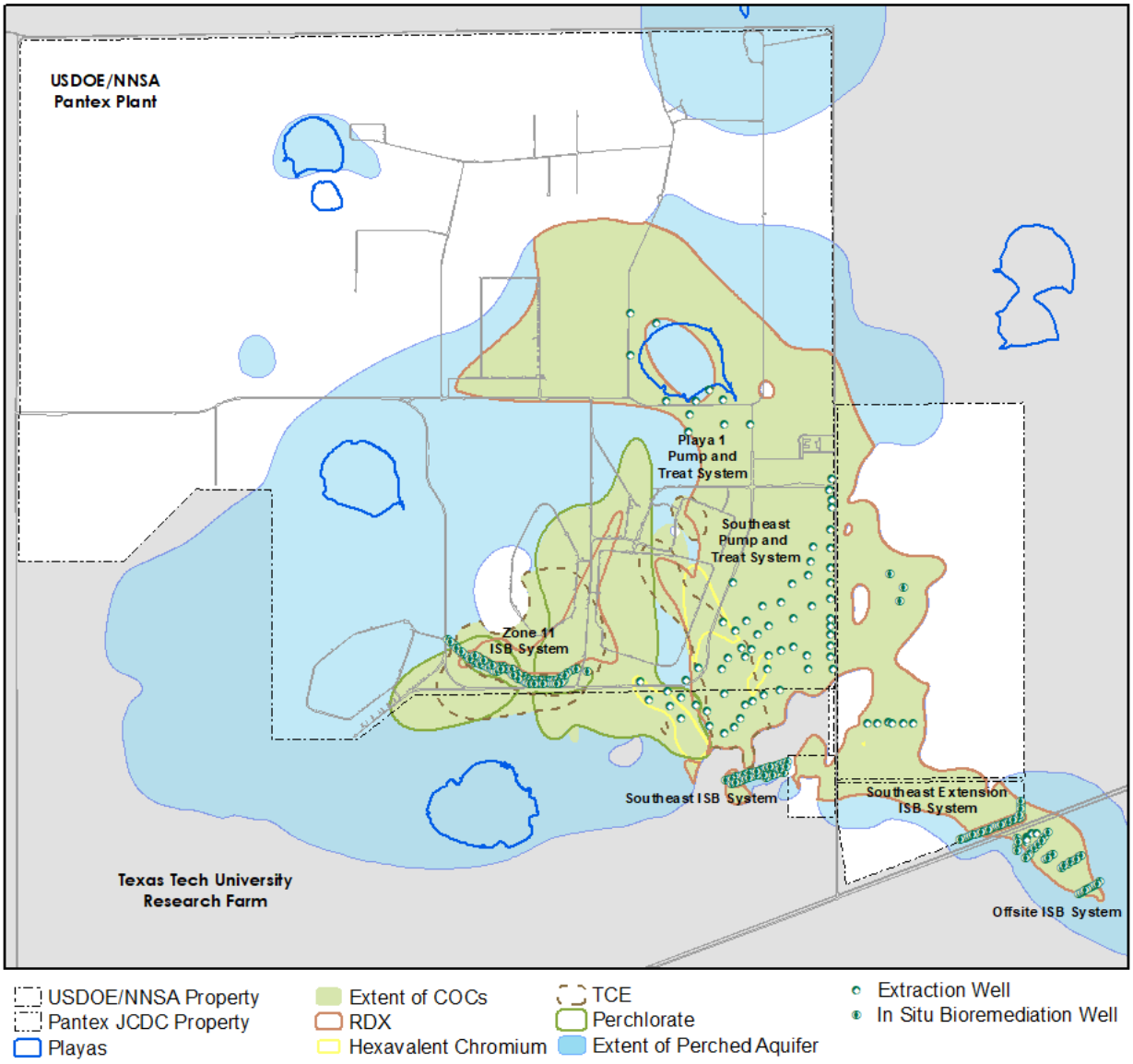


Fig. 6.2. Major Perched Groundwater Plumes and Remediation Systems

6.3 THE SCOPE OF THE GROUNDWATER MONITORING PROGRAM

Groundwater is monitored at Pantex in accordance with requirements of the TCEQ HW-50284 (Texas Commission on Environmental Quality 2014). Pantex is also subject to requirements in the IAG, signed jointly by the EPA and TCEQ, and issued effective in 2008. The *LTM System Design Report* and a new *SAP*, approved by the EPA and TCEQ in July 2009, identified the final monitoring well network and the parameters to be monitored.

An update to the *LTM System Design Report* and revised *SAP* were submitted in 2019 and approved by the TCEQ and EPA in early 2020. Table 6.1 summarizes the number of wells sampled in 2022 that were used in the monitoring of the remedial actions and the total number of analytes assessed.

Table 6.1. Summary of Well Monitoring in 2022

Well Type	Drinking Water Aquifer		Perched Groundwater	
	# Wells	# Analytes Assessed	# Wells	# Analytes Assessed
Long-Term Monitoring Well	24	1,709	106	5,734
Other Wells	3	117	10	227
Pump & Treat Extraction Well	--	--	54	912
ISB Treatment Zone Monitoring Wells	--	--	39	1,113
Total	27	1,826	209	7,986

6.4 REMEDIAL ACTION EFFECTIVENESS AND PLUME STABILITY

The purpose of the remedial action evaluation is to determine the effectiveness of remedial measures, indicate when RAOs for perched groundwater have been achieved, and validate groundwater modeling results or provide data that can be used to refine modeling. The expected conditions for the remedial action effectiveness wells are that indicators of the reduction in volume, toxicity, and mobility of constituents will be observed over time as remedial actions continue. These indicators include stable or decreasing concentrations of constituents, or declining water levels in areas where pump-and-treat remedies have been implemented.

The purpose of plume stability wells is to determine if impacted areas (plumes) of perched groundwater are expanding and affecting uncontaminated perched groundwater and to monitor the changes occurring within the perched groundwater plumes. The expected conditions for the plume stability wells are that, over time, a reduction in the toxicity and mobility of constituents will be observed.

6.4.1 Pump-and-Treat Systems

The two pump-and-treat systems (depicted in Fig. 6.2) are designed to remove and treat perched groundwater, provide hydraulic control of plume movement away from Pantex, and reduce saturated thickness in the perched groundwater to lessen the potential for impacted perched groundwater to migrate to the drinking water aquifer below. The systems were designed to remove and treat perched groundwater and beneficially use the treated water. The SEPTS has the capability to inject the treated water back into the perched aquifer when beneficial use is not possible. Operational priorities for the pump-and-treat systems emphasizes beneficial use of water. Pantex has focused on beneficial use of the treated water, to the extent possible, since the subsurface irrigation system operation began in May 2005.

The Playa 1 Pump-and-Treat System (P1PTS) 2022 annual average operational rate was approximately six percent, which was heavily affected by the break at the irrigation filter bank that occurred in 2017 and prioritization of operating SEPTS. The SEPTS annual average operation in 2022 was 97 percent.

Performance of the systems has been affected by a failure of the on-site subsurface irrigation system. Final repairs to the subsurface irrigation system were completed in March 2022 but Pantex continues to send discharge WWTF wastewater to Playa 1 due to limited capacity of the subsurface system and operational issues. The flow to Playa 1 is restricted by permit, so flow from the systems must also be restricted until the irrigation system is fully operational. Pantex is currently installing an irrigation alternative on the property east of FM 2373 to provide additional long-term use of the treatment system water. Construction on the system began in November 2021 and is expected to be completed by summer of 2023.

The SEPTS system was operated at a higher capacity using injection, release to Playa 1, and intermittent shutdowns of the P1PTS to allow full treatment at the system. SEPTS operations focus on removing water in high priority locations that help control migration of the plume to the southeast. New extraction wells

were drilled east of FM 2373 to provide additional control of plume movement and have been operating since July 2019. Water levels are continuing to decline in the areas down gradient of the pump-and-treat systems, with declines exceeding one foot per year in several wells as depicted in Fig. 6.3.

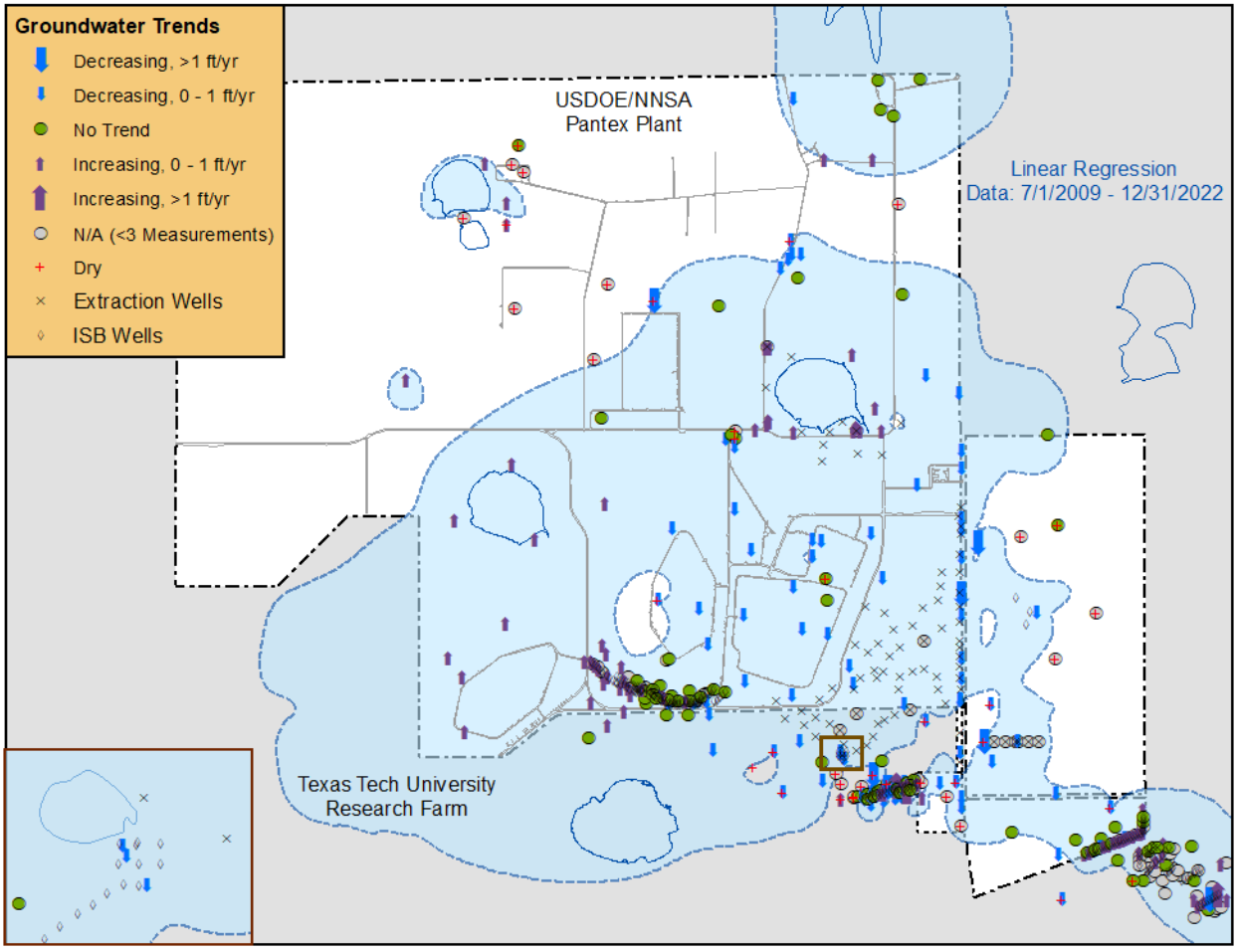


Fig. 6.3. Water-Level Trends in the Perched Aquifer

RDX concentration trends since the start of remedial action in July 2009, depicted in Fig. 6.4, generally indicate that RDX is decreasing or does not demonstrate a trend at the source areas (Playa 1 and the ditch along the eastern side of Zone 12). The SEPTS has affected the plume as the majority of COC concentrations are declining or not demonstrating a trend along the outer margins of the system, with the exception of the off-site plume. Wells across the Zone 11 treatment zone are indicating a long-term increasing trend but in recent data have demonstrated a decreasing trend. PTX06-1153 is the only well downgradient of the Southeast ISB System that is not indicating effective treatment. Pantex continues to evaluate conditions in the area of this well and further recommendations will be made based on evaluation of data over time.

Concentration trends for the remaining major COCs (perchlorate, TCE, and hexavalent chromium) are discussed in the 2022 Annual Progress Report. Fig. 6.5 shows plume movement of major COCs in perched groundwater for the time period of 2009 to 2022. Fig. 6.6 shows the annual maximum concentrations of the major COCs observed in the perched aquifer since 2009.

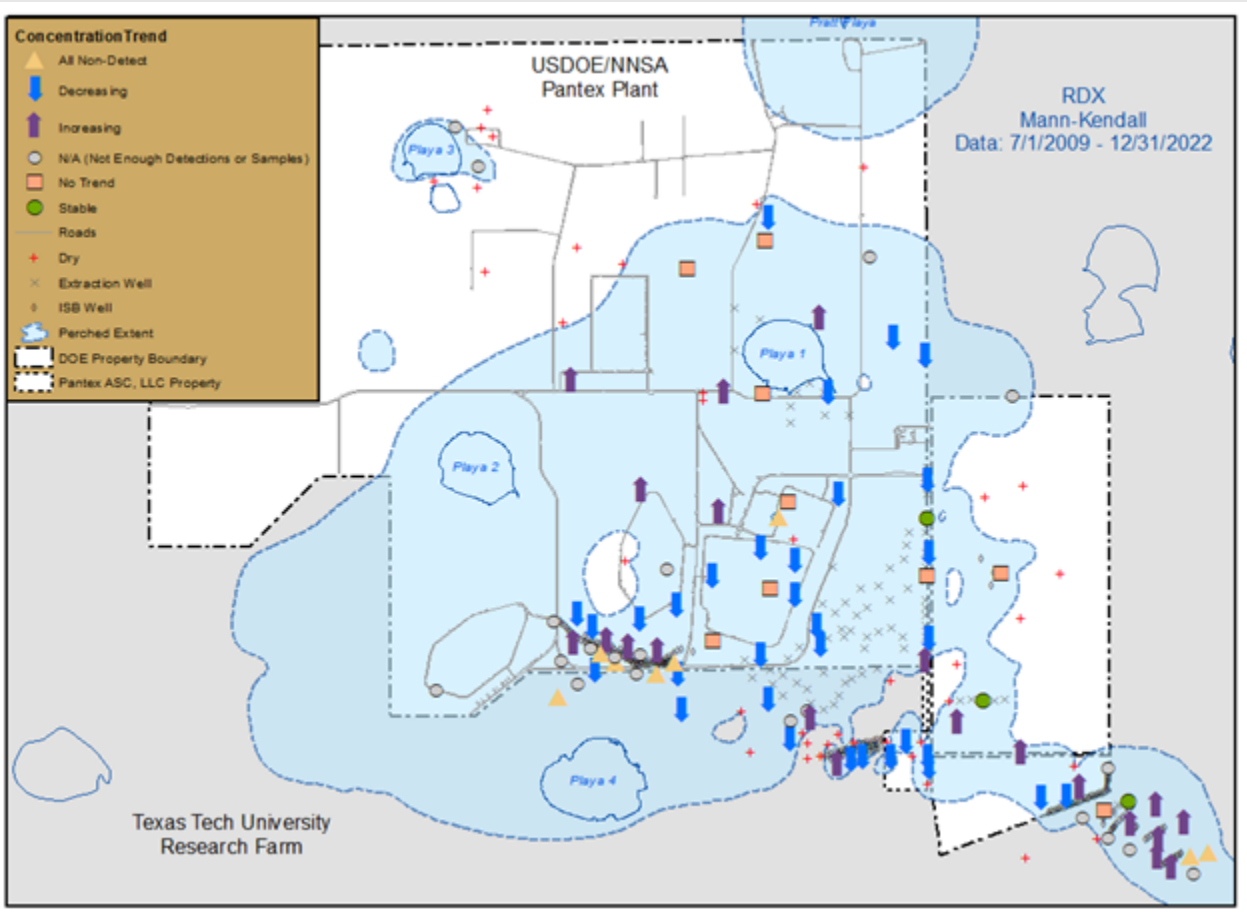


Fig. 6.4. RDX Concentration Trends in the Perched Aquifer

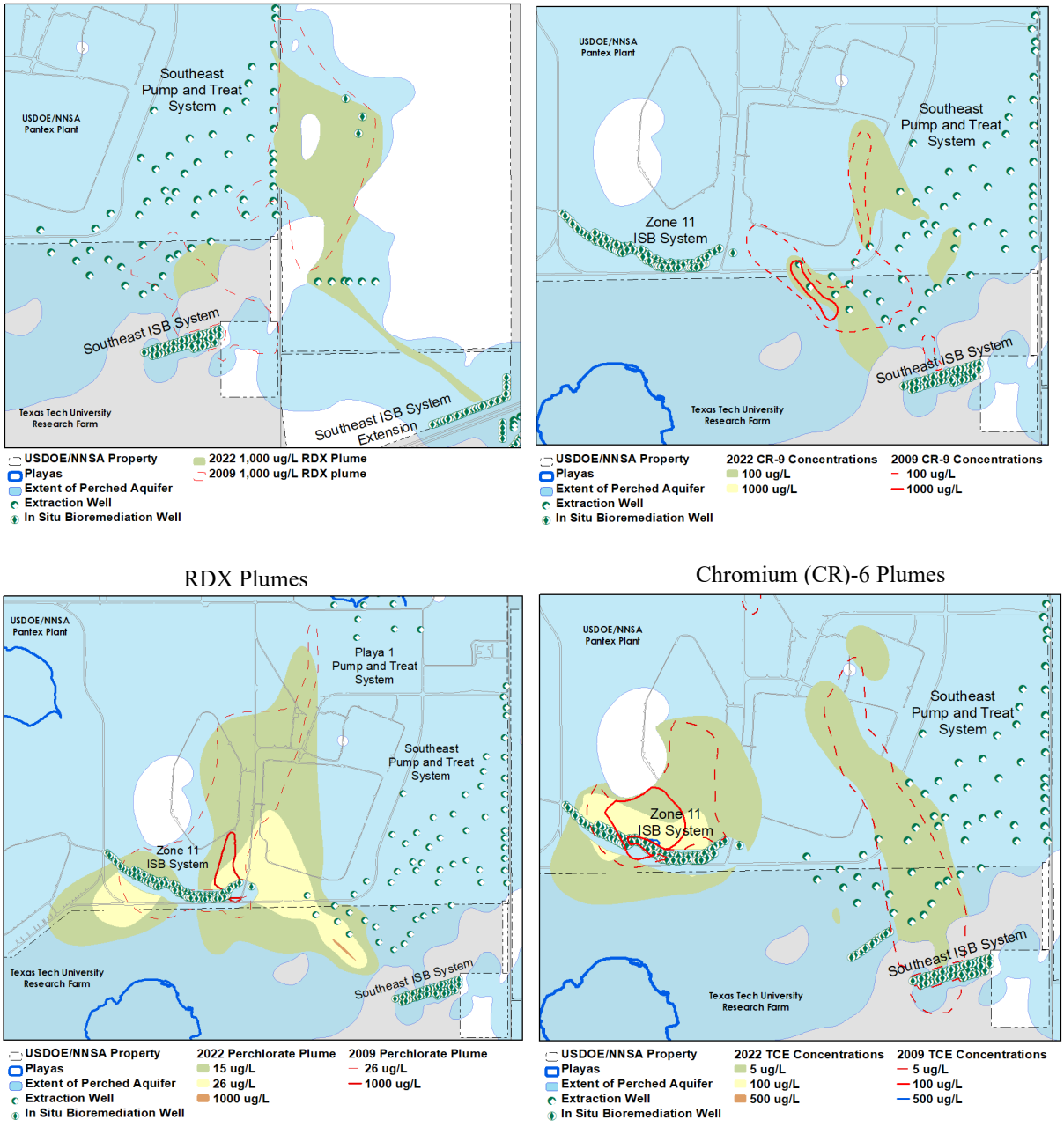
RDX and hexavalent chromium have demonstrated significant decreases over time, while perchlorate and TCE do not show significant decreases; they, are trending downward. This indicates that sources are declining and where the plume is under the influence of a remediation system, the concentrations have dropped significantly.

Areas outside the influence of the remedial action systems are also monitored for HEs and TCE breakdown products to gather data regarding natural attenuation and will be evaluated over time to attempt to estimate the rate of these processes.

6.4.2 In-Situ Bioremediation Systems

The ISB systems (depicted in Fig. 6.2) treat the impacted groundwater as it moves through the bioremediation zone with the goal of reducing concentrations below the Groundwater Protection Standard (GWPS) established in the CERCLA ROD. Creation of a bioremediation zone is achieved by injecting amendment and nutrients to stimulate resident bacteria. With complete reduction, the resident bacteria will reduce the COCs to less harmful substances.

Four ISB systems (Zone 11 ISB, Southeast ISB, Southeast ISB Extension, and off-site) are installed at Pantex. Overall, the Zone 11 and Southeast ISB have been effective in treating the primary COCs: RDX, hexavalent chromium, TCE, and perchlorate. Pantex continues to evaluate areas of the ISBs where an issue has been identified with treatment and has made adjustment to the treatment as needed based on the results of evaluation.



RDX Plumes

Chromium (CR)-6 Plumes

Perchlorate Plume

TCE Plume

Fig. 6.5. 2009 - 2022 Plume Movement – Perchlorate, Hexavalent Chromium, RDX, and TCE in the Perched Aquifer

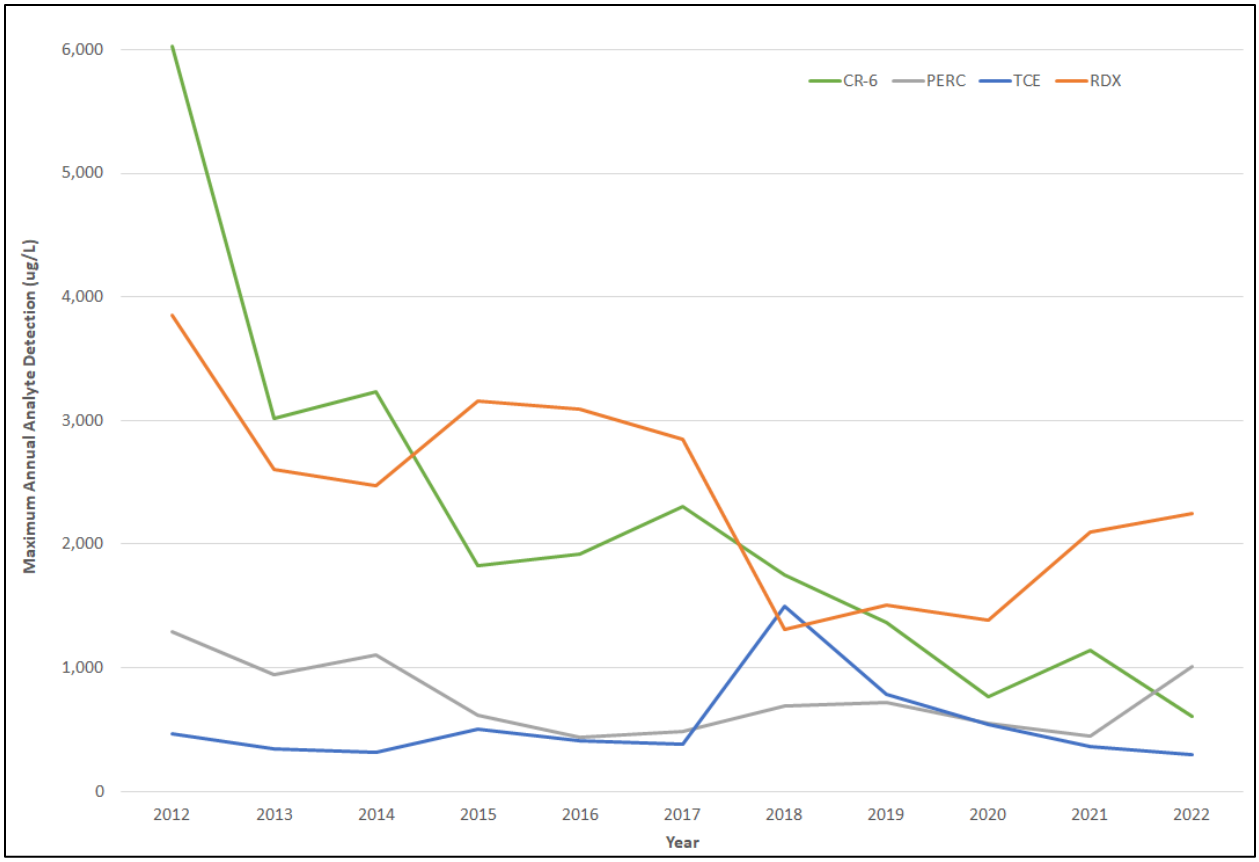


Fig. 6.6. Annual Maximum Concentration Trends in the Perched Aquifer

Monitoring of conditions within the treatment zone indicates that a reducing zone has been established at all ISB systems, with the exception of the newly installed off-site system.

Downgradient monitoring at the Southeast ISB demonstrates that the system has been effective at reducing concentrations of RDX and hexavalent chromium to levels below the GWPS across most of the treatment zone. Pantex will continue to monitor wells in the area to determine groundwater flow patterns, mass flux, and treatment conditions in the western side of the treatment zone where RDX concentrations persist above the GWPS. In addition, water levels in the area of the Southeast ISB are declining as the pump-and-treat systems continue to remove water causing persistent low water levels or dry conditions across the system. As a result, future need for injections at the Southeast ISB may be reduced or eliminated.

Evaluation of data collected downgradient of the Zone 11 ISB treatment zone indicates that a very mild to strong reducing zone has been established and maintained over time with conditions favorable for reduction of perchlorate and reductive dechlorination of TCE. Overall, perchlorate concentrations have been reduced to concentrations below the GWPS, and TCE concentrations continue to trend downward in downgradient wells.

The Southeast ISB Extension was installed in 2017 as an extension for remediation for the southeast-perched groundwater. Injections for this system began in 2019. Wells sampled within the treatment zone, including new TZM (titanium, zinc, molybdenum) wells, indicate that HEs are treated below the GWPS. The systems designated downgradient wells did not demonstrate treatment during 2022. However, at the downgradient off-site ISB, arrival of treated water from the Southeast ISB Extension was seen in 2022 in some extraction wells, but treated water is not expected to arrive at other locations for a couple more years.

Perched groundwater wells installed outside the previously defined extent of the southeast lobe of the perched aquifer indicates that water and contamination have migrated further to the southeast, beyond Pantex property boundary. Results indicate the presence of the HEs 4-amino-2,6-dinitrotoluene (DNT) and RDX at concentrations exceeding GWPS (1.2 and 2 µg/L, respectively). Movement of the plumes in this area appears to be associated with faster groundwater flow paths in channel-type features along the top of the FGZ. In response, Pantex installed a new off-site ISB system. Installation of the Phase 3 wells for the off-site ISB system was completed in 2022, with Phase 4 wells being installed in 2023. Phase 3 and 4 infrastructures to support an injection event was started in late 2022 and will complete by the end of summer 2023. The system will be injected every six months.

6.5 UNCERTAINTY MANAGEMENT AND EARLY DETECTION

Because the evaluation of uncertainty management and early detection well types are similar, they are evaluated together for unexpected conditions. The purpose of uncertainty management wells in perched groundwater is to confirm expected conditions identified in the RCRA Facility Investigations and ensure there are not any deviations, fill potential data gaps, and fulfill LTM requirements for soil units evaluated in the baseline risk assessment. The purpose of early detection wells is to identify breakthrough of constituents to the drinking water aquifer from overlying perched groundwater, if present, or from potential source areas in the unsaturated zone, before potential points of exposure have been impacted.

Fig. 6.7 depicts the perched and Ogallala Aquifer wells used in this evaluation for 2022. Pantex monitors for the most widespread and leachable contaminants at the uncertainty management and early detection wells. The monitoring lists for these wells are included in the *Sampling and Analysis Plan (SAP)* (AL-PX-SW-8418) and consist of all HEs found in perched groundwater, degradation products of RDX, perchloroethylene (PCE), and TCE, as well as chloroform and boron. The data for each well in each aquifer were evaluated for unexpected conditions. Discussions of unexpected conditions are provided in the following sections.

6.5.1 Perched Groundwater Uncertainty Management and Unexpected Conditions

In perched groundwater, statistical trend analysis demonstrated source areas are stable or declining as expected in wells monitored for uncertainty management in 2022. Other wells downgradient of source sites show plume movement from previous source areas but no new sources have been detected.

6.5.2 Ogallala Aquifer Uncertainty Management and Early Detection

Unexpected conditions in the Ogallala Aquifer primarily involve detections of organic constituents at one well, PTX06-1056 (shown in Fig. 6.7). While boron and hexavalent chromium were also detected in Ogallala wells, these detections are related to background fluctuations or corrosion. Other corrosion indicator metals were also detected in Ogallala wells above background. These detections are expected because of the use of stainless steel in Ogallala well construction. Only one well had detections that exceeded the GWPS in the Ogallala Aquifer uncertainty management wells sampled during 2022.

PTX06-1056 continues to demonstrate detections of 4-amino-2,6-DNT (DNT4A), a breakdown product of the HE 2,4,6-TNT, and 1,2-dichloroethane, as shown in Fig. 6.8. 1,2-Dichloroethane has been variably detected since August 2015 and was detected slightly below the practical quantitation limit (PQL) (1.0 µg/L) in 2022.

DNT4A was first detected in April 2014, and sample results collected since that time have been variable with most recent values in 2022 exceeding the GWPS. Results in July 2022 detected DNT4A above the PQL (0.26 ug/L) and GWPS at 1.22 ug/L and RDX below the PQL (0.26 ug/L) at 0.09 ug/L. As a result, Pantex performed a high-volume purge, time-series sampling event in August 2022. PTX06-1056 was resampled for DNT4A and RDX six weeks following the high-volume purge to verify previous concentrations.

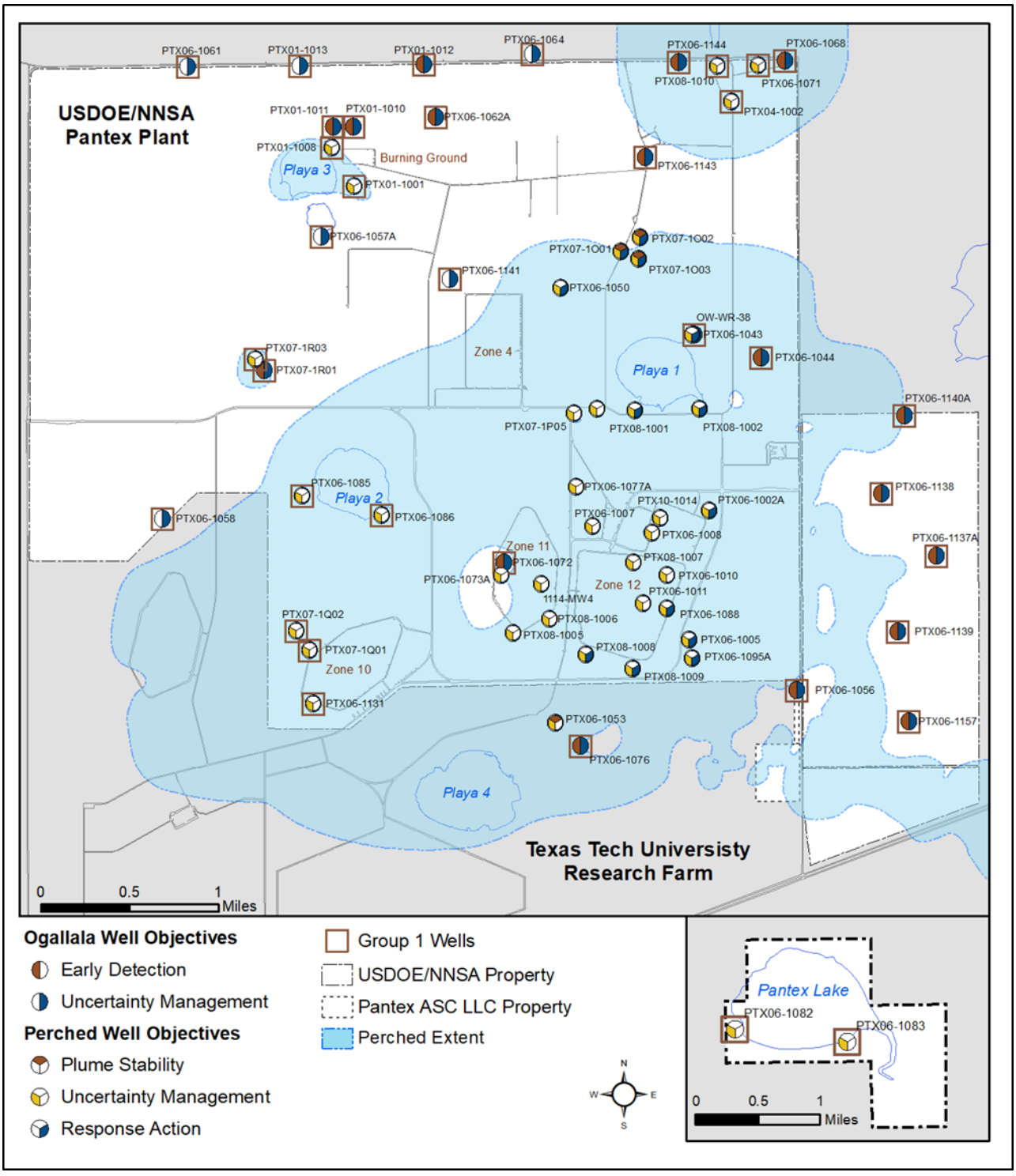


Fig. 6.7. Uncertainty Management and Early Detection Wells

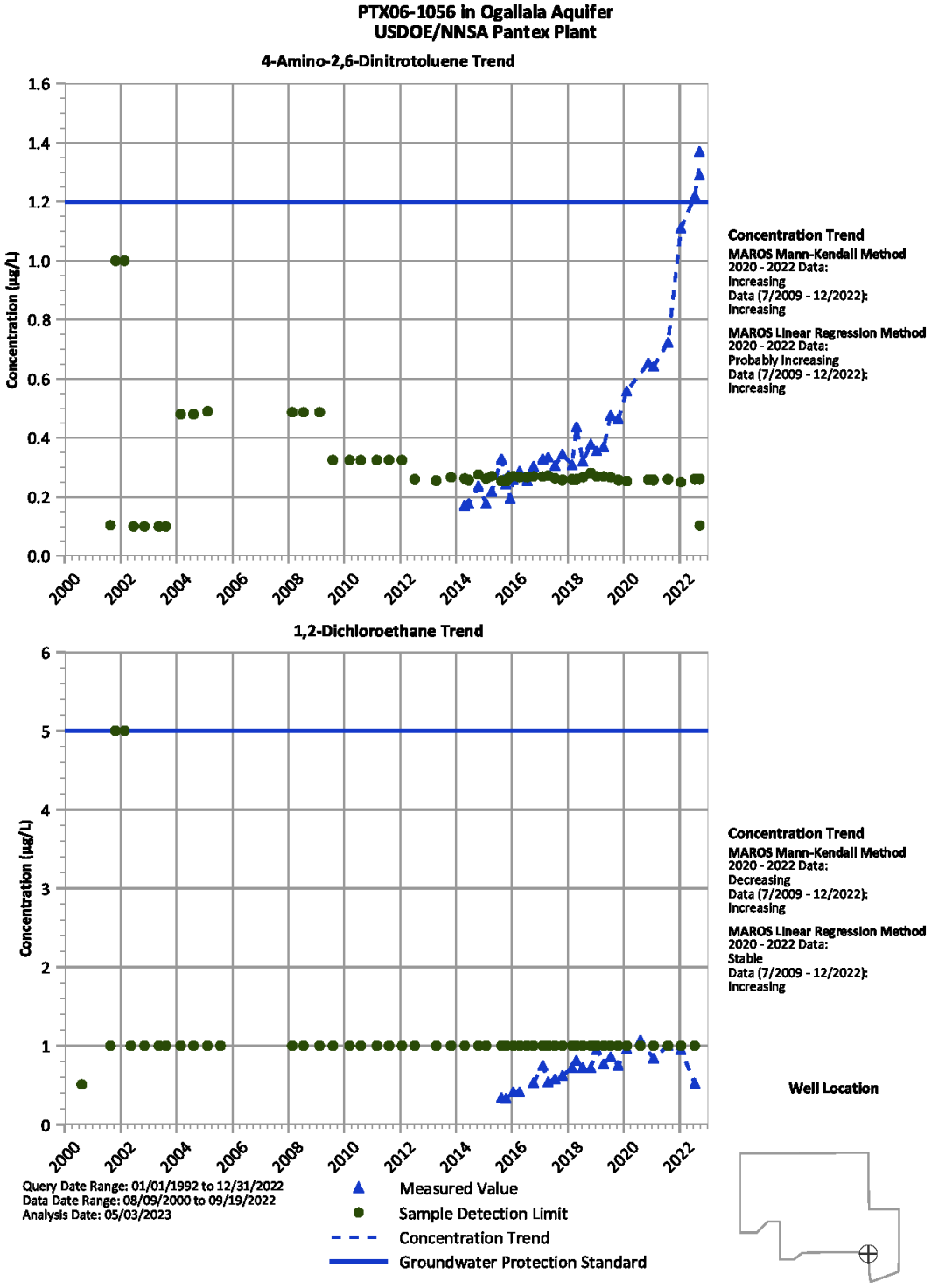


Fig. 6.8. Summary of Unexpected Conditions in Ogallala Aquifer Well PTX06-1056

Results from the verification samples confirmed DNT4A above the GWPS and detections of RDX below the PQL. The high-volume purge, time-series sampling also continued to indicate the presence of DNT4A throughout the sampling event, with RDX only detected at the beginning of sampling. Pantex is responding by installing two additional Ogallala monitoring wells to help understand whether a plume is forming. These wells are anticipated to be installed in spring 2023. Notifications to regulators, Pantex personnel and the public was sent. Further actions will be determined based on future sampling results and in accordance with the *Pantex Plant Ogallala Aquifer and Perched Groundwater Contingency Plan* (2010).

Although PTX06-1056 indicates that an HE is exceeding the GWPS, no other downgradient Ogallala monitor wells indicate the presence of the detected constituents at PTX06-1056. PTX06-1056 is distant from drinking water sources and drinking water is considered safe for the area based on monitoring results.

6.6 NATURAL ATTENUATION

Natural attenuation is the result of processes that naturally lower concentrations of contaminants over time. This process is monitored at Pantex to help determine where natural attenuation is occurring, under what conditions it is occurring, and to eventually determine rates of attenuation for various constituents.

Pantex routinely monitors for breakdown products of the primary COCs. Groundwater conditions that may affect attenuation, such as dissolved oxygen and redox potential, are also monitored in each well. For example, RDX can degrade under aerobic and anaerobic conditions, but achieves faster reduction under anaerobic conditions. Trending of concentrations is also performed at each well to determine if concentrations are declining as expected.

Based on monitoring results for TNT and its breakdown products (2-amino-4,6-DNT and 4-amino-2,6-DNT), TNT continues to naturally attenuate over time (Fig. 6.9). TNT has been manufactured at Pantex since the 1950s yet is only present in the central portion of the overall southeastern plume – within the SEPTS well field and near Playa 1. Its first breakdown product, 2-amino-4,6-DNT, occurs near the TNT plume and extends slightly beyond. The plume for the final breakdown product, 4-amino-2,6-DNT, extends to the eastern edge of the perched saturation at low concentrations. Only TNT breakdown products are present in perched groundwater beneath Zone 11 and north of Playa 1. Concentrations of the breakdown products are still above GWPS, but most wells with detections are recently showing a decreasing or stable trend.

Perched groundwater sampling results for RDX and breakdown products (MNX, DNX, and TNX) indicate that the breakdown products are present throughout most of the RDX plume, with TNX being the most widespread. TNX, the final degradation product, is a better indicator of degradation because the other intermediate products (MNX, DNX) degrade rapidly and do not accumulate in the environment (SERDP, 2004). If complete biodegradation of RDX were occurring, RDX and all breakdown products would be expected to decrease over time. As depicted in Fig. 6.10, the TNX plume is similar in size and in extent to the RDX plume, but at much lower concentrations. Pantex contracted for a project to evaluate lines of evidence for natural attenuation of RDX at Pantex. The study included both aerobic and anaerobic degradation with evidence of both occurring. Biodegradation rates of 0.016 to 0.168 / year were calculated translating to RDX half-lives of approximately five to 50 years. The project found that the rates of RDX biodegradation are likely limited by the available labile organic carbon in the groundwater. The predominant attenuation process is aerobic biodegradation by bacterial strains. The study found several lines of evidence for natural attenuation of RDX as well as the potential to enhance aerobic biodegradation of RDX with introduction of low levels of labile organic carbon. Recommendations for further study were presented for additional treatability studies, bioaugmentation, and additional proteomics analyses for the degrading bacterial strains.

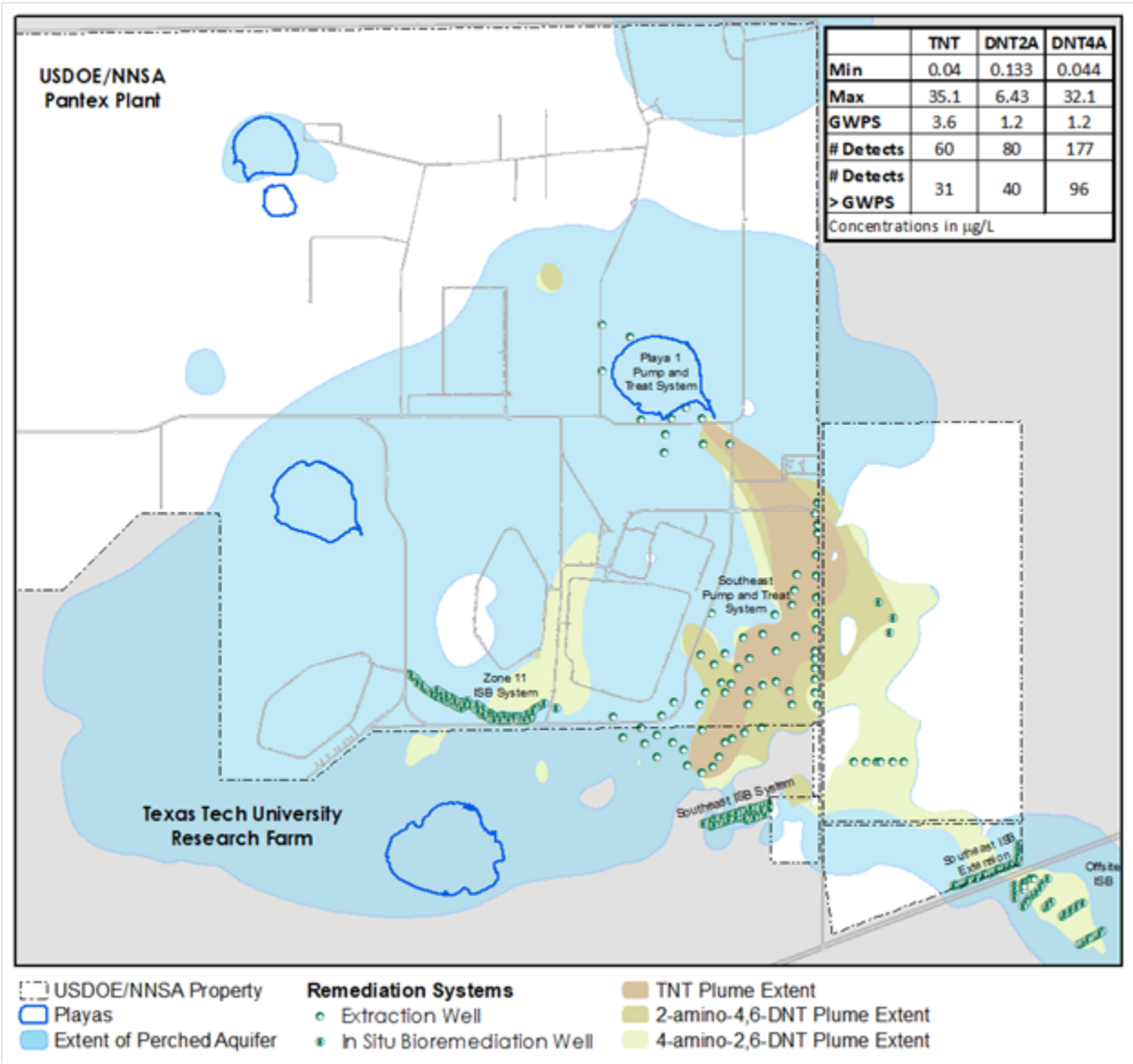


Fig. 6.9. TNT and Degradation Product Plumes

Pantex has monitored for breakdown products of TCE for many years; however, a strong indication of natural attenuation of TCE has not been observed in perched groundwater. TCE has started degrading in the Zone 11 ISB treatment zone. The SEPTS and the ISB treatment zones are actively treating the TCE plumes at Pantex.

6.7 CONCLUSIONS

Overall, the groundwater remedial actions continued to be effective in 2022. The remedial actions continue to operate and meet short-term expectations for cleanup of the perched groundwater in areas under the influence of the remediation systems. As a whole, perched water levels continue to decline. Perched aquifer wells near Playa 1 reported a slight increase in groundwater levels attributable to rainfall, infiltration and

release of treated water from the WWTF and pump-and-treat systems. COC mass is being removed or reduced and institutional controls provide protection for use of impacted groundwater, while the remedial

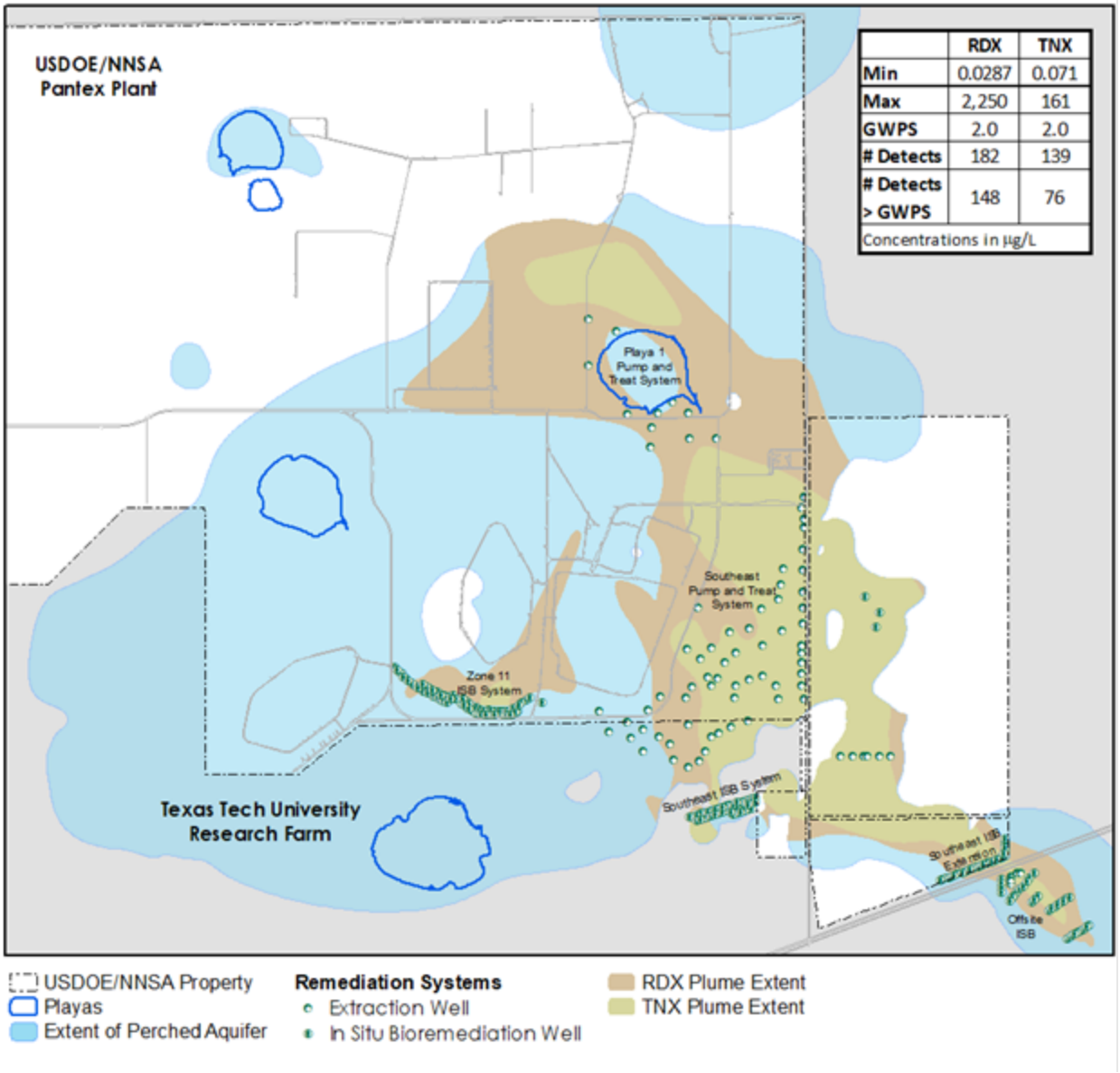


Fig. 6.10. RDX and Degradation Product Plume

actions continue to operate to meet long-term goals. The influence of both pump-and-treat systems will continue to expand as the saturated thickness is reduced in the perched aquifer.

New perched groundwater wells installed outside the previously defined extent of the southeast lobe of the perched aquifer indicate that water and contamination have migrated further to the southeast and to off-site property. With the identification of a preferential pathway and the extent of contamination, Pantex has installed and started operating an off-site ISB system to address the migration of the southeast plume.

One Ogallala Aquifer well (PTX06-1056) had COC detections slightly above the GWPS, indicating possible migration of perched groundwater to the Ogallala Aquifer. In response to these detections, Pantex has fully

implemented the conditions specified in Pantex Ogallala Aquifer and Perched Groundwater Contingency Plan (Pantex 2019). Sampling will continue in accordance with the approved SAP (AL-PX-SW-8418) or HEs and volatile organic compounds at this well. Two additional Ogallala monitoring wells are being installed in 2023 to help define extent of the contamination. Other Ogallala monitoring wells downgradient of PTX06-1056 continue to indicate that drinking water resources are safe.

Pantex evaluated lines of evidence for natural attenuation of RDX in perched groundwater beneath Pantex. The study included both aerobic and anaerobic degradation with evidence of both occurring. The project found that the rates of RDX biodegradation are likely limited by the available labile organic carbon in the groundwater.

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CHAPTER 7 - DRINKING WATER

Pantex's drinking water system (State of Texas Public Water System I.D. No. 0330007) is considered a non-transient, non-community PWS under the Safe Drinking Water Act (SDWA) regulations. The EPA created this category to identify private systems that continuously supply water to small groups of people (for example, in schools and factories). The same group of people consumes water supplied by such systems daily over long periods.

Chapter Highlights

- There was an increase of twenty-three million gallons produced/pumped from the Ogallala Aquifer compared to 2021.
- Results from the routine drinking water compliance samples collected by Pantex and a Texas Commission on Environmental Quality (TCEQ) contractor in September 2022 confirmed that the drinking water system at Pantex met all water quality regulatory requirements.
- All analytical results for bacteria, chemical compounds, disinfection by-products, metals, pesticides, and volatile organic compounds were below regulatory limits, and adequate levels of disinfectant were maintained in the distribution system.
- Pantex PWS continues to be recognized by the TCEQ as a "Superior" supply system.

7.1 DRINKING WATER AT PANTEX

Drinking water at Pantex originates from the Ogallala Aquifer. The water is obtained via groundwater production wells. These wells supply all of Pantex's water needs. The water pumped from the Ogallala Aquifer is treated to provide disinfection protection, and is then transferred to a distribution system which distributes water across Pantex. In addition, the system provides water to adjacent TTU-owned property for domestic and livestock use.

Samples from the drinking water system are collected by Pantex personnel and analyzed by contract laboratories monthly for biological contaminants. Similarly, the drinking water system is also sampled and analyzed annually and triennially for various chemical contaminants as required by the SDWA and its implementing regulations (Title 40 of the Code of Federal Regulations (CFR), Chapter 141 and 143, and Title 30 of the TAC, Chapter 290). Additionally, samples from the drinking water system are collected each year by TCEQ contractor personnel and analyzed for biological and chemical contaminants. Analytical results, from samples collected by both Pantex and the TCEQ contractor, were compared to regulatory guidelines for drinking water. Sampling locations were chosen to meet regulatory requirements and to provide system operators with data that would assist their evaluation of the system's integrity.

7.2 NEW REQUIREMENTS AND PROGRAM CHANGES

There were no new regulatory requirements or changes implemented in 2022. However, due to an increased work force, the population served by the water system also increased. During 2022, the number of microbial samples increased from five to six samples per month, based on the population served.

7.3 WATER PRODUCTION AND USE

During 2022, Pantex produced/pumped approximately 130 million gallons of water from the Ogallala Aquifer. This was an increase of twenty-three million gallons compared to water produced in 2021. The increase was due to construction activities and water system refurbishment. Pursuant to the requirements

found in Chapter 16 of the Texas Water Code, Section 16.012(m) and Title 31 TAC, Chapter 358, Pantex submits an Annual Water Use Survey to the Texas Water Development Board to show water production and reuse.

Pantex remains committed to reducing the amount of produced water by implementing a water reuse and recycling program. Examples of the water conservation and reuse initiatives include the procurement of more efficient industrial cooling equipment (such as water re-circulating systems) and beneficial reuse of treated wastewater. Typically, Pantex beneficially reuses 100 percent of its treated wastewater to grow crops in the northeast portion of the Plant. Pantex environmental compliance personnel continue to investigate other reuse opportunities.

7.4 SAMPLING

Pantex collected routine drinking water samples at 11 locations. Nine locations were sampled for biological indicators and residual disinfectant levels, and two locations were monitored for chemical and water quality constituents. Sample locations are periodically changed to assure there is adequate Pantex coverage. The sampling locations are representative of drinking water at Pantex and are listed in Table 7.1.

Table 7.1. Drinking Water Sampling Locations, 2022

Description	Location
Chemical & Water Quality Monitoring	Building 15-27 (entry point to the distribution system) Building 16-12 (Total Trihalomethanes [TTHM] second site[a])
Biological and Disinfectant Level Monitoring	Building 12-103 Building 18-1 Building 12-15A Building 16-12 Building 12-70 Building 11-2 Building 15-27 Building 16-1 Building 10-9

[a] The TTHM site is the second sampling location within the distribution system with the potential for high disinfection by-products (Total Trihalomethanes {TTHM} and Haloacetic Acids {HAA5}) formation. Samples were collected for TTHMs and HAA5s at the entry point to the distribution system, but these constituents are not regulated at this location. All sample results were below applicable regulatory limits.

7.5 RESULTS

In 2022, the TCEQ contractor also sampled the water system at Pantex. Results for this drinking water sampling were within regulatory limits for chlorine (disinfectant) and below regulatory limits for disinfection by-products, metals, microbial contaminants, inorganic contaminants, nitrate, pesticides, and VOCs. Table 7.2 shows the water quality results from Pantex water system as measured by the TCEQ contractor.

Table 7.2. Water Quality Results from TCEQ Samples and Analysis

Analyte	Measured Value	EPA Limit	Unit of Measure
PCBs (Method E508.1 Pesticides by GC)			
Aroclor-1016	<0.07	0.50	ug/L

Table 7.2. Water Quality Results from TCEQ Samples and Analysis

Analyte	Measured Value	EPA Limit	Unit of Measure
Aroclor-1221	<0.1	0.50	ug/L
Aroclor-1232	<0.1	0.50	ug/L
Aroclor-1242	<0.1	0.50	ug/L
Aroclor-1248	<0.1	0.50	ug/L
Aroclor-1254	<0.1	0.50	ug/L
Aroclor-1260	<0.1	0.50	ug/L
PCB, Total	<0.1	N/A	ug/L
Pesticides (Method E508.1 Pesticides by GC)			
Chlorodane	<0.1	2	ug/L
Toxaphene	<0.1	3	ug/L
PAHs (Method E525.2 Pesticides by GC/MS)			
Benzo(a)pyrene	<0.02	0.20	ug/L
Pesticides (Method E525.2 Pesticides by GC/MS)			
trans-Nonachlor-chlordane	<0.1	N/A	ug/L
Alachlor	<0.1	2	ug/L
Aldrin	<0.1	N/A	ug/L
alpha-Chlordane	<0.1	2	ug/L
Atrazine	<0.1	3	ug/L
Bromacil	<0.1	N/A	ug/L
Butachlor	<0.1	N/A	ug/L
Dieldrin	<0.1	N/A	ug/L
Endrin	<0.01	2	ug/L
gamma-BHC (Lindane)	<0.02	0.20	ug/L
gamma-Chlordane	<0.1	2	ug/L
Heptachlor	<0.03	0.40	ug/L
Heptachlor epoxide	<0.02	0.20	ug/L
Hexachlorobenzene	<0.1	1	ug/L
Hexachlorocyclopentadiene	<0.1	50	ug/L
Methoxychlor	<0.1	40	ug/L
Metolachlor	<0.1	N/A	ug/L
Metribuzin	<0.1	N/A	ug/L
Propachlor	<0.1	N/A	ug/L
Simazine	<0.06	4	ug/L
Phthalates (Method E525.2 Pesticides by GC/MS)			
Bis(2-ethylhexyl)adipate	<0.5	400	ug/L
Bis(2-Ethylhexyl)phthalate	<0.5	6	ug/L

Table 7.2. Water Quality Results from TCEQ Samples and Analysis

Analyte	Measured Value	EPA Limit	Unit of Measure
Volatile Organic Compounds, Regulated (Method E524.2)			
Vinyl chloride	<0.500	2	ug/L
1, 1-Dichloroethene	<0.500	7	ug/L
Methylene chloride	<0.500	5	ug/L
trans-1,2-Dichloroethene	<0.500	100	ug/L
cis-1,2-Dichloroethene	<0.500	70	ug/L
1, 1, 1-Trichloroethane	<0.500	200	ug/L
Carbon tetrachloride	<0.500	5	ug/L
1,2-Dichloroethane	<0.500	5	ug/L
Benzene	<0.500	5	ug/L
Trichloroethene	<0.500	5	ug/L
1,2-Dichloropropane	<0.500	5	ug/L
Toluene	<0.500	1000	ug/L
1, 1,2-Trichloroethane	<0.500	5	ug/L
Tetrachloroethene	<0.500	5	ug/L
Chlorobenzene	<0.500	100	ug/L
Ethyl Benzene	<0.500	700	ug/L
m,p-Xylene	<0.500	N/A	ug/L
Styrene	<0.500	100	ug/L
1,4-Dichlorobenzene	<0.500	75	ug/L
1,2-Dichlorobenzene	<0.500	600	ug/L
1,2,4-Trichlorobenzene	<0.500	70	ug/L
Xylene (total)	<0.500	10000	ug/L
Volatile Organic Compounds, Unregulated (Method E524.2)			
Dichlorodiftuoromethane	<0.500	N/A	ug/L
Chloromethane	<0.500	N/A	ug/L
Bromomethane	<0.500	N/A	ug/L
Chloroethane	<0.500	N/A	ug/L
4-Chlorotoluene	<0.500	N/A	ug/L
Trichlorofluoromethane	<0.500	N/A	ug/L
Acetone	<5.00	N/A	ug/L
Methyl iodide	<0.500	N/A	ug/L
Carbon disulfide	<0.500	N/A	ug/L
Acrylonitrile	<0.500	N/A	ug/L
Tert-Butyl methyl ether	<0.500	N/A	ug/L
1,1-Dichloroethane	<0.500	N/A	ug/L
Vinyl acetate	<0.500	N/A	ug/L
2,2-Dichloropropane	<0.500	N/A	ug/L
2-Butanone	<5.00	N/A	ug/L
Bromochloromethane	<0.500	N/A	ug/L
Tetrahydrofuran	<5.00	N/A	ug/L
Chloroform	<1.00	N/A	ug/L

Table 7.2. Water Quality Results from TCEQ Samples and Analysis

Analyte	Measured Value	EPA Limit	Unit of Measure
Volatile Organic Compounds, Unregulated (Method E524.2) (cont.)			
1,1-Dichloropropene	<0.500	N/A	ug/L
Methyl methacrylate	<0.500	N/A	ug/L
Dibromomethane	<0.500	N/A	ug/L
Bromodichloromethane	<1.00	N/A	ug/L
Cis-1,3-Dichloropropene	<0.500	N/A	ug/L
4-Methyl-2-pentanone	<0.500	N/A	ug/L
Trans-1,3-Dichloropropene	<0.500	N/A	ug/L
Ethyl methacrylate	<0.500	N/A	ug/L
1,3-Dichloropropane	<0.500	N/A	ug/L
2-Hexanone	<0.500	N/A	ug/L
Dibromochloromethane	<1.00	N/A	ug/L
1,1,1,2-Tetrachloroethane	<0.500	N/A	ug/L
o-Xylene	<0.500	N/A	ug/L
Bromoform	<1.00	N/A	ug/L
Isopropylbenzene	<0.500	N/A	ug/L
1,1,2,2-Tetrachloroethane	<0.500	N/A	ug/L
Bromobenzene	<0.500	N/A	ug/L
1,2,3-Trichloropropane	<0.500	N/A	ug/L
n-Propylbenzene	<0.500	N/A	ug/L
2-Chlorotoluene	<0.500	N/A	ug/L
1,3,5-Trimethylbenzene	<0.500	N/A	ug/L
Tert-Butylbenzene	<0.500	N/A	ug/L
1,2,4-Trimethylbenzene	<0.500	N/A	ug/L
Sec-Butylbenzene	<0.500	N/A	ug/L
1,3-Dichlorobenzene	<0.500	N/A	ug/L
4-Isopropyltoulene	<0.500	N/A	ug/L
n-Butylbenzene	<0.500	N/A	ug/L
Hexachlorobutadiene	<0.500	N/A	ug/L
Naphthalene	<0.500	N/A	ug/L
1,2,3-Trichlorobenzene	<0.500	N/A	ug/L
Heavy Metals (Method 245.1 Hg)			
Mercury Total	<0.00020	0.002	mg/L
Inorganics (E200. 7 Prep/E200. 7 Metals, Trace Elements)			
Calcium Total	36.3	N/A	mg/L
Iron Total	<0.0500	N/A	mg/L
Potassium Total	5.47	N/A	mg/L
Magnesium Total	20.6	N/A	mg/L
Sodium Total	31.1	N/A	mg/L

Table 7.2. Water Quality Results from TCEQ Samples and Analysis

Analyte	Measured Value	EPA Limit	Unit of Measure
Inorganics (E200.8, ICP-MS Prep/E200.8, ICP-MS)			
Aluminum Total	<0.005	N/A	mg/L
Antimony Total	<0.001	0.006	mg/L
Arsenic Total	0.002	0.01	mg/L
Barium Total	0.13	2	mg/L
Beryllium Total	<0.001	0.004	mg/L
Cadmium Total	<0.001	0.005	mg/L
Chromium Total	0.0042	0.10	mg/L
Copper Total	<0.001	1	mg/L
Lead Total	<0.001	0.015	mg/L
Manganese Total	<0.001	N/A	mg/L
Nickel Total	<0.001	N/A	mg/L
Selenium Total	<0.005	0.05	mg/L
Silver Total	<0.001	N/A	mg/L
Thallium Total	<0.001	0.002	mg/L
Zinc Total	<0.005	N/A	mg/L
Inorganics (SM2340B, Hardness Calc.)			
Total Hardness (as CaCO3)	176	N/A	mg/L
Anions by Ion Chromatography (E300.0, Anions)			
Nitrate (as N)	1.40	10	mg/L
Disinfection By-Products, Haloacetic Acids (Method E552.2)			
Bromochloroacetic acid	3.10	N/A	ug/L
Dibromoacetic acid	2.50	N/A	ug/L
Dichloroacetic acid	2.80	N/A	ug/L
Monobromoacetic acid	<1.00	N/A	ug/L
Monochloroacetic acid	<1.00	N/A	ug/L
Trichloroacetic acid	<1.00	N/A	ug/L
Total Regulated HAA	5.30	60	ug/L
Disinfection By-Products, Trihalomethanes (Method E524.2)			
Chloroform	9.70	N/A	ug/L
Bromodichloromethane	14.1	N/A	ug/L
Dibromochloromethane	13.9	N/A	ug/L
Bromoform	6.27	N/A	ug/L
Total Trihalomethanes	43.9	80	ug/L

Definitions:

Maximum contaminant level (MCL): The highest level of a contaminant allowed in drinking water.
mg/L = milligrams per liter or parts per million
N/A = Not applicable; there are no MCLs under the Safe Drinking Water Act.
ug/L = micrograms per liter or parts per billion
umho/cm = microsiemens per centimeter; this is a measurement of electrical conductivity in water.

7.5.1 Inorganic Contaminants

Monitoring for inorganic contaminants in the PWS is required under the SDWA and the TAC. The State of Texas regulates the amount of these contaminants in drinking water to protect public health. Consumption of these contaminants may cause health problems if present in public water supplies in amounts greater than the drinking water standard set by the EPA. All inorganic contaminant results from monitoring conducted in 2022 were below regulatory levels.

7.5.2 Biological Monitoring

Water distribution systems may contain naturally occurring microorganisms and other organic matter that could enter a system through leaks, cross-connections, back-flow events, or disinfection system failures. Bacterial growth may occur within the water itself, at or near the pipe surfaces, or from suspended particulates. Factors that influence bacterial growth include water temperature, flow rate, and chlorination. During 2021, all microbial sample results were negative for coliform and Escherichia coli bacteria.

7.5.3 Radiological Monitoring

Radiological monitoring is not required for the non-transient, non-community PWS at Pantex. During 2022, no radiological monitoring was conducted.

7.5.4 Disinfection By-Products

All drinking water at Pantex is chlorinated prior to entry into the distribution system. Disinfection by-products (DBPs) are produced by the reaction between the disinfectant (chlorine) and organic matter in the water. Reducing the amount of organic matter in the source water before disinfection can help control the quantity of DBPs produced. In addition, limiting the amount of disinfectant introduced in the system reduces the formation of these by-products. All PWSs where chlorine is used are required to maintain residual levels between 0.2 and 4.0 milligrams chlorine per liter (mg/L) throughout the distribution system. These levels provide assurance that the water is safe from most water-borne pathogens while minimizing any adverse health risks to the population from DBPs or the higher concentrations of chlorine.

DBPs are broken into two groups: Total Trihalomethanes (TTHMs) and haloacetic acids (HAA5). TTHMs are reported as the sum of the chloroform, dibromochloromethane, bromo-dichloromethane, and bromoform concentrations in milligrams per liter. Haloacetic acids are reported as the sum of the monochloroacetic acid, dichloroacetic acid, trichloroacetic acid, monobromoacetic acid, and dibromoacetic acid concentrations in milligrams per liter. All tests for DBPs were at or below SDWA MCLs.

7.5.5 Water Quality Parameters

No water quality parameter testing was conducted in 2022. Testing typically includes constituents such as metals. Typically, detection of these constituents does not indicate that the water is unsafe to drink; rather they may have considerations of the water such as color, odor, and taste.

7.5.6 Synthetic Organic Contaminants

Synthetic organic chemicals are products derived from naturally occurring materials (petroleum, natural gas, and coal), which have undergone at least one chemical reaction, such as oxidation, hydrogenation, or other process.

7.5.7 Volatile Organic Contaminants

VOCs include a variety of chemicals, some of which may have short and long-term adverse health effects. VOCs are released by a wide array of products, numbering in the thousands. Organic chemicals are widely used as ingredients in household products such as fuels, paints, varnishes, waxes containing organic solvents, and many cleaning, disinfecting, cosmetic, degreasing, and hobby products. All of these products can release organic compounds while being used, and to some degree, while they are stored. Due to the vast number of products on the market that contain VOCs, it is possible that some of these constituents will find

their way into drinking water supplies. The TCEQ monitored the water system for VOCs during 2022. All sample results were below any regulatory limits established in federal or state regulations, and within the ranges observed in previous years.

7.5.8 Lead and Copper Monitoring

The Lead and Copper Rule under the SDWA requires that concentrations of lead and copper remain below action levels (0.015 and 1.3 mg/L, respectively) for the 90th percentile of the sampling locations. These regulations establish requirements for monitoring, reporting, corrosion control studies and treatment, source water treatment, lead service line replacement, and public education. PWSs must control the levels of lead and copper in drinking water by controlling the corrosiveness of the water. Pantex is on a triennial monitoring schedule for lead and copper. Compliance monitoring for lead and copper was conducted during 2021 and is scheduled for sampling in 2024.

7.5.9 Contaminant Candidate Monitoring

The drinking water Contaminant Candidate List (CCL) is a list of contaminants that are currently not subject to national primary drinking water regulations, but are known or anticipated to occur in PWSs. Contaminants listed on the CCL may require future regulation under the SDWA. The EPA is required to publish the CCL every five years. The SDWA directs the EPA to consider the health effects and occurrence information for unregulated contaminants as the agency makes decisions to place contaminants on the list. The SDWA further specifies that the EPA place those contaminants on the list that present the greatest public health concern related to exposure from drinking water. The EPA uses the CCL to identify priority contaminants for regulatory decision making and information collection.

The EPA published 86 FR 73131, *Revisions to the Unregulated Contaminant Monitoring Rule (UCMR 5) for Public Water Systems and Announcement of Public Meetings*, which was effective January 26, 2022. The Unregulated Contaminant Monitoring Rule will require Pantex to collect drinking water samples for 29 PFAS and lithium analysis during a 12-month period between 2023 and 2025.

7.6 INSPECTIONS

The TCEQ monitors the water supply in accordance with the drinking water standards. In September 2022, a TCEQ contractor collected samples from Pantex PWS system. The report generated from that event indicated that Pantex met or surpassed all requirements for operating a PWS. The TCEQ did not perform a Comprehensive Compliance Inspection of the Pantex Drinking Water system in 2022.

7.7 CONCLUSIONS

Results from the routine drinking water compliance samples collected by Pantex and a TCEQ contractor in September 2022 confirmed that the drinking water system at Pantex met all water quality regulatory requirements.

No corrective actions, deficiencies, or violations were identified during the last routine drinking water compliance inspection conducted in November 2021. Samples were collected by Pantex and a TCEQ contractor and were below applicable regulatory limits under the SDWA. Monitoring results demonstrate that Pantex continues to provide safe drinking water while the water supply system maintains a “Superior Rating.”

CHAPTER 8 - WASTEWATER

Pantex operates an on-site wastewater treatment facility (WWTF). The wastewater treatment system consists of a facultative lagoon and two wastewater storage lagoons. This facility is permitted by the TCEQ to treat and dispose of domestic and industrial wastewater.

Chapter Highlights

- During 2022, Pantex discharged approximately 93 million gallons (gal.) of treated wastewater to the on-site playa lake.

8.1 WASTEWATER AT PANTEX

Domestic and industrial wastewaters generated at Pantex are treated at an on-site WWTF. Industrial effluents from Pantex operations are generally pre-treated and directed into the WWTF for further treatment. All such effluents are collected in the sanitary sewer, managed in the WWTF, and can be discharged through permitted outfalls to either an underground irrigation system or an on-site playa lake. The playa is an ephemeral lake and is not connected to any other lakes, rivers, or streams (Fig. 8.1).

Fig. 8.1. Playa 1

The WWTF (Fig. 8.2) is a clay-lined, facultative lagoon that covers approximately 3.94 acres (ac) and has a capacity of 11 million gal. In addition to the WWTF, there are two storage lagoons (Figs. 8.3 and 8.4) that are utilized for the storage and retention of treated wastewater. The east lagoon (Fig. 8.3) is a storage lagoon that is lined with a polyethylene liner and has similar dimensions and capacity to the facultative

lagoon. This lagoon receives treated domestic and industrial wastewater, as well as treated groundwater from environmental remediation projects. If necessary, the east lagoon can serve as a facultative lagoon.

The treatment process in the facultative lagoon involves a combination of aerobic, anaerobic, and facultative bacteria. At the surface, aerobic bacteria and algae exist in a symbiotic relationship. Oxygen is provided by natural aeration processes, algal photosynthesis, and by solar-powered mechanical aerators. Bacteria utilize the oxygen for the aerobic degradation of organic matter, while algae utilize the nutrients and carbon dioxide released in the degradation process. Facultative bacteria within the water column are used in the treatment and degradation of organic matter. Anaerobic bacteria decompose organic matter that is deposited in a sludge layer at the bottom of the lagoon. The wastewater treatment process in a facultative lagoon is complex and nearly all treatment is accomplished by biological activity.

Fig. 8.2. Wastewater Treatment Facility, Facultative Lagoon

8.2 OPERATIONAL DESCRIPTION AND METRICS

During 2022, Pantex had three authorizations from TCEQ for wastewater disposal. Each required analytical monitoring and periodic reporting to the TCEQ.

Under the TLAP, WQ0004397000, Pantex is permitted to dispose of treated wastewater by means of a subsurface irrigation system into agricultural fields for beneficial reuse (Fig. 8.5). This permit was modified and reissued on August 11, 2020, and will expire on August 11, 2030. When discharging to the subsurface irrigation system, water is distributed through manifold pipes to individual zones located within four tracts of land that are each approximately 100 acres (ac) in size.

The irrigation areas consist of agricultural land owned by the DOE and farmed by TTU. Crops grown in this area may include winter wheat, sorghum, soybeans, cotton, corn, oats, and opportunity wheat. Crops will vary from field to field, depending on the cropping needs of TTU. The subsurface irrigation system was operational during 2022, but was limited by repairs.

Fig. 8.3. East Wastewater Storage Lagoon

Fig. 8.4. Wastewater Storage Lagoon

Fig. 8.5. Irrigation Tract 101

During periods when the agricultural fields are fallow, Pantex is authorized to apply limited quantities of wastewater to the irrigation area according to UIC Authorization 5W2000017. There is no expiration date on this authorization.

Pantex maintains a Texas water quality permit, WQ0002296000, which allows for the discharge of treated wastewater to Playa 1, an on-site playa. This permit was renewed by the TCEQ on August 27, 2020, and will expire on August 27, 2025. Through compliance with these three authorizations, Pantex manages and discharges treated effluent in a manner that is beneficial to the environment.

Pantex also began a Lagoon Liner Refurbishment Project to replace, repair, and refurbish the liners for all three-wastewater treatment and storage lagoons. This project is scheduled to be complete in 2023.

Finally, during 2022, Pantex started construction of an irrigation storage lagoon and installation of five center-pivot irrigation system for the beneficial reuse of treated wastewater. This area is located east of (FM 2373 and is approximately 1,050 acres. This project should be completed in early to mid-2023.

8.3 SAMPLING LOCATIONS

Sampling was conducted at the incoming weir of the lagoon system (before treatment) and at the permitted discharge point for surface water discharge, Outfall 001A. Monitoring the water quality at the incoming weir was done to determine the effectiveness of the wastewater treatment system. Results of these efforts showed that the treatment system adequately treated the wastewater to comply with all effluent limitations.

8.4 ANALYTICAL RESULTS

During 2022, Pantex discharged approximately 93 million gal. of treated wastewater through Outfall 001A. Water quality results from this outfall are shown in Table 8.1.

Table 8.1. Water Quality Results from Outfall 001A, 2022

Analyte	Maximum Discharge Limits[a] (mg/L)	Minimum Detected Concentration (mg/L)	Maximum Detected Concentration (mg/L)	Permit Exceedance / Violation[b]	Percent Compliance
Copper	1.0	0.003	<0.020	0/0	100
Manganese	2.0	0.006	0.012	0/0	100
Zinc	2.0	0.004	0.012	0/0	100
Octahydro-1,3,5,7-tetranitro 1,3,5,7-tetrazocine	Report	0.0001	<0.0003	0/0	100
Research Department Explosive (hexahydro-1,3,5-trinitro-1,3,5-triazine)	Report	<0.0003	<0.0003	0/0	100
Pentaerythrithol tetranitrate	Report	<0.001	<0.001	0/0	100
trinitrotoluene	Report	<0.0003	<0.0003	0/0	100
TATB	Report	<0.001	<0.001	0/0	100
Biochemical oxygen demand	70	1.9	15.9	0/0	100
Chemical oxygen demand	150	11.9	110.0	0/0	100
Total suspended solids	90	0.6	54	0/0	100
Oil/Grease	15	2.7	<10.2	0/0	100
pH[c]	6.0 Min. 10.0 Max.	6.4	9.3	0/0	100

[a] The maximum discharge limits are based on the daily maximum levels stated in the permit.
[b] An exceedance is defined as a measured value above or below a permit limit. A violation is defined as a missing permit parameter such as failure to obtain a sample required by the permit.
[c] pH is measured in standard units and not in mg/L.

8.5 PERMIT COMPLIANCE VIOLATIONS

During 2022, Pantex had two unauthorized discharges of untreated wastewater from the sanitary sewer system. An unauthorized discharge is defined as either a discharge of untreated wastewater prior to treatment or a discharge to the environment at any location other than through a permitted outfall. In both instances, actions were taken to remediate the areas of concern and notifications were submitted to TCEQ.

8.6 CONCLUSIONS

At Outfall 001A, the 2022 results for explosives, metals, biochemical oxygen demand, chemical oxygen demand, total suspended solids (TSS), and oil/grease were all within accepted ranges and did not exceed permit limits. However, multiple oil/grease samples were rejected by the laboratory during the latter part of 2022 due to low matrix spike duplicate recoveries.

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CHAPTER 9 - SURFACE WATER

To ensure outdoor operations at Pantex are not adversely affecting the environment, Pantex actively monitors the storm water runoff from each industrial area and the surface water quality of each on-site playa lake.

Chapter Highlights

- Data from the surface water program collected during 2022 was consistent with historical data from past monitoring activities, indicating that operations at Pantex did not adversely affect the water quality of the playas.
- No significant changes were made to the surface water sampling program during Calendar Year 2022.

9.1 SURFACE WATER AT PANTEX

Pantex is located in a region with a semi-arid climate and a relatively flat topography. Surface water represented by rivers or streams does not exist around the site. All surface water drains to isolated playa lakes. Playa lakes are shallow, ephemeral lakes that have clay-lined basins that fill periodically with surface water runoff. Playa basins consist of the ephemeral lakes themselves and their surrounding watersheds. There are approximately 20,000 of these playas on the Southern High Plains. Playa lakes are extremely important hydrologic features that provide prime habitat for wildlife, especially waterfowl that winter in the Southern High Plains. Playas are also believed by most authorities to be an important source of recharge for the Ogallala Aquifer, the area's primary source of groundwater.

There are six playas located on DOE-owned or -leased property. Two are located on property leased from TTU. Most surface drainage on DOE property flows via man-made ditches, via natural drainage channels, or by sheet flow to the on-site playa basins. Some storm water flows to off-site playas at the outer periphery of the site which are a considerable distance from most Pantex operations. Fig. 9.1 is a map of Pantex that shows the locations of the six playas with their respective drainage basins (watersheds).

Effluent from the wastewater treatment facility (WWTF) and storm water runoff from Zones 4, 12, and the northeastern portion of Zone 11 are permitted to discharge to Playa 1. Storm water runoff from the northwestern portions of Zone 11 is channeled to Playa 2 via a ditch system. Storm water runoff from the Burning Ground flows, primarily as sheet flow, into Playa 3. Storm water runoff from the southern portions of Zones 10, 11, and 12 discharge into Playa 4 on TTU property. There are no discharges from Pantex to Pantex Lake or Playa 5. Pantex Lake is located on DOE property to the northeast of the main property, and Playa 5 is located on TTU property to the southwest. Both of these playas receive storm water runoff from surrounding pastures and agricultural operations.

9.2 SAMPLING LOCATIONS AND MONITORING RESULTS

Surface water sampling occurs in response to precipitation or discharge events. During 2022, Pantex collected samples in accordance with the permits issued by the TCEQ and the Data Quality Objective documents developed by Pantex media scientists. The TCEQ is the permitting authority for storm water discharges in the State of Texas.

Storm water runoff at Pantex is sampled in accordance TPDES Multi-Sector General Permit (MSGP) TXR050000. General permits are typically active for five years with the most recent MSGP expiring in

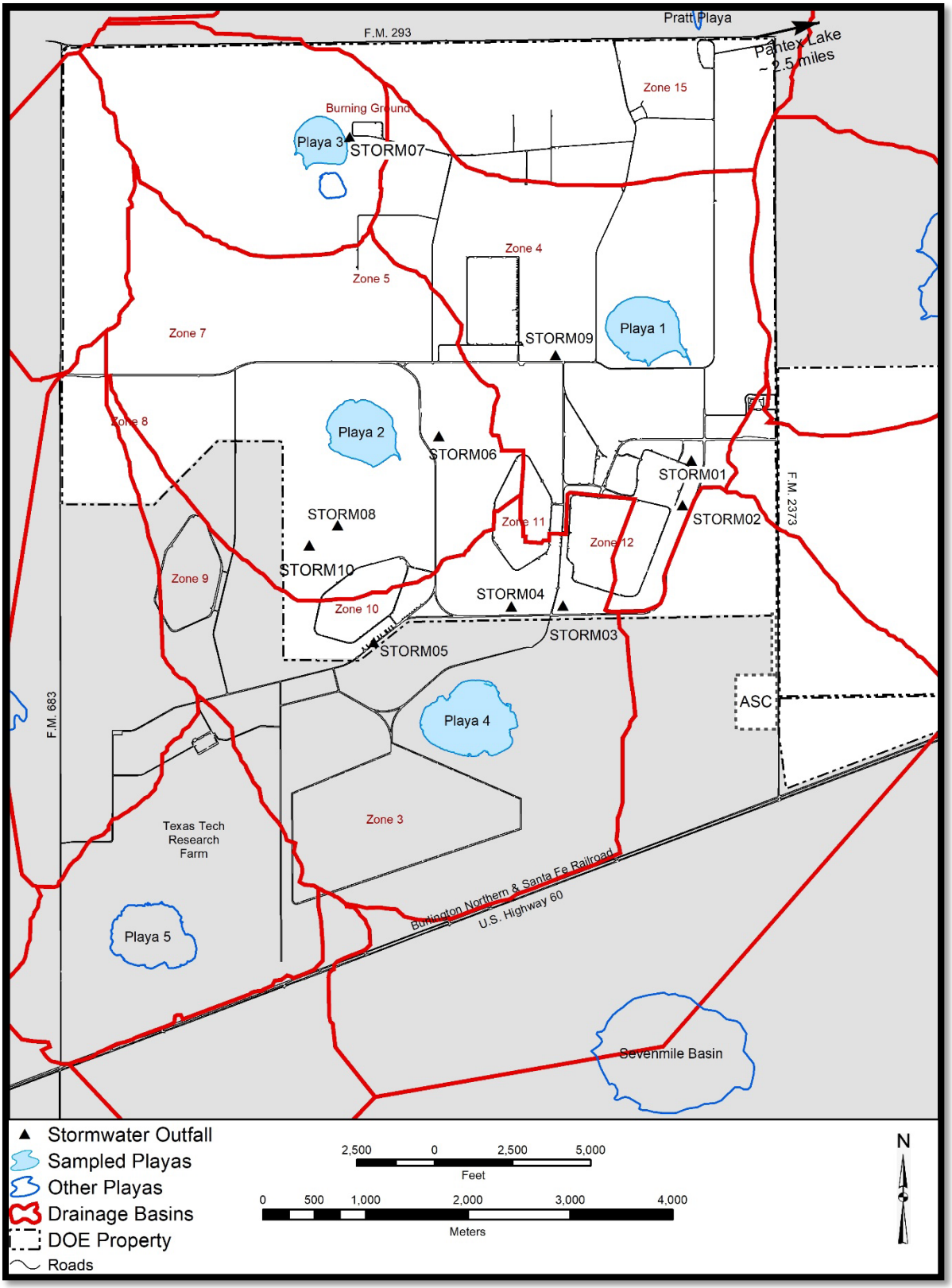

Fig. 9.1. Drainage Basins, Playas, and Storm Water Outfalls at Pantex

August 2026. Storm water sampling locations, known as outfalls, are conveyances in which storm water accumulates and discharges. Locations have been selected based on their proximity to Pantex operations.

The TCEQ issued an additional five-year general permit, TPDES General Permit No. TXR150000, relating to storm water discharges associated with construction activities. The most recent general permit expires in March 2028. There were 14 construction projects filed under this general permit at the end of 2022 for Pantex. This permit does not require analytical monitoring, but relies on best management practices, such as storm water pollution prevention plans, soil stabilization controls, and routine field inspections.

Environmental surveillance monitoring is also conducted at the on-site playas as a best management practice. Appendix C contains a list of the surface water analytes that were monitored during 2022. In addition to the playa lake sampling program, Pantex also monitors storm water quality at nine different outfalls (shown on Fig. 9.1). The flow diagram in Fig. 9.2 depicts how storm water and treated industrial effluents discharge through the outfalls, and ultimately to the playas or the subsurface drip irrigation system.

During 2022, Pantex collected samples at two playas and nine storm water outfalls. Based on data from the NWS – Amarillo, located northeast of Amarillo and southwest of Pantex, rainfall during 2022 was below average with approximately 16.4 inches (in.) for the year. The average annual rainfall for Amarillo is typically 19.7 in.

Storm water monitoring required by the TPDES MSGP in 2022 consisted of both visual monitoring and analytical monitoring. Both are required each year for the duration of the MSGP. Visual monitoring involves the examination of the physical properties of storm water including color, clarity, odor, oil sheen, solids, and foam. Visual samples taken and examined in 2022 appeared to be of good quality, and none showed any abnormalities based on the criteria specified in the MSGP. Analytical monitoring consisted of metals [inland water quality parameters (IWQPs)] listed in Title 30 of the TAC, Chapter 319 and sector-specific analytes required by the MSGP. Metal concentrations were compared with IWQPs, and sector-specific analytes were compared to benchmark levels listed in the MSGP. The 2022 storm water outfall sample results for metals are listed in Table 9.1.

9.2.1 Playa 1 Basin

Playa 1 is approximately 79.3 acres (ac) in size and may receive treated wastewater effluent and storm water runoff from several small drainages. One of the drainages to the playa is associated with Pantex operations (permitted Industrial Wastewater Outfall 001A). The other drainages receive only storm water runoff from agricultural and operational areas. There are three drainages along the southern perimeter of Playa 1. All three include storm water from both agricultural and operational areas. Storm Water Outfalls 01 and 02 are located upstream in one of these drainages, which originates from some of the operational areas of Zone 12 North. The western edge of Playa 1 receives storm water runoff from the Zone 4 area. Two additional drainages transport storm water runoff from agricultural areas that are north of the playa. In 2022, Pantex collected samples at Playa 1 and within the Playa 1 basin at Storm Water Outfalls 01 and 02.

During the second and fourth quarter of 2022, samples were collected from Playa 1 for metals, radionuclides, and explosives. Metal analyses were consistent with historic levels found at the playa and all were below their respective IWQP. Isotopic radiological analyses for uranium were all below their respective DCS for ingested water. Tritium was also below the DCS for ingested water, as well as the more conservative MCL for drinking water standards. All explosive analyses were below laboratory detection levels except for HMX.

This explosive was detected slightly above the laboratory detection limit and is consistent with historical levels. These types of detections are from operations that occurred in the past.

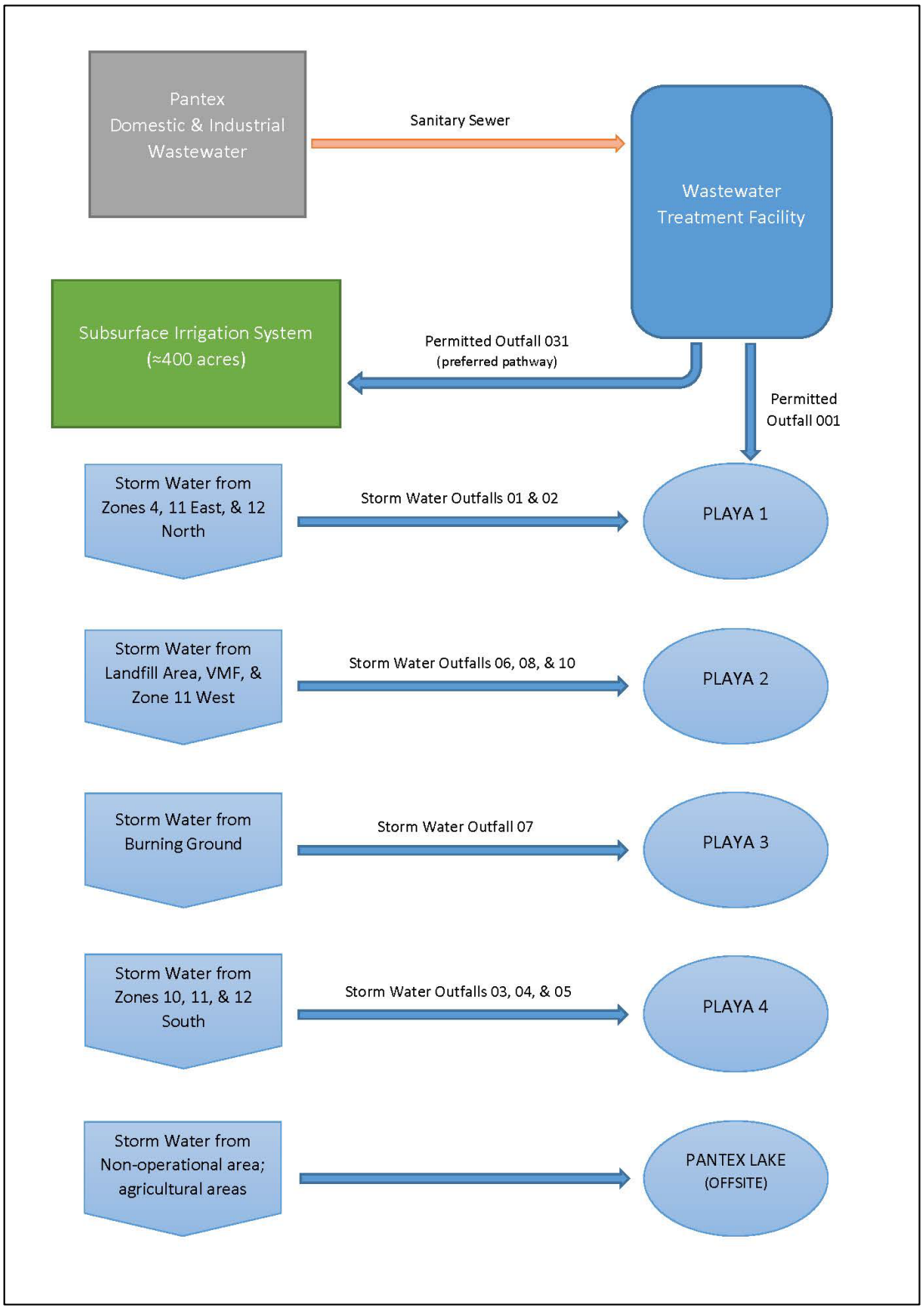

Fig. 9.2. Pantex Surface Water Schematic

Table 9.1. Annual Storm Water Results (metals), 2022 (mg/L)

	Outfall 01	Outfall 02	Outfall 03	Outfall 04	Outfall 05	Outfal 06	Outfall 07	Outfall 08	Outfall 10	IWQP[a]
Arsenic	0.005	0.005	0.004	0.002	0.001	0.004	0.001	0.007	0.011	0.3
Barium	0.220	0.250	0.280	0.090	0.044	0.350	0.210	0.330	0.390	4.0
Cadmium	0.0002	0.0003	0.0003	<0.001	0.0002	0.001	0.0001	0.0003	0.001	0.2
Chromium	0.007	0.019	0.014	0.007	0.001	0.012	0.002	0.020	0.033	5.0
Copper	0.010	0.015	0.014	0.006	0.007	0.020	0.005	0.017	0.026	2.0
Lead	0.003	0.013	0.010	0.004	0.002	0.013	0.002	0.012	0.020	1.5
Manganese	0.160	0.290	0.230	0.140	0.047	0.370	0.048	0.300	0.370	3.0
Mercury	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	0.00003	<0.0002	<0.0002	0.0001	0.01
Nickel	0.006	0.016	0.012	0.006	0.003	0.014	0.004	0.017	0.027	3.0
Selenium	0.003	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.2
Silver	0.0001	0.001	<0.005	<0.005	<0.005	<0.005	0.0001	<0.005	<0.005	0.2
Zinc	0.063	0.190	0.150	0.026	0.035	0.210	0.020	0.060	0.096	6.0

[a] IWQP = Inland Water Quality Parameter limits, 30 TAC 319.22

Note: The values above are the average concentration from all samples, if more than one sample was collected during the year.

9.2.2 Storm Water Outfall 01 – Zone 12 North at BN5A

BN5A is the designation for the parking lot located north of operational areas, south of Playa 1, and west of agricultural areas. Flow through this outfall consists entirely of storm water that originates in the operational areas of Zone 12 North. The storm water flows northward from the outfall through the BN5A ditch, and then northward to Playa 1 where it finally discharges.

Pantex performed permit-required monitoring at Storm Water Outfall 01 during all four quarters of 2022. Activities included visual monitoring, pH evaluation, and metal analyses. Visual examinations showed no abnormalities based on the visual criteria described in the MSGP, pH was normal (6.0 – 9.0 s.u.), and all metal concentrations were below their respective IWQP in 2022.

9.2.3 Storm Water Outfall 02 – Zone 12 East at South 15th Street

Storm water discharges that flow through Storm Water Outfall 02 originate from the eastern portions of Zone 12 South, which include some of the operational areas of Pantex. Storm water from this outfall flows northward and combines with the discharge from Storm Water Outfall 01 as it flows to Playa 1.

Pantex performed permit-required monitoring at Storm Water Outfall 02 during the second, third, and fourth quarters of 2022. Activities included visual monitoring, pH evaluation, and metal analyses. Visual examinations showed no abnormalities based on the visual criteria described in the MSGP, pH was normal, and all metal concentrations were below their respective IWQP in 2022.

9.2.4 Playa 2 Basin

Playa 2 is approximately 74 ac and only receives storm water runoff. Playa 2 receives runoff from the northwest side of Zone 11, the north side of Zone 10, and an area of agricultural fields that includes both pasture and cultivated land. Three storm water outfalls, Outfalls 06, 08, and 10, are within the Playa 2 basin. During 2022, Pantex collected samples at Playa 2 and all three storm water outfalls.

During the third quarter of 2022, samples were collected at Playa 2 for metals, radionuclides, and explosives. Metal analyses were consistent with historic levels found at the playa and all were below their respective IWQP. Isotopic radiological analyses for uranium were all below their respective DCS for ingested water. Tritium was also below the DCS for ingested water, as well as the more conservative MCL for drinking water standards. All explosive analyses were below laboratory detection levels.

9.2.5 Storm Water Outfall 06 – Vehicle Maintenance Facility

Storm Water Outfall 06 receives storm water runoff from an area that includes the Vehicle Maintenance Facility (VMF) and portions of the parking lot around the VMF where vehicles awaiting maintenance are staged. The refueling stations for Pantex fleet are also located in this drainage area. The drainage area is primarily a paved lot utilized for parking and staging vehicles on the south side of the VMF

Pantex performed permit-required monitoring at Storm Water Outfall 06 during the first, second, and third quarters of 2022. Activities included visual monitoring, pH testing, total petroleum hydrocarbons (TPHs) analysis, and metal analyses. Visual examinations showed no abnormalities based on the visual criteria contained in the MSGP and pH was normal. TPH results were only slightly above the laboratory detection limits, indicating that runoff from the VMF is not contributing significant hydrocarbon pollutants to the environment. All metal concentrations were below their respective IWQP in 2022.

9.2.6 Storm Water Outfalls 08 and 10 – Landfill

These outfalls receive storm water runoff from an area within Pantex's active landfill. Runoff from active open landfill cells is retained within each cell. Storm water at these outfalls consists of runoff over the landfill area, including runoff over closed cells. Storm water from this area eventually makes its way northward to Playa 2.

Pantex performed permit-required monitoring at Storm Water Outfalls 08 and 10 during the second and third quarters of 2022. Activities included visual monitoring, pH evaluation, and metal analyses. Visual examinations showed no abnormalities based on the visual criteria described in the MSGP, pH was normal, and all metal concentrations were below their respective IWQP in 2022. Sector-specific monitoring is required at these locations and includes TSS and iron. TSS concentrations averaged 778 milligrams per liter (mg/L) for the year, which is above the benchmark level of 100 mg/L. Iron concentrations averaged 22.8 mg/L for the year, which is also above the benchmark level of 1.3 mg/L. However, background samples collected from different outfalls outside the landfill have confirmed that these two anayltes are naturally occurring in the soils at Pantex and are not indicative of a contaminant problem. Depending on the lack of vegetative cover during drought conditions and the severity of each storm event, these naturally occurring anayltes can be easily entrained in storm water runoff at levels well above the benchmark limits from any area at the site. As a best management practice, additional erosion control features will be installed at the landfill during 2023 to help counteract the effects of persistent drought.

9.2.7 Playa 3 Basin

Playa 3, the smallest playa at Pantex, is approximately 54 ac and receives storm water runoff from pastureland, cultivated fields, and portions of the Burning Ground. No well-defined ditches feed into the playa and runoff occurs primarily as sheet flow. Storm Water Outfall 07 is located within the basin and is northeast of Playa 3 between the playa and Pantex Burning Ground. During 2022, Pantex collected samples within the Playa 3 basin at Storm Water Outfall 07. However, due to below average rainfall in 2022, samples could not be collected at Playa 3.

9.2.8 Storm Water Outfall 07 – Burning Ground

Storm Water Outfall 07 receives storm water runoff from the Burning Ground operational area through a culvert that underlies a circumferential road around the Burning Ground, a relatively small land area. For this reason, sampling at the outfall can be a challenge.

Pantex performed permit-required monitoring at Storm Water Outfall 07 during the third quarter of 2022. Activities included visual monitoring, pH evaluation, and metal analyses. Visual examinations showed no abnormalities based on the visual criteria described in the MSGP, pH was normal, and all metal concentrations were below their respective IWQP in 2022.

9.2.9 Playa 4 Basin

Playa 4 is approximately 112.5 ac and is located on property owned by TTU. This playa receives runoff primarily from pasture areas, but does receive storm water runoff from portions of Zone 10 (through Storm Water Outfall 05), Zone 11 (through Storm Water Outfall 04), and Zone 12 South (through Storm Water Outfall 03). Discharges from Zone 12 are predominately storm water runoff; however, Fire Department personnel periodically flush firewater storage tanks or test fire hydrants in sufficient volumes that can reach Storm Water Outfall 03. During 2022, Pantex collected samples within the Playa 4 basin at Storm Water Outfalls 03, 04, and 05. Due to below average rainfall, samples could not be collected at Playa 4 during 2022.

9.2.10 Storm Water Outfall 03 – Zone 12 South

Surface water monitored at Storm Water Outfall 03 is primarily storm water runoff from the west half of Zone 12 South. Storm water flows southward through this outfall to Playa 4 where it finally discharges. Periodically, water from the fire protection system is discharged through this outfall during routine maintenance activities.

Pantex performed permit-required monitoring at Storm Water Outfall 03 during the second, third, and fourth quarters of 2022. Activities included visual monitoring, pH evaluation, and metal analyses. Visual examinations showed no abnormalities based on the visual criteria contained in the MSGP, pH was normal, and all metal concentrations were below their respective IWQP in 2022.

9.2.11 Storm Water Outfall 04 – Zone 11 South

Surface water monitored at Storm Water Outfall 04 is entirely storm water runoff from the southern half of Zone 11. Storm water from this area discharges southward through the outfall to Playa 4. The terrain in this area is very flat and all operations occur indoors.

Pantex performed permit-required monitoring at Storm Water Outfall 04 during the second and third quarters of 2022. Activities included visual monitoring, pH evaluation, and metal analyses. Visual examinations showed no abnormalities based on the visual criteria described in the MSGP, pH was normal, and all metal concentrations were below their respective IWQP in 2022.

9.2.12 Storm Water Outfall 05 – Zone 10 South

Surface water monitored at Storm Water Outfall 05 is entirely storm water runoff from the southern half of Zone 10. The terrain in this area is also very flat and includes several contractor laydown yards. Some of the laydown yards contain material staging areas, waste bins utilized primarily for scrap metal, and double-walled aboveground storage tanks utilized for equipment refueling.

Pantex performed permit-required monitoring at Storm Water Outfall 05 during all four quarters of 2022. Activities included visual monitoring, pH evaluation, and metal analyses. Visual examinations showed no abnormalities based on the visual criteria contained in the MSGP, pH was normal, and all metal concentrations were below their respective IWQP in 2022.

9.2.13 Pantex Lake

Pantex Lake is the largest playa controlled by the DOE and is approximately 337 ac in size. This playa is located approximately 2.5 miles to the northeast from the main Pantex site. Monitoring at Pantex Lake was discontinued in 2003, as it does not receive any runoff or discharges from Pantex.

9.3 CONCLUSIONS

Monitoring storm water runoff at Pantex is performed as required by the TCEQ's general permit. Sampling results from the storm water outfalls during 2022 showed no significant changes from the results of previous years. All monitoring results for metals were below their respective IWQP established by the State of Texas. Sample results continue to indicate that the storm water discharges at Pantex are of relatively good quality and that current operations are not degrading storm water quality.

The playa lakes at Pantex are monitored as a best management practice, but monitoring is often limited due to the semi-arid climate of the Texas Panhandle. The playa lake sample results obtained during 2022 were very similar with past monitoring results. The playa data continues to support the premise that operations at Pantex are not negatively affecting the water quality of the playas.

CHAPTER 10 - SOILS

In accordance with Pantex Hazardous Waste Permit (HW-50284) and Pantex Texas Land Application Permit (TLAP) (WQ0004397000), surface and subsurface soil samples are collected and analyzed for various parameters.

Chapter Highlights

- Results of soil monitoring conducted at the subsurface irrigation site were consistent with historical and the previous year's results.
- On-site Burning Ground surface soil monitoring results were within the concentration ranges of the established background levels.

10.1 SOIL SAMPLING AT PANTEX

Surface soil samples are collected at Pantex Burning Ground and analyzed for metals and explosives in accordance with Provision VI.C of Pantex's Hazardous Waste Permit HW-50284 (Permit HW-50284) (Texas Commission on Environmental Quality 2014). Subsurface soil samples are also collected from four subsurface irrigation tracts and analyzed for various parameters in accordance with Provision V.O of Pantex TLAP (WQ0004397000) (Texas Commission on Environmental Quality 2020). All samples are analyzed by off-site contract laboratories that meet EPA requirements as discussed in Chapter 13, "Quality Assurance." Specific analytes are listed in Appendix C.

10.2 BURNING GROUND SURFACE SOIL SAMPLING AND ANALYSIS

In 2022, surface soil samples were collected from two general landscape positions: playa bottoms and inter-playa uplands. The characteristic soil types for these landscape positions are Randall clay in playas, and Pullman clay loam in the uplands. Soil was sampled at five on-site locations, representing three upland and two playa sampling areas associated with the Burning Ground. Samples from each associated grid area (Fig. 10.1) were collected from a depth of 0 to 2 in., and combined to form individual composite samples.

10.2.1 Surface Soil Data Comparisons

Background comparison levels were determined by obtaining samples during three consecutive calendar quarters in 2006 for each monitoring parameter required by Permit HW-50284. If all analytical results of the background samples for a particular constituent at any location were less than the method detection limit (MDL) identified in Permit HW-50284, the background value was set at the MDL or the PQL, whichever was greater. If less than 50 percent of the analytical results of the background samples for a particular constituent at any location were greater than the MDL, the background value was set at the highest detected value, the MDL, or the PQL, whichever was greater. If the analytical results of more than 50 percent of the background samples for a particular constituent at any location were greater than the MDL, the background value was calculated using a 95 percent upper tolerance limit with 99.9 percent coverage.

10.2.2 Surface Soil Metals Analysis

Soil samples collected from the Burning Ground and Playa 3 were analyzed for 10 metals (see the "BG Soil" column in Appendix C). All metal concentrations observed in 2022 were below the established permit background concentrations as shown in Tables D10.1 through D10.5 in Appendix D.

10.2.3 Surface Soil Explosives Analysis

Soil samples collected from the Burning Ground and Playa 3 were analyzed for eight explosive compounds (Appendix C). All sampling results for explosives in 2022 were below the established permit background concentrations as shown in Tables D10.1 through D10.5 in Appendix D.

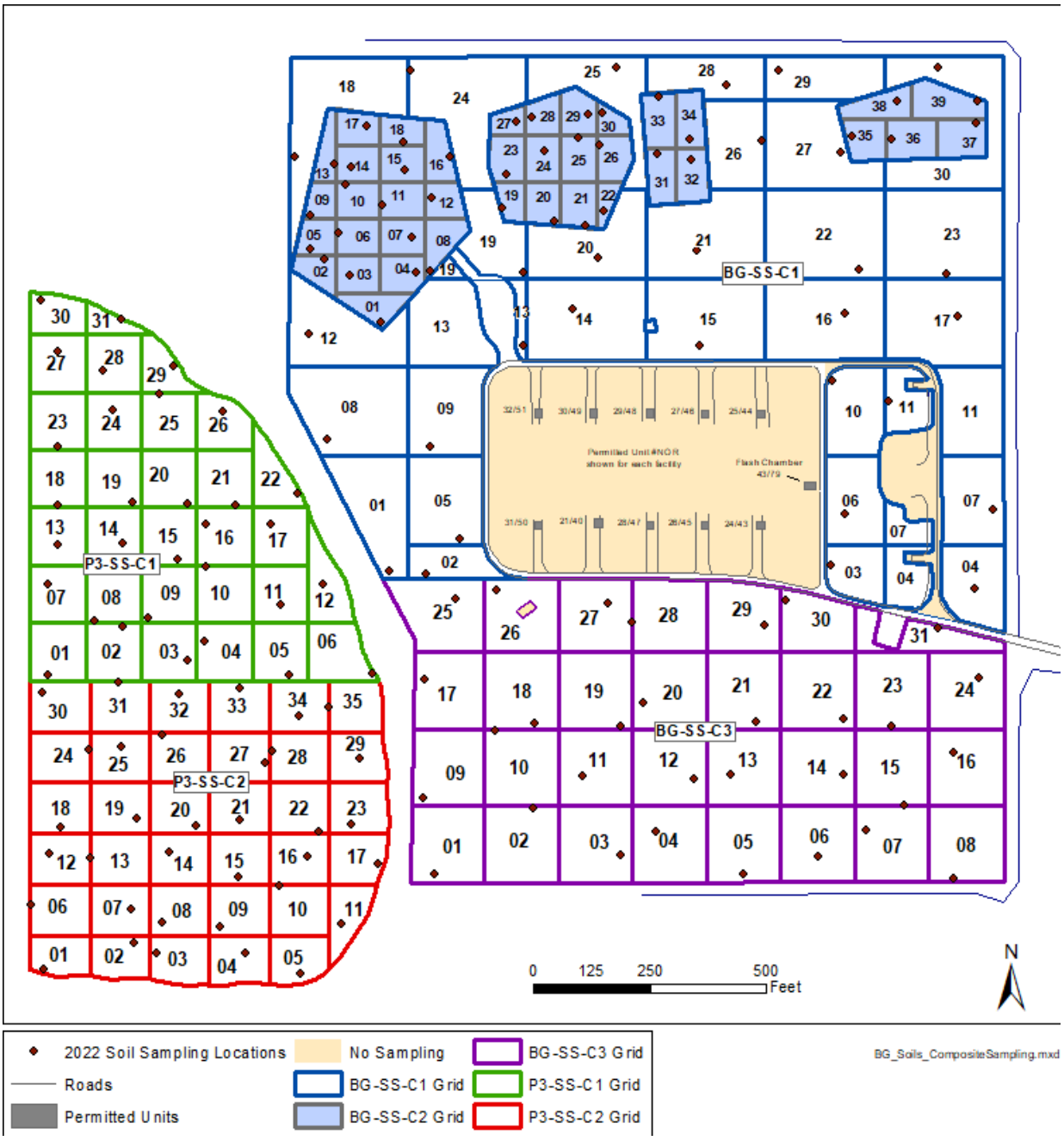

Fig. 10.1. Burning Ground Multi-Incremental Soil Sampling Locations for 2022

10.3 SUBSURFACE DRIP IRRIGATION SYSTEM SOIL SAMPLING AND ANALYSIS

In 2022, the annual TLAP subsurface drip irrigation system soil samples were collected from four locations: Tract 101; Tract 201; Tract 301; and Tract 401. Each tract represents 100 ac. Representative soil samples were collected from the root zones of the irrigation areas using random sampling and composite techniques. Each composite sample represented no more than 40 ac with no less than two soil cores representing each composite sample. Subsamples were composited by like sampling depth and soil type, and individually at depths of 0 to 12 in. and 12 to 24 in. for analysis and reporting (Fig. 10.2). These composite samples were analyzed for agricultural parameters, reactivity, two HEs, and one semi-volatile organic compound. See the "TLAP Soil" column in Appendix C for specific analytes.

10.3.1 Subsurface Drip Irrigation System Soil Sampling Results

The 2022 subsurface soil sampling results for HE, reactivity, and semi-volatile organic compound were all non-detects. The results of the agricultural parameters (nutrient parameters analyzed on a plant-available or extractable basis) are presented in Tables D10.6 through D10.9 in Appendix D. The TLAP subsurface soil sampling results are reported annually to the TCEQ as report only information, with no comparison values. The agricultural parameters are also used for decision making regarding the addition of nutrient amendments to the agricultural soils.

10.4 CONCLUSIONS

On-site Burning Ground surface soil monitoring results for 2022 were within the concentration ranges of the established background levels. Results of soil monitoring conducted at the subsurface irrigation for 2022 were consistent with previous year's results.

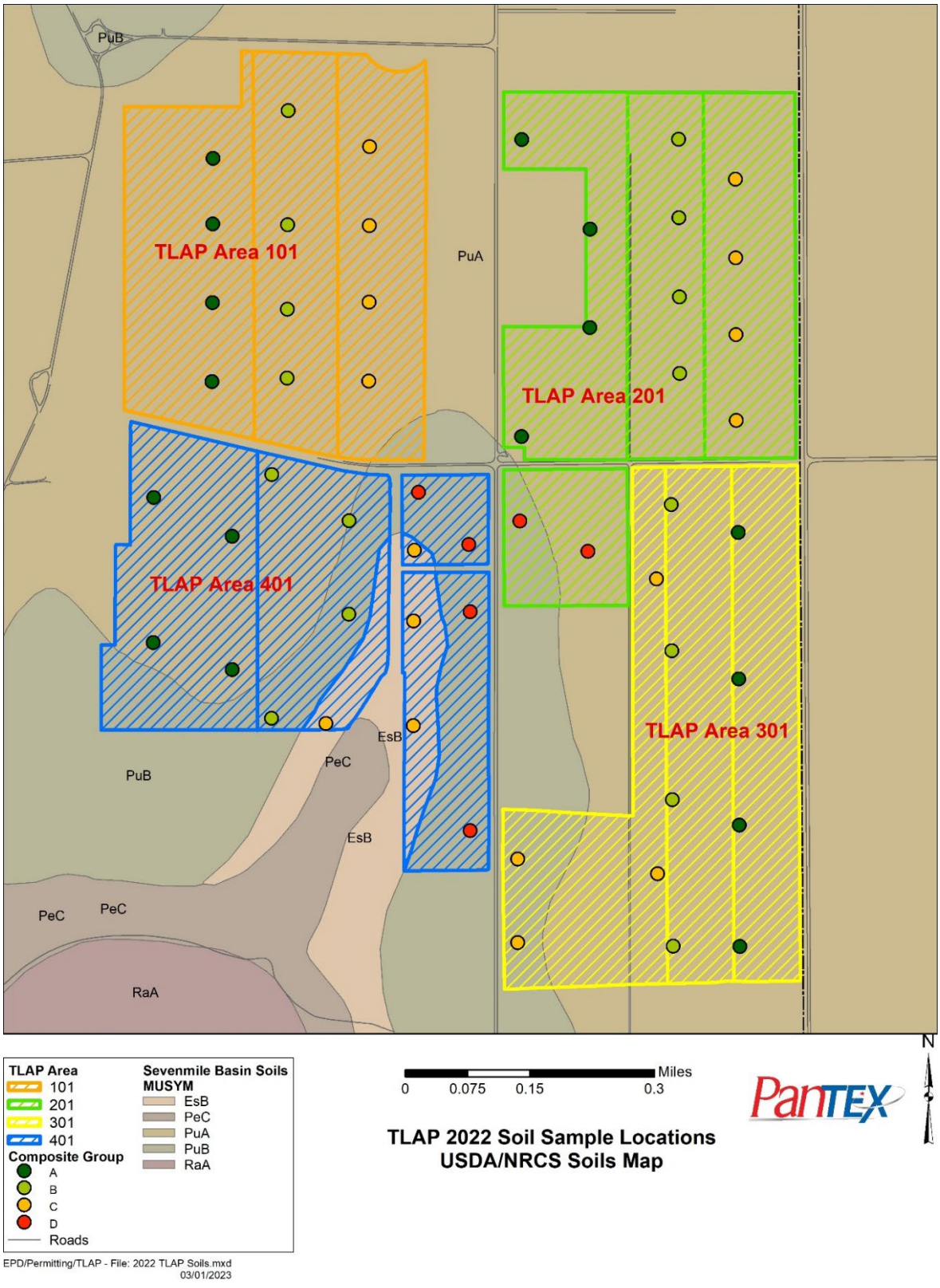

Fig. 10.2. TLAP Soil Sampling Locations for 2022

CHAPTER 11 - FLORA AND FAUNA

The flora and fauna surveillance program is a complementary program to air and water monitoring. The program is designed to augment the assessment of potential short-term and long-term effects to the environment as a result of operations at Pantex. The program samples native vegetation, crops, and native animals for radionuclide analyses.

Chapter Highlights

- Radionuclide measurements in flora and fauna samples from on and near Pantex were similar to historical data and samples from the control location, indicating no influence from Pantex operations in 2022.

11.1 FLORA AND FAUNA SELECTION AT PANTEX

Flora at Pantex consists of native vegetation and crops. Native vegetation species on the Southern High Plains consists primarily of prairie grasses and forbs. Crops are defined as any agricultural product harvested or gathered for animal or human food. Because vegetation species accumulate contaminants differently under varied growing conditions, data interpretation is complex, and results must be evaluated in concert with other environmental media.

Black-tailed prairie dogs were the primary species selected for sampling because of their place near the end of both the air and water pathways as well as their diet which consist of a wide variety of flora. Due to their regular proximity to potential sources of radionuclide contamination cottontails residing in certain locations are regularly sampled as well.

Radionuclide concentrations in all samples were compared to historical and control location sample concentrations. Control locations are selected primarily due to their distance from Pantex. Distance and direction of prevailing winds in the area make it extremely unlikely that there has been any impact from Pantex operations past or present at these locations. Due to this separation, any detected concentration of radionuclides is assumed to be either naturally occurring materials or legacy fallout from Cold War-era nuclear weapons testing. Availability of routine access, lack of industrial activity, and the presence of typical Southern High Plains flora and fauna are also secondary factors considered when selecting background locations.

11.2 RADIOLOGICAL SURVEILLANCE IN FLORA

Surveillance of native vegetation at on-site and off-site locations is used to monitor any potential impacts from current Pantex operations. Samples are collected from locations on-site, at the perimeter of the property, and up to approximately five miles from the center point of Pantex (Figs. 11.1 and 11.2). Rotational crops are also sampled (Fig. 11.3) as available. Background samples of crop and native vegetation species were collected from control locations at the USDA research farm in Bushland, Texas

Sampling locations are circles, approximately 33 ft in diameter, from which vegetation is collected, when it is available. Drought, cultivation, excessive grazing, prescribed burning and/or mowing may limit vegetation availability during certain parts of the growing season.

Vegetation samples were analyzed for tritium, uranium-233/234 (U-233/234), and uranium-238 (U-238). Analytical data were corrected for moisture content and reported in picocuries per gram (pCi/g) dry weight.

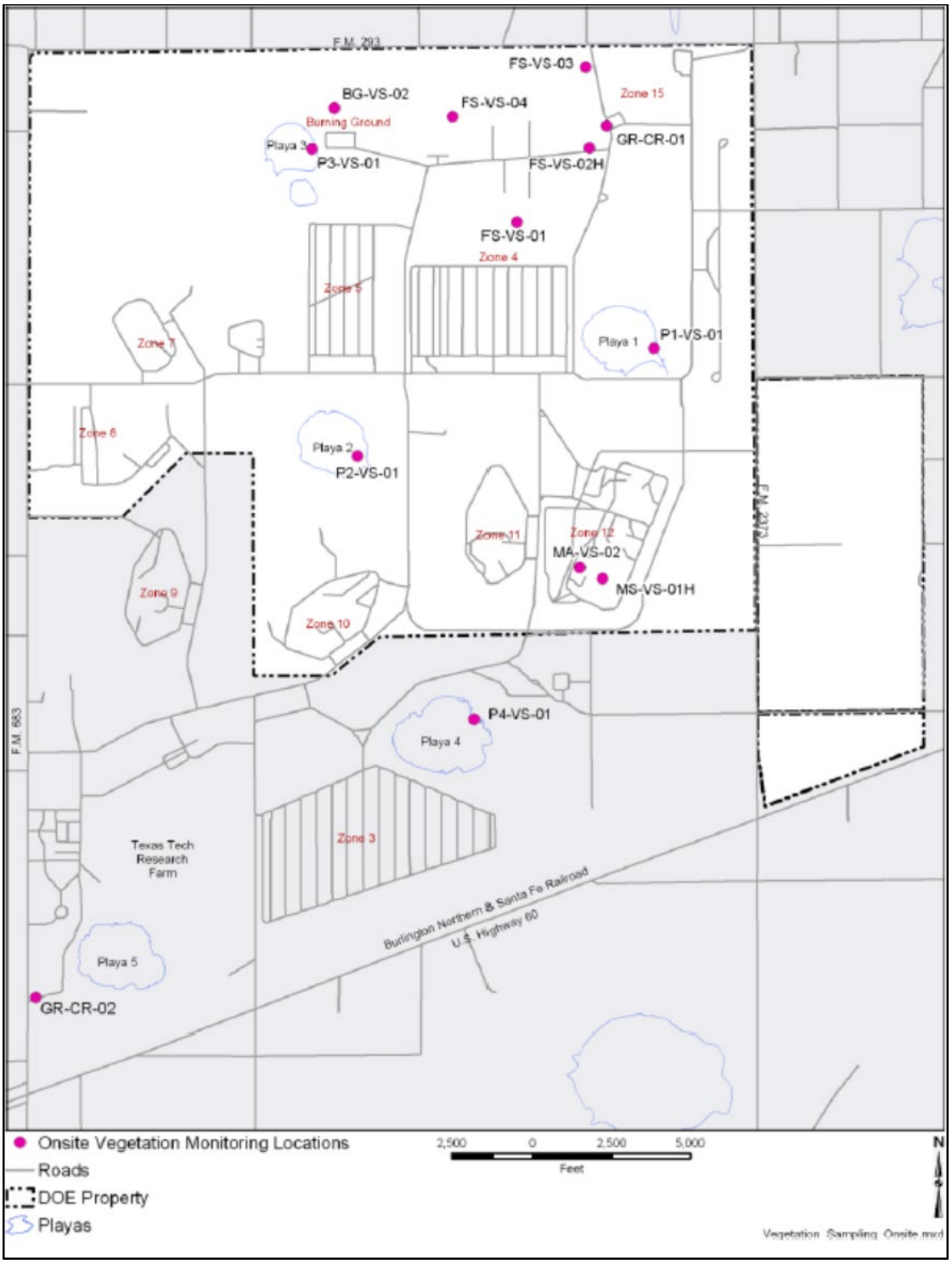

Fig. 11.1. On-site Vegetation Monitoring Locations

NOTE: On Figures 11.1, 11.2, and 11.3, note the following designations: B- Bushland, BG- Burning Ground, CR-crops, FS- Firing Sites, GR- garden produce, MA- Material Access Area, O- off-site, P- playa, S- sample, SO- grain sorghum, TL-Texas Land Application Permit, V-vegetation, and WW- winter wheat. Any sample location with H behind it is historical and is not currently being sampled.

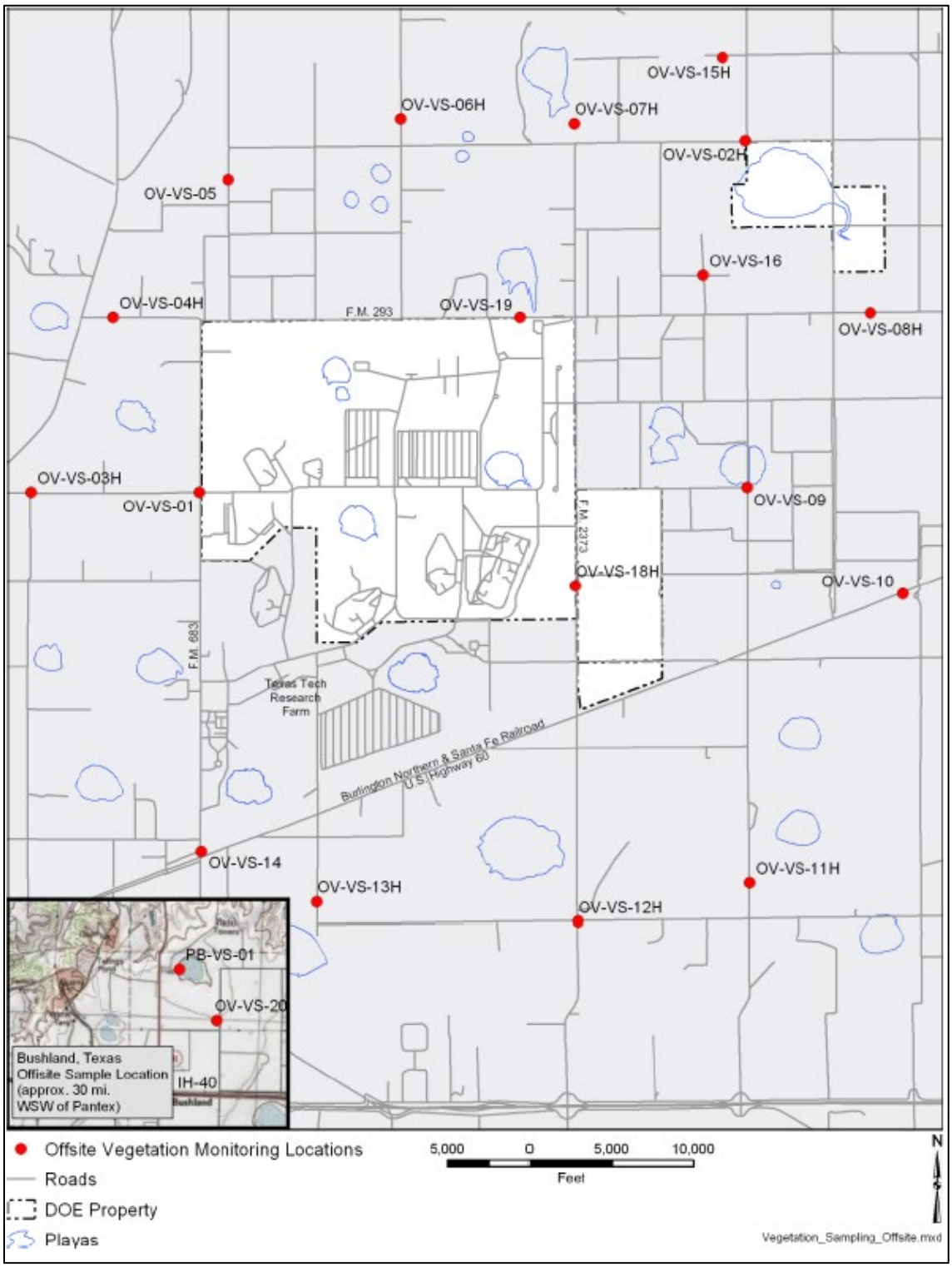

Fig. 11.2. Off-site Vegetation Monitoring Locations

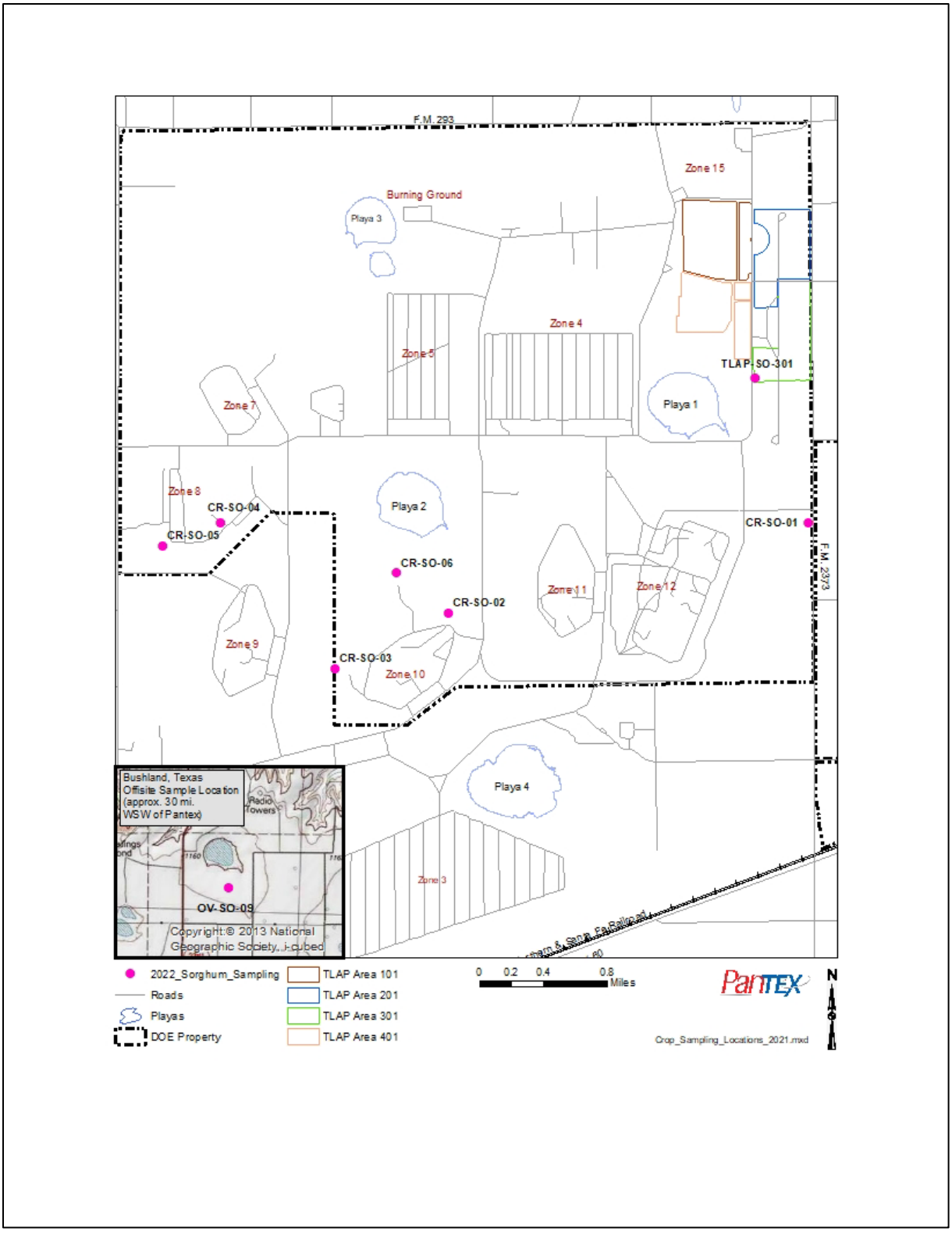

Fig. 11.3. Crop Monitoring Locations for 2022

The on-site and off-site data were compared to those from the control locations and six-year mean values, where possible, to identify and interpret differences. Although the DOE limits the dose to terrestrial plants to one rad/day (see Chapter 4), there are currently no limiting concentrations for tritium or uranium in vegetation.

11.2.1 Native Vegetation

Native vegetation samples, consisting primarily of stem and leaves from grasses and forbs, were collected from two control locations, 10 on-site locations, and six off-site locations. Sampling occurred two times during the growing season, no more frequently than once per month.

Tritium results from all on-site and off-site sample locations were at or below MDA levels (Table 11.1).

Table 11.1. Vegetation Comparison of Tritium 2022, Control Location, and Highs for the Year

Sampling Location	Tritium pCi/g + Error
OV-VS-09	<MDA
BG-VS-02	<MDA
OV-VS-20 (control)	<MDA

The percentage of vegetation samples at or below the MDA level for U-233/234 and U-238 in all vegetation was 76 percent for U-233/234 and 82 percent for U-238. Usually, the percentage of vegetation samples at or below the MDA level is near 50 percent. The measured values in general for locations for the year were not significantly elevated and were comparable to the control location (Table 11.2). Results for all on-site and off-site locations were consistent with those found in previous years. Concentration of U-233/234 and U-238 in native vegetation indicates that no uptake of U-233/234 and U-238 into vascular plants has occurred.

Table 11.2. Native Vegetation Comparison of U-233/234 2022, Control Location & Highs

Sampling Location	U-233/234 pCi/g + Error
P3-VS-01	0.07±0.04
OS-VS-14	<MDA
PB-VS-01 (control)	<MDA

11.2.2 Crops

Crop surveillance enables the evaluation of potential impacts to humans and livestock from Pantex operations. Samples of stems and leaves from dryland and irrigated grain sorghum were collected from on-site locations and from the Bushland, Texas control location.

Crop sampling locations vary annually according to crop rotation. Garden produce was sampled at two specially grown garden locations: one on the northeast side of Pantex property and one on the southwest side of the TTU property (Fig. 11.1).

Seven dryland grain sorghum samples, a duplicate sample from on-site, and a control sample from the control site were collected in September 2022. Dryland grain sorghum sampling locations were focused on the southwest side of the property, due to the availability of crop locations in 2022 (Fig. 11.3). Due to drought conditions, there was no dryland winter wheat available to sample in 2022. Fruits and leaves from garden plants were sampled in September 2022.

All crop and garden samples were analyzed for tritium, U-233/234 and U-238. All crop and garden produce analyzed in 2022 were at or below the MDA level for tritium. A vast majority of the crop and garden produce samples analyzed in 2022 were at or below MDA levels for U-233/234, and U-238 and were comparable to the off-site control location. Results for all crop and garden results were similar to historical data. Results for crop and garden locations are in Table 11.3 and Table11.4. Concentrations of U-233/234 and U-238 in crop and garden vegetation indicates no uptake of U- 233/234 and U-238 into vascular plants has occurred due to activities at Pantex, and that the radiological dose to terrestrial plant of one rad/day, as indicated in DOE-STD-1153-2002, has not been exceeded.

Table 11.3. Crop Comparison of Tritium 2022, High Locations and Control Location

Sampling Location	Tritium pCi/g + Error
TL-SO-301	<MDA
GR-CR-01	< MDA
CR-SO-06	<MDA
OV-SO-09 (control)	<MDA

Table 11.4. Crop Comparison of U-233/234 and U-238 2022, High Locations and Control Location

Sampling Location	U-233/234 (pCi/g) + Error	U-238(pCi/g) + Error
GR-CR-01	0.07±0.03	0.06±0.02
CR-SO-02	<MDA	<MDA
TL-SO-301	<MDA	<MDA
OV-SO-09 (control)	0.04±0.02	<MDA

11.3 RADIOLOGICAL SURVEILLANCE IN FAUNA

Semi-annual radionuclide surveillance of fauna (prairie dogs and cottontails) at Pantex was scheduled at six on-site locations and one control location. The sites were:

- Burning Ground,
- Firing Site 4 (FS-4),
- West of Zone 4,
- Playa 2,
- Playa 3,
- Zone 8, and
- Control site, Buffalo Lake National Wildlife Refuge near Umbarger, Texas.

Buffalo Lake National Wildlife Refuge was chosen as the control site because fauna populations there are far enough from Pantex (41 miles) to be unaffected by Pantex operations and affords a dependable availability of prairie dogs and property access. As in recent years, prairie dogs were not available at Playa 3 in 2022.

Sample animals are live-trapped, humanely euthanized, and shipped to the analytical lab. Whole-body composites are prepared for determination of tritium, uranium-233/234 (U-233/234), and uranium-238 (U-238) activities. These radionuclides are associated with activities at Pantex, but are also naturally occurring in soils at and around Pantex. Analytical results of the 2022 faunal sampling are presented in Table 11.5 and Table 11.6.

Table 11.5. Tritium, U-233/234, and U-238 in Prairie Dogs in 2022, in pCi/g Dry Weight

Location	No. of Samples (# ≤ MDA)	Maximum[a]	Minimum[a]	Mean ± Std.[b]
Tritium				
Zone 4 (W)	4 (4)	<MDA	<MDA	<MDA
Zone 8	4 (4)	<MDA	<MDA	<MDA
Playa 2	4 (4)	<MDA	<MDA	<MDA
Burning Ground	2(2)	<MDA	<MDA	<MDA
Playa 3	--[c]	--	--	--
FS-4	4 (4)	<MDA	<MDA	<MDA
Buffalo Lake	4 (4)	<MDA	<MDA	<MDA
U-233/234				
Zone 4 (W)	4 (4)	<MDA	<MDA	<MDA
Zone 8	4 (4)	<MDA	<MDA	<MDA
Playa 2	4 (4)	<MDA	<MDA	<MDA
Burning Ground	2(2)	<MDA	<MDA	<MDA
Playa 3	--[c]	--	--	--
FS-4	4 (3)	0.0284 ± 0.0143	<MDA	<MDA
Buffalo Lake	4 (4)	<MDA	<MDA	<MDA
U-238				
Zone 4 (W)	4 (4)	<MDA	<MDA	<MDA
Zone 8	4 (4)	<MDA	<MDA	<MDA
Playa 2	4 (4)	<MDA	<MDA	<MDA
Burning Ground	2(2)	<MDA	<MDA	<MDA
Playa 3	--[c]	--	--	--
FS-4	4 (3)	0.0455 ± 0.0156	<MDA	<MDA
Buffalo Lake	4 (4)	<MDA	<MDA	<MDA

[a] Counting error at 95 percent confidence level. The second of each paired set of values in the "Maximum" and "Minimum" columns.

[b] Standard deviation.

[c] Prairie dogs unavailable.

Table 11.6 Tritium, U-233/234, and U-238 in Cottontail Rabbits in 2022, in pCi/g Dry Weight

Location	No. of Samples (# ≤ MDA)	Maximum[a]	Minimum[a]	Mean ± Std.[b]
Tritium				
Zone 4	4 (4)	<MDA	<MDA	<MDA
Zone 12 South	4 (4)	<MDA	<MDA	<MDA
Buffalo Lake[c]	2 (2)	<MDA	<MDA	<MDA
U-233/234				
Zone 4	4 (4)	<MDA	<MDA	<MDA
Zone 12 South	4 (4)	<MDA	<MDA	<MDA
Buffalo Lake	2 (2)	<MDA	<MDA	<MDA
U-238				
Zone 4	4 (4)	<MDA	<MDA	<MDA
Zone 12 South	4 (4)	<MDA	<MDA	<MDA
Buffalo Lake	2 (2)	<MDA	<MDA	<MDA

[a] Counting error at 95 percent confidence level. The second of each paired set of values in the "Maximum" and "Minimum" columns is the "error."

[b] Standard deviation. (see definition in glossary.)

[c] Control site.

Twenty-two prairie dogs were sampled during 2022. Results were similar to or less than historic data, and most (95%) were below the MDA. Ten cottontail rabbits were sampled in 2022. Results were similar to historic data, and all samples were below the MDA. None of the results exceeded any of the BCGs for the analyzed radionuclides and thus would not be expected to cause a dose exceeding 0.1 rad/day for terrestrial animals.

11.4 CONCLUSIONS

Radionuclide concentrations in vegetation samples were comparable to values observed in samples from control locations and historical data. These data indicate the uptake of radionuclides by vegetation on or near Pantex is similar to uptake occurring in vegetation at the control location.

Radionuclide concentrations in fauna samples were comparable to values observed in samples from control locations and historical data. The majority of radionuclide analyses in sampled prairie dogs were reported to be below the MDA. These results indicate that uptake of radionuclides by fauna on Pantex is similar to uptake by fauna at the control location.

CHAPTER 12 - QUALITY ASSURANCE

Due to its unique mission and service to the country, Pantex must strive to become a High Reliability Organization. High reliability includes robust QA that ensures all environmental monitoring data provides definitive evidence of regulatory compliance and protection of human health and the environment. The complexity of analytical chemistry and radiochemistry performed to support environmental monitoring programs necessitates that Pantex maintain an unparalleled QA and QC program that meets our need for high reliability.

Chapter Highlights

- More than 99 percent of the 2022 analytical results were useable for making environmental decisions.
- All Pantex requirements for subcontract laboratories were met.

12.1 QUALITY ASSURANCE AT PANTEX

Pantex has an established QA/QC program designed to ensure the reliability of analytical data used to support all site environmental programs. This program also satisfies the quality requirements implemented under the following:

- CERCLA ROD
- TCEQ permits
- DOE Order 414.1D *Quality Assurance*
- ISO 14001:2004 *Environmental Management Systems – Requirements with Guidance for Use* (ISO 2004).

During 2022, the QA/QC program enhanced the reliability of data acquired for environmental monitoring, which includes air, soil, groundwater, surface water, flora, and fauna programs.

The ultimate goal of Pantex environmental monitoring QA/QC program is to consistently generate reliable, high quality environmental monitoring data. One measure of success for this QA/QC program is the amount of usable environmental data based on technical acceptance criteria for chemical and radiochemical measurements. By providing consistently usable data, Pantex fosters a high degree of confidence for regulatory compliance and protection of human health and the environment with stakeholders. This approach also allows Pantex to provide maximum value for the resources utilized to acquire environmental monitoring data.

12.2 ENVIRONMENTAL DATA ACQUISITION, PLANNING AND EXECUTION

Acquisition of environmental monitoring data is planned with its end use in mind. Each media scientist or subject matter expert defined the data collection requirements based on program needs and used guidance, such as EPA *QA/G4 Guidance for Data Quality Objective Process* (2006), in developing data quality objectives (DQOs) for data collection. The media scientists prepared the DQOs based on the overall data collection needs, regulatory requirements, stakeholder concerns, technical factors, quality requirements, and historical data in their respective areas of expertise.

The approved DQO for a specific monitoring program was scheduled and executed by using technical specifications in the DQO. This included sample location, sampling frequency, analytical method, and data acceptance criteria. During 2022, each DQO was associated with a procedure, defining requirements for sample collection and data management. Procedures were reviewed and updated, as necessary, to reflect

new requirements in associated DQOs or enhancements to the sample collection and data management process.

12.3 ENVIRONMENTAL DATA QUALITY ASSURANCE AND CONTROL

Pantex relies on a robust quality system. The intent of this system is to integrate and manage quality elements for field sampling, laboratory analysis, data management, and to monitor and control factors that affect overall data quality. Components of this quality system are described below.

12.3.1 Field Assessments/Surveillances

Internal assessments/surveillances are conducted annually, at a minimum, on representative field operations. These assessments are used to assure the reliability and defensibility of analytical data acquired to support environmental monitoring programs. They are also a tool for continuous improvement of sampling operations, administrative functions, control procedures, and quality systems. Activities reviewed in the field assessment may include calibration and documentation for field equipment, proper field sampling procedures, provisions for minimization of potential sample contamination, compliance with Chain-of-Custody (COC) procedures, sample documentation, and sample transfer to the laboratory.

12.3.2 Recordkeeping

All environmental records and documents are issued, revised, controlled, stored, and archived in accordance with the requirements of Pantex.

12.3.3 Quality Plan Requirements for Subcontract Laboratories

Subcontract laboratories are accredited by The National Environmental Laboratory Accreditation Conference Institute and are in accordance with Title 30 of the TAC, Chapter 25 for all parameters within the scope of work provided by Pantex. Exceptions might be made when National Environmental Laboratory Accreditation Conference Institute accreditation is not available.

Each subcontract laboratory must be qualified by Pantex prior to receiving samples for analysis. The prequalification process includes a review of the technical proposal submitted by the prospective laboratory, successful analysis of performance evaluation (PE) samples, and a systems audit performed by a DOE Consolidated Audit Program (DOECAP) accrediting agency, NNSA Analytical Management Program, or Pantex Supplier Quality Department.

In addition to the initial systems audit, all subcontract laboratories must submit to annual systems audits in order to maintain status as a qualified subcontract laboratory. These audits are technical and programmatic, and are performed by a DOECAP accrediting agency. Their purpose is to ensure that all existing subcontract laboratories are qualified to provide high quality analytical laboratory services.

A data package assessment is conducted annually at subcontract laboratories. In this type of assessment, random analytical deliverables are selected, and all the supporting documentation, such as calibration records, method detection limits, and QA/QC reports, are reviewed. The subcontract laboratory is also required to conduct internal audits at least annually to assure they are compliant with the laboratory's quality systems and with the *Pantex Statement of Work for Analytical Laboratories (2020)*.

Qualified subcontract laboratories must successfully analyze PE samples semi-annually in order to maintain qualified status, and they may be subject to submission of PE samples from Pantex at any time. PE sample analyses are designed to evaluate normal laboratory operations, and evaluation of the PE sample results must consider factors, such as identification of false positives, false negatives, large analytical errors, and indications of calibration or dilution errors.

NCRs are submitted by the laboratory if unacceptable PE results are reported. PE sample requirements may be waived for any analysis in which a suitable PE sample is not available. Sample shipments to a subcontract

laboratory may be suspended if it is determined that the laboratory is not capable of meeting the analytical, QA, and deliverable requirements of the Statement of Work (SOW).

12.4 LABORATORY QUALITY ASSURANCE

During 2022, Pantex Laboratory Quality Assurance Program continued to provide qualified laboratory auditors to participate in data package assessments. All Pantex requirements for the subcontract laboratories were met. All of the subcontract laboratories had the proper certifications for analyzing environmental samples from Pantex. They performed the necessary internal audits, and participated in the appropriate PE programs. Annual DOECAP audits were also conducted by accrediting agencies. A technical and contractual verification of the laboratory deliverables, performed by staff scientists as analytical results were received from the laboratories, ensured that contractual deliverable specifications, technical content, and QC deliverables complied with SOW requirements consistent with industry standards.

12.4.1 Data Review and Qualification

Historically, the vast majority of analytical results are usable unless there is a catastrophic QA/QC failure (such as no surrogate or radiotracer recovery) during the analytical process that causes the results to be rejected (declared not usable). Based on industry standard conventions, sample results are qualified as usable by means of various data qualifier flags to alert the end user to any limitations in using the result. This approach was taken to make use of as many sample results as possible without sacrificing quality. Sample results that were completely unusable were rejected and not made available for use. Several criteria were used during the verification process so that analytical results could be appropriately qualified. Some of the criteria that caused data to be rejected during the verification process are described below.

- Missed Holding Times: The analysis was not initiated, or the sample was not extracted/prepared, within the time frame required by the EPA method and the SOW.
- Control Limits: A QC parameter, such as a surrogate, spike recovery, response factor, or tracer recovery, associated with a sample failed to meet the limits of acceptability.
- Not Confirmed: Analytical methods for HEs and perchlorate may employ enhanced confirmation techniques, such as mass spectral or diode array detectors. This information is used to qualify data obtained from traditional techniques, such as use of a second chromatographic column, which may be prone to matrix interference. Second column confirmation is especially susceptible to false positives when the constituent of interest is at or near the MDL.
- Sample or Blank Contamination: The sensitivity of modern analytical techniques can make it difficult to have a blank sample that is truly analyte-free. This is especially true for inorganic parameters such as metals. When the laboratory either accidentally contaminates the actual sample or the lab blank contains parameters of interest above a control limit, the associated sample results may be rejected.
- Other: This category includes, but is not limited to, the issues listed below.
    - Broken COC: There was a failure to maintain proper custody of samples, as documented on COC forms and laboratory sample login records.
    - Instrument Failure: Either the instrument failed to attain minimum method performance specifications or the instrument or a piece of equipment was not functioning.
    - Preservation Requirements: The requirements, as identified by the EPA or a specific method, were not met and/or properly documented.
    - Incorrect Test Method: The analysis was not performed according to a method contractually required by Pantex.
    - Incorrect or Inadequate Detection or Reporting Limit: The laboratory is required to attain specific levels of sensitivity when reporting target analytes, unless matrix effects prevent adequate detection and quantitation of the compound of interest.

Pantex media scientist was alerted to any limitations in the use of the data, based on the DQO requirements. Of the 20,119 individual results obtained in 2022 from all laboratory analyses, 99.02 percent were deemed to be of suitable quality for the intended end use of the data. Fig. 12.1 graphically summarizes the causes for the 0.98 percent of data rejected.

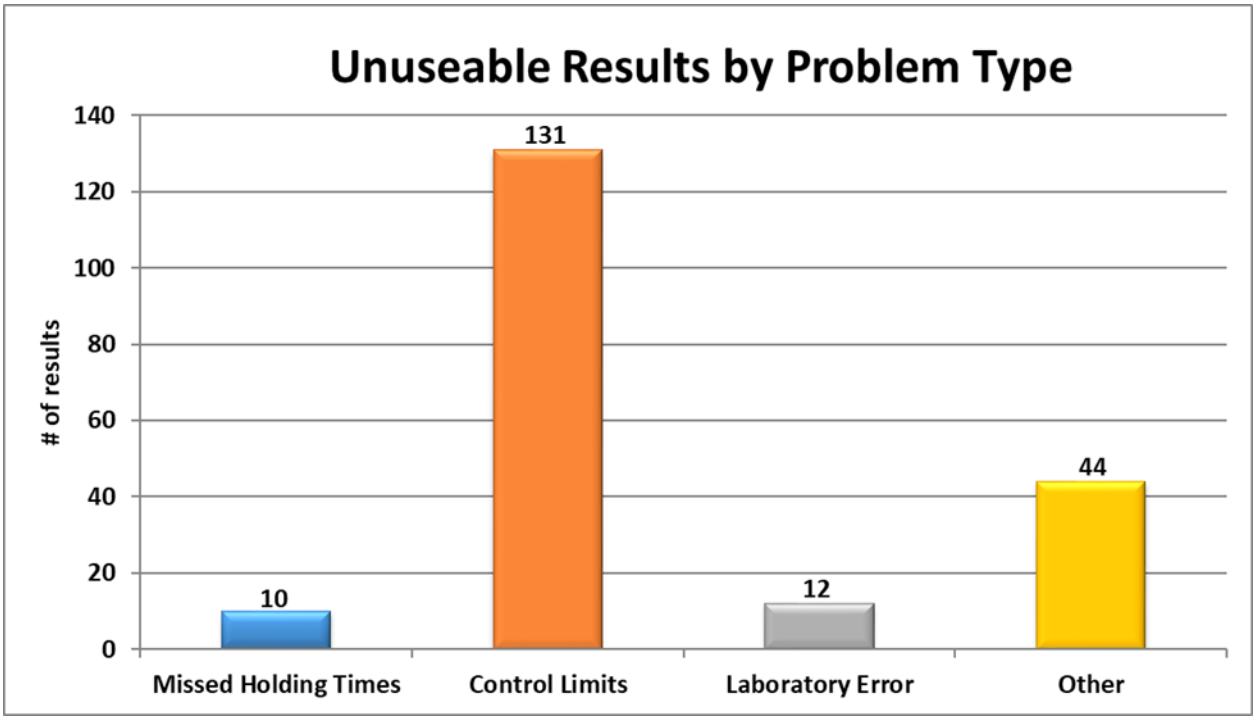

Fig. 12.1. 2022 Data Rejection Summary

12.4.2 Laboratory Technical Performance

All subcontract laboratories were required to participate in inter-laboratory comparison studies administered by a NELAC and/or DOE approved provider. In 2022, Pantex off-site subcontract laboratories participated in the Multimedia Radiochemistry (MRaD) PE sample analysis, sponsored by Environmental Resource Associates.

The MRaD samples include radiological compounds in matrices including water, soil, air filters, and vegetation. MRaD results, particularly the results for MRaD Series 36 and 37, for all participating subcontract laboratories used by Pantex in 2022 (GEL and Eurofins TestAmerica) are presented in Fig. 12.2. Both subcontract laboratories had acceptable MRaD results in 2022.

The primary purpose of the PE programs is to measure a laboratory's implementation of methods to obtain accurate results and serve as a comparison between laboratories.

12.5 FIELD OPERATIONS QUALITY ASSURANCE

QA samples, such as duplicates, replicates, blanks, and equipment rinsates, were collected at intervals specified in the DQOs. This was initiated to allow the media scientists to evaluate the data for potential bias or variability originating from either the sampling or the analytical process.

12.5.1 Duplicate and Replicate Analyses

During 2022, Pantex continued to collect and analyze field duplicate and replicate samples. A true field duplicate sample set consists of a thoroughly homogenized sample collected from one desired location.

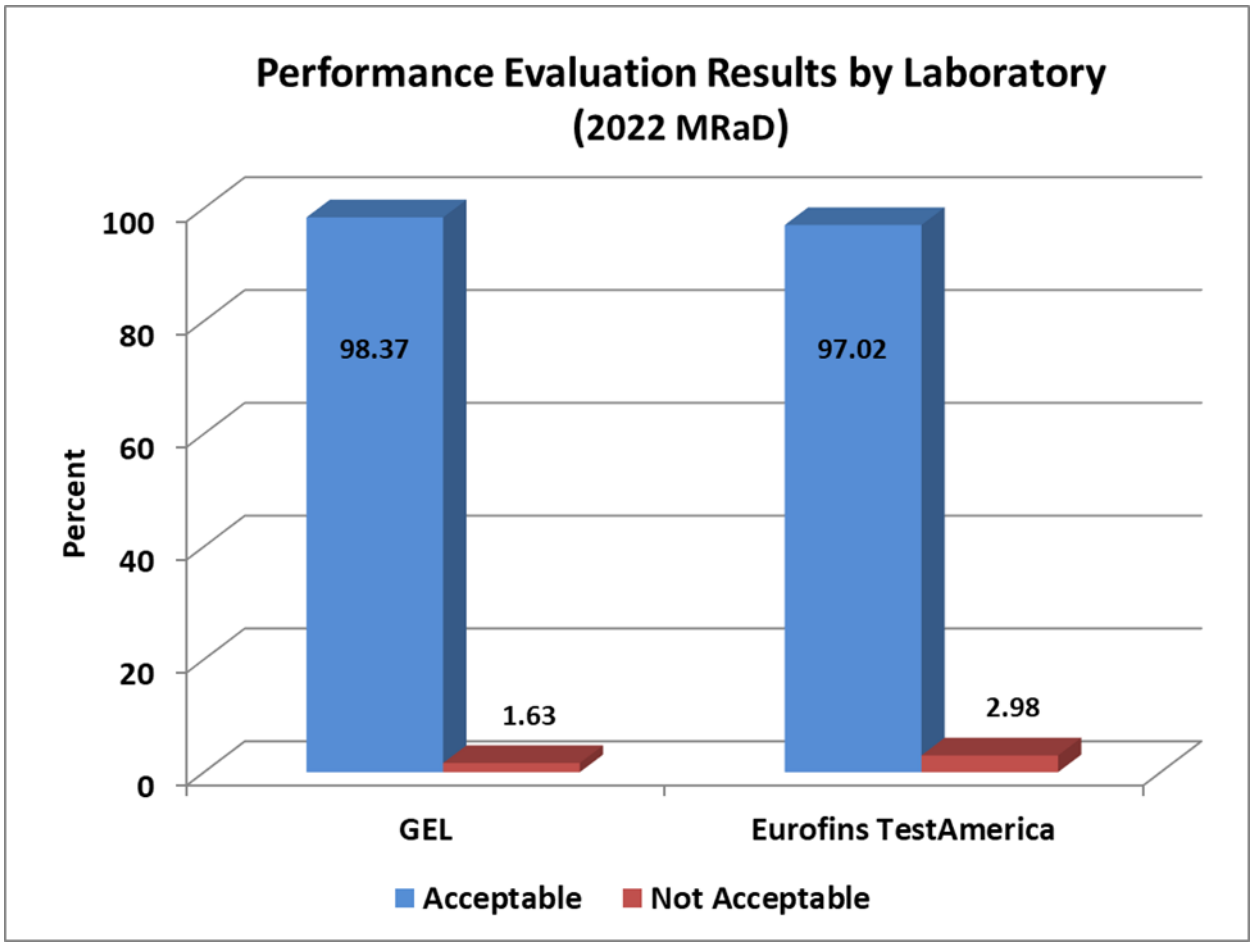

Fig. 12.2. 2022 Multimedia Radiochemistry Results

The sample is split into two discrete samples and may even be labeled as representing two separate sampling locations. When the laboratory is not informed that the two samples are subsamples from a single sampling location, these samples are referred to as blind duplicate samples. When samples are collected from the same site at the same time, the samples are considered field replicates. For comparison purposes, field duplicates and field replicates are evaluated by the same criteria. Random replicate samples were collected for all media except air and fauna. These exceptions are based upon the uniqueness of the sample type and the inability to replicate the sample.

The vegetation program's isotopic uranium data were analyzed to compare actual sample values to field replicate values. This program was chosen for statistical analysis because of the relatively high number of replicates required during the sample collection process. The replicate error ratio (RER) was used to perform the replicate analysis. The ratio takes into account the sample and replicate uncertainty to determine data variability. The RER is given by:

$$RER = | S - R | / (\sigma 95S + \sigma 95R);$$

Where: RER = replicate error ratio

S = sample value (original)
R = replicate sample value
σ95S = sample uncertainty (95 percent)
σ95R = replicate uncertainty (95 percent)

An RER of less than or equal to one indicates that the replicates are comparable within the 95 percent confidence interval. For 2022, the average RER value for vegetation data was 0.319 with an associated standard deviation of 0.232. The 2022 vegetation sample RER analysis indicated that field replicate sample precision accurately reflects the actual sample value. Fig. 12.3 summarizes the RER data.

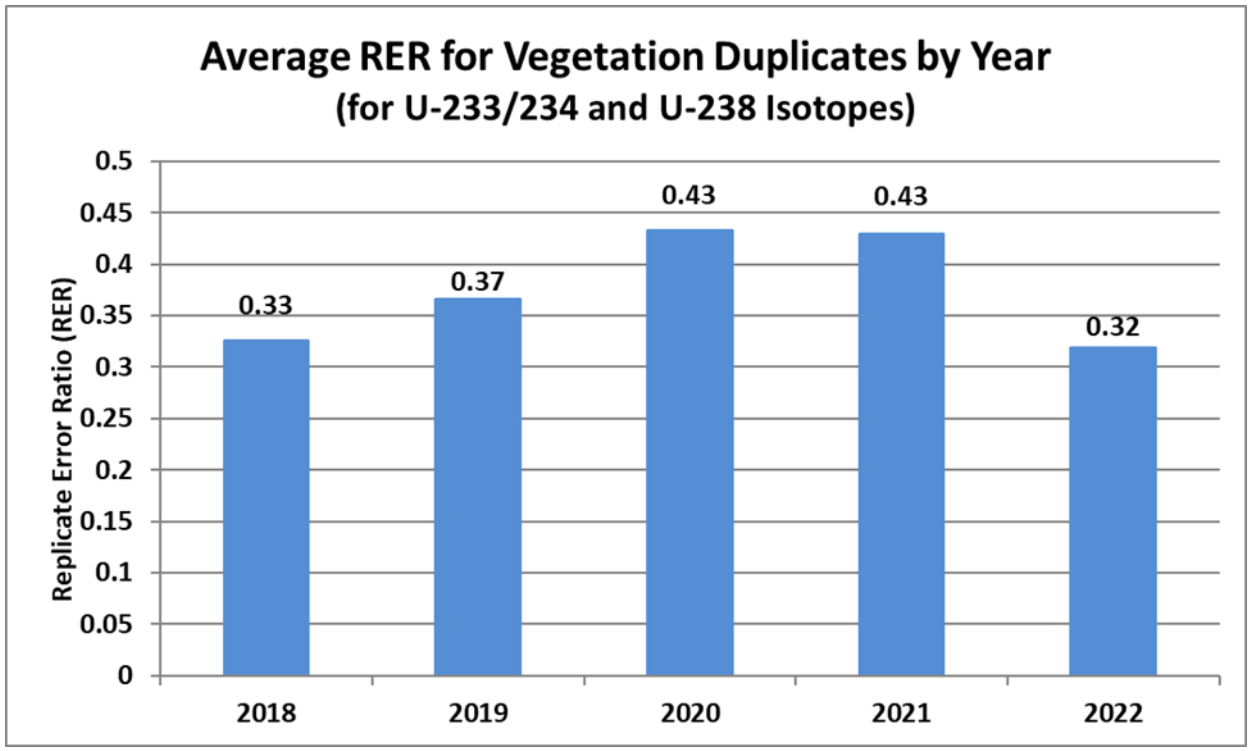

Fig. 12.3. Five-Year Average Replicate Error Ratio for Vegetation Duplicates

12.5.2 Blanks and Rinsates

During 2022, trip blanks, field blanks, and/or rinsate samples were collected for all applicable media programs. Blank samples were used to evaluate contamination that may have occurred during sampling, sample shipment, or laboratory operations. Trip blank and field blank values were used to flag detections found in sample values. The detections found were used to flag associated sample detects as "U" (undetected).

A rinsate (equipment) blank is a sample of analyte-free water poured over or through decontaminated sampling equipment. The rinse solution is collected to show that there is no contamination from the sampling tool, or cross-contamination between samples.

Field blanks are analyte-free water samples that are taken to the field and opened for the duration of the sampling event and then closed and sent to the lab. Field blanks assess if airborne contamination exists at the sampling site.

Trip blanks are provided for each shipping container (cooler) containing VOC vials to evaluate potential contamination of the sample bottles during shipment from the manufacturer, storage of the bottles, shipment to the laboratory, or analysis at the laboratory. VOCs were detected in trip blanks in 2022. These compounds are indicative of common laboratory solvents. The frequency of detection was 0.2 percent.

12.6 ON-SITE ANALYTICAL LABORATORIES

A limited number of samples were analyzed on-site during 2022, using approved EPA or standard industry methods. On-site analyses included the following:

- Pantex Materials and Analytical Services Laboratory performed analysis of samples for alkalinity, nitrate, nitrite, and hexavalent chromium.

The on-site laboratories followed an internal QC program similar to the program outlined in the SOW. The on-site laboratories were audited by Pantex internal quality audit program. Sampling technicians performed field measurements of certain samples for residual chlorine, dissolved oxygen, turbidity, conductivity, hydrogen sulfide, temperature, oxidation reduction potential, and pH.

12.7 CONTINUOUS IMPROVEMENT

During 2022, Pantex acquired analytical data to support several aspects of the environmental monitoring program as required by permits, regulations, and DOE Orders. The QA/QC program described in this chapter was implemented to ensure the programmatic and technical elements required to meet these criteria were executed. In addition, this program functioned to provide cost efficient analytical data of known and defensible quality.

Overall, programmatic data quality has continued to improve because of improved analytical methods, QA/QC practices, and refinement of DQOs, which can be quantified by trending the amount of usable data acquired over the past 20-plus years (Fig. 12.4). Using 1996 as the base year, a 95 percent lower performance target was established to trend data usability. As with any data collection process, improvements are continually being made in defining technical specifications and improving sample collection methodology, laboratory instrumentation, and QC practices. It is important to remember that any viable quality system undergoes continuous improvement by the very nature of the quality elements employed. This is the QA/QC program perspective used to review data critically for this report.

A well-established quality framework exists at Pantex that supports the environmental monitoring program. The acquisition and review of analytical data is based on procedurally controlled sampling, analysis, data management (validation), and standardized technical specifications governing analytical measurements. The integration of each of these elements ensures environmental data collection and monitoring requirements are achieved for meeting all site and stakeholder requirements for quality and reliability.

12.8 CONCLUSIONS

During 2022, the QA/QC program enhanced the reliability of data acquired for environmental monitoring, which includes air, soil, groundwater, surface water, flora, and fauna programs. Pantex obtained 20,119 individual analysis results in 2022, with 99.02 percent deemed to be of suitable quality for the intended end use of the data.

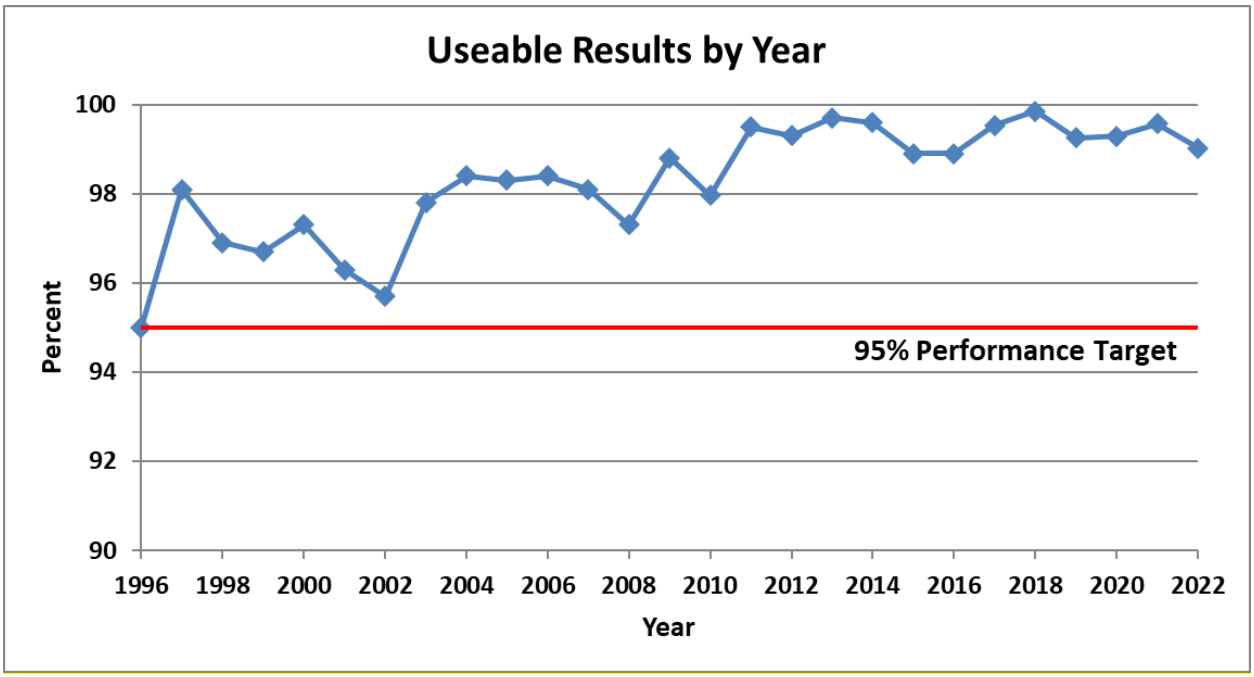

Fig. 12.4. History of Usable Results Data

APPENDIX A –
BIRDS IDENTIFIED AT PANTEX IN 2022

Common Name	*Scientific Name*
American avocet	*Recurvirostra americana*
American green-winged teal	*Anas crecca*
American kestrel	*Falco sparverius*
Bald eagle	*Haliaeetus leucocephalus*
Barn swallow	*Hirundo rustica*
Black-necked stilt	*Himantopus mexicanus*
Blue-winged teal	*Anas discors*
Bufflehead	*Bucephala albeola*
Bullock's Oriole	*Icterus bullockii*
Burrowing owl	*Athene curnicularia hypugea*
Cackling Goose	*Branta hutchinsii*
Canada goose	*Branta canadensis*
Canvasback	*Aythya valisineria*
Chihuahuan raven	*Corvus crytoleucus*
Chippping sparrow	*Spizella passerina*
Cinnamon teal	*Anas cyanoptera*
Cliff swallow	*Hirundo pyrrhonota*
Common poorwill	*Phalaenoptilus nuttallii*
Dickcissel	*Spiza americana*
Double-crested cormorant	*Phalacrocorax auritus*
Eurasian collared dove	*Streptopelia decaocto*
European starling	*Sturnus vulgaris*
Feral pigeon	*Columba livia*
Ferrugionus hawk	*Buteo regalis*
Field sparrow	*Spizella pusilla*
Glossy ibis	*Plegadis falcinellus*
Golden eagle	*Aquila chrysaetos*
Great blue heron	*Ardea herodias*
Greater scaup	*Aythya marila*
Horned lark	*Eremophila alpestris*
House sparrow	*Passer domesticus*
Killdeer	*Charadrius vociferus*
Lark bunting	*Calamospiza melanocorys*
Lark sparrow	*Chondestes grammacus*
Lesser scaup	*Athya affinis*
Lesser yellowlegs	*Tringa flavipes*
Long-billed dowitcher	*Limnodromus scolopaceus*

Common Name	*Scientific Name*
Mallard	*Anas platyrhyncos*
Mississippi kite	*Ictinia mississippiensis*
Mourning dove	*Zenaida macroura*
Northern harrier	*Circus cyaneus*
Northern mockingbird	*Mimus polyglottos*
Northern pintail	*Anas acuta*
Northern shoveler	*Anas clypeata*
Osprey	*Pandion haliaetus*
Prairie falcon	*Falco mexicanus*
Red-tailed hawk	*Buteo jamaicensis*
Red-winged blackbird	*Agelaius phoeniceus*
Ring-necked duck	*Athya collaris*
Ring-necked pheasant	*Phasianus colchicus*
Ruddy duck	*Oxyura jamaicensis*
Sandhill crane	*Grus canadensis*
Say's phoebe	*Sayornis saya*
Swainson's hawk	*Buteo swainsoni*
Upland sandpiper	*Bartramia longicauda*
Western kingbird	*Tyrannus verticalis*
Western meadowlark	*Sturnella neglecta*
White-winged dove	*Zenaida asiatica*
Wilson's phalarope	*Phalaropus tricolor*

APPENDIX B –
2022 DRINKING WATER ANALYTICAL RESULTS

Contaminant Category	Analyte	Measured Value	Action Level/Max Contaminate Level
PCBs (Method E508.1 Pesticides by GC)	Aroclor-1016	<0.07 µg/L	0.50 µg/L
	Aroclor-1221	<0.1 µg/L	0.50 µg/L
	Aroclor-1232	<0.1 µg/L	0.50 µg/L
	Aroclor-1242	<0.1 µg/L	0.50 µg/L
	Aroclor-1248	<0.1 µg/L	0.50 µg/L
	Aroclor-1254	<0.1 µg/L	0.50 µg/L
	Aroclor-1260	<0.1 µg/L	0.50 µg/L
Total PCBs		<0.1 µg/L	N/A
Pesticides (Method E508.1 Pesticides by GC)	Chlorodane	<0.1 µg/L	2 µg/L
	Toxaphene	<0.1 µg/L	3 µg/L
PAHs (Method E525.2 Pesticides by GC/MS)	Benzo(a)pyrene	<0.02 µg/L	0.20 µg/L
Pesticides (Method E525.2 Pesticides by GC/MS)	trans-Nonachlor-chlordane	<0.1 µg/L	N/A
	Alachlor	<0.1 µg/L	2 µg/L
	Aldrin	<0.1 µg/L	N/A
	alpha-Chlordane	<0.1 µg/L	2 µg/L
	Atrazine	<0.1 µg/L	3 µg/L
	Bromacil	<0.1 µg/L	N/A
	Butachlor	<0.1 µg/L	N/A
	Dieldrin	<0.1 µg/L	N/A
	Endrin	<0.01 µg/L	2 µg/L
	gamma-BHC (Lindane)	<0.02 µg/L	0.20 µg/L
	gamma-Chlordane	<0.1 µg/L	2 µg/L
	Heptachlor	<0.03 µg/L	0.40 µg/L
	Heptachlor epoxide	<0.02 µg/L	0.20 µg/L
	Hexachlorobenzene	<0.1 µg/L	1 µg/L
	Hexachlorocyclopentadiene	<0.1 µg/L	50 µg/L
	Methoxychlor	<0.1 µg/L	40 µg/L
	Metolachlor	<0.1 µg/L	N/A
	Metribuzin	<0.1 µg/L	N/A
	Propachlor	<0.1 µg/L	N/A
	Simazine	<0.06 µg/L	4 µg/L
Phthalates (Method E525.2 Pesticides by GC/MS)	Bis(2-ethylhexyl)adipate	<0.5 µg/L	400 µg/L
	Bis(2-Ethylhexyl)phthalate	<0.5 µg/L	6 µg/L

Contaminant Category	Analyte	Measured Value	Action Level/Max Contaminate Level
Volatile Organic Compounds, Regulated (Method E524.2)	Vinyl chloride	<0.500 µg/L	2 µg/L
	1, 1-Dichloroethene	<0.500 µg/L	7 µg/L
	Methylene chloride	<0.500 µg/L	5 µg/L
	trans-1,2-Dichloroethene	<0.500 µg/L	100 µg/L
	cis-1,2-Dichloroethene	<0.500 µg/L	70 µg/L
	1, 1, 1-Trichloroethane	<0.500 µg/L	200 µg/L
	Carbon tetrachloride	<0.500 µg/L	5 µg/L
	1,2-Dichloroethane	<0.500 µg/L	5 µg/L
	Benzene	<0.500 µg/L	5 µg/L
	Trichloroethene	<0.500 µg/L	5 µg/L
	1,2-Dichloropropane	<0.500 µg/L	5 µg/L
	Toluene	<0.500 µg/L	1000 µg/L
	1, 1,2-Trichloroethane	<0.500 µg/L	5 µg/L
	Tetrachloroethene	<0.500 µg/L	5 µg/L
	Chlorobenzene	<0.500 µg/L	100 µg/L
	Ethyl Benzene	<0.500 µg/L	700 µg/L
	m,p-Xylene	<0.500 µg/L	N/A
	Styrene	<0.500 µg/L	100 µg/L
	1,4-Dichlorobenzene	<0.500 µg/L	75 µg/L
	1,2-Dichlorobenzene	<0.500 µg/L	600 µg/L
	1,2,4-Trichlorobenzene	<0.500 µg/L	70 µg/L
	Xylene (total)	<0.500 µg/L	10000 µg/L
	Dichlorodifluoromethane	<0.500 µg/L	N/A
	Chloromethane	<0.500 µg/L	N/A
	Bromomethane	<0.500 µg/L	N/A
	Chloroethane	<0.500 µg/L	N/A
	4-Chlorotoluene	<0.500 µg/L	N/A
	Trichlorofluoromethane	<0.500 µg/L	N/A
	Acetone	<5.00 µg/L	N/A
	Methyl iodide	<0.500 µg/L	N/A
	Carbon disulfide	<0.500 µg/L	N/A
	Acrylonitrile	<0.500 µg/L	N/A
	Tert-Butyl methyl ether	<0.500 µg/L	N/A
	1,1-Dichloroethane	<0.500 µg/L	N/A
	Vinyl acetate	<0.500 µg/L	N/A
	2,2-Dichloropropane	<0.500 µg/L	N/A
	2-Butanone	<5.00 µg/L	N/A
	Bromochloromethane	<0.500 µg/L	N/A

Contaminant Category	Analyte	Measured Value	Action Level/Max Contaminate Level
Volatile Organic Compounds, Regulated (Method E524.2)	Tetrahydrofuran	<5.00 µg/L	N/A
	Chloroform	<1.00 µg/L	N/A
	1,1-Dichloropropene	<0.500 µg/L	N/A
	Methyl methacrylate	<0.500 µg/L	N/A
	Dibromomethane	<0.500 µg/L	N/A
	Bromodichloromethane	<1.00 µg/L	N/A
	Cis-1,3-Dichloropropene	<0.500 µg/L	N/A
	4-Methyl-2-pentanone	<0.500 µg/L	N/A
	Trans-1,3-Dichloropropene	<0.500 µg/L	N/A
	Ethyl methacrylate	<0.500 µg/L	N/A
	1,3-Dichloropropane	<0.500 µg/L	N/A
	2-Hexanone	<0.500 µg/L	N/A
	Dibromochloromethane	<1.00 µg/L	N/A
	1,1,1,2-Tetrachloroethane	<0.500 µg/L	N/A
	o-Xylene	<0.500 µg/L	N/A
	Bromoform	<1.00 µg/L	N/A
	Isopropylbenzene	<0.500 µg/L	N/A
	1,1,2,2-Tetrachloroethane	<0.500 µg/L	N/A
	Bromobenzene	<0.500 µg/L	N/A
	1,2,3-Trichloropropane	<0.500 µg/L	N/A
	n-Propylbenzene	<0.500 µg/L	N/A
	2-Chlorotoluene	<0.500 µg/L	N/A
	1,3,5-Trimethylbenzene	<0.500 µg/L	N/A
	Tert-Butylbenzene	<0.500 µg/L	N/A
	1,2,4-Trimethylbenzene	<0.500 µg/L	N/A
	Sec-Butylbenzene	<0.500 µg/L	N/A
	1,3-Dichlorobenzene	<0.500 µg/L	N/A
	4-Isopropyltoulene	<0.500 µg/L	N/A
	n-Butylbenzene	<0.500 µg/L	N/A
	Hexachlorobutadiene	<0.500 µg/L	N/A
	Naphthalene	<0.500 µg/L	N/A
	1,2,3-Trichlorobenzene	<0.500 µg/L	N/A
Inorganics (E200. 7 Prep/E200. 7 Metals, Trace Elements)	Calcium Total	36.3 mg/L	N/A
	Iron Total	<0.0500 mg/L	N/A
	Potassium Total	5.47 mg/L	N/A
	Magnesium Total	20.6 mg/L	N/A
	Sodium Total	31.1 mg/L	N/A
Heavy Metals (Method 245.1 Hg)	Mercury Total	<0.00020 mg/L	0.002 mg/L

Contaminant Category	Analyte	Measured Value	Action Level/Max Contaminate Level
Inorganics (E200.8, ICP-MS Prep/E200.8, ICP-MS)	Aluminum Total	<0.005 mg/L	N/A
	Antimony Total	<0.001 mg/L	0.006 mg/L
	Arsenic Total	0.002 mg/L	0.01 mg/L
	Barium Total	0.13 mg/L	2 mg/L
	Beryllium Total	<0.001 mg/L	0.004 mg/L
	Cadmium Total	<0.001 mg/L	0.005 mg/L
	Chromium Total	0.0042 mg/L	0.10 mg/L
	Copper Total	<0.001 mg/L	1 mg/L
	Lead Total	<0.001 mg/L	0.015 mg/L
	Manganese Total	<0.001 mg/L	N/A
	Nickel Total	<0.001 mg/L	N/A
	Selenium Total	<0.005 mg/L	0.05 mg/L
	Silver Total	<0.001 mg/L	N/A
	Thallium Total	<0.001 mg/L	0.002 mg/L
	Zinc Total	<0.005 mg/L	N/A
Inorganics (SM2340B, Hardness Calc.)	Total Hardness (as CaCO3)	176 mg/L	N/A
Anions by Ion Chromatography (E300.0, Anions)	Nitrate (as N)	1.40 mg/L	10 mg/L
Disinfection By-Products, Haloacetic Acids (Method E552.2)	Bromochloroacetic acid	3.10 µg/L	N/A
	Dibromoacetic acid	2.50 µg/L	N/A
	Dichloroacetic acid	2.80 µg/L	N/A
	Monobromoacetic acid	<1.00 µg/L	N/A
	Monochloroacetic acid	<1.00 µg/L	N/A
	Trichloroacetic acid	<1.00 µg/L	N/A
Total Regulated Haloacetic Acids		5.30 µg/L	60 µg/L

APPENDIX C –
ANALYTES MONITORED IN 2022

Analyte	CAS Number	Air	GW[a]	DW[b]	SW[c]	IW[d]	BG[e] Soil	TLAP Soil[f]	Veg.[g]	WW[j]	Fauna
Radionuclides											
Gross alpha, total	12587-46-1	-	-	-	-	-	-	-	-	-	-
Gross beta, total	12587-47-2	-	-	-	-	-	-	-	-	-	-
Plutonium-238	12059-95-9	-	-	-	-	-	-	-	-	-	-
Plutonium-239/240	10-12-8	+	-	-	-	-	-	-	-	-	-
Tritium	10028-17-8	+	-	-	+	-	-	-	+	-	+
Uranium-233/234	11-08-5	+	-	-	-	-	-	-	+	-	+
Uranium-235/236	15117-96-1	-	-	-	+	-	-	-	-	-	-
Uranium-238	7440-61-1	+	-	-	+	-	-	-	+	-	+
Metals											
Aluminum	7429-90-5	-	+	+	-	-	-	-	-	+	-
Antimony	7440-36-0	-	-	+	-	-	-	-	-	+	-
Arsenic	7440-38-2	-	+	+	+	-	-	-	-	+	-
Barium	7440-39-3	-	+	+	+	-	-	-	-	+	-
Beryllium	7440-41-7	-	-	+	-	-	-	-	-	+	-
Boron	7440-42-8	-	+	-	-	+	+	+[i]	-	-	-
Cadmium	7440-43-9	-	-	+	+	-	+	-	-	+	-
Calcium	7440-70-2	-	+	+	-	-	-	+[i]	-	+	-
Chromium	7440-47-3	-	+	+	+	-	+	-	-	+	-
Chromium (hexavalent)	18540-29-9	-	+	-	-	-	-	-	-	+	-
Cobalt	7440-48-4	-	-	-	-	-	+	-	-	-	-
Copper	7440-50-8	-	-	+	+	+	+	+[i]	-	+	-
Iron	7439-89-6	-	+	+	+	-	-	+[i]	-	-	-
Lead	7439-92-1	-	-	+	+	-	+	-	-	+	-
Magnesium	7439-95-4	-	+	+	-	-	-	+[i]	-	+	-
Manganese	7439-96-5	-	+	+	+	+	-	+[i]	-	+	-
Mercury	7439-97-6	-	-	+	+	-	+	-	-	+	-

Analyte	CAS Number	Air	GW[a]	DW[b]	SW[c]	IW[d]	BG[e] Soil	TLAP Soil[f]	Veg.[g]	WW[j]	Fauna
Molybdenum	7439-98-7	-	+	-	-	-	-	-	-	+	-
Nickel	7440-02-0	-	+	+	+	-	+	-	-	+	-
Potassium	7440-09-7	-	+	+	-	-	-	+ [i]	-	+	-
Selenium	7782-49-2	-	-	+	+	-	-	-	-	+	-
Silver	7440-22-4	-	-	+	+	-	+	-	-	+	-
Sodium	7440-23-5	-	+	+	-	-	-	+ [i]	-	-	-
Thallium	7440-28-0	-	-	+	-	-	-	-	-	+	-
Tin	7440-31-5	-	-	-	-	-	-	-	-	-	-
Titanium	7440-32-6	-	-	-	-	-	-	-	-	-	-
Uranium, Total	11-09-6	-	-	-	-	-	-	-	-	-	-
Vanadium	7440-62-2	-	+	-	-	-	-	-	-	-	-
Zinc	7440-66-6	-	-	+	+	+	+	+ [i]	-	+	-
Explosives											
1,3-dinitrobenzene	99-65-0	-	+	-	+	-	-	-	-	-	-
1,3,5-trinitrobenzene	99-35-4	-	+	-	+	-	+	-	-	-	-
2-amino-4,6-dinitrotoluene	35572-78-2	-	+	-	+	-	-	-	-	-	-
2-nitrotoluene	88-72-2	-	-	-	+	-	-	-	-	-	-
2,4-dinitrotoluene	121-14-2	-	+	-	+	-	+	+	-	-	-
2,6-dinitrotoluene	606-20-2	-	+	-	+	-	+	-	-	-	-
3-nitrotoluene	99-08-1	-	-	-	+	-	-	-	-	-	-
4-amino-2,6-dinitrotoluene	19406-51-0	-	+	-	+	-	-	-	-	-	-
4-nitrotoluene	99-99-0	-	-	-	+	-	-	-	-	-	-
HMX	2691-41-0	-	+	-	+	+	+	-	-	+	-
Nitrobenzene	98-95-3	-	-	-	+	-	-	+	-	-	-
PETN	78-11-5	-	-	-	+	+	+	-	-	+	-
RDX	121-82-4	-	+	-	+	+	+	-	-	+	-
TATB	3058-38-6	-	-	-	+	+	+	-	-	+	-
Tetryl	479-45-8	-	-	-	+	-	-	-	-	-	-
TNT	118-96-7	-	+	-	+	+	+	-	-	+	-
MNX	5755-27-1	-	+	-	-	-	-	-	-	-	-
DNX	80251-29-2	-	+	-	-	-	-	-	-	-	-

Analyte	CAS Number	Air	GW[a]	DW[b]	SW[c]	IW[d]	BG[e] Soil	TLAP Soil[f]	Veg.[g]	WW[j]	Fauna
TNX	13980-04-6	-	+	-	-	-	-	-	-	-	-
Polychlorinated Biphenyls (PCBs)											
Aroclor 1016	12674-11-2	-	-	+	-	-	-	-	-	-	-
Aroclor 1221	1104-28-2	-	-	+	-	-	-	-	-	-	-
Aroclor 1232	11141-16-5	-	-	+	-	-	-	-	-	-	-
Aroclor 1242	53469-21-9	-	-	+	-	-	-	-	-	-	-
Aroclor 1248	12672-29-6	-	-	+	-	-	-	-	-	-	-
Aroclor 1254	11091-69-1	-	-	+	-	-	-	-	-	-	-
Aroclor 1260	11096-82-5	-	-	+	-	-	-	-	-	-	-
PCB, Total	1336-36-3	-	-	+	-	-	-	-	-	-	-
Pesticides											
Alachlor	15972-60-8	-	-	+	-	-	-	-	-	-	-
Aldrin	309-00-2	-	-	+	-	-	-	-	-	-	-
Atrazine	1912-24-9	-	-	+	-	-	-	-	-	-	-
Bromacil	314-40-9	-	-	+	-	-	-	-	-	-	-
alpha-Chlordane	57-74-9	-	-	+	-	-	-	-	-	-	-
Chlordane	12789-03-6	-	-	+	-	-	-	-	-	-	-
gamma-Chlordane	5566-34-7	-	-	+	-	-	-	-	-	-	-
Dieldrin	60-57-1	-	-	+	-	-	-	-	-	-	-
Endrin	72-20-8	-	-	+	-	-	-	-	-	-	-
Heptachlor	76-44-8	-	-	+	-	-	-	-	-	-	-
Heptachlor epoxide	1024-57-3	-	-	+	-	-	-	-	-	-	-
Lindane (gamma-BHC)	58-89-9	-	-	+	-	-	-	-	-	-	-
Methoxychlor	72-43-5	-	-	+	-	-	-	-	-	-	-
Methyl n,n-dimethyl-n-{(methlycarbamoyl)oxy}-1	23135-22-0	-	-	+	-	-	-	-	-	-	-
s-Methyl-n-((Methylcarb amoyl)-oxy)-thioacetimidate	16752-77-5	-	-	+	-	-	-	-	-	-	-
Metribuzin	21087-64-9	-	-	+	-	-	-	-	-	-	-
Prometon	1610-18-0	-	-	+	-	-	-	-	-	-	-
Propachlor	1918-16-7	-	-	+	-	-	-	-	-	-	-

Analyte	CAS Number	Air	GW[a]	DW[b]	SW[c]	IW[d]	BG[e] Soil	TLAP Soil[f]	Veg.[g]	WW[j]	Fauna
Sevin (carbaryl)	63-25-2	-	-	-	-	-	-	-	-	-	-
Simazine	122-34-9	-	-	+	-	-	-	-	-	-	-
Toxaphene	8001-35-2	-	-	+	-	-	-	-	-	-	-
trans-Nonachlor-chlordane	57-74-9	-	-	+	-	-	-	-	-	-	-
Herbicides											
2,4-D	94-75-7	-	-	-	-	-	-	-	-	-	-
Miscellaneous											
Alkalinity	T-005	-	+	-	-	-	-	-	-	-	-
Ammonia (as N)	7664-41-7	-	-	-	-	+	-	-	-	+	-
Biochemical oxygen demand	10-26-3	-	-	-	-	+	-	-	-	+	-
Bromide	24959-67-9	-	+	-	-	-	-	-	-	-	-
Carbonaceous biochemical oxygen demand	10078	-	-	-	-	-	-	-	-	+	-
Chemical oxygen demand	C-004	-	-	-	-	+	-	-	-	+	-
Chlorate	14866-68-3	-	-	-	-	-	-	-	-	-	-
Chloride	16887-00-6	-	-	-	-	-	-	-	-	+	-
Chlorine residual	7782-50-5	-	-	+	-	-	-	-	-	-	-
Color	M-002	-	-	-	-	-	-	-	-	-	-
Corrosivity	10-37-7	-	-	-	-	-	-	-	-	-	-
Cyanide, free	10-71-9	-	-	-	-	-	-	-	-	-	-
Cyanide, total	57-12-5	-	-	-	-	-	-	-	-	+	-
Dissolved Organic Carbon	11-59-6	-	+	-	-	-	-	-	-	-	-
Dissolved Oxygen	NA	-	+	-	-	-	-	-	-	-	-
Electrical Conductivity-Paste	NA	-	-	-	-	-	-	+ [i]	-	-	-
Fluoride	7782-41-4	-	-	-	-	-	-	-	-	+	-
Foaming agents (surfactants)	NA	-	-	-	-	-	-	-	-	-	-
Ignitability	NA	-	-	-	-	-	-	+	-	-	-
Nitrate (as N)	14797-55-8	-	+	+	-	-	-	+	-	+	-
Nitrate/nitrite (as N)	1-005	-	-	-	-	+	-	-	-	-	-
Nitrite (as N)	14797-65-0	-	+	-	-	-	-	-	-	-	-
Oil and grease	10-30-0	-	-	-	-	+	-	-	-	+	-

Analyte	CAS Number	Air	GW[a]	DW[b]	SW[c]	IW[d]	BG[e] Soil	TLAP Soil[f]	Veg.[g]	WW[j]	Fauna
Ortho Phosphate	14265-44-2	-	-	-	-	-	-	+ [i]	-	-	-
Oxidation – Reduction Potential		-	+	-	-	-	-	-	-	-	-
Perchlorate	14797-73-0	-	+	-	-	-	-	-	-	-	-
pH	10-29-7	-	+	+	+	+	-	-	-	+	-
pH (1:1 ratio soil pH)	NA	-	-	-	-	-	-	+ [i]	-	-	-
pH (2:1 ratio soil pH)	NA	-	-	-	-	-	-	+ [i]	-	-	-
Phosphorus, Total (As P)	7723-14-0	-	+	-	-	-	-	-	-	+	-
Reactivity	NA	-	-	-	-	-	-	+	-	-	-
Sodium Adsorption Ratio	NA	-	-	-	-	-	-	+ [i]	-	-	-
Specific conductance	10-34-4	-	-	-	-	-	-	-	-	+	-
Sulfate	14808-79-8	-	+	-	-	-	-	-	-	+	-
Sulfide	18496-25-8	-	+	-	-	-	-	-	-	-	-
Sulfur	NA	-	-	-	-	-	-	+ [i]	-	-	-
Temperature	NA	-	+	+	+	+	-	-	-	+	-
Total dissolved solids	10-33-3	-	+	-	-	-	-	-	-	+	-
Total hardness (as $CaCO_3$)	11-02-9	-	-	+	-	-	-	-	-	+	-
Total Kjeldahl Nitrogen	NA	-	-	-	-	-	-	+ [i]	-	+	-
Total Nitrogen	NA	-	-	-	-	-	-	+ [i]	-	+	-
Total organic carbon	C-012	-	+	-	-	-	-	-	-	+	-
Total petroleum hydrocarbons	10-90-2	-	-	-	+	-	-	-	-	-	-
Total suspended solids	10053	-	-	-	+	-	-	-	-	+	-
Turbidity	G-019	-	+	-	-	-	-	-	-	-	-
Volatile Organics											
1,1,1,2-tetrachloroethane	630-20-6	-	-	+	-	-	-	-	-	-	-
1,1,2,2-tetrachloroethane	79-34-5	-	-	+	-	-	-	-	-	-	-
1,1,1-trichloroethane	71-55-6	-	-	+	-	-	-	-	-	-	-
1,1,2-trichloroethane	79-00-5	-	-	+	-	-	-	-	-	-	-
1,2,3-tricholorobenzene	87-61-6	-	-	+	-	-	-	-	-	-	-
1,2,3-trichloropropane	96-18-4	-	-	+	-	-	-	-	-	-	-
1,2,4-trimethylbenzene	95-63-6	-	-	+	-	-	-	-	-	-	-
1,3,5-trimethylbenzene	108-67-8	-	-	+	-	-	-	-	-	-	-

Analyte	CAS Number	Air	GW[a]	DW[b]	SW[c]	IW[d]	BG[e] Soil	TLAP Soil[f]	Veg.[g]	WW[j]	Fauna
1,1-dichloroethane	75-34-3	-	-	+	-	-	-	-	-	-	-
1,1-dichloroethene	75-35-4	-	+	+	-	-	-	-	-	-	-
1,1-dichloropropene	563-58-6	-	-	-	-	-	-	-	-	-	-
1,2-dibromo-3-chloropropane	96-12-8	-	-	-	-	-	-	-	-	-	-
1,2-dibromoethane	106-93-4	-	-	+	-	-	-	-	-	-	-
1,2-dichlorobenzene	95-50-1	-	-	+	-	-	-	-	-	-	-
1,2-dichloroethane	107-06-2	-	+	+	-	-	-	-	-	-	-
1,2-dichloroethene	156-60-5	-	+	-	-	-	-	-	-	-	-
cis-1,2-dichloroethene	156-59-2	-	+	+	-	-	-	-	-	-	-
trans-1,2-dichloroethene	156-60-5	-	+	+	-	-	-	-	-	-	-
1,2-dichloropropane	78-87-5	-	-	+	-	-	-	-	-	-	-
1,3-dichlorobenzene	541-73-1	-	-	+	-	-	-	-	-	-	-
1,3-dichloropropane	142-28-9	-	-	+	-	-	-	-	-	-	-
cis-1,3-dichloropropene	10061-01-5	-	-	+	-	-	-	-	-	-	-
trans-1,3-dichloropropene	10061-02-6	-	-	+	-	-	-	-	-	-	-
trans-1,4-dichloro-2-butene	110-57-6	-	-	-	-	-	-	-	-	-	-
1,4-dichlorobenzene	106-46-7	-	-	+	-	-	-	-	-	-	-
2,2-dichloropropane	594-20-7	-	-	+	-	-	-	-	-	-	-
2-butanone (methyl ethyl ketone)	78-93-3	-	-	+	-	-	-	-	-	-	-
2-chloro-1,3-butadiene	126-99-8	-	-	-	-	-	-	-	-	-	-
2-chlorotoluene	95-49-8	-	-	+	-	-	-	-	-	-	-
2-hexanone	591-78-6	-	-	+	-	-	-	-	-	-	-
4-chlorotoluene	106-43-4	-	-	+	-	-	-	-	-	-	-
4-isopropyltoluene	99-87-6	-	-	+	-	-	-	-	-	-	-
Acetone	67-64-1	-	-	+	-	-	-	-	-	-	-
Acetonitrile	75-05-8	-	-	-	-	-	-	-	-	-	-
Acetylene	74-86-2	-	-	-	-	-	-	-	-	-	-
Acrolein	107-02-8	-	-	-	-	-	-	-	-	-	-
Acrylonitrile	107-13-1	-	-	+	-	-	-	-	-	-	-
Allyl Chloride	107-05-1	-	-	-	-	-	-	-	-	-	-
Benzene	71-43-2	-	-	+	-	-	-	-	-	-	-

Analyte	CAS Number	Air	GW[a]	DW[b]	SW[c]	IW[d]	BG[e] Soil	TLAP Soil[f]	Veg.[g]	WW[j]	Fauna
Bromobenzene	108-86-1	-	-	+	-	-	-	-	-	-	-
Bromochloromethane	74-97-5	-	-	+	-	-	-	-	-	-	-
Bromodichloromethane	75-27-4	-	-	+	-	-	-	-	-	-	-
Bromoform	75-25-2	-	-	+	-	-	-	-	-	-	-
Bromomethane	74-83-9	-	-	+	-	-	-	-	-	-	-
sec-Butylbenzene	135-98-8	-	-	+	-	-	-	-	-	-	-
tert-Butylbenzene	98-06-6	-	-	+	-	-	-	-	-	-	-
Carbon disulfide	75-15-0	-	-	+	-	-	-	-	-	-	-
Carbon tetrachloride	56-23-5	-	-	+	-	-	-	-	-	-	-
Chlorobenzene	108-90-7	-	-	+	-	-	-	-	-	-	-
Chloroethane	75-00-3	-	-	+	-	-	-	-	-	-	-
Chloroform	67-66-3	-	+	+	-	-	-	-	-	-	-
Chloromethane	74-87-3	-	-	+	-	-	-	-	-	-	-
Dibromochloromethane	124-48-1	-	-	+	-	-	-	-	-	-	-
Dibromomethane	74-95-3	-	-	+	-	-	-	-	-	-	-
Dichlorodifluoromethane	75-71-8	-	-	+	-	-	-	-	-	-	-
Ethylbenzene	100-41-4	-	-	+	-	-	-	-	-	-	-
Ethyl methacrylate	97-63-2	-	-	+	-	-	-	-	-	-	-
Freon 113	76-13-1	-	-	-	-	-	-	-	-	-	-
Iodomethane	74-88-4	-	-	-	-	-	-	-	-	-	-
Isobutyl alcohol	78-83-1	-	-	-	-	-	-	-	-	-	-
Isopropylbenzene	98-82-8	-	-	+	-	-	-	-	-	-	-
Methylacrylonitrile	126-98-7	-	-	-	-	-	-	-	-	-	-
Methylene chloride	75-09-2	-	-	+	-	-	-	-	-	-	-
Methyl isobutyl ketone	108-10-1	-	-	-	-	-	-	-	-	-	-
Methyl methacrylate	80-62-6	-	-	+	-	-	-	-	-	-	-
n-Butylbenzene	104-51-8	-	-	+	-	-	-	-	-	-	-
n-Propylbenzene	103-65-1	-	-	+	-	-	-	-	-	-	-
Pentachloroethane	76-01-7	-	-	-	-	-	-	-	-	-	-
Propionitrile	107-12-0	-	-	-	-	-	-	-	-	-	-
Styrene	100-42-5	-	-	+	-	-	-	-	-	-	-

Analyte	CAS Number	Air	GW[a]	DW[b]	SW[c]	IW[d]	BG[e] Soil	TLAP Soil[f]	Veg.[g]	WW[j]	Fauna
tert-Butyl methyl ether	1634-04-4	-	-	+	-	-	-	-	-	-	-
Tetrachloroethylene	127-18-4	-	+	+	-	-	-	-	-	-	-
Tetrahydrofuran	109-99-9	-	-	+	-	-	-	-	-	-	-
Toluene	108-88-3	-	-	+	-	-	-	-	-	-	-
Trichloroethene (Trichloroethylene)	79-01-6	-	+	+	-	-	-	-	-	-	-
Trichlorofluoromethane	75-69-4	-	-	+	-	-	-	-	-	-	-
Vinyl acetate	108-05-4	-	-	+	-	-	-	-	-	-	-
Vinyl chloride	75-01-4	-	+	+	-	-	-	-	-	-	-
Xylene, m	108-38-3	-	-	+	-	-	-	-	-	-	-
Xylene, o	95-47-6	-	-	+	-	-	-	-	-	-	-
Xylene, p	106-42-3	-	-	+	-	-	-	-	-	-	-
Xylenes, Total	1330-20-7	-	-	+	-	-	-	-	-	-	-
Semi-Volatile Organic Compounds											
1,2,4,5-tetrachlorobenzene	95-94-3	-	-	-	-	-	-	-	-	-	-
1,2,4-trichlorobenzene	120-82-1	-	-	+	-	-	-	-	-	-	-
1,2-diphenylhydrazine	122-66-7	-	-	-	-	-	-	-	-	-	-
1,4-dioxane	123-91-1	-	+	-	-	-	-	-	-	-	-
1,4-naphthoquinone	130-15-4	-	-	-	-	-	-	-	-	-	-
2,3,4,6-tetrachlorophenol	58-90-2	-	-	-	-	-	-	-	-	-	-
2,4,5-trichlorophenol	95-95-4	-	-	-	-	-	-	-	-	-	-
2,4,6-trichlorophenol	88-06-2	-	-	-	-	-	-	-	-	-	-
2,4-dichlorophenol	120-83-2	-	-	-	-	-	-	-	-	-	-
2,4-dimethylphenol	105-67-9	-	-	-	-	-	-	-	-	-	-
2,4-dinitrophenol	51-28-5	-	-	-	-	-	-	-	-	-	-
2-chloronaphthalene	91-58-7	-	-	-	-	-	-	-	-	-	-
2-chlorophenol	95-57-8	-	-	-	-	-	-	-	-	-	-
2-methylnaphthalene	91-57-6	-	-	-	-	-	-	-	-	-	-
2-methylphenol (o-Cresol)	795-48-7	-	-	-	-	-	-	-	-	-	-
4,6-dinitro-2-methylphenol	534-52-1	-	-	-	-	-	-	-	-	-	-
4-chloroaniline	106-47-8	-	-	-	-	-	-	-	-	-	-
4-chlorophenyl phenyl ether	7005-72-3	-	-	-	-	-	-	-	-	-	-

Analyte	CAS Number	Air	GW[a]	DW[b]	SW[c]	IW[d]	BG[e] Soil	TLAP Soil[f]	Veg.[g]	WW[j]	Fauna
4-methylphenol (p-Cresol)	106-44-5	-	-	-	-	-	-	-	-	-	-
Acenaphthene	83-32-9	-	-	-	-	-	-	-	-	-	-
Acenaphthylene	208-96-8	-	-	-	-	-	-	-	-	-	-
Acetophenone	98-86-2	-	-	-	-	-	-	-	-	-	-
Anthracene	120-12-7	-	-	-	-	-	-	-	-	-	-
Benzidine	92-87-5	-	-	-	-	-	-	-	-	-	-
Benzo[*a*]anthracene	56-55-3	-	-	-	-	-	-	-	-	-	-
Benzo[*a*]pyrene	50-32-8	-	-	+	-	-	-	-	-	-	-
Benzo[*b*]fluoranthene	205-99-2	-	-	-	-	-	-	-	-	-	-
Benzo[*g,h,i*]perylene	191-24-2	-	-	-	-	-	-	-	-	-	-
Benzo[*k*]fluoranthene	207-08-9	-	-	-	-	-	-	-	-	-	-
Benzoic acid	65-85-0	-	-	-	-	-	-	-	-	-	-
Benzyl alcohol	100-51-6	-	-	-	-	-	-	-	-	-	-
bis(2-chloroethyl) ether	111-44-4	-	-	-	-	-	-	-	-	-	-
bis(2-chloroisopropyl) ether	39638-32-9	-	-	-	-	-	-	-	-	-	-
bis(2-ethylhexyl)adipate	103-23-1	-	-	+	-	-	-	-	-	-	-
bis(2-ethylhexyl) phthalate	117-81-7	-	-	+	-	-	-	-	-	-	-
Butachlor	23184-66-9	-	-	+	-	-	-	-	-	-	-
Butyl benzyl phthalate	85-68-7	-	-	-	-	-	-	-	-	-	-
Carbazole	86-74-8	-	-	-	-	-	-	-	-	-	-
Cresol, m	108-39-4	-	-	-	-	-	-	-	-	-	-
Chrysene	218-01-9	-	-	-	-	-	-	-	-	-	-
Dibenz[*a,h*]anthracene	53-70-3	-	-	-	-	-	-	-	-	-	-
Dibenzofuran	132-64-9	-	-	-	-	-	-	-	-	-	-
Dibromoacetic acid	631-64-1	-	-	+	-	-	-	-	-	-	-
Dichloroacetic acid	79-43-6	-	-	+	-	-	-	-	-	-	-
Diethyl phthalate	84-66-2	-	-	-	-	-	-	-	-	-	-
Dimethyl phthalate	131-11-3	-	-	-	-	-	-	-	-	-	-
Di-n-butyl phthalate	84-74-2	-	-	-	-	-	-	-	-	-	-
Di-n-octyl phthalate	117-84-0	-	-	-	-	-	-	-	-	-	-
Diphenylamine	122-39-4	-	-	-	-	-	-	-	-	-	-

Analyte	CAS Number	Air	GW[a]	DW[b]	SW[c]	IW[d]	BG[e] Soil	TLAP Soil[f]	Veg.[g]	WW[j]	Fauna
Fluoranthene	206-44-0	-	-	-	-	-	-	-	-	-	-
Fluorene	86-73-7	-	-	-	-	-	-	-	-	-	-
Hexachlorobenzene	118-74-1	-	-	+	-	-	-	-	-	-	-
Hexachlorobutadiene	87-68-3	-	-	-	-	-	-	-	-	-	-
Hexachlorocyclopentadiene	77-47-4	-	-	+	-	-	-	-	-	-	-
Hexachloroethane	67-72-1	-	-	-	-	-	-	-	-	-	-
Indeno(1,2,3-c,d)pyrene	193-39-5	-	-	-	-	-	-	-	-	-	-
Isophorone	78-59-1	-	-	-	-	-	-	-	-	-	-
Monobromoacetic acid	79-08-3	-	-	+	-	-	-	-	-	-	-
Monochloroacetic acid	79-11-8	-	-	+	-	-	-	-	-	-	-
Methyl iodide	74-88-4			+						-	
Naphthalene	91-20-3	-	-	+	-	-	-	-	-	-	-
N-nitrosodiethylamine	55-18-5	-	-	-	-	-	-	-	-	-	-
N-nitrosodimethylamine	62-75-9	-	-	-	-	-	-	-	-	-	-
N-nitrosodiphenylamine	86-30-6	-	-	-	-	-	-	-	-	-	-
N-nitrosodi-n-propylamine	621-64-7	-	-	-	-	-	-	-	-	-	-
N-nitrosopyrrolidine	930-55-2	-	-	-	-	-	-	-	-	-	-
Parathion, ethyl	56-38-2	-	-	-	-	-	-	-	-	-	-
Parathion, methyl	298-00-0	-	-	-	-	-	-	-	-	-	-
Pentachlorophenol	87-86-5	-	-	-	-	-	-	+	-	-	-
Phenanthrene	85-01-8	-	-	-	-	-	-	-	-	-	-
Phenol	108-95-2	-	-	-	-	-	-	-	-	-	-
Pronamide	23950-58-5	-	-	-	-	-	-	-	-	-	-
Pyrene	129-00-0	-	-	-	-	-	-	-	-	-	-
Pyridine	110-86-1	-	-	-	-	-	-	-	-	-	-
Trichloroacetic acid	76-03-9	-	-	+	-	-	-	-	-	-	-
Biological											
Complete blood count	NA	-	-	-	-	-	-	-	-	-	+
Histopathology	NA	-	-	-	-	-	-	-	-	-	+
Necropsy	NA	-	-	-	-	-	-	-	-	-	+
Total coliform bacteria	10-46-8	-	-	+	-	-	-	-	-	+	-

Analyte	CAS Number	Air	GW[a]	DW[b]	SW[c]	IW[d]	BG[e] Soil	TLAP Soil[f]	Veg.[g]	WW[j]	Fauna
Escherichia coli	NA	-	-	+	-	-	-	-	-	+	-
Eastern encephalitis	NA	-	-	-	-	-	-	-	-	-	+
Western encephalitis	NA	-	-	-	-	-	-	-	-	-	+
Hanta virus	NA	-	-	-	-	-	-	-	-	-	+
Plague bacteria	NA	-	-	-	-	-	-	-	-	-	+
Pseudorabies	NA	-	-	-	-	-	-	-	-	-	+
Tuleremia	NA	-	-	-	-	-	-	-	-	-	+
Dissolved Gases[h]											
Ethane	74-84-0	-	+	-	-	-	-	-	-	-	-
Ethene	74-85-1	-	+	-	-	-	-	-	-	-	-
Methane	74-82-8	-	+	-	-	-	-	-	-	-	-

[a] Groundwater
[b] Drinking water
[c] Storm water and playas
[d] Irrigation water
[e] Burning Ground soils & sediment
[f] TLAP soils
[g] Vegetation
[h] Only applicable to ISB and In Situ Performance Monitoring wells to monitor performance of the ISB Systems
[i] TLAP nutrient parameters analyzed on a plant-available or extractable basis
[j] Wastewater
+ = Sampled for
- = Not sampled
NA = Not available

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APPENDIX D –
2022 SOIL SAMPLING MONITORING RESULTS

Table D10.1. Sampling Location: BG-SS-C1

Constituent (Code)	Monitoring Result (mg/kg)	Background Comparison Level (mg/kg)	Monitoring Result Exceeds Background?
Silver (Ag)	1.3	8.4	No
Boron (B)	9.1	50	No
Cadmium (Cd)	0.62	1	No
Cobalt (Co)	6.8	17.6	No
Chromium (Cr)	19	19.9	No
Copper (Cu)	16	67.3	No
2,4-dinitrotoluene (2,4-DNT)	<0.097	0.5	No
2,6-dinitrotoluene (2,6-DNT)	<0.097	0.5	No
Mercury (Hg)	0.08	0.3	No
Octahyro-1,3,5,7-tetranitro-1,3,5,7-tetraazozine (HMX)	75.9	858.2	No
Nickel (Ni)	15	29.8	No
Lead (Pb)	15	54.8	No
Pentaerythritol tetranitrate (PETN)	<1.9	5	No
Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)	0.21	2.6	No
Triaminonitrobenzene (TATB)	<0.37	23.3	No
1,3,5-trinitrobenzene (TNB135)	<0.097	10	No
Trinitrotoluene (TNT)	<0.097	10	No
Zinc (Zn)	64	160.6	No

Table D10.2. Sampling Location: BG-SS-C2

Constituent (Code)	Monitoring Result (mg/kg)	Background Comparison Level (mg/kg)	Monitoring Result Exceeds Background?
Silver (Ag)	0.07	1	No
Boron (B)	7.7	50	No
Cadmium (Cd)	0.26	1	No
Cobalt (Co)	7.1	8.8	No
Chromium (Cr)	16	16.2	No
Copper (Cu)	19	75.4	No
2,4-dinitrotoluene (2,4-DNT)	< 0.097	0.5	No
2,6-dinitrotoluene (2,6-DNT)	< 0.097	0.5	No
Mercury (Hg)	0.02	0.2	No
Octahyro-1,3,5,7-tetranitro-1,3,5,7-tetraazozine (HMX)	< 0.097	1	No
Nickel (Ni)	14	24.5	No
Lead (Pb)	11	77.8	No
Pentaerythritol tetranitrate (PETN)	< 1.9	5	No
Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)	< 0.19	1	No
Triaminonitrobenzene (TATB)	< 0.38	3	No
1,3,5-trinitrobenzene (TNB135)	< 0.097	10	No
Trinitrotoluene (TNT)	< 0.097	10	No
Zinc (Zn)	82	317.3	No

Table D10.3. Sampling Location: BG-SS-C3

Constituent (Code)	Monitoring Result (mg/kg)	Background Comparison Level (mg/kg)	Monitoring Result Exceeds Background?
Silver (Ag)	0.28	1	No
Boron (B)	7.3	50	No
Cadmium (Cd)	0.49	1	No
Cobalt (Co)	6.7	18.7	No
Chromium (Cr)	16	28.9	No
Copper (Cu)	18	53.8	No
2,4-dinitrotoluene (2,4-DNT)	< 0.098	0.5	No
2,6-dinitrotoluene (2,6-DNT)	< 0.098	0.5	No
Mercury (Hg)	0.03	0.2	No
Octahyro-1,3,5,7-tetranitro-1,3,5,7-tetraazozine (HMX)	12.7	367.1	No
Nickel (Ni)	13	30.9	No
Lead (Pb)	18	54.9	No
Pentaerythritol tetranitrate (PETN)	< 1.95	5	No
Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)	<0.195	1.8	No
Triaminonitrobenzene (TATB)	< 0.39	26.9	No
1,3,5-trinitrobenzene (TNB135)	< 0.098	10	No
Trinitrotoluene (TNT)	< 0.098	10	No
Zinc (Zn)	66	168	No

Table D10.4. Sampling Location: P3-SS-C1

Constituent (Code)	Monitoring Result (mg/kg)	Background Comparison Level (mg/kg)	Monitoring Result Exceeds Background?
Silver (Ag)	0.08	1	No
Boron (B)	7.6	50	No
Cadmium (Cd)	0.46	1	No
Cobalt (Co)	7.3	35.8	No
Chromium (Cr)	20	36.4	No
Copper (Cu)	17	44.2	No
2,4-dinitrotoluene (2,4-DNT)	< 0.099	0.5	No
2,6-dinitrotoluene (2,6-DNT)	< 0.099	0.5	No
Mercury (Hg)	0.03	0.2	No
Octahyro-1,3,5,7-tetranitro-1,3,5,7-tetraazozine (HMX)	< 0.099	1	No
Nickel (Ni)	16	43.4	No
Lead (Pb)	16	54.1	No
Pentaerythritol tetranitrate (PETN)	< 1.9	5	No
Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)	< 0.19	1	No
Triaminonitrobenzene (TATB)	< 0.398	3	No
1,3,5-trinitrobenzene (TNB135)	< 0.099	10	No
Trinitrotoluene (TNT)	< 0.099	10	No
Zinc (Zn)	72	129.8	No

Table D10.5. Sampling Location: P3-SS-C2

Constituent (Code)	Monitoring Result (mg/kg)	Background Comparison Level (mg/kg)	Monitoring Result Exceeds Background?
Silver (Ag)	0.07	1	No
Boron (B)	5.8	50	No
Cadmium (Cd)	0.39	1	No
Cobalt (Co)	7.6	37.2	No
Chromium (Cr)	20	49.3	No
Copper (Cu)	17	43.9	No
2,4-dinitrotoluene (2,4-DNT)	< 0.096	0.5	No
2,6-dinitrotoluene (2,6-DNT)	< 0.096	0.5	No
Mercury (Hg)	0.03	0.2	No
Octahyro-1,3,5,7-tetranitro-1,3,5,7-tetraazozine (HMX)	< 0.096	1	No
Nickel (Ni)	16	53.2	No
Lead (Pb)	16	24.4	No
Pentaerythritol tetranitrate (PETN)	< 1.9	5	No
Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)	< 0.19	1	No
Triaminonitrobenzene (TATB)	< 0.386	3	No
1,3,5-trinitrobenzene (TNB135)	< 0.096	10	No
Trinitrotoluene (TNT)	< 0.096	10	No
Zinc (Zn)	69	139.9	No

Table D10.6. Sampling Location: TLAP Tract 101

Analyte (Agricultural Parameters)	Tract 101A Measured Value		Tract 101B Measured Value		Tract 101C Measured Value		Unit of Measurement
	Depth (in.)		Depth (in.)		Depth (in.)		
	12	24	12	24	12	24	
pH (2:1 ratio soil pH)	7.6	8.3	8.1	8.3	8.3	8.4	pH Units
Total Nitrogen	483.1	406.1	520.8	360.5	411.3	246	mg/kg
Nitrate (as Nitrogen)	9.1	4.1	2.8	2.5	3.3	4	mg/kg
Total Kjeldahl Nitrogen	474	402	518	358	408	242	mg/kg
Ortho Phosphate (plant-available)	19	7	8	5	9	8	mg/kg
Calcium (plant-available)	2225	6090	3693	6151	5572	8449	mg/kg
Magnesium (plant-available)	454	706	558	780	646	737	mg/kg
Sodium (plant-available)	74	155	118	181	119	151	mg/kg
Sodium Absorption Ratio (SAR)	1.3	1.7	2.1	2	1.9	1.8	Percent
Potassium (plant-available)	289	2.99	241	303	280	250	mg/kg
Conductivity (Sat Paste ECe)	0.62	0.43	0.57	0.56	0.46	0.53	µmho/cm
Calcium (Water-soluble)	55	26	40	33	33	32	mg/L
Magnesium (Water-soluble)	15	7	11	9	9	9	mg/L
Sodium (Water-soluble)	43	38	57	49	48	45	mg/L
Sulfur (plant-available)	20	52	31	53	44	75	mg/kg

Table D10.7. Sampling Location: TLAP Tract 201

Analyte (Agricultural Parameters)	Tract 201A Measured Value		Tract 201B Measured Value		Tract 201C Measured Value		Tract 201D Measured Value		Unit of Measurement
	Depth (in.)		Depth (in.)		Depth (in.)		Depth (in.)		
	12	24	12	24	12	24	12	24	
pH (2:1 ratio soil pH)	8.1	8.3	8.0	8.3	7.8	8.3	7.9	8.3	pH Units
Total Nitrogen	550.5	283.8	522.9	246.5	489.2	398.3	488	323.5	mg/kg
Nitrate (as Nitrogen)	6.5	5.8	6.9	4.5	5.2	2.3	7	3.5	mg/kg
Total Kjeldahl Nitrogen	546	278	516	242	484	396	481	320	mg/kg
Ortho Phosphate (Plant-available)	22	13	14	7	12	9	27	8	mg/kg
Calcium (Plant-available)	5134	6177	5001	6545	3499	5400	4254	6894	mg/kg
Magnesium (Plant-available)	589	757	643	762	579	683	573	799	mg/kg
Sodium (Plant-available)	90	140	117	167	119	169	89	173	mg/kg
Sodium Absorption Ratio (SAR)	1.5	1.5	1.6	1.7	1.7	2.2	1.4	1.7	Percent
Potassium (Plant-available)	350	414	416	418	327	296	354	332	mg/kg
Conductivity (Sat Paste ECe)	0.51	0.44	0.46	0.47	0.55	0.53	0.61	0.38	µmho/cm
Calcium (Water-soluble)	40	29	35	30	46	31	54	25	mg/L
Magnesium (Water-soluble)	11	8	9	8	12	8	14	7	mg/L
Sodium (Water-soluble)	42	36	41	41	50	53	44	37	mg/L
Sulfur (Plant-available)	41	50	41	55	29	46	35	58	mg/kg

Table D10.8. Sampling Location: TLAP Tract 301

Analyte (Agricultural Parameters)	Tract 301A Measured Value		Tract 301B Measured Value		Tract 301C Measured Value		Unit of Measurement
	Depth (in.)		Depth (in.)		Depth (in.)		
	12	24	12	24	12	24	
pH (2:1 ratio soil pH)	6.3	7.8	7.7	7.8	7.8	8.0	pH Units
Total Nitrogen	416.2	591.7	878.4	645	841.2	572.8	mg/kg
Nitrate (as Nitrogen)	4.2	6.7	6.4	6	6.2	4.8	mg/kg
Total Kjeldahl Nitrogen	414	585	872	639	835	568	mg/kg
Ortho Phosphate (Plant-available)	21	7	17	11	15	8	mg/kg
Calcium (plant-available)	2526	5722	4052	5488	4549	5828	mg/kg
Magnesium (plant-available)	560	780	643	732	669	826	mg/kg
Sodium (plant-available)	95	168	106	134	106	148	mg/kg
Sodium Absorption Ratio (SAR)	1.2	2.0	1.6	1.7	1.6	1.8	Percent
Potassium (plant-available)	448	302	333	370	308	352	mg/kg
Conductivity (Sat Paste ECe)	0.48	0.46	0.5	0.44	0.5	0.38	µmho/cm
Calcium (Water-soluble)	34	40	43	40	37	30	mg/L
Magnesium (Water-soluble)	11	12	13	11	9	9	mg/L
Sodium (Water-soluble)	31	56	46	47	41	43	mg/L
Sulfur (plant-available)	32	51	35	48	39	52	mg/kg

Table D10.9. Sampling Location: TLAP Tract 401

Analyte (Agricultural Parameters)	Tract 401A Measured Value		Tract 401B Measured Value		Tract 401C Measured Value		Tract 401D Measured Value		Unit of Measurement
	Depth (in.)		Depth (in.)		Depth (in.)		Depth (in.)		
	12	24	12	24	12	24	12	24	
pH (2:1 ratio soil pH)	7.8	7.9	8.0	8.1	8.0	8.0	7.7	7.9	pH Units
Total Nitrogen	640.2	515.1	891.2	574.4	1066.6	646.3	967.2	554.7	mg/kg
Nitrate (as Nitrogen)	5.2	3.1	7.2	5.4	16.6	14.3	11.2	4.7	mg/kg
Total Kjeldahl Nitrogen	635	512	884	569	1050	632	956	550	mg/kg
Ortho Phosphate (Plant-available)	6	4	9	6	33	24	24	14	mg/kg
Calcium (Plant-available)	4768	5838	4448	7538	5101	5852	3643	4820	mg/kg
Magnesium (Plant-available)	696	780	571	671	470	572	489	679	mg/kg
Sodium (Plant-available)	115	123	63	93	62	91	72	106	mg/kg
Sodium Absorption Ratio (SAR)	1.4	1.3	1	1.2	0.8	0.9	0.9	1.1	Percent
Potassium (Plant-available)	280	300	298	245	438	486	374	465	mg/kg
Conductivity (Sat Paste ECe)	0.4	0.36	0.41	0.36	0.54	0.5	0.45	0.45	µmho/cm
Calcium (Water-soluble)	22	21	48	35	41	33	28	29	mg/L
Magnesium (Water-soluble)	6	6	12	9	8	6	5	7	mg/L
Sodium (Water-soluble)	28	25	31	30	22	21	20	24	mg/L
Sulfur (Plant-available)	40	51	37	69	44	52	31	43	mg/kg

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APPENDIX E – GLOSSARY

Activity – The rate of disintegration or transformation of radioactive material, generally expressed in units of Curies (Ci). The official SI unit is the Becquerel (Bq). One Bq (one disintegration or transformation per second) is equivalent to 2.7×10^{-11} Ci.

ALARA – An acronym and phrase, "As Low As Reasonably Achievable," used to describe an approach to radiation exposures and emission control or management whereby the exposures and resulting doses to the public are maintained as far below the specified limits as economic, technical, and practical considerations will permit. ALARA is not a dose limit.

Aliquot – Contained an exact number of times in something else – used of a divisor or part.

Alpha particle – Type of particulate radiation (identical to the nucleus of the helium atom) consisting of two protons and two neutrons.

Ammonium nitrate – A colorless crystalline salt (NH_4NO_3) used in explosives, fertilizers, and veterinary medicine.

Anion – A negatively charged ion that migrates to an anode, as in electrolysis.

ANSI – American National Standards Institute, a voluntary standards organization; Administrator, U.S. Technical Advisory Group to the International Organization for Standardization

Aquifer – Rock or sediment in a formation, group of formations, or part of a formation that is saturated and sufficiently permeable to transmit economic quantities of water to wells and springs.

Archaeology – Scientific discipline responsible for the recovery, analysis, interpretation, and explanation of the unwritten portion of the prehistoric and historic past.

Archival – Relating to, held in, or constituting archives, which are places where public records or historic documents are preserved.

Artifact – Any object manufactured or modified by human beings.

Asbestos – Group of naturally occurring minerals that separate into fibers. The asbestos family includes actinolite, anthophyllite, chrysotile, crocidolite, and tremolite.

Assembly – The process of putting together a nuclear weapon or nuclear weapon component. This process takes place at Pantex.

Background or control samples – Samples obtained from a background sampling location for comparison with samples obtained at or near Pantex. Background or control samples are not expected to be affected by Pantex operations. The U.S. Department of Agriculture Research Station and the Texas Agri-Life Bush Research Farm at Bushland, Texas, have often been used as a control or background location.

Background radiation – Ionizing radiation which is in the natural environment, including cosmic rays and radiation from the naturally radioactive elements, both outside and inside the bodies of humans and animals.

Becquerel (Bq) – The Système International d'Unités (SI units) unit of radioactivity defined as one nuclear disintegration per second; therefore, one Curie (Ci) is equivalent to 3.7×10^{10} Bq.

Best Management Practices – Practices that are not required by law, regulation, or permit, but are designed to help ensure that Pantex produces the highest quality services and products.

Beta particle – Type of particulate radiation emitted from the nucleus of an atom that has a mass and charge equal in magnitude to that of the electron.

Biomass – Literally, "living weight," refers to mass having its origin as living organisms.

Biome – Recognizable community units formed by the interaction of regional climate, regional biota, and substrate, e.g., the same biome units generally can be found on different continents at the same latitudes with approximately the same weather conditions and where topography is similar. Biomes are the largest land community units recognized.

Biota – Living organisms.

Biota Concentration Guide – The limiting concentration of a radionuclide in soil, sediment, or water that would not cause dose limits for protection of aquatic and terrestrial biota to be exceeded. An analogue to the Derived Concentration Guide (DCG) used for human exposure.

Blackwater Draw Formation – Quaternary formation consisting primarily of pedogenically modified eolian sands and silts interbedded with numerous caliche layers. The Blackwater Draw Formation overlies the Tertiary Ogallala Formation at Pantex.

Burning Ground – Pantex location where thermal processing (burning) of high explosives is conducted.

Calibration – The adjustment of a measurement system and the determination of its accuracy using known sources and instrument measurements. Adjustment of flow, temperature, humidity, or pressure gauges and the determination of system accuracy should be conducted using standard operating procedures and sources that are traceable to the National Institute of Standards and Technology.

Categorical Exclusion – Categorical exclusions are categories of actions under the National Environmental Policy Act (NEPA) that DOE has determined, by regulation, do not individually or cumulatively have a significant effect on the human environment and for which; therefore, neither an environmental assessment nor an environmental impact statement normally is required.

Cation – A positively charged ion that in an electrolyte moves toward a negative electrode.

Cell – (1) This is the smallest unit capable of independent functioning. (2) A structure at Pantex in which certain nuclear explosive assembly or disassembly operations are conducted.

Central flyway – A major migratory route used by large numbers of migrating birds in fall and spring that crosses the central portion of North America from Canada to Mexico.

Centripetal drainage – The flow of water in a basin toward a central drain or sink, such as a pond or lake.

Code of Federal Regulations (CFR) – Final federal regulations in force: published in codified form.

Composite samples – Samples that contain a certain number of subsamples.

Council on Environmental Quality – Created, in the Executive Office of the President, by the National Environmental Policy Act (NEPA), such that its members are exceptionally well qualified to analyze and interpret environmental trends and information of all kinds; to appraise programs and activities of the federal government in the light of the policy set forth in Title I of NEPA; to be conscious of and responsive to the scientific, economic, social, aesthetic, and cultural needs and interests of the Nation; and to formulate and recommend national policies to promote the improvement of the quality of the environment.

Cultural Resources – Districts, sites, structures, and objects and evidence of some importance to a culture, a subculture, or a community for scientific, traditional, religious, and other reasons. These resources and relevant environmental data are important for describing and reconstructing past lifeways, for interpreting human behavior, and for predicting future courses of cultural development.

Depleted uranium – Uranium for which the content of the isotope of ^{235}uranium is smaller than 0.7 percent; the level found in naturally occurring uranium (and thus generally synonymous with isotope ^{238}uranium).

Derived Concentration Guide – Concentration of the radionuclide in air or water that, under conditions of continuous exposure for one year by one exposure mode (for example, ingestion of water or breathing the air) would result in an effective dose equivalent of 100 mrem (0.1 rem or 1 mSv). Values for these concentrations are tabulated in DOE-STD-1196-2011; Derived Concentration Technical Standard.

Dismantlement – The disassembly of a nuclear weapon no longer required by the DOD. This process takes place at Pantex.

Dockum Group – Triassic sedimentary rocks that underlie the Ogallala Formation at Pantex. The Dockum Group rocks consist of shale, clayey siltstone, and sandstone.

Dose – The quantity of ionizing radiation received. Often used in the sense of exposure dose (a measure of the total amount of ionization that the radiation could produce in air, measured in roentgens [R]). This should be distinguished from the absorbed dose (measured in rads) that represents the energy absorbed from the radiation per gram of any material. Furthermore, dose equivalent (or biological dose); given in rem, is a term used to express the amount of effective radiation when modifying factors such as quality factors have been considered. It is therefore a measure of the biological damage to living tissue from the radiation exposure.

Duplicate sample – A sample that is taken at the same location and the same site; it may be taken simultaneously or consecutively. This sample may be collected for the purpose of evaluating the performance of a measurement system or of the homogeneity of a sample population; i.e., to determine whether the sample results are representative or an anomaly. The duplicates are supposed to be similar in terms of the population sampled.

Ecosystem – Living organisms and their nonliving (abiotic) environment functioning together as a community.

Effective Dose Equivalent (EDE) – The sum of the products of the exposures to individual organs and tissues and appropriate weighting factors representing the risk relative to that for an equal dose to the whole body.

Effluent – A fluid discharged into the environment; an outflow of waste. Its monitoring is conducted at the point of release.

Emission – A substance discharged to the air.

Emissions standards – Legally enforceable limits placed on the quantities and/or kinds of air contaminants that can be emitted into the atmosphere.

Encephalitis – Inflammation of the brain. In the U.S., this is an acute, often fatal, viral disease of the central nervous system that is transmitted to humans by mosquitoes (arthropods) after a blood meal from infected horses or mules.

Environmental Assessment – A concise public document that a federal agency prepares under NEPA to provide sufficient evidence and analysis to determine whether a proposed agency action would require preparation of an environmental impact statement or a finding of no significant impact.

Environmental Impact Statement – The fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income, with respect to development, implementation, and enforcement of environmental laws, regulations, and policies.

Environmental Justice (EJ) – The detailed written statement that is required by Section 102(2)(C) of NEPA for a proposed major federal action significantly affecting the quality of the human environment.

Environmental Monitoring – Sample collection and analysis of environmental media, i.e., air, water, soil, foodstuff, and biota for the purpose of assessing effects of operations at that site on the local environment. It consists of effluent monitoring and environmental surveillance.

Environmental Projects – Program at Pantex responsible for investigation and remediation of Solid Waste Management Units.

Environmental Protection Agency – Federal agency created to protect the nation's water, land, and air from pollution or environmental damage.

Environmental Surveillance – The collection and analysis of samples, or direct measurements of air, water, soil, foodstuff, and other media for the purpose of determining compliance with applicable standards and permit requirements, assessing radiation exposures of members of the public, and assessing the effects, if any, on the local environment.

Ephemeral – Lasting only a short period of time. Used in this document to describe water bodies that often does not have water year-round. Typically, these water bodies have water

following the wet seasons and then are dry during the dry seasons.

Evapotranspiration – The sum of evaporation, the process by which water passes from the liquid to the vapor state, and transpiration, the process by which plants give off water vapor through their leaves.

Extirpate – To destroy completely.

Fauna – Animal life, or animals as a whole, especially those that are characteristic of a region.

Fecal coliform bacteria – Simple organisms associated with the intestine of warm-blooded animals that are commonly used to indicate the presence of fecal material and the potential presence of organisms capable of causing human disease.

Flora – Plant life or plants as a whole, especially those that are characteristic of a region.

Gamma ray (gamma radiation) – High-energy, short wavelength electromagnetic radiation (a packet of energy) emitted from the nucleus. (Gamma radiation frequently accompanies alpha and beta emissions and always accompanies fission.) Gamma rays are very penetrating and can be stopped or shielded against by dense materials such as lead or uranium. Gamma rays are similar to X-rays, but are usually more energetic.

Grab sample – A single sample, collected at one time and place.

Greenhouse Gases (GHGs) – Chemical compounds found in the earth's atmosphere which absorb infrared radiation (heat) from the reflection of sunlight striking the earth's surface and cause rising temperatures. Some occur in nature (e.g., carbon dioxide, methane, and nitrous oxide), and others such as hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride are anthropogenic (man-made). For Federal agencies emissions of greenhouse gases are further classified as:

Scope 1: direct GHG emissions from sources that are owned or controlled by the Federal agency;

Scope 2: direct GHG emissions resulting from the consumption of purchased or acquired electricity, heat, or steam purchased by a federal agency; and

Scope 3: GHG emissions from sources not owned or directly controlled by a federal agency but related to agency activities such as vendor supply chains, delivery services, and employee travel and commuting.

Hantavirus Pulmonary Syndrome – The Hantavirus is found in saliva, urine, or feces of various rodent species and is transmitted to humans by inhalation. It causes rapidly progressive pulmonary symptoms that result in serious illness. Human-to-human transmission has not been demonstrated.

Hazardous material – A material, including a hazardous substance, as defined by 49 CFR 171.8 that poses a risk to health, safety, and property when handled or transported.

Hazardous waste – Defined by 40 CFR Part 261, as any material that a) is a solid waste, and b) is a listed hazardous waste (Subpart D), or c) exhibits any of the characteristics of ignitibility, corrosivity, reactivity or toxicity (Subpart C).

Hemoglobin – A protein found in red blood cells that transports oxygen.

Herpesvirus – Any virus belonging to the family Herpesviridae. It is basically a wildlife disease, and offers possible implications to research on human viruses.

Herbicide – A substance (usually chemical) used to destroy undesirable plants.

Herpetofauna – Reptiles (snakes, turtles, lizards, etc.) and amphibians (frogs, toads, salamanders).

High explosives – Any chemical compound or mechanical mixture which, when subjected to heat, impact, friction, shock, or other suitable initiation stimulus undergoes a very rapid chemical change with the evolution of large volumes of highly heated gases that exert pressure in the surrounding medium.

Histopathology – The science or study of dealing with the structure of abnormal or diseased tissue; examination of the tissue changes that accompany a disease.

Historic – Of, relating to, or existing in times postdating the development of written records.

Historic cultural resources are all evidences of human occupations that date to recorded periods in history. Historic resources may be considered archaeological resources when archaeological work is involved for identification and interpretation.

Industrial solid waste – Solid waste resulting from or incidental to any process of industry or manufacturing, or mining or agricultural operations.

Infrastructure – The basic services, facilities and equipment needed for the functioning and growth of an area.

Insecticide – A substance used to destroy undesirable insects.

Invertebrate – Animals characterized by not having a backbone or spinal column, including a wide variety of organisms such as insects, spiders, worms, clams, crayfish, etc.

Isotope – Any of two or more species of atoms of a chemical element with the same atomic number and position in the periodic table and nearly identical chemical behavior but with different numbers of neutrons in their nuclei, and thus differing atomic mass number and different physical properties.

Lacustrine – Pertaining to, produced by, or inhabiting a lake or lakes.

Lagomorph – Any of the various gnawing mammals in the order Lagomorpha, including rabbits, hares, and pikas.

Less than 55-gallon Hazardous Waste Accumulation Sites – Temporary hazardous or mixed waste accumulation points located at or near the point of generation to collect no more than a total of 55 gallons of hazardous waste or no more than 1 quart of acutely hazardous waste. This area must be under the control of the operator of the process generating the waste.

Less than 90-Day Hazardous Waste Accumulation Sites – These are temporary accumulation areas used to collect hazardous wastes for 90 days or less before transfer to an interim status or permitted hazardous waste processing or storage facility.

Llano Estacado – Spanish for "staked plains", used to refer to the Southern High Plains.

Low-level radioactive waste – Waste containing radioactivity not classified as high-level, transuranic waste, spent nuclear fuel, or special by-product material.

Mammal – Animals in the class Mammalia that are distinguished by having self-regulating body temperature, hair, and in females, milk-producing mammary glands to feed their young.

Matrix spike duplicates – Used to evaluate the precision of a specific analysis.

Maximum Contaminant Levels – The maximum permissible level of a contaminant in water that is delivered to the free-flowing outlet of the ultimate user of a public water system. MCLs are enforceable standards.

Method Detection Limit – A measure of instrument sensitivity using solutions that have been subjected to all sample preparation steps for the method.

Metric System – See International System of Units.

Mitigation – The alleviation of adverse impacts on resources by avoidance through project redesign or project relocation.

Mixed waste – Waste containing both radionuclides as defined by the Atomic Energy Act, and hazardous constituents as defined by 42 USC 6901 et seq. and 40 CFR 261.

Mortuary remains – Human physical remains and associated artifacts that exist in prehistoric and historic temporal contexts.

National Ambient Air Quality Standards NAAQS) – Standards developed, under the authority of the Clean Air Act by the Environmental Protection Agency, to protect the quality of the air we breathe. Standards are set for six pollutants: sulfur dioxide, particulate matter with a mean aerodynamic diameter of 10 microns or less, carbon monoxide, ozone, nitrogen dioxide, and lead.

National Environmental Policy Act (NEPA) – Federal statute promulgated under 40 CFR part 1500 through 1508; requires Federal facility actions be evaluated for environmental impacts,

usually in the form of environmental Impact Statements or Environmental Assessments. 10 CFR 1021 is DOE's Implementing Procedures for NEPA.

National Pollutant Discharge Elimination System (NPDES) – U.S. Federal Regulation (40 CFR, Parts 122 and 125) that requires permits for the discharge of pollutants from any point source into the waters of the United States.

National Register of Historic Places (NRHP) – A national list of districts, sites, buildings, structures, and objects significant in American history, architecture, archaeology, engineering, and culture.

Native American – A tribe, people, or culture that is indigenous to the United States.

Necropsy – Autopsy, postmortem examination.

Nuclear weapon – Any weapon with a nuclear device designed specifically to produce a large release of energy (nuclear explosion) from the fission and/or fusion of atomic nuclei.

Off-Normal Event – Abnormal or unplanned events or conditions that adversely affect, potentially affect, or are indicative of degradation in, the safety, security, environmental or health protection performance or operation of a facility.

Off-site – Outside Pantex site boundary.

On-site – Within Pantex site boundary.

Ogallala Formation – Tertiary formation consisting of gravel, sand, silt, and clay. This is the principal geologic unit in the High Plains Aquifer. Comprises the Ogallala Aquifer in the Panhandle of Texas, the primary source of groundwater in the region. The top of the Ogallala Formation in large areas of Texas and New Mexico consists of a resistant caliche layer. The Ogallala Formation at Pantex overlies the Triassic Dockum Group strata and underlies the Quaternary Blackwater Draw Formation.

Outfall – The outlet of a body of water. In the surface water permitting program, the term outfall refers to the effluent monitoring location identified by the permit. An outfall may be "internal" (associated with a building) or "final" (the last monitoring point at Pantex.)

Perched aquifer – Groundwater separated from the underlying main body of groundwater, or aquifer, by unsaturated rock.

Permian – The last period of the Paleozoic era (after the Pennsylvanian) thought to have covered the span of time between 280 and 225 million years ago (Ma); also, the corresponding system of rocks. It is named after the province of Perm, Russia, where rocks of this age were first studied.

Per- and Polyfluoroalkyl Substances (PFAS) – PFAS are a group of manufactured chemicals that have been used in industry and consumer products since the 1940s because of their useful properties. There are thousands of different PFAS, some of which have been more widely used and studied than others.

Plague – An acute infection caused by the bacterium *Yersinia pestis*. It is transmitted from rodent to humans by the bite of an infected flea. It is less commonly transmitted by direct contact with infected animals or airborne droplets. This disease is also manifested by an acute onset of fever followed by shock, multiple organ failure, and death; caught early, it is treatable with antibiotics.

Playa – A natural depression acting as a detention basin receiving surface runoff within a watershed area; an ephemeral lake.

Plume – An elongated pattern of contaminated air or water originating at a point source, such as a smoke stack or a hazardous waste disposal site.

Plutonium – A heavy, radioactive, man-made metallic element with atomic number 94. Its most important isotope is fissile ^{239}plutonium, which is produced by neutron irradiation of ^{238}uranium. The nuclei of all atoms of this isotope contain 94 protons and 145 neutrons.

Pollution prevention – The process of reducing and/or eliminating the generation of waste materials through source reduction, process modification, and recycling/reuse to minimize environmental or health hazards associated with hazardous wastes, pollutants or contaminants.

Potable – Suitable for drinking.

Potentially interested parties – Under the National Historic Preservation Act (NHPA),

organizations that have requested to be informed of Federal actions at a particular site.

Practical Quantitation Limit (PQL) – The Final Risk Reduction Rule Guidance is used to identify the quantifiable limit of detection for sampled constituents at Pantex. This limit is defined as Practical Quantitation Limit. A PQL is the lowest level that can be accurately and reproducibly quantified.

Prehistoric – Of, relating to, or existing in times antedating written history. Prehistoric cultural resources are those that pre-date written records of the human cultures that produced them.

Process knowledge – Used to characterize a waste stream when it is difficult to sample because of physical form, the waste is too heterogeneous to be characterized by one set of samples, or the sampling and analysis of the waste stream results in unacceptable risks of radiation exposure.

Programmatic Agreement – The document outlining specific plans for the management of cultural resources at Pantex before the long-term Cultural Resource Management Plan was implemented. The parties to the agreement were the U.S. Department of Energy, the President's Advisory Council on Historic Preservation, and the Texas State Historic Preservation Office.

Pseudorabies – A highly contagious disease affecting cattle, horses, dogs, swine, and other mammalian species, caused by porcupine herpes virus 1, which has its reservoir in swine. In species other than swine, pseudorabies is highly fatal.

Pullman soil series – Silty clay loams; soils found in the interplaya areas at Pantex.

Quaternary – The most recent of the three periods of the Cenozoic Era in the geologic time scale. It follows the Neogene Period and spans from 2.588 ± 0.005 million years ago to the present. It is divided into two epochs: the Pleistocene and the Holocene.

Rabies – A rapidly fatal disease of the central nervous system that may be transmitted to any warm-blooded animal. The disease starts with a fever, headache, muscle aches, nausea, and vomiting, and eventually progresses to agitation, confusion, combativeness, increased salivation and decreased swallowing, followed by coma and death. It can be transmitted to humans through the bite of infected animals such as dogs, cats, skunks, wolfs, foxes, raccoons, and bats.

Radiation (nuclear) – Particles (alpha, beta, neutrons) or photons (gamma) emitted from the nucleus of an unstable (radioactive) atom as a result of radioactive decay. It does not include non-ionizing radiation, such as microwaves or visible, infrared, or ultraviolet light.

Radioactive – The state of emitting radiation in the form of waves (rays) or particles.

Radioactivity – The spontaneous emission of radiation, generally alpha or beta particles, often accompanied by gamma rays, from the nucleus of an unstable isotope.

Randall soil series – Clay soils present in the playa bottoms at Pantex.

Raptor – Birds of prey including various species of hawks, falcons, eagles, vultures and owls.

Replicate analysis – A repeated operation occurring within an analytical procedure, e.g., two or more analyses for the same constituent in an extract of a single sample. Replicate environmental samples measure the overall precision of the sampling or analytical methods, while replicate analyses are identical analyses carried out on the same sample multiple times. They measure analytical laboratory precision only.

Resource Conservation and Recovery Act (RCRA) – Federal statute which governs current and planned hazardous waste management activities.

Risk Reduction Rules – 30 TAC 335 Subchapter S, outline three risk reduction levels to be considered relative to the corrective measures.

Risk Reduction Standard 1 – Closure and/or remediation to background levels by removing or decontaminating all waste, waste residues, leachate, and contaminated media to levels unaffected by waste management activities.

Risk Reduction Standard 2 – Closure and/or remediation to health-based standards and criteria by removing, containing, or decontaminating all

waste, waste residues, leachate, and contaminated media to meet standards and criteria such that any substantial present and future threats to human health and the environment are very low.

Risk Reduction Standard 3 – Closure and/or remediation with controls, which entails removal, containment, or decontamination of waste, waste residues, leachate, and contaminated media to such levels and in such a manner that any substantial present or future threats to human health and the environment are reduced to an acceptable level, based on use.

Sanitization – The irreversible modification or destruction of a component or part of a component of a nuclear weapon, device, trainer or test assembly, as necessary, to prevent revealing classified or otherwise controlled information, as required by the Atomic Energy Act of 1954, as amended.

Saturated zone – The zone in which the voids in the rock or soil are filled with water at a pressure greater than atmospheric. The water table is the top of the saturated zone in an unconfined aquifer.

Sedimentation – The process of deposition of sediment, especially by mechanical means from a state of suspension in air or water.

Seismic – Pertaining to any earth vibration, especially an earthquake.

Sievert (Sv) – The Système International d'Unités (SI units) unit of equivalent dose. One Sievert is equivalent to 100 rem.

Site – A geographic entity comprising leased or owned land, buildings, and other structures required to perform program activities.

Site (archaeological) – Any area or location occupied as a residence or used by humans for a sufficient length of time to leave physical remains or traces of occupancy. The sites are extremely variable in size and may range from a single hunting camp to an extensive land surface with evidence of numerous settlements and activities. The site(s) may consist of secondarily deposited archaeological remains.

Slug test – An aquifer test made either by pouring a small instantaneous charge of water into a well or by withdrawing a slug of water from the well. The rate of recovery of the water table to equilibrium conditions is monitored as the stress is applied to the aquifer. Information from slug tests can be used to estimate the hydraulic conductivity of the aquifer.

Solid Waste Management Unit (SWMU) – Any unit from which hazardous constituents may migrate, as defined by RCRA. A designated area that is, or is suspected to be, the source of a release of hazardous material into the environment that will require investigation and/or corrective action.

Split – One larger sample is split into "equal" parts. The goal of a split sample is to evaluate analytical accuracy. If a sample is split into two parts: one may go to the contractor, one to the regulator; or the two parts may go to two different labs for comparison purposes, or one may be sent to a laboratory for analysis; the second one held for later confirmatory analysis, or in case the first one is lost/broken.

Standard deviation – The absolute difference between one of a set of numbers and their means. It is a statistic used as a measure of dispersion in a distribution, the square root of the arithmetic average of the squares of the deviations from the mean.

Storm water – A precipitation event that leads to an accumulation of water; it includes storm water runoff, snowmelt runoff, surface runoff, and drainage.

Supplement Analysis – A document that DOE prepares in accordance with DOE NEPA regulations (10 CFR 1021.314(c)) to determine whether a supplemental or new EIS should be prepared pursuant to CEQ NEPA regulations (40 CFR 1502.9(c)).

Surface water – Water that is open to the atmosphere and subject to surface runoff. Surface water includes storm water.

Tertiary – The first period of the Cenozoic era (after the Cretaceous of the Mesozoic era and before the Quaternary) thought to have covered the span of time between 65 and 2 Ma; also, the corresponding system of rocks.

Texas Commission on Environmental Quality (TCEQ) –The state agency responsible for the

environmental quality of Texas. TCEQ has the lead regulatory role for RCRA-regulated waste generated at Pantex.

Thermoluminescent Dosimeter (TLD) – A device containing crystalline materials that, when struck by radiation, contain more energy than in their normal state. At the end of the measurement period, heat is used to anneal the crystals and free the energy, which emerges as a light pulse. The pulse is then mathematically converted to the dose received by the TLD. Correction factors in the conversion equation are adjusted for various filters, TLD crystal elements and incident radiation. The device can either be carried by a radiation worker, or, as used in this document, placed at a specific location to measure the cumulative radiation dose.

Thorium – A radioactive metallic element that occurs combined in minerals and is usually associated with rare earth elements. Thorium's atomic number is 90.

Toxic Substances Control Act (TSCA) – Federal statute that establishes requirements for identifying and controlling toxic chemical hazards to human health and the environment.

Tracer – A labeled element used to trace the course of a chemical or biological process.

Triassic – The first period of the Mesozoic era (after the Permian of the Paleozoic era, and before the Jurassic) thought to have covered the span of time between 225 and 190 Ma; also, the corresponding system of rocks.

Trihalomethanes – One of the families of organic compounds (methane derivatives) in which three of the four hydrogen atoms in methane are substituted by a halogen atom in the molecular structure.

2,4,6-trinitrotoluene (TNT) – A flammable toxic compound ($C_7H_5N_3O_6$) obtained by nitrating toluene and used as an high explosive and in chemical synthesis.

Trip blanks – Provided for each shipping container to be analyzed for volatile organic compounds (VOCs). Analytical results from trip blanks are used to evaluate whether there was any contamination of the sample bottle during shipment from the manufacturer, storage of the bottles, during shipment to the laboratories, or during analysis at the laboratory.

Tritiated – Containing tritium.

Tritium – A radioactive isotope of hydrogen with one proton and two neutrons in its nucleus. It is chemically identical to natural hydrogen and reacts with other substances and is absorbed into the body in the same manner. Elemental tritium incorporates readily with water to form tritiated water (HTO) or oxidized tritium. When this tritiated water is present in the gaseous state in the atmosphere, it is referred to as tritiated water vapor. Tritium decays by beta emission with a radioactive half-life of about 12.5 years.

Tularemia – A disease caused by *Francisella tularensis* and transmitted to humans by rodents through the bite of a deer fly, *Chrysops discalis*, and other bloodsucking insects; it can also be acquired directly through the bite of an infected animal or through handling of an infected animal carcass.

Uranium – A silvery, heavy, radioactive, polyvalent metallic element that is found especially in pitchblende and uraninite and exists naturally as a mixture of three isotopes of mass number 234, 235, and 238 in the proportions of 0.006 percent, 0.71 percent, and 99.28 percent, respectively. Uranium has an atomic number of 92.

Vadose zone – Also called the unsaturated zone, the zone between the land surface and the water table. The pore spaces in the vadose zone contain water at less than atmospheric pressure, as well as air and other gases. Saturated bodies, such as perched aquifers, may exist in the vadose zone.

Volatile organic compounds (VOCs) – Organic compounds capable of being readily vaporized at normal temperatures and pressures. Examples are benzene, toluene, and carbon tetrachloride.

Waste generator – Any individual or group of individuals that generate radioactive, mixed, hazardous, or other types of wastes at Pantex.

Waste minimization – Refers to a practice that reduces the environmental or health hazards associated with hazardous wastes, pollutants, or contaminants after generation.

Waste Tracking System Database – The computerized log maintained by the Waste Operations Department.

Watershed – A ridge of high land dividing two areas that are drained by different river systems. It can also be the region draining into a river, river system, or body of water.

Weapon component – A part designed specifically for use in a weapon.

Weir – A fence or enclosure set in a waterway to raise the water level or to gauge or divert its flow.

Wetlands – Land or areas exhibiting hydric soil concentrations saturated or inundated soil during some portion of the year, and plant species tolerant of such conditions.

Wind Rose – A graphical depiction of the annual frequency distribution of wind speed and the direction from which the wind has blown.

APPENDIX F –
ELEMENTS AND CHEMICALS

Ag	silver
As	arsenic
Ba	barium
Be	beryllium
Ca	calcium
Cd	cadmium
CO	carbon monoxide
Cr	chromium
Cu	copper
DNX	hexahydro-1,3-Dinitroso-5-Nitro 1,3,5-triazine
DNT	4-amino-2,6-dinitrotoluene
DNT4A	4-amino-2,6-DNT
Fe	iron
HAA5	haloacetic acids
HF	hydrofluoric acid
Hg	mercury
HMX	octahydro-1,3,5,7-tetranitro 1,3,5,7-tetrazocine
MEK	methyl ethyl ketone
Mn	manganese
MNX	hexahydro-1-Nitroso-3,5-Dinitro-1,3,5-triazine
NO_x	nitrogen oxides
O_3	ozone
Pb	lead
PCBs	polychlorinated biphenyls
PCE	perchloroethylene
PETN	Pentaerythrithol tetranitrate
RDX	Royal Demolition Explosive (hexahydro-1,3,5-trinitro-1,3,5-triazine)
SO_x	sulfur oxides
SO_2	sulfur dioxide
TCE	trichloroethylene/ethene
THF	tetrahydrofuran
Ti	titanium
TNB	trinitrobenzene
TNT	trinitrotoluene
TNX	hexahydro-1,3,5-Trinitroso-1,3,5-triazine
TZM	titanium, zirconium, and molybdenum
VOC	volatile organic compound
Zn	zinc

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APPENDIX G -
UNITS OF MEASURE

ac	acres
Bq	becquerel
°C	degrees Celsius
cfm	cubic feet per minute
Ci	curie
cm	centimeter
E ±n	exponential (E) is10± n where n is some number (see Appendix F: Conversion Information)
°F	degrees Fahrenheit
ft	foot/feet
ft/min	feet per minute
ft^2	square foot
ft^3	cubic feet
g or gm	gram
gal	gallon
gpm	gallons per minute
ha	hectare
hr	hour
in	inch(es)
kg	kilogram
km	kilometer
$kBtu/ft^2/year$	energy per square foot per year
L	liter(s)
lb	pound
m	meter
m^3	cubic meter (approx. 1.308 cubic yards)
Ma	million years ago
mg/L	milligrams per liter
mGy	milligray
mi	mile
mi^2	square mile
min	minute
MMBtu	one million British Thermal Units
mps	meters per second
mrem/yr	millirem per year
mSv	milliSievert
mSv/yr	milliSievert per year
$MtCO_2e$	metric tons CO_2 equivalent
MWh	megawatt hour
pCi/g	picocuries per gram
ppb	parts per billion
ppm	parts per million
R	Roentgen
rem	Roentgen equivalent man

sec	second
SU	standard units
Sv	Sievert
TPY	tons per year
yr	year
µ	micro (1.0×10^{-6})
µg/L	micrograms per liter
µmho/cm	micromhos per centimeter

APPENDIX H - CONVERSION FACTORS

Units of Radiation Measurement

Current System	*Systéme International*	Conversion
curie (Ci)	becquerel (Bq)	1 Ci = 3.7×10^{10} Bq
rad	gray (Gy)	1 rad = 0.01 Gy
rem	Sievert (Sv)	1 rem = 0.01 Sv

Scientific Notation Used for Units

Multiple	Decimal Equivalent	Notation	Prefix	Symbol
1×10^{3}	1,000	E+03	kilo-	k
1×10^{-2}	0.01	E-02	centi-	c
1×10^{-3}	0.001	E-03	milli-	m
1×10^{-6}	0.000001	E-06	micro-	µ
1×10^{-9}	0.000000001	E-09	nano-	n
1×10^{-12}	0.000000000001	E-12	pico-	p
1×10^{-18}	0.000000000000000001	E-18	atto-	a

Metric Conversions

When you know	Multiply by	To Get	When you know	Multiply by	To Get
cm	0.39	in.	in.	2.54	cm
m	3.28	ft	ft	0.305	m
km	0.62	mi	mi	1.61	km
kg	2.21	lb	lb	0.45	kg
L	0.26	gal	gal	3.79	L
L	1.04	quart	quart	0.95	L
hectare	2.47	acre	acre	0.40	hectare
km^2	0.39	mi^2	mi^2	2.59	km^2
m^3	35.32	ft^3	ft^3	0.03	m^3

To convert the temperature in degrees Celsius (degrees C) to degrees Fahrenheit (degrees F), use degrees F = 1.8(degrees C) + 32 degrees.

Prefixes Used in the Metric System

Prefix	Abbreviation	Meaning	Example
Giga	G	10^9	1 gigameter (Gm) = 1×10^9 m
Mega	M	10^6	1 megameter (Mm) = 1×10^6 m
Kilo	k	10^3	1 kilometer (km) = 1×10^3 m
Deci	d	10^{-1}	1 decimeter (dm) = 0.1 m
Centi	c	10^{-2}	1 centimeter (cm) = 0.01 m
Milli	m	10^{-3}	1 millimeter (mm) = 0.001 m
Micro	μ[a]	10^{-6}	1 micrometer (μm) = 1×10^{-6} m
Nano	n	10^{-9}	1 nanometer (nm) = 1×10^{-9} m
Pico	p	10^{-12}	1 picometer (pm) = 1×10^{-12} m
Femto	f	10^{-15}	1 femtometer (fm) = 1×10^{-15} m

[a] This is the Greek letter mu (pronounced “mew”).

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