Pantex Plant

# Third Five-Year Review Report

# Remedial Action Progress

# Pantex Plant

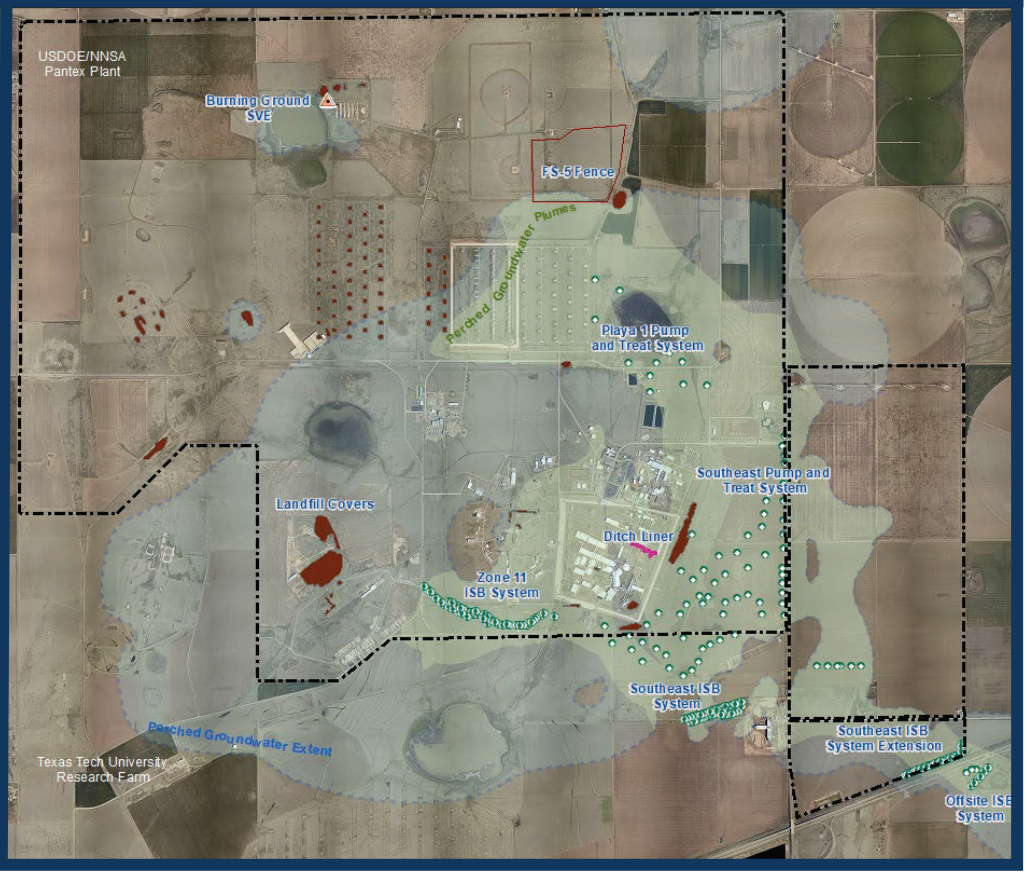
## VOLUME I

August 2023
Final


Pantex Plant
FM 2373 and U.S. Highway 60
Carson County
P.O. Box 30030
Amarillo, Texas 79120

EPA ID No. TX4890110527
RN 100210756 (Pantex Plant)
CN 600125009 (USDOE/NNSA)
CN 604601344 (CNS)


Pantex Plant Remedial Action Systems



**THIRD FIVE-YEAR REVIEW REPORT**
**PANTEX PLANT SUPERFUND SITE**
**CARSON COUNTY, TEXAS**
**EPA ID NO: TX4890110527**

This memorandum documents the U.S. Environmental Protection Agency's performance, determinations, and approval of the Pantex Plant Superfund Site (Site) third five year review under Section 121(c) of the Comprehensive Environmental Response, Compensation, and Liability Act, 42 U.S. Code Section 9621(c), as provided in the attached Third Five-Year Review Report.

## Third Five-Year Review Report

The soil remedies are perfoming as designed with minor deficiencies in soil covers, although this has not affected the ability to meet the Response Action Objectives (RAOs).

The groundwater remedies are performing as designed with the exception of Playa 1 Pump & Treat System (P1PTS), which did not operate as designed due to subsurface irrigation failures that resulted in extended shut down periods. Additionally, high explosives (HE) plumes have continued to expand off-site in a southeast direction within the perched groundwater. In response to the off-site migration, additional in-situ barriers (ISB) have been installed along Highway 60 and on a neighboring property southeast of Highway 60 which is referred to as the Offsite In Situ Bioremediation (ISB) system. The Offsite ISB continues to be expanded in a phased approach that includes extraction wells which supply water for the amendment injections.

EPA Region 6 conducted a preliminary assessment of the effect of climate on the Site remedies. The preliminary assessment determined that the Site risk levels for dry days and wildfire is high. The Site is staffed with security and emergency personnel and grasses are mowed, maintained, and kept clear of remedy structures. The protectiveness of the remedy is anticipated to not be affected by climate change. A Climate Vulnerability Assessment is not recommended to be completed prior to the next Five-Year Review (FYR).

The Environmental Justice (EJ) Screen report (Attachment 15) did not identify any EJ Indexes that exceed the 80th percentile at the national or state average level. Public input on the FYR was solicited through a mailed survey. Public comments and/or Site interviews are summarized in Section 6.6, Interviews.

## Actions Needed

The following actions must be taken for the remedy to be protective in the long term:

- Continue operations and maintenance (O&M) of the soil remedies. Repair areas where soil and landfill covers have eroded or have holes.
- Operate and maintain groundwater remedies as designed to continue achieving progress towards cleanup standards in the perched groundwater.
- Enhance existing remedies and consider additional extraction wells (EWs), as identified in the Pump and Treat (P&T) Optimization Report, and complete construction of the Offsite ISB system and continue O&M as planned.

- Continue to maintain and enforce the established institutional controls (ICs) to restrict access, use of perched groundwater, and drilling.
- Continue to collect data on performance and efficacy of updates and expansions of the Selected Remedy.
- Sample for per- and polyfluoroalkyl substances (PFAS) to determine if present and evaluate the additive risk associated with PFAS contamination detected.
- Evaluate and propose treatment options for PFAS contamination, as appropriate and needed.
- Investigate and evaluate a potential 4-amino-2,6-dinitrotoluene (DNT4A) plume in the vicinity of PTX06-1056 in the Ogallala Aquifer.
- Address the issues identified in the Five-Year Review Summary Form (Section ES-5.1) by implementing the follow-up actions identified for each.

**Determination**

I have determined that the remedy for the Pantex Plant Superfund Site is short-term protective. This five-year review report specifies the actions that need to be taken for the remedy to to be protective in the long term.

LISA PRICE Digitally signed by LISA PRICE Date: 2023.09.07 13:18:03 -05'00'

Lisa Price
Acting Director, Superfund and Emergency Management Division
U.S. Environmental Protection Agency Region 6

# Third Five-Year Review Report
# Remedial Action Progress
# For Pantex Plant

Prepared By:
*Consolidated Nuclear Security, LLC* (CNS)
For
U.S. Department of Energy (USDOE)/National Nuclear Security Administration (NNSA)
NNSA Production Office

CERTIFICATION STATEMENT

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision according to a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fines and imprisonment for knowing violations.

08/31/23

Jimmy C. Rogers — Date
Senior Director
Pantex Environment, Safety & Health
Consolidated Nuclear Security, LLC

Chuck Smolens

Digitally signed by Chuck Smolens
Date: 2023.09.13 14:26:45 -04'00'

Chuck Smolens — Date
Assistant Manager for
Environment, Safety, Health & Quality
U.S. Department of Energy
NNSA Production Office

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# Third Five-Year Review
# in Support of Pantex Plant Interagency Agreement and Compliance Plan No. 50284 for the Pantex Plant, Amarillo, Texas

Final
August 2023

Prepared by:
HydroGeoLogic, Inc.
for
Consolidated Nuclear Security, LLC (CNS)
P.O. Box 30020
Amarillo, Texas 79120

In accordance with 30 TAC §335.553 (g), this report has been prepared and sealed by an appropriately qualified licensed professional engineer or licensed professional geoscientist.

STATE OF TEXAS
JEFFREY DICK
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LICENSED
PROFESSIONAL ENGINEER

Jeff Dick, P.E. — Date: 8/26/23

STATE OF TEXAS
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Martin R. Amos, P.E. — Date: 8/28/2023

**Project Team**

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# ES-1 EXECUTIVE SUMMARY

The U.S. Department of Energy (USDOE)/National Nuclear Security Administration (NNSA) has conducted the Third Five-Year Review (FYR) of the remedial action (RA) implemented at the Pantex Plant Superfund Site (U.S. Environmental Protection Agency [EPA] Site #TX4890110527) in Carson County, Texas. The purpose of this FYR is to evaluate the efficacy of the Selected Remedy for the Pantex Plant and determine if it is protective of human health and the environment. This review was conducted from August 1, 2022, to April 17, 2023, and its findings and conclusions are documented in this report.

## ES-1.1 Regulatory Framework

The Pantex Plant is currently managed as a government-owned, contractor-operated facility, overseen by the USDOE/NNSA and operated by Consolidated Nuclear Security, LLC (CNS). Consistent with Executive Order 12580, federal agencies are responsible for ensuring that FYRs are conducted at federal facilities regulated under Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). Roles and responsibilities of EPA and USDOE/NNSA pertaining to RA oversight at the Pantex Plant are detailed in the Interagency Agreement (IAG) executed in 2008. The Pantex Plant is also regulated under the Resource Conservation and Recovery Act (RCRA) and Texas Risk Reduction Rules (RRR).

The Pantex Plant Site (Site) was proposed for addition to the National Priorities List (NPL) under the CERCLA in 1991 and formally listed in 1994. Under Section 121 of CERCLA, as amended by the Superfund Amendments and Reauthorization Act of 1986 and outlined in 42 U.S. Code (U.S.C.) § 9621I, RAs that result in any hazardous substances, pollutants, or contaminants remaining at the site, preventing unlimited use and unrestricted exposure (UU/UE), must be reviewed every five years to ensure protection of human health and the environment.

The Record of Decision (ROD) selecting RAs to address hazardous substances in Site soil and groundwater was issued in September 2008. Selected RAs that have helped control the spread of hazardous substances and resulted in hazardous substances remaining in place along with primary constituents of concern (COCs) consist of the following:

- Institutional controls (ICs) for both soil and groundwater (defined by the extents of hexahydro-1,3,5-trinitro-1,3,5-triazine [RDX], hexavalent chromium [Cr(VI)], perchlorate, 2,4,6-trinitrotoluene [TNT] [in soil], and uranium-238 [in soil])
- Soil vapor extraction (SVE) in the Burning Ground (BG) area (toluene, acetone, and trichloroethene [TCE]);
- Synthetic liners installed in Zone 12 ditches (RDX);
- Protective covers installed on the BG Former Ash Disposal Trench, the former operational area of Firing Site (FS-5), and Pantex Plant Landfills (RDX, TNT, uranium-238);
- Operation of the groundwater extraction and treatment system (Southeast Pump and Treat System [SEPTS]) to stabilize migration of the plume and treat groundwater in the perched unit (RDX, Cr(VI), 4-amino-2,6-dinitrotoluene [DNT4A], perchlorate);
- Construction and operation of the Playa 1 Pump and Treat System (P1PTS) to reduce mounding of perched groundwater under Playa 1 (RDX and DNT4A); and
- Continued operation of the in situ bioremediation (ISB) systems to treat high explosives (HE) southeast of Zone 12 and downgradient of Zone 11 to treat TCE and perchlorate.

A complete list of COCs and protective levels defined in the ROD is provided in Table 2.3 of Attachment 7.

The continued presence of residual hazardous substances requires a FYR to evaluate the efficacy and protectiveness of the remedies selected in the ROD.

The triggering action initiating the FYR cycle was the publication of the Pantex Plant ROD in September 2008. The First FYR for the Pantex Plant was produced in 2013 summarizing RAs conducted between 2008 and 2012. The Second FYR was produced in 2018 and considers remedial performance between January 1, 2012, and December 31, 2016. This Third FYR was produced in 2023 and considers remedial performance between January 1, 2017, and December 31, 2021.

## ES-2.1 Basis for Response Action

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

## ES-3.1 Remedial Action Objectives

Remedial Action Objectives (RAOs) for the Selected Remedy as defined in the ROD are:

- Soils
  - Reduce the exposure risk to onsite industrial and construction/excavation workers through removal, treatment, or prevention of contact with COCs in the soil.
  - Reduce potential impact to perched groundwater and the Ogallala Aquifer (the primary regional groundwater source in the Texas Panhandle) through source abatement and stabilization/control measures in the vadose zone.
- Perched Groundwater
  - Reduce the risk of exposure to perched groundwater through contact prevention.
  - Achieve cleanup standards for the perched groundwater COCs (i.e., restoration of the perched groundwater).
  - Prevent growth of perched groundwater contaminant plumes.
  - Prevent contaminants from exceeding cleanup standards in the Ogallala Aquifer.

## ES-4.1 Response Actions

Site-wide RAs were established in the Final Pantex ROD, which is the single document for the Selected Remedy for all Solid Waste Management Units (SWMUs), Areas of Concern (AOCs), and Supplemental Verification Sites (SVSs) at Pantex. The Selected Remedy addresses all soil areas that do not meet UU/UE standards and locations with commingled groundwater plumes and impacts to the perched groundwater beneath the Site. Construction of the Selected Remedy was completed in June 2009. Remedy operation and maintenance (O&M) and upgrades to the Selected Remedy have been conducted since 2009. The Selected Remedy was modified by an Explanation of Significant Difference (ESD) in December 2022 that incorporated significant additions to the Selected Remedy for perched groundwater.

The components of the Selected Remedy address both the soil locations requiring a remedial response and affected perched groundwater. Perched groundwater remedies are primarily focused in two areas: the Southeast Area and Zone 11.

The Selected Remedy for soils containing contaminants at concentrations that do not allow for UU/UE includes the following:

- Presumptive remedy of SVE and ICs for SWMU 47 at the BG;
- Protective covers for the BG Former Ash Disposal Trench (SWMUs 14 through 24), the former operational area of Firing Site 5 (SWMU 70) and Pantex Plant landfills (consisting of 27 units);
- Ditch liners for Zone 12 ditches SWMU 2 and SWMU 5-05; and
- ICs for select sites (Limited Action Soil Units; Burn Pads 11, 12, and 13 [SWMUs 25, 26 and 27]; and the Zone 12 Main Perimeter Ditch [SWMU 5/12a]).

The Selected Remedy for the Southeast Area and Zone 11 perched groundwater includes the following:

- Two Pump and Treat (P&T) Systems: the SEPTS and the P1PTS for the Southeast Area;
- ISB Systems to treat HE contaminants and Cr[VI] for the Southeast Area and TCE and perchlorate contaminants for Zone 11; and
- ICs to prevent exposure to contaminants and cross-contamination to the regional Ogallala Aquifer for both the Southeast Area and Zone 11.

The effectiveness of the Selected Remedy for the Pantex Plant Site is determined through groundwater monitoring implemented through a Long-Term Groundwater Monitoring Plan, developed as part the Remedial Design (RD), in accordance with the IAG. The monitoring network provides data for evaluation of both the soil and groundwater remedies. Groundwater results provide data for direct evaluation of groundwater remedies and indirect determinations of sourcing from soil contamination areas.

### ES-4.1.1 Soil Remedy Performance

All soil remedies are performing as designed and expected. Some minor deficiencies in soil covers have been noted, but the deficiencies have not affected the ability to meet the RAOs.

The BG SVE system is operating as designed. The system is continuing to remove soil gas and reduce the mass of volatile organic compounds (VOCs) in the vadose zone from a single extraction well (EW), SVE-S-20. Groundwater monitoring indicates the system has been effective in meeting the objective of protecting the underlying Ogallala Aquifer. Access to the area is restricted in accordance with established ICs, thereby preventing exposure.

The SVE system was modified in 2017 to rework six inactive shallow zone EWs to allow ambient air to be drawn into the formation. Additional air flow to the subsurface enhanced extraction and biodegradation of VOCs during the Third FYR period with decreasing effectiveness as the VOC mass was depleted. During 2020 and 2021, operation of the SVE system included extended periods of downtime to assess the need for continued system operation. Pulsed system operation showed that the system had effectively removed available VOC mass and that SVE system shutdown is recommended.

Containment of landfill materials combined with ICs has been effective at preventing exposure to contaminants and protecting underlying groundwater. Programs are in place for inspecting landfill covers annually and repairing the protective covers by filling holes and controlling burrowing animals

as part of ongoing maintenance. Installation of Closure Turf™ at SWMU 68b and SWMU 68c has been effective at replacing deficiencies in the vegetated covers caused by drought conditions in 2011 and 2012. Inspection of landfill covers in 2022 identified some minor deficiencies such as holes, erosion, and settlement. These minor deficiencies will be addressed through a combination of onsite resources and contracts.

The ditch liner for Zone 12 ditches SWMU 2 and SWMU 5-05 has been effective at preventing infiltration of water through the ditch that promoted leaching of soil contamination and subsequent dissolved transport. Concentrations of COCs in perched groundwater below the ditches showed stable to decreasing statistical trends, supporting the conclusion that the ditches are not leaching additional contamination to perched groundwater. Tears were noted in the ditch liner during the 2021 annual inspection, and sedimentation and erosion of the anchor trench continue to be an issue. Repairs have been contracted and will be completed in 2023. The ditch liner is inspected annually to confirm the integrity of the remedy.

### ES-4.1.2 Groundwater Remedy Performance

The SEPTS functioned as designed during the Third FYR period. The P1PTS did not operate as designed during the Third FYR period as a result of subsurface irrigation system failures that forced the system to shut down and have limited operation for long periods of time. The P1PTS was designed to reduce flux of both contaminants and groundwater into the SEPTS area, and the SEPTS was designed to reduce flux into the Southeast ISB (SEISB) and areas east of it toward the edge of the perched groundwater. The SEISB is creating and maintaining an anaerobic treatment zone that is effectively treating the target COCs to concentrations below the groundwater protection standards (GWPSs) over most of the zone. The SEPTS is reducing saturation in the area of the SEISB that is sensitive to vertical migration. The effects of each system combine synergistically to achieve the RAOs and, eventually, long-term protectiveness through cleanup of the perched groundwater.

However, HE plumes are migrating offsite to the southeast in the perched groundwater unit through areas of low saturated thickness (less than 15 feet [ft]). These areas are not hydraulically controlled by the SEPTS due to limited saturated thickness or other limiting hydrogeologic conditions. Additional ISB systems have been installed along Highway 60 (the Southeast ISB Extension) and to the southeast of Highway 60 on neighboring properties (the Offsite ISB). The Offsite ISB system continues to be expanded in a phased approach that includes Extraction Wells (EWs) to supply water for amendment injections and enhance the remedy. As part of the Offsite ISB system design, the HE plumes migrating offsite in perched groundwater have been fully delineated to the GWPSs defined in the ROD. The additional ISB systems are components consistent with the Selected Remedy.

Biodegradation appears to be addressing HE contamination to some degree in those areas outside the influence of the active remedies, as breakdown products for the primary risk driver (RDX) have been detected throughout the plume. Ongoing evaluations of these data will be conducted to determine if future inclusion of Monitored Natural Attenuation as a part of the Selected Remedy in the ROD is appropriate.

The SEISB, SEISB Extension, Offsite ISB, and Zone 11 ISB systems are currently meeting the design objective of creating and maintaining anaerobic treatment zones capable of reducing the target COCs to concentrations below the GWPSs. The Zone 11 ISB is effectively treating the perchlorate plume in the eastern part of the ISB system. However, some bypass of the ISB has occurred as groundwater flow directions have changed under the influence of the SEPTS. Data indicate improved performance of the ISB for treating TCE in some areas of the system. Other areas of the system, near PTX06-1164 and

PTX06-1169, are showing complete treatment of TCE, but show a lagging rate of degradation for the cis-1,2-dichloroethene (DCE) daughter product. During the FYR period, the Zone 11 ISB was expanded by adding a second line of more tightly spaced injection wells (IWs) in the southeast area. It is anticipated that the tighter spacing of IWs will allow for more complete carbon substrate amendment distribution and improve TCE degradation between IWs. Several recommendations for optimizing the Zone 11 ISB have been developed, including increasing the volume of injected carbon amendments and installing a groundwater recirculation system to improve amendment distribution.

### ES-4.1.3 Remedial Action Performance

The Site-wide remedy for the Pantex Plant is functioning as intended for the short-term. The landfill soil covers, ICs, and engineered controls (e.g., fencing, protective covers, and ditch liner) currently protect workers and the general public from exposure to soil by restricting access and from impacted perched groundwater by restricting use, drilling, and access. These measures are expected to continue to be protective. The SVE is removing soil gas and residual non-aqueous phase liquids (NAPLs) in soils to protect the underlying drinking water aquifer.

Groundwater monitoring has demonstrated that the SEPTS groundwater remedy is performing as expected and concentrations of COCs and water levels are declining in most areas. However, the P1PTS groundwater remedy is not performing as expected and water levels have increased around Playa 1. Additionally, HE and Cr(VI) contamination has migrated to areas of low saturation, outside of the influence of the SEPTS in the southeast lobe of the perched unit. ISB treatment systems were installed in this area to prevent further migration offsite.

The SEISB system is performing as expected with significant reductions in contaminant mass below GWPSs in most areas. The SEPTS continues to reduce saturation in the area of the SEISB, with many wells showing very limited saturation to dry conditions. However, HE concentrations in one location (PTX06-1153) remain above GWPSs. Understanding of the local conceptual site model (CSM) and approaches to enhancing treatment of COCs in this limited area continue to be investigated.

The SEISB system extension is performing as expected. RDX within the treatment zone is degrading to less than the GWPS, and the current amendment injection schedule is maintaining elevated total organic carbon (TOC) concentrations. Although the SEISB Extension is degrading RDX, concentrations in the downgradient monitoring wells have not begun to attenuate. Based on seepage velocity estimates, it is expected that treated groundwater from the SEISB Extension will not reach the downgradient monitoring wells until between 2022 and 2027.

The Offsite ISB system is operating as designed hydraulically and was able to receive the target volume of injected amendment solution in 2021. However, due to the recency of the initial injection event, the Offsite ISB's performance with respect to COC degradation was not evaluated.

The Zone 11 ISB system is effectively treating perchlorate in the eastern section of the system and is treating TCE with varying effectiveness across the system. The system was expanded to the west in 2014 through 2016, and it is effectively treating TCE in the area that was previously bypassing the system. Additional IWs were installed in a second row on the southern side of the Zone 11 ISB system in 2021 with a tighter spacing of 50 ft compared to previously installed IWs that were approximately 100 ft apart. Because of their recent addition, there is not sufficient data available to assess the performance of the IWs installed in 2021. Remedy optimization strategies continue to be investigated to improve performance of the Zone 11 ISB system for treating TCE.

The Selected Remedy will continue to be implemented as designed during the next five years. Data will continue to be collected through the long-term monitoring (LTM) network to assess remedy effectiveness and to document natural attenuation to better define the long-term performance.

## ES-5.1 Conclusions and Recommendations

The FYR indicates that the Selected Remedy is primarily performing as intended and is protective of human health and the environment. The recommendations and follow-up actions identified in this FYR should be addressed to ensure that the remedy will result in long-term protectiveness of human health and the environment.

The Selected Remedy at the Pantex Plant Site currently protects human health and the environment because:

- All soil remedies are functioning as designed and performing as expected.
- Risk of exposure to contaminated soils and affected perched groundwater is being minimized through contact prevention and control (maintenance and enforcement of ICs).
    - Access to contaminated surface soil is controlled through a combination of protective covers, fencing, signage, work plans, SWMU Interference permits, and other access controls associated with the active mission of the Site.
    - Access to contaminated perched groundwater is prevented through a combination of restrictions on use, drilling, and access.
- The P&T systems, when operated as designed, reduce the saturated thickness of the perched groundwater, thus reducing the potential for vertical movement of affected perched groundwater, protecting the underlying Ogallala Aquifer.
- The SEPTS is removing significant quantities of contaminant mass, mitigating plume migration to the east, and reducing saturation in the area of the SEISB.
- The SEISB system is reducing COC concentrations below GWPSs in an area sensitive to vertical movement of affected perched groundwater, thus protecting the underlying Ogallala Aquifer.
- The SEISB Extension is reducing COC concentrations in the treatment zone and will likely cause concentrations to attenuate in downgradient monitoring wells given enough time for perched groundwater from the IWs to travel to downgradient monitoring locations.
- The Offsite ISB system is hydraulically operating as designed, and target volumes were injected at the leading edge of the RDX plume.
- The Zone 11 ISB system has established a reducing zone in the perched groundwater, treating perchlorate to concentrations below the GWPS and degrading TCE in areas where microbial communities have evolved in response to repeat additions of amendments. Additional IWs on the western end are effectively treating the TCE plume that was previously migrating around the Zone 11 ISB system, and a second line of more tightly spaced IWs on the southeastern end are more effectively distributing carbon substrate amendment.

However, for the Selected Remedy to be protective in the long-term, the following actions need to be implemented:

- Continue O&M of the soil remedies. Repair areas where soil and landfill covers have eroded or have holes.
- Operate and maintain groundwater remedies as designed to continue achieving progress toward cleanup standards in the perched groundwater.
- Enhance existing remedies and consider additional EWs, as identified in the P&T Optimization Report, and complete construction of the Offsite ISB system and continue O&M as planned.
- Continue to maintain and enforce the established ICs to restrict access, use of perched groundwater, and drilling.
- Continue to collect data on performance and efficacy of updates and expansions of the Selected Remedy.
- Sample for per- and polyfluoroalkyl substances (PFAS) to determine if present and evaluate the additive risk associated with PFAS contamination detected.
- Evaluate and propose treatment options for PFAS contamination, as appropriate and needed.
- Investigate and evaluate a potential DNT4A plume in the vicinity of PTX06-1056 in the Ogallala Aquifer.
- Address the issues identified in the Five-Year Review Summary Form (Section ES-5.1) by implementing the follow-up actions identified for each.

**Five-Year Review Summary Form**

| **SITE IDENTIFICATION** | | |
|---|---|---|
| **Site Name:** Pantex Plant Superfund Site | | |
| **EPA ID:** 4890110527 | | |
| **Region:** 6 | **State:** TX | **City/County:** Carson County |
| **SITE STATUS** | | |
| **NPL Status:** Final | | |
| **Multiple OUs?** No | **Has the site achieved construction completion?** Yes (June 2009) | |
| **REVIEW STATUS** | | |
| **Lead agency:** Other Federal Agency<br>**If "Other Federal Agency" was selected above, enter Agency name:** USDOE/NNSA | | |
| **Author name (Federal or State Project Manager):** Chuck Smolens | | |
| **Author affiliation:** USDOE/NNSA Production Office | | |
| **Review period:** August 1, 2022 through April 17, 2023 | | |
| **Date of site inspection:** September 27 and 28, 2022 | | |
| **Type of review:** Statutory | | |
| **Review number:** 3 | | |
| **Triggering action date:** September 25, 2008 – ROD Signature | | |
| **Due date *(fifteen years after triggering action date)*:** September 25, 2023 | | |

**Five-Year Review Summary Form (continued)**

**Issues/Recommendations**

| **Operable Units (OUs) without Issues/Recommendations Identified in the FYR:** |
|---|
| **Not Applicable** |

**Issues and Recommendations Identified in the FYR:**

| **Media Type: Soil** | **Issue Category: Changed Site Conditions** | | | |
|---|---|---|---|---|
| | **Issue:** Minor deficiencies in protective soil covers including erosion, animal burrows, and settling. | | | |
| | **Recommendation:** Fill holes on soil cover surfaces and address settlement of a culvert at SWMU 56. | | | |
| **Affect Current Protectiveness** | **Affect Future Protectiveness** | **Implementing Party** | **Oversight Party** | **Milestone Date** |
| No | Yes | Federal Facility | EPA/State | September 2025 |

| **Media Type: Soil** | **Issue Category: Changed Site Conditions** | | | |
|---|---|---|---|---|
| | **Issue:** Tears were observed in the SWMU 2 and 5-05 ditch liner during the 2021 inspection, and sedimentation and erosion of the anchor trench continues to occur. | | | |
| | **Recommendation:** Repair tears in the ditch liner. | | | |
| **Affect Current Protectiveness** | **Affect Future Protectiveness** | **Implementing Party** | **Oversight Party** | **Milestone Date** |
| No | Yes | Federal Facility | EPA/State | April 2024 |

| **Media Type: Groundwater** | **Issue Category: Remedy Performance** | | | |
|---|---|---|---|---|
| | **Issue:** Perched groundwater elevations and RDX concentrations around Playa 1 are increasing as a result of limited P1PTS operation and discharges of treated groundwater to Playa 1. | | | |
| | **Recommendation:** Eliminate unnecessary discharges to Playa 1. Resume operating the P1PTS system as designed as soon as the center-pivot irrigation system is completed. Continue to monitor LTM wells near Playa 1 to verify that perched groundwater elevations and RDX concentrations decrease over the next FYR period. | | | |
| **Affect Current Protectiveness** | **Affect Future Protectiveness** | **Implementing Party** | **Oversight Party** | **Milestone Date** |
| No | Yes | Federal Facility | EPA/State | July 2024 |

| **Media Type: Groundwater** | **Issue Category: Remedy Performance** | | | |
|---|---|---|---|---|
| | **Issue:** Incomplete treatment of contaminants (HE and Cr[VI]) observed downgradient of the west end of the SEISB at PTX06-1153. Other ISB performance wells show results below remedial goals. | | | |
| | **Recommendation:** Continue to collect and evaluate data from the SEISB area. Consider targeted injections in the area of/or at PTX06-1153. Evaluate the impacts of a slight high in the FGZ between the SEISB and PTX06-1153 on remedial performance. | | | |
| **Affect Current Protectiveness** | **Affect Future Protectiveness** | **Implementing Party** | **Oversight Party** | **Milestone Date** |
| No | Yes | Federal Facility | EPA/State | September 2025 |

**Five-Year Review Summary Form (continued)**

| Media Type: Groundwater | Issue Category: Changing Site Conditions | | | |
|---|---|---|---|---|
| | **Issue:** Detections of HEs (DNT4A) have occurred in the Ogallala Aquifer above the GWPS in PTX06-1056. | | | |
| | **Recommendation:** Continue characterization efforts in the Ogallala Aquifer northeast of the SEISB area and evaluate migration potential toward Site boundaries. | | | |
| **Affect Current Protectiveness** | **Affect Future Protectiveness** | **Implementing Party** | **Oversight Party** | **Milestone Date** |
| No | Yes | Federal Facility | EPA/State | September 2025 |

| Media Type: Groundwater | Issue Category: Changing Site Conditions | | | |
|---|---|---|---|---|
| | **Issue:** Potential development of a DNT4A plume in the Ogallala Aquifer near PTX06-1056. | | | |
| | **Recommendation:** Prepare a work plan for delineating nature and extent of impacts to the Ogallala Aquifer if continuing characterization efforts confirm the presence of a plume in the Ogallala Aquifer northeast of the SEISB area. | | | |
| **Affect Current Protectiveness** | **Affect Future Protectiveness** | **Implementing Party** | **Oversight Party** | **Milestone Date** |
| No | Yes | Federal Facility | EPA/State | March 2026 |

| Media Type: Groundwater | Issue Category: Changed Guidance and Toxicity Evaluation | | | |
|---|---|---|---|---|
| | **Issue:** PFAS were released at the Pantex Plant from fire-fighting activities that used aqueous film-forming foam (AFFF) and are present in materials used in the manufacture of HEs. PFAS are likely present in soil and perched groundwater. | | | |
| | **Recommendation:** Add PFAS to the suite of analytes for select monitoring wells to identify the extent of PFAS contamination. Treated effluent from the SEPTS, P1PTS, and wastewater treatment plant should be characterized. | | | |
| **Affect Current Protectiveness** | **Affect Future Protectiveness** | **Implementing Party** | **Oversight Party** | **Milestone Date** |
| No | Yes | Federal Facility | EPA/State | September 2024 |

**Five-Year Review Summary Form (continued)**

| Media Type: Groundwater | Issue Category: Changed Guidance and Toxicity Evaluation | | | |
|---|---|---|---|---|
| | **Issue:** PFAS are likely present in soil and perched groundwater. Nature and extent of the presence of these compounds is important for understanding effects on cumulative risk. These data will allow for evaluation of the future protectiveness of the Selected Remedy. | | | |
| | **Recommendation:** Prepare an investigation work plan for delineating nature and extent of PFAS based on initial data gathering using the existing monitoring wells. | | | |
| **Affect Current Protectiveness** | **Affect Future Protectiveness** | **Implementing Party** | **Oversight Party** | **Milestone Date** |
| No | Yes | Federal Facility | EPA/State | March 2026 |

| Media Type: Groundwater | Issue Category: Changing Site Conditions | | | |
|---|---|---|---|---|
| | **Issue:** Persistence of 1,4 dioxane in the Zone 11 ISB area. Continued movement downgradient at sustained or increasing concentrations would create the potential for Ogallala Aquifer impact in areas sensitive to vertical migration. | | | |
| | **Recommendation:** Update the Contingency Plan to recognize this potential deviation and determine conditions that would trigger further action. | | | |
| **Affect Current Protectiveness** | **Affect Future Protectiveness** | **Implementing Party** | **Oversight Party** | **Milestone Date** |
| No | Yes | Federal Facility | EPA/State | March 2025 |

| Media Type: Groundwater | Issue Category: Changed Site Conditions | | | |
|---|---|---|---|---|
| | **Issue:** Sections of the Zone 11 ISB demonstrate mixed degradation results, with incomplete degradation of TCE near treatment zone monitoring (TZM) wells PTX06-1164 and PTX06-1169. | | | |
| | **Recommendation:** Review amendment injection volumes to confirm that they are sufficient to distribute amendment away from the IWs and test alternative well maintenance approaches, such as sequential application of different chemical agents, longer surge times, or a heated water maintenance approach to improve transmissivities around the well screens. | | | |
| **Affect Current Protectiveness** | **Affect Future Protectiveness** | **Implementing Party** | **Oversight Party** | **Milestone Date** |
| No | Yes | Federal Facility | EPA/State | September 2024 |

**Five-Year Review Summary Form (continued)**

| *Media Type:* **Soil** | *Protectiveness Determination:* **Short-Term Protective** | *Addendum Due Date (if applicable):* **Not Applicable** |
|---|---|---|
| *Protectiveness Statement:* The soil remedy is in place and progressing as expected. It is currently meeting RAOs intended to prevent exposure and infiltration that would result in vertical migration of contaminants to underlying groundwaters. ICs are in place to restrict public access and potential for exposure. The remedy is expected to protect future groundwater resources. | | |
| *Media Type:* **Groundwater** | *Protectiveness Determination:* **Short-Term Protective** | *Addendum Due Date (if applicable):* **Not Applicable** |

*Protectiveness Statement:* The groundwater remedy is progressing as expected and is currently meeting RAOs intended to prevent exposure by restricting access, drilling, and use. However, the remedy has not yet achieved RAOs that ensure protectiveness of future groundwater resources:

1. Achieve cleanup standard for the perched groundwater COCs (i.e., restoration of the perched groundwater) - Although significant progress has been made reducing concentrations and extracting or destroying contaminant mass in perched groundwater, COC concentrations have not yet attained remedial goals across the entire perched unit.
2. Prevent growth of perched groundwater contaminant plumes - Perched groundwater COC plumes continue to move and/or expand downgradient in the southeastern lobe of the perched groundwater. Plume migration directly east has stabilized. While perched groundwater has expanded, new ISB systems have been constructed to extend active remediation to the southeast of Highway 60 and at the toe of the current offsite HE plume.
3. Prevent migration of COCs from perched groundwater to the Ogallala Aquifer - Ogallala Aquifer monitoring well PTX06-1056 had detections of DNT4A that exceeded the GWPS. No additional monitoring wells closer to the Site boundaries had exceedances of COCs, indicating that the monitoring wells are working to provide early warning of COCs reaching the Ogallala Aquifer. Additional planned monitoring wells will further delineate the extent of Ogallala Aquifer impacts.

**Sitewide Protectiveness Statement (if applicable)**

*For sites that have achieved construction completion, enter a site-wide protectiveness determination and statement.*

| *Protectiveness Determination:* **Short-Term Protective** | *Addendum Due Date (if applicable):* **Not Applicable** |
|---|---|

*Protectiveness Statement:*
Results of the five-year 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. Access to contaminated surface soil is prevented through a combination of protective covers, fencing, and other access controls associated with the active mission of the site. Access to contaminated perched groundwater is prevented through a combination of use, drilling, and access restrictions. In order to achieve long-term protectiveness of human health and the environment, operation and maintenance of the remedial action systems must continue and enhancements to existing systems and institutional controls need to be evaluated, planned, and implemented to address the aforementioned issues.

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# LIST OF ACRONYMS AND ABBREVIATIONS

| | |
|---|---|
| % | percent |
| ft | feet/foot |
| gpd | gallons per day |
| gpm | gallons per minute |
| kg | kilogram |
| µg/L | micrograms per liter |
| Mgal | million gallons |
| mrem/yr | millirems per year |
| lb | pound |
| | |
| AFCEC | Air Force Civil Engineer Center |
| AFFF | aqueous film-forming foam |
| AO | Administrative Order |
| AOC | area of concern |
| ARAR | applicable, relevant, and appropriate requirement |
| | |
| B&W Pantex | Babcock and Wilcox Technical Services Pantex, LLC |
| BG | Burning Ground |
| bgs | below ground surface |
| | |
| Carollo | Carollo Engineers, Inc. |
| CatOx | catalytic oxidation |
| CERCLA | Comprehensive Environmental Response, Compensation, and Liability Act |
| CFR | Code of Federal Regulations |
| CNS | Consolidated Nuclear Security, LLC |
| COC | constituent of concern |
| COPC | constituent of potential concern |
| CP | Compliance Plan |
| CP-50284 | Compliance Plan No. 50284 [HW-50284] |
| Cr(VI) | hexavalent chromium |
| CSM | conceptual site model |
| | |
| DCE | dichloroethene |
| DNT | dinitrotoluene |
| DNT2A | 2-amino-4,6-dinitrotoluene |
| DNT4A | 4-amino-2,6-dinitrotoluene |
| DO | dissolved oxygen |
| DU | depleted uranium |
| | |
| EPA | U.S. Environmental Protection Agency |
| ERA | Ecological Risk Assessment |
| ESD | Explanation of Significant Differences |
| EW | extraction well |

## LIST OF ACRONYMS AND ABBREVIATIONS (continued)

| | |
|---|---|
| FGZ | fine-grained zone |
| FM | Farm-to-Market |
| FS | Feasibility Study |
| FS-5 | Firing Site 5 |
| FY | fiscal year |
| FYR | Five-Year Review |
| GAC | granular activated carbon |
| GWPS | Groundwater Protection Standard |
| HE | high explosives |
| HFPO-DA | hexafluoropropylene oxide-dimer acid or GenX |
| HGL | HydroGeoLogic, Inc. |
| HHRA | Human Health Risk Assessment |
| HMX | octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine |
| HSWA | Hazardous and Solid Waste Amendment |
| HW-50284 | Hazardous Waste Permit No. 50284 |
| IAG | Interagency Agreement |
| IC | Institutional Control |
| ICM | Interim Corrective Measure |
| ISB | in situ bioremediation |
| ISM | Interim Stabilization Measure |
| ISPM | in situ performance monitoring |
| IW | injection well |
| Leidos | Leidos, Inc. |
| LGWUCIP | Land and Groundwater Use Control Implementation Plan |
| LHA | lifetime drinking water health advisory |
| LiDAR | Light Detection and Ranging |
| LTM | long-term monitoring |
| MAROS | Monitoring and Remediation Optimization System |
| MCL | maximum contaminant level |
| MDC | maximum detected concentration |
| MHC | Mason & Hanger Corporation |
| MSC | medium specific concentration |
| NAPL | non-aqueous phase liquid |
| NNSA | National Nuclear Security Administration |
| NPL | National Priorities List |
| NWAR | nuclear weapon accident residue |

## LIST OF ACRONYMS AND ABBREVIATIONS (continued)

| | |
|---|---|
| O&M | operation and maintenance |
| ORP | oxidation reduction potential |
| OU | operable unit |
| P&T | pump and treat |
| P1PTS | Playa 1 Pump and Treat System |
| PAH | polycyclic aromatic hydrocarbons |
| PBMO™ | Physics-Based Management Optimization |
| PCE | tetrachloroethene |
| PCL | protective concentration level |
| PCOR | Preliminary Close Out Report |
| PFAS | per- and polyfluoroalkyl substances |
| PFBS | perfluorobutane sulfonic acid |
| PFHxS | perfluorohexane sulfonic acid |
| PFNA | perfluorononanoic acid |
| PFOA | perfluorooctanoic acid |
| PFOS | perfluorooctane sulfonic acid |
| PQL | practical quantitation limit |
| PRG | Preliminary Remediation Goal |
| PTFE | polytetrafluoroethylene or Teflon |
| RA | Remedial Action |
| RAO | Remedial Action Objective |
| RCRA | Resource Conservation and Recovery Act |
| RD | Remedial Design |
| RDX | hexahydro-1,3,5-trinitro-1,3,5-triazine |
| RFA | RCRA Facility Assessment |
| RFI | RCRA Facility Investigation |
| RFIR | RCRA Facility Investigation Report |
| RI | Remedial Investigation |
| ROD | Record of Decision |
| RRR | Risk Reduction Rule |
| RSL | regional screening level |
| SDWA | Safe Drinking Water Act |
| SEISB | Southeast ISB |
| SEPTS | Southeast Pump and Treat System |
| SVE | soil vapor extraction |
| SVOC | semi-volatile organic compound |
| SVS | Supplemental Verification Site |
| SWDA | Solid Waste Disposal Act |
| SWMU | solid waste management unit |

## LIST OF ACRONYMS AND ABBREVIATIONS (continued)

| | |
|---|---|
| TAC | Texas Administrative Code |
| TBC | to be considered |
| TCE | trichloroethene |
| TCEQ | Texas Commission on Environmental Quality |
| TNB | trinitrobenzene |
| TNRCC | Texas Natural Resource Conservation Commission (forerunner to TCEQ) |
| TNT | trinitrotoluene |
| TOC | total organic carbon |
| TPAH | total polycyclic aromatic hydrocarbons |
| TPDES | Texas Pollution Discharge Elimination System |
| TRV | toxicity reference value |
| TRRP | Texas Risk Reduction Program |
| TSWDA | Texas Solid Waste Disposal Act |
| TTRF | Texas Tech Research Farm |
| TTU | Texas Tech University |
| TZM | treatment zone monitoring |
| U.S.C. | U.S. Code |
| UCL | upper confidence limit |
| USDOE | U.S. Department of Energy |
| UU/UE | unlimited use and unrestricted exposure |
| VFD | Variable Frequency Drive |
| VOC | volatile organic compound |
| WMG | Waste Management Group |
| WWTF | wastewater treatment facility |

# 1.0 INTRODUCTION

This report documents the findings of the Third Five-Year Review (FYR) for the Pantex Plant Superfund Site (U.S. Environmental Protection Agency [EPA] Site #TX4890110527). The triggering action for this statutory review is the Record of Decision (ROD) issued September 25, 2008. The First FYR for the Pantex Plant was issued August 25, 2013, and the Second FYR was issued August 17, 2018.

This Third FYR was conducted to ensure that the remedial actions (RAs) for soils and groundwater at the Pantex Plant are protective of human health and the environment. The methods, findings, and conclusions of reviews of several projects are documented in this report, as well as any issues and recommendations to address them. This FYR is part of the Administrative Record for the Pantex Plant.

The U.S. Department of Energy (USDOE)/National Nuclear Security Administration (NNSA) conducted this FYR in accordance with requirements in the Pantex Plant Interagency Agreement (IAG) and the Pantex Compliance Plan [which is incorporated as Provision XI of the hazardous waste permit HW-50284] as well as the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), 42 U.S. Code (U.S.C) § 9621(c), and the National Oil and Hazardous Substances Pollution Contingency Plan [40 Code of Federal Regulation (CFR) § 300.430(f)(4)(ii)]. Additionally, this document meets guidance set forth in the CERCLA FYR Guidance, (EPA 540-R-01-007). Per this guidance, USDOE/NNSA notified the public (Attachment 1) that the FYR had been initiated.

The USDOE/NNSA serves as the lead agency for conducting and reporting the findings of the FYR. Consolidated Nuclear Security, LLC (CNS), the managing and operating contractor for the Pantex Plant, conducted the FYR with support from HydroGeoLogic, Inc. (HGL), Leidos, Inc. (Leidos), and Carollo Engineers, Inc. (Carollo). The FYR was conducted from August 1, 2022, through April 17, 2023, and this report documents the results of the review. This FYR contains evaluations of remedy performance and data for the period of January 1, 2017 through December 31, 2021. The FYR schedule was implemented such that it would be approved within five years from approval of the Second FYR, i.e., September 13, 2023.

The purpose of the FYR is as follows:

- To evaluate the implementation and performance of the RAs at the Pantex Plant;
- To determine if the RAs are, or will be, protective of human health and the environment;
- To determine what corrective measures are required to address any identified deficiencies; and
- To evaluate whether there are opportunities to optimize the long-term performance and/or reduce life cycle costs of the RAs.

The Third FYR report is organized as follows:

- Section 1 presents a summary of RAs and report organization.
- Section 2 provides a chronology of significant Pantex Plant history and regulatory actions.
- Section 3 presents the Pantex Plant background, land use, history of contaminant releases, and scope of RAs.
- Section 4 describes response actions and remedies selected in the ROD, the status of their implementation, and operation and maintenance (O&M) over the FYR period.
- Section 5 discusses progress and updates to RAs since the Second FYR.

- Section 6 describes the FYR process including reviewers and review methods as well as steps to engage stakeholders.
- Section 7 provides the technical assessment of the RAs and summarizes efficacy of selected remedies relative to remedial action objectives (RAOs).
- Section 8 describes issues encountered with the implementation or maintenance of the remedies and changing site conditions.
- Section 9 consists of a table of recommendations and follow-up actions to address issues described in Section 8 and recommendations for optimization of RAs.
- Section 10 provides a statement of protectiveness.
- Section 11 identifies the schedule of the next FYR.

Supplemental material and detailed reviews of individual RAs are included as attachments to this document.

This FYR focuses on the implementation, O&M, and continued protectiveness of the following RAs.

For soils:

- Institutional controls (ICs) for select sites (Limited Action Soil Units [identified in blue on Figure 1.1]), Burn Pads 11-13 at the Burning Ground (BG) (Solid Waste Management Units [SWMUs] 25, 26, and 27), and the Zone 12 Main Perimeter Ditch (SWMU 5-12a) along the east side of Zone 12.
- Presumptive Remedy of Soil Vapor Extraction (SVE) and ICs for SWMU 47 at the BG.

Containment and ICs for the following sites:

- Covers installed for the BG Former Ash Disposal Trench (SWMUs 14-24) and the former operational area of Firing Site-5 (FS-5) (SWMU 70) will control the potential for exposure to contaminants in soil and minimize the potential for migration of contaminants from soil to groundwater via infiltration. ICs implemented to maintain these protective covers and provide for continued containment of contaminated soils, while also restricting access and land use to prevent exposure.
- Installed synthetic liners in Zone 12 ditches SWMU 2 and SWMU 5-05 to prevent leaching of contaminants to perched groundwater via infiltration. ICs restrict access and land use, and they protect the integrity of the liners to prevent exposure to contaminants.
- Containment (presumptive remedy) and ICs for the 29 Pantex Plant landfills and disposal areas identified in the ROD that require soil cover maintenance. Covers installed prevent site worker exposure to soil contaminants, minimize the potential for contaminant leaching to groundwater, and promote surface water runoff and erosion control. ICs restrict access and property use, and ongoing inspection and maintenance ensure continued integrity of the covers.

For Southeast perched groundwater:

- Continued operation of the installed Southeast Pump and Treat System (SEPTS) to stabilize migration and treat perched groundwater contaminants.

- Continued operation of the Playa 1 Pump and Treat System (P1PTS) to reduce the mounding of perched groundwater in the Playa 1 area, mitigating the potential for lateral and vertical contaminant migration.
- Continued operation of the Southeast In Situ Bioremediation (SEISB) System, SEISB System Extension, and Offsite ISB System to treat high explosives (HE) and hexavalent chromium [Cr(VI)].
- ICs to prevent exposure to contaminants and cross-contamination to the regional Ogallala Aquifer through access, drilling, and land use restrictions.

For Zone 11 perched groundwater:

- Continued operation of the Zone 11 In Situ Bioremediation (ISB) System to treat trichloroethene (TCE) and perchlorate.
- ICs to prevent exposure to contaminants and cross-contamination to the regional Ogallala Aquifer through access, drilling, and land use restrictions.

In total, 254 individual locations at the Pantex Plant were investigated as potential sources of contaminant release; these locations are referenced as potential release units and are listed in Attachment 5. Fifteen of those units are active, and 79 were investigated and closed either administratively or by removal/remediation of contaminants to background concentrations. One site, FS-4 (SWMU 69), is currently inactive with investigation and remediation planned for 2034. Soils at the remaining 159 units contain contaminants at concentrations that do not allow for unlimited use and unrestricted exposure (UU/UE); therefore, the remedies addressing these units are evaluated in this FYR to ensure that the Selected Remedy is protective of human health and the environment.

The 15 units still in active use will be closed in accordance with CERCLA and Resource Conservation and Recovery Act (RCRA) permit provisions when they become inactive and are determined to be of no further use. The units undergoing RAs are included within the SWMUs and areas identified in the soils and groundwater bullet lists above. All the units and their closure status are depicted on Figure 1.1. The extent of affected groundwater and RA locations for groundwater are depicted on Figure 1.2. Attachment 5 provides a detailed summary of the units identified during the RCRA Facility Assessment (RFA) and their status. Chapter 3 provides a summary of the units, previous removal actions, closure status, and current RAs.

The 14 attachments present information that supports this FYR, including RA effectiveness evaluations for soil and perched groundwater remedies, constituent of concern (COC) trend charts and groundwater hydrographs, perched groundwater and Ogallala Aquifer monitoring evaluations, a risk assessment evaluation, and an evaluation of ICs.

This report provides a summarized level of information regarding these evaluations. Documents and references reviewed for this report are presented in Attachment 2. Reference the additional attachments for further details on the operation of the RAs.

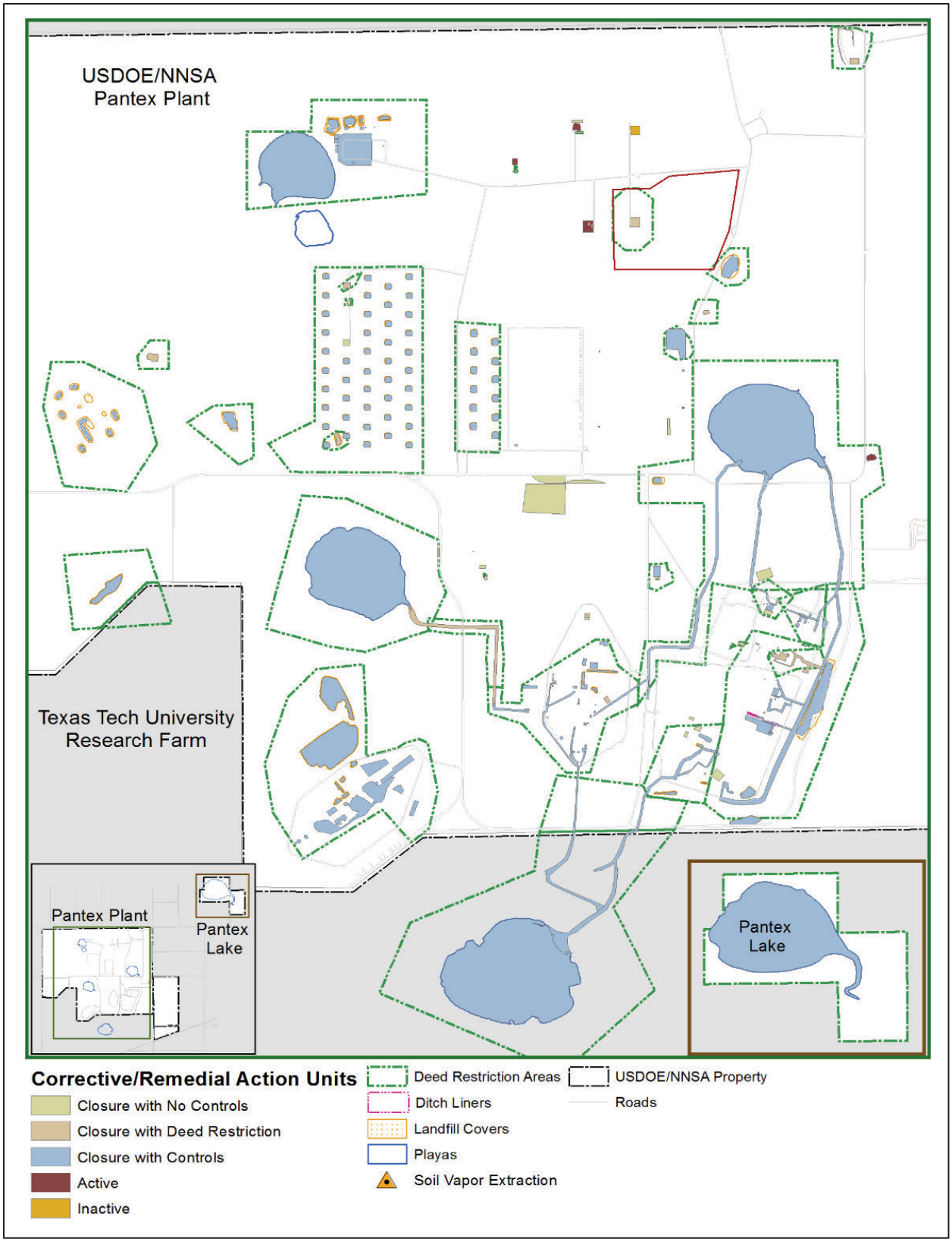


Figure 1.1. Status of Remedial Action Units

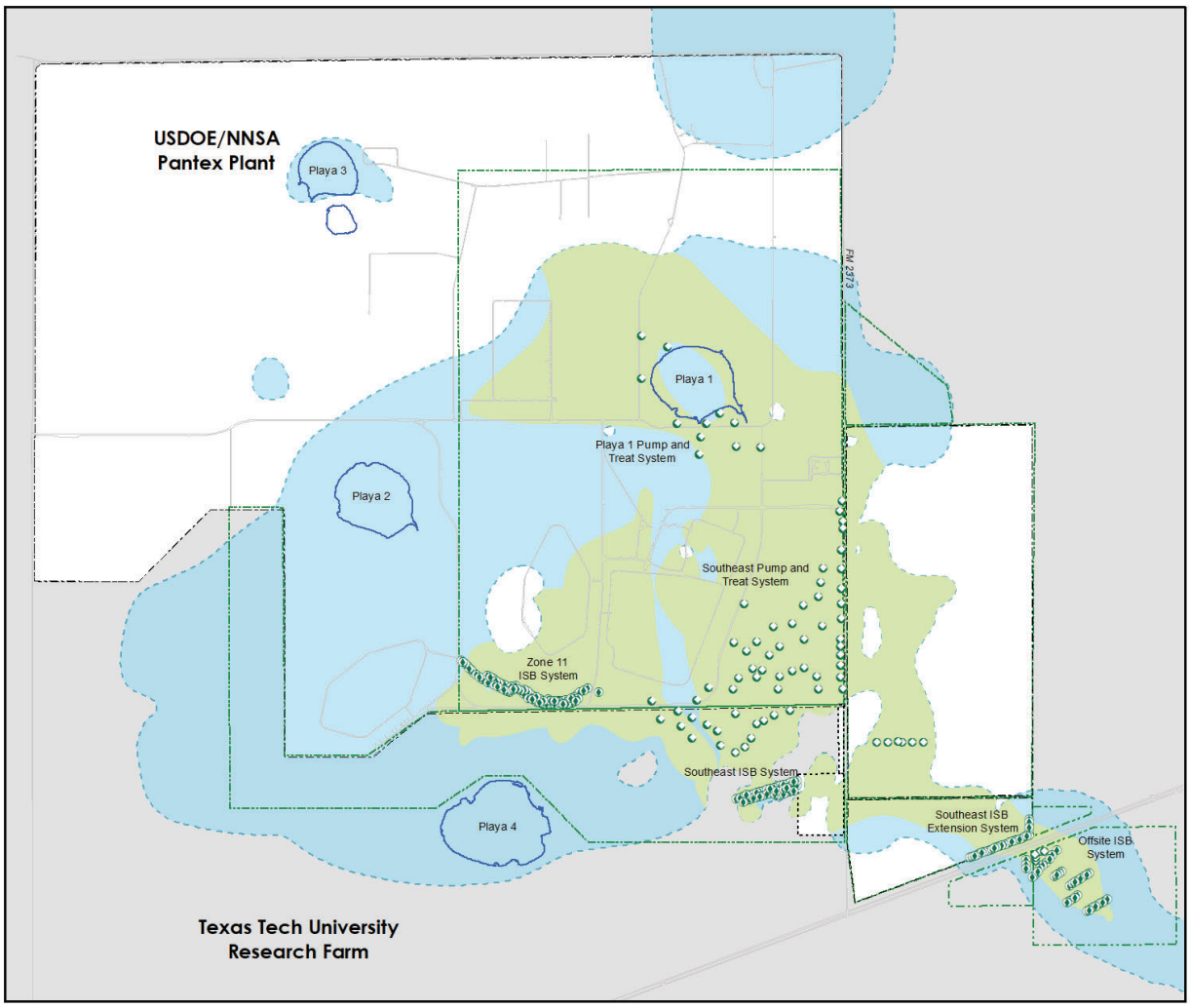


Figure 1.2. Status of Groundwater Remedial Action

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# 2.0 SITE CHRONOLOGY

In 1986, contaminants were discovered in soils and perched groundwater at the Pantex Plant. As a result, groundwater monitoring and investigation of site media were initiated to define the nature and extent of contaminants. Since that time, several investigations and RAs have occurred. Those included in this review are listed in **Table 2.1** below, along with other dates that are important to the environmental response program at the Pantex Plant.

Table 2.1. Chronology of Remedial Actions at Pantex Plant

| Event | Date |
|---|---|
| Operations begin at Pantex Plant | 1942 |
| Initial discovery of problem or contamination: | |
| *Comprehensive Environmental Assessment and Response Program* | October 1986 |
| *RFA Visual Site Inspection Report* | March 1989 |
| RCRA permit (HW-50284) issued | April 25, 1991 |
| NPL listing | May 31, 1994 |
| Enforcement documents | |
| Section 3008(h) AO on Consent | December 11, 1990 |
| Notice of Enforcement Action – TCEQ | July 11, 2000 |
| Remedial Investigation/Feasibility Studies approved: | |
| *Firing Sites 5, 6, and 15 RFIR* | September 1999 |
| *Active Firing Sites Preliminary RFIR* | July 2000 |
| *Fire Training Area RFIR* | March 2002 |
| *BG Waste Management Group RFIR* | September 2003 |
| *Independent Sites RFIR* | August 2004 |
| *Zone 10 RFIR* | August 2004 |
| *Zone 11 RFIR* | August 2004 |
| *Zone 12 RFIR* | August 2004 |
| *Ditches and Playas RFIR* | August 2004 |
| *Groundwater RFIR* | July 2005 |
| *Radiological Investigation Report* | September 2005 |
| Corrective Measures Study/Feasibility Study | April 2008 |
| Proposed Plan | April 2008 |
| ROD | |
| ROD signature (Benchmark for Five-Year Review Completion) * | September 25, 2008 |
| Explanation of Significant Differences (signature) | December 21, 2022 |
| Compliance Plan (CP) 50284: | |
| *Interim Stabilization Measure CP* | October 21, 2003 |
| *Corrective Action System CP* | September 16, 2010 |
| *Incorporated into Hazardous Waste Permit No. 50284 (HW-50284)* | May 30, 2014 |
| IAG (Effective) | February 22, 2008 |
| Physical Construction /Remedial Design Approval/Actual RA Start | August 30, 2010 |
| First Five-Year Review | August 25, 2013 |
| Second Five-Year Review | August 16, 2018 |

*Since many interim actions were taken at the site under RCRA authority, it was difficult to gain consensus on the date the selected remedial action was initiated. This resulted in selection of the ROD signature as the benchmark for determining when to conduct the first Five-Year Review.

*Notes:*
AO = Administrative Order
CP = Compliance Plan
NPL = National Priorities List
RFA = RCRA Facility Assessment
RFIR = RCRA Facility Investigation Report
TCEQ = Texas Commission on Environmental Quality

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# 3.0 BACKGROUND

The Pantex Plant, located in the Texas Panhandle approximately 17 miles northeast of Amarillo (see Figure 3.1), was established in 1942 to build conventional munitions in support of World War II. The Plant was deactivated in 1945 and was sold to Texas Tech University (TTU). In 1951, it was reclaimed for use by the Atomic Energy Commission to build nuclear weapons. The Pantex Plant continues an active mission to support the nuclear weapons stockpile for the USDOE/NNSA.

## 3.1 LAND AND RESOURCE USE

The main Pantex Plant Site encompasses approximately 9,100 acres. Approximately 2,000 acres of the USDOE/NNSA-owned property are used for industrial operations at the Pantex Plant, excluding the BG, Firing Sites, and other outlying areas. The BG and Firing Sites occupy approximately 489 acres. Remaining USDOE/NNSA-owned land serves safety and security purposes.

Approximately 1,526 acres east of Farm-to-Market (FM) 2373 was purchased in 2008 to provide better access and control of perched groundwater areas included in the RA. USDOE/NNSA also owns a detached piece of property, called "Pantex Lake," approximately 2.5 miles northeast of the main Pantex Plant. This property, comprised of 1,077 acres, includes the playa lake itself. No industrial operations are conducted at the Pantex Lake property.

The Pantex Plant will continue as an active USDOE/NNSA facility; current and future land use is industrial. Three distinct types of land use were identified on the Pantex Plant Site:

- Industrial areas – Industrial areas include active operational areas and inactive areas surrounding the operational areas that serve as safety and security buffers. The main plant mission is carried out in specific zones that are within high security fencing and are, therefore, subject to highly restricted access. Support facilities occur in Zones 10, 11, 12, and the BG, Firing Ranges, and Firing Sites. The active operational areas are mowed and maintained in short grass prairie. Shrubs, trees, and watered lawns are present around some of the administrative buildings in the operational areas. Denuded areas are also maintained as a safety and security buffer for portions of the operational areas.
- Agricultural areas – Agricultural lands within the combined main Pantex Plant area and Pantex Lake (that is, not including the TTU property) are owned by USDOE/NNSA but managed by Texas Tech Research Farm (TTRF). The lands are managed through a service agreement with USDOE that allows TTU to use the land for farming and ranching; about 4,400 acres are available for cultivation, and about 3,200 acres are available for grazing. These areas are required to be managed in accordance with the Pantex Plant mission, including protection of the environment, safety, and health of employees and the public, and national security.
- Playas/playa management units – Playas are natural depressions in land surface that are ephemeral water bodies that serve as areas of focused recharge to the subsurface. Generally, playas are dry during one or more periods each year, usually late winter, early spring, and late summer. Many playas meet the soils, hydrology, and vegetation criteria for classification as wetlands. Playas are considered closed drainage basins and typically do not drain to other surface water tributaries or bodies. Playas are the most significant topographical features at the Site and provide some of the most important wildlife habitat on the Southern High Plains. Playas at the Pantex Plant Site are typically managed for wildlife use but are occasionally grazed.

Historically, industrial wastewater was discharged to playas at Pantex through a series of drainage ditches, with Playa 1 (Figure 3.1) receiving most of the wastewater and Playas 2 and 4 receiving less. Discharge of wastewater to these playas has been discontinued and saturation currently consists of natural drainage and rainfall. Release of treated wastewater to Playa 1 is permitted, when necessary, and occurred throughout much of the Third FYR period.

The predominant land use within a 10-mile (16-kilometer) radius of the Pantex Plant Site is agricultural, including both grazing and cultivation of crops. Grazing is the predominant land use west and northwest of the Site. Cultivated land, with scattered grazing, predominates the areas immediately surrounding the Pantex Plant Site and areas north, northeast, east, southeast, south, and southwest of the Pantex Plant. Several large-scale, wind energy generating systems have been installed near the Site. Some industrial areas are located south and southwest of the Pantex Plant. The only urban centers in this area are Highland Park Village to the southwest on the outskirts of Amarillo, Texas; Panhandle, Texas to the east; and Washburn, Texas, to the south. Land use surrounding the Pantex Plant is expected to continue as agricultural. The current land use surrounding Pantex is not expected to change in the foreseeable future.

The only environmentally sensitive areas are the playa lakes at the Pantex Plant.

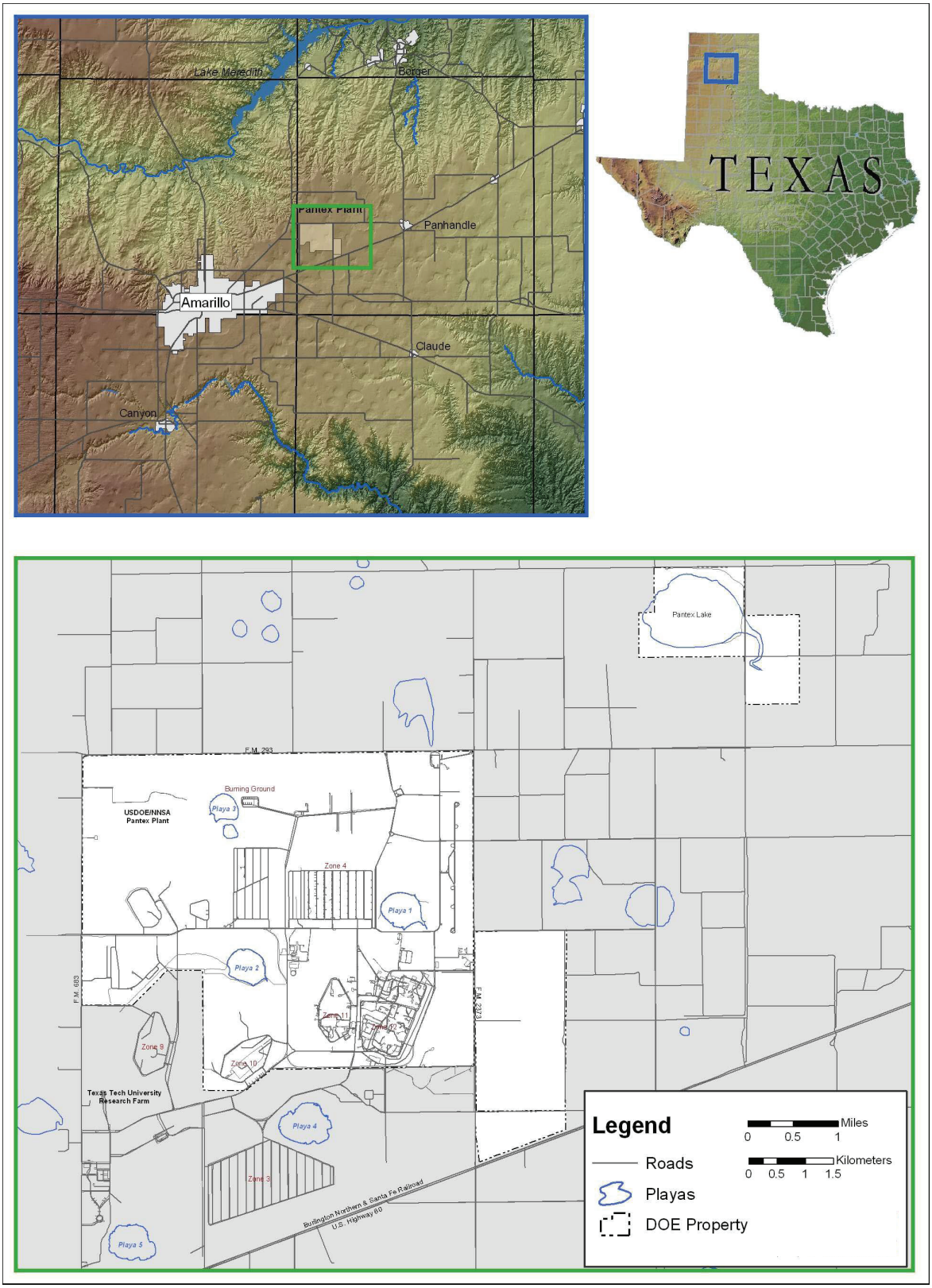


Figure 3.1. Pantex Plant Location and Site Features

Groundwater beneath the Pantex Plant and vicinity occurs in the Ogallala and Dockum formations at two intervals (Figure 3.2). The first water-bearing unit below the Pantex Plant in the Ogallala Formation is a discontinuous zone of perched groundwater located at approximately 200 to 300 ft below ground surface (bgs) and 100 to 200 ft above the Ogallala Aquifer, which is used as a primary source of drinking water in the region. A zone of fine-grained sediment (consisting of sand, silt, and clay) that created the perched groundwater by impeding vertical migration of recharge 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. The largest area of perched groundwater beneath the Pantex Plant 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 stormwater runoff that drains to the unlined ditches and playas. Discharge of untreated historical wastewater to Playa 1 was discontinued in the 1980s, and routine discharge of treated sanitary wastewater was discontinued in 2005. Pantex maintains a permit to discharge treated sanitary wastewater and treated perched groundwater to Playa 1 when the irrigation system is not functioning.

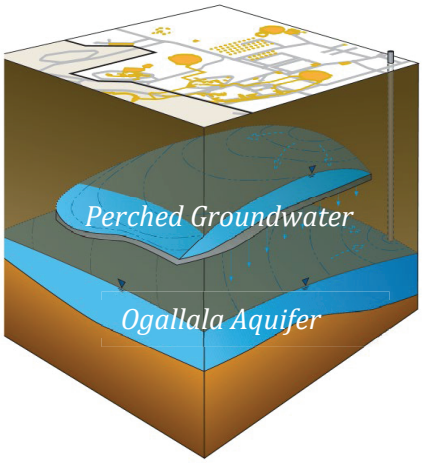


Figure 3.2. Groundwater Beneath Pantex Plant

Perched groundwater at the Pantex Plant flows outward in a radial manner away from the playa lakes and is then influenced by the regional south to southeast slope of the top surface of the FGZ. Two hydraulically separate, relatively small, perched zones occur around Playa 3 (near the BG in the northwest portion of the Site) and near the Old Sewage Treatment Plant in the northeast corner of the Site (near Pratt Playa) as shown on Figure 3.3. Additional details on the delineation of the perched zone are provided in the Annual Reports (Figure 3.2, CNS, 2022a). Untreated perched groundwater at the Pantex Plant Site is not used for any purpose, and future use is limited by deed restrictions and ICs. TTU and three offsite property owners, one to the east and two to the southeast, have each 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.

A second water-bearing zone is located below the FGZ in the Ogallala and Dockum formations. The Ogallala Aquifer (present in the lower region of the Ogallala Formation and below the perched groundwater found in the upper part of the Ogallala Formation) is a primary drinking and irrigation water source for most of the High Plains. The surface of the Ogallala Aquifer beneath the Plant is approximately 400 to 500 feet (ft) bgs; saturated thickness is approximately 1 to 100 ft in the southern regions of the Site and approximately 250 to 400 ft in the northern regions. In the vicinity of the Plant, the primary flow direction of the Ogallala Aquifer is north to northeast due to the influence of the City of Amarillo's municipal well field located north of the Plant.

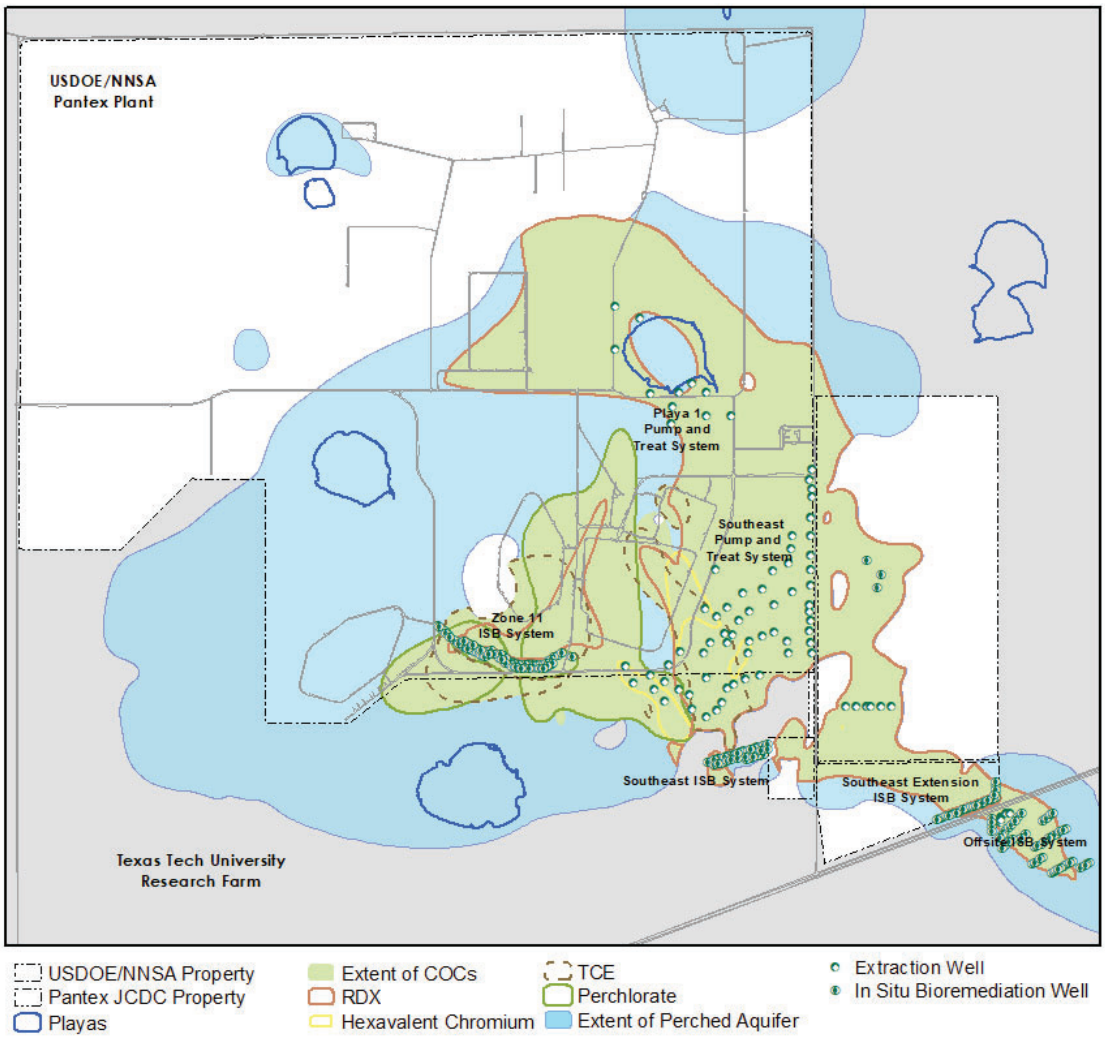


Figure 3.3. Perched Groundwater Extent and Major COC Plumes

## 3.2 HISTORY OF CONTAMINATION

Historical waste management practices at the Pantex Plant resulted in the release of contaminants through various waste streams. Chemical and radionuclide contamination has been released to soils at the Pantex Plant. Chemical impacts have occurred to perched groundwater beneath the Pantex Plant.

### 3.2.1 Historical Practices Leading to Chemical Contaminants

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

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

The high volume of treated and untreated wastewater discharge that entered Playa 1 and its ditch system, primarily from Zone 12 with smaller amounts from Zone 11, impacted perched groundwater beneath the Pantex Plant. See Figure 3.3 for the current extent of perched groundwater and groundwater plumes at the Pantex Plant. These maps are generated annually to develop Progress Reports available on the website at pantex.energy.gov.

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

Until 2005, treated effluent from the WWTF was released into an outfall approximately 350 ft from Playa 1. A subsurface irrigation system for the beneficial reuse of treated wastewater was constructed in 2004, and routine discharge to Playa 1 was eliminated, except when the subsurface irrigation system is not functioning (as noted in Section 3.1). Flow in the other ditches since 1999 consisted of only stormwater runoff and infrequent releases of potable water related to maintenance and testing of the Plant's fire protection systems.

The subsurface irrigation system had routine failures starting in 2017 that resulted in discharges of treated groundwater to Playa 1 in accordance with Texas Commission on Environmental Quality (TCEQ) Permit to Discharge Wastes (Permit No. WQ0002296000). A new center-pivot irrigation system is scheduled to supplement the subsurface irrigation system in 2023. The subsurface irrigation system eliminated discharges to the ditches and Playa 1, when operational. The new center-pivot irrigation system is anticipated to operate in conjunction with the subsurface irrigation system to remove the primary driving force for further movement of constituents of potential concern (COPCs) through the ditches and Playa 1 soils, as well as the driving force that caused the expansion of the perched groundwater to its current extent.

### 3.2.2 Historical Practices Leading to Radiological Contaminants

As a final nuclear weapons assembly plant, the Pantex Plant primarily handles sealed nuclear weapon components. As a result of this particular type of nuclear material, and because of the stringent safety and material accountability controls, the Pantex Plant represents a unique USDOE nuclear facility that

manages substantial quantities of nuclear materials in a manner and form that has not resulted in significant environmental risk from radionuclides.

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

Three primary types of nuclear materials have been handled at the Pantex Plant:

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

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

- The Nuclear Weapon Accident Residue (NWAR) area, where DU from weapons operations and from the Firing Sites, and nuclear weapon accident debris were temporarily stored;
- The BG, where DU residue was identified in limited areas; and
- The Firing Sites, where test shots, containing DU as a surrogate material, were detonated. FS-5 is a closed firing location that was used for detonation of test shots containing DU.

## 3.3 SITE INVESTIGATION AND RESPONSE ACTIONS

Beginning in the 1980s, personnel from the Pantex Environmental Restoration Project investigated historical release locations, as well as sites impacted by past waste management practices, and conducted cleanup actions to remediate impacts at release units. In January 1988, EPA conducted a RFA (EPA, 1989) at the Pantex Plant that identified SWMUs that potentially required investigation/corrective action under the 1984 Hazardous and Solid Waste Amendments (HSWA) to RCRA. The RFA report listed SWMUs and Areas of Concern (AOCs) identified during site assessment activities. In September 1989, a draft AO on Consent for corrective action at the Pantex Plant was issued to the USDOE/NNSA by the EPA. The terms of the AO were negotiated and a final AO (EPA Docket Number VI-002(h)-89-H) was issued pursuant to Section 3008(h) of the Solid Waste Disposal Act (SWDA), 42 U.S.C. 6928(h), as amended by RCRA, and HSWA of 1984. The final AO was signed by EPA and USDOE/NNSA in December 1990. The AO outlined requirements for performing interim corrective measures (ICMs), RCRA facility investigations (RFIs), corrective measures studies, and corrective measures implementations at identified release sites or potential release sites at the Pantex Plant. Sites were assigned to 14 operable units (OUs) based on historical process and expected contaminants. Investigations and corrective actions were to be implemented independently for each OU. In 1991, EPA and the TCEQ jointly issued HW-50284 that authorized the Pantex Plant to store and process hazardous waste. TCEQ regulates waste at the Pantex Plant under both state and federally authorized programs. In 1984, TCEQ received authorization to carry out the Texas hazardous waste program, in lieu of the federal program, under § 3006 of RCRA, 42 U.S.C. § 6926(b). Since then,

under the Texas Solid Waste Disposal Act (TSWDA), TCEQ has continued to revise the Texas hazardous waste rules so that the Texas rules are equivalent to, and no less stringent than, federal regulations.

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

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

In 2003, HW-50284 was renewed again. With this renewal, CP-50284 was issued to maintain the RFI and corrective action requirements and establish a RCRA Interim Stabilization Measure (ISM) program for the Pantex Plant. The ISM program implemented two specific ISM components, the SEPTS and the BG SVE System, and established a network of monitoring wells in the perched groundwater and Ogallala Aquifer to monitor the effectiveness of stabilization efforts. The CP also replaced the process/contaminant-driven OUs. Release units were grouped according to spatial proximity, referred to as Waste Management Groups (WMGs) and Zones, to complete the investigations. This approach increased the efficiency and effectiveness of final characterization, the risk assessment, and RA efforts. As a result, the Pantex Plant Site does not have separate OUs. A Site-wide ROD was implemented to select a remedy for releases across the Pantex Plant, including select RCRA ICMs and ISMs, as appropriate. The ROD was issued September 25, 2008.

### 3.3.1 Release Unit Status

Investigation efforts culminating in the 1989 RFA identified a total of 254 release units at Pantex Plant warranting further investigation and/or cleanup activities. Inactive units were investigated, and some units were closed early because either contamination was not found, or the early cleanup actions met regulatory standards. Of the 254 identified release units, 94 are either active or were investigated and closed either administratively or by remediating them to background. One site, FS-4 (SWMU 69), is currently inactive with investigation and remediation planned for 2034. Soils at the remaining 159 units contain contaminants at concentrations that do not allow for UU/UE and, therefore, are discussed as part of this review. The status of the 159 units requiring consideration is as follows:

- 24 units were closed to screening levels – investigation of these units under RCRA indicated that residual contamination was protective of human health and the environment based on comparison of data to risk-based screening levels and results of the ecological risk assessment (ERA). At some of these units, an early response action was conducted to mitigate risks to workers. These units required ICs (deed recordation) to ensure continued industrial use and to document the residual contamination because the contaminant levels do not allow for UU/UE.
- 135 units were evaluated in a baseline risk assessment to determine current and future risks from soil and groundwater.
    - 90 units required limited RA – ICs with long-term groundwater monitoring were implemented at these sites because the risk assessment determined that no further action

was necessary to protect human health and the environment. ICs are sufficient for future protection of human health and the environment and current industrial site use.

- 45 units required RA to control or reduce risks to on-site and/or off-site receptors. No actions were required at these units for protection of ecological receptors.

Attachment 5 provides a detailed table listing each of the 254 units and its closure status. Figure 1.1 depicts the location of the units and their closure status.

## 3.4 SCOPE AND ROLE OF RESPONSE ACTIONS

ICMs, non-time critical removal actions, and final RAs have been implemented at the Pantex Plant.

### 3.4.1 Past Response Actions

RCRA ICMs were completed during the period from 1989 to 2006. Four RCRA regulatory drivers (AO-1989, HW-50284-1991, HW-50284-1996, and CP-50284) directed USDOE/NNSA to cease industrial discharges to the ditches to eliminate the driving force for further migration of contaminants to perched groundwater; to perform ICMs, investigations, corrective measures studies, and corrective measures implementations at identified Pantex Plant SWMUs; and to conduct corrective action as necessary to protect human health and the environment for releases from any SWMU, AOC, or WMG defined in CP-50284.

ICMs were conducted under RCRA authority to address immediate risk, implement protective measures, and control exposure, as necessary. Attachment 5 contains a table that identifies specific ICMs and removal actions implemented at the site that were later recognized in the ROD, Remedial Design (RD), and Interim RA Report as part of the Final RA. This table identifies the regulatory driver under which each ICM or removal action was completed. All but two of the cleanup actions taken at the site before the ROD (the P1PTS and the SEISB System) were performed under RCRA authority. The interim response actions are discussed further in the remainder of this section.

Two of the aforementioned actions that were initiated under RCRA authority, the BG SVE System and the SEPTS, were recognized as ISMs in CP-50284 when it was issued in 2003. CP-50284 required these ISMs to be modified, as needed, to effectively stabilize the contaminants. Therefore, both systems have changed over time.

The SEPTS was initially installed in 1995 as a treatability study. It later became an ICM through expansions designed to make it capable of capturing and removing more contaminants. The SEPTS was expanded to improve its capability to control and reduce saturation in the impacted areas of the perched groundwater, reduce contaminants in the sensitive areas of the perched groundwater, and mitigate potential impacts from the perched groundwater to the Ogallala Aquifer.

The BG SVE System, originally installed with 28 extraction wells (EWs) to treat the area of the solvent evaporation pit (SWMU 47), has been reduced to extraction from a single well (SVE-S-20) completed in the shallow portion of the unsaturated zone just above the caliche caprock. SVE-S-20, which is screened to intercept the zone about 50 to 80 ft bgs. In 2017, six inactive shallow zone SVE EWs were modified to allow ambient air to be drawn into the formation while simultaneously pulling air from SVE-S-20. Treatment of the extracted vapors is now accomplished using a small-scale catalytic oxidation (CatOx) unit that was installed in 2012.

In accordance with CP-50284, several other ISMs were implemented under RCRA authority as information from the Human Health Risk Assessments (HHRAs) and the Corrective Measures Study/Feasibility Study (FS) efforts progressed. Engineered covers were placed on the BG Landfills (SWMUs 37 through 44), synthetic liners were installed in SWMU 2 and 5-05 ditches that drain a portion of Zone 12, and soil removals were performed at Burn Pad 16 and SWMUs 1, 5/4, 5/7, 64, 117, 118, and 122b to eliminate the hotspots driving the direct contact risk in these areas. In addition, an SVE system was installed at SWMU 113 (Building 11-36) as an ICM. This system was a best management practice undertaken by USDOE/NNSA to reduce future risk of cross-media migration, even though fate and transport evaluations performed as part of the HHRA for Zone 11 did not indicate that the area was a threat to human health or the environment. As such, the SWMU 113 stabilization was not carried forward in the ROD and is not addressed in this or previous FYRs.

### 3.4.2 Remedial Actions for Pantex

RAs have been implemented for soils and groundwater at the Pantex Plant. The RAs and units at the Pantex Plant are depicted on Figures 1.1 and 1.2. The ROD implements Site-wide actions to mitigate risks from commingled plumes and to provide consistent controls and monitoring across the Pantex Plant.

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

- Releases to soils that pose a direct contact risk to onsite workers and ecological receptors.
  - Contaminants include volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), DU, HEs, poly-aromatic hydrocarbons, poly-chlorinated biphenyls, dioxins/furans, metals, and pesticides.
- Releases to soils at concentrations that may impact perched groundwater above the Groundwater Protection Standards (GWPSs). A full table of the GWPSs is provided in Table 2.3 of Attachment 7.
- Perched groundwater impacted above GWPS. Perched groundwater COCs[1] by area include the following:
  - Southeast plumes: Cr (VI); total chromium (Cr); perchlorate; TCE; 2-amino-4,6-dinitrotoluene (DNT2A); 4-amino-2,6-dinitrotoluene (DNT4A); 1,3-dinitrobenzene; 2,4-dinitrotoluene (DNT); 2,6-DNT; octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX); hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX); 1,3,5-trinitrobenzene (TNB); and 2,4,6-trinitrotoluene (TNT).
  - Zone 11 plumes: 1,2-dichloroethane; 1,4-dioxane; tetrachloroethene (PCE); TCE; RDX; and perchlorate.

[1] Boron, although not included in this list, is monitored like a COC because it was a constituent of some high explosive formulations and is present at elevated concentrations in the perched groundwater. Boron does not exceed the GWPS for human health but can have deleterious effects on some crops grown on irrigation tracts where the treated perched groundwater from the P&T systems is beneficially reused, so it is included in the list of monitored analytes.

- Perched groundwater impacted above GWPS that could potentially impact the Ogallala Aquifer above the GWPS.

RAs at the Pantex Plant are dominated by actions to mitigate perched groundwater contamination. Perched groundwater remedies include both pump and treat (P&T) and ISB technologies that work together to control the lateral and vertical migration of contaminants and to reduce the total mass of the contaminants. The effectiveness of these actions is determined by sampling an established network of monitoring wells for analytical, physical, and geochemical parameters and groundwater elevations.

The perched groundwater meets the yield and quality criteria to be considered a potential drinking water source, so its restoration to GWPS is one goal of the remedy. An equally important goal is to reduce the potential for contaminants above GWPS to migrate vertically to the underlying Ogallala Aquifer, particularly in areas sensitive to vertical migration. Migration of contaminants above GWPS to the underlying Ogallala Aquifer would provide an exposure pathway to receptors onsite or offsite who use the Ogallala Aquifer as a primary source of drinking water with potential for impacts to human health.

The RAs for soils, identified in the ROD, eliminate direct contact risks to onsite workers and ecological receptors, and they minimize further migration of contaminants into the soil column and underlying perched groundwater. The RAs for soils include containment, protective covers and liners, excavation, and access controls. Similarly, the BG SVE System was installed as a stabilization measure under the State program to mitigate potential impact to the perched groundwater from residual contaminants in soil gas and became part of the final RAs.

ICs are also a part of the RAs for perched groundwater. ICs include restrictive covenants to prohibit drilling through contaminated portions of the perched groundwater beneath USDOE/NNSA-owned property and to the east and south of the main property. Restrictions that prohibit the use of the perched groundwater as a source of drinking water or for industrial purposes have been placed on site and at select areas offsite. ICs have also been implemented to prevent unauthorized access to soils containing residual contaminants at levels that prohibit unrestricted use of the land. Land use controls were implemented to prohibit the use of units for residential housing, elementary or secondary schools, childcare facilities, or playgrounds. Engineered controls (i.e., fences or barriers) and security measures such as signage and work plans minimize access and protect components of the active RAs.

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# 4.0 REMEDIAL ACTIONS

## 4.1 REMEDY SELECTION

The components of the Selected Remedy address both the soil areas requiring a remedial response and the perched groundwater contaminants in two focus areas: the Southeast Area and Zone 11. Construction of the Selected Remedy was completed by June 2009.

The Selected Remedy for soils is:

- Presumptive Remedy of SVE and ICs for SWMU 47 (BG).
- Protective Covers:
  - The BG Former Ash Disposal Trench (SWMUs 14 through 24) and the former operational area of FS-5 (SWMU 70). The installed covers control the potential for exposure to contaminants in soil and minimize the potential for migration of contaminants from soil to groundwater via infiltration. ICs were implemented to maintain these protective covers and provide for continued containment of contaminated soils, while also restricting access and land use.
  - Pantex Plant landfills (consisting of 27 units described in further detail in Section 4.2.1.2 and in Attachments 7 and 8). The installed covers (the presumptive remedy) prevent worker exposure to soil contaminants, minimize the potential for contaminant leaching to groundwater, and promote surface water runoff and erosion control. ICs restrict access and property use, and mandate work plans to protect remedy components through routine O&M. Annual inspections and ongoing O&M ensure continued integrity of the protective covers.
- Ditch Liners:
  - Two Zone 12 ditches (SWMU 2 and SWMU 5-05). The installed synthetic liners prevent leaching of contaminants to perched groundwater via infiltration from the ditch. ICs restrict access and land use, and O&M protects the integrity of the liners.
- ICs for select areas (Limited Action Soil Units, Burn Pads 11, 12, and 13 [SWMUs 25, 26, and 27, respectively], and SWMU 5/12a).

The Selected Remedy for the Southeast Area perched groundwater is:

- SEPTS to stabilize and control plume migration and remove contaminants from perched groundwater.
- P1PTS to reduce the mounding of perched groundwater in the Playa 1 area, mitigating the potential for contaminant migration from the perched groundwater to the Ogallala Aquifer and reducing lateral groundwater velocities resulting in slower plume movement.
- SEISB System to treat HE contaminants and Cr(VI).
- SEISB Extension to treat HE at the southeast Pantex Plant boundary (installed in 2017 and expanded in 2020 and 2021).
- Offsite ISB to treat HE on neighboring properties southeast of Highway 60 (installed in a phased approach between 2020 and 2023).

- ICs to prevent exposure to contaminants and cross-contamination to the regional Ogallala Aquifer.

The Selected Remedy for the Zone 11 perched groundwater is:

- Zone 11 ISB System to primarily treat TCE and perchlorate contaminants.
- ICs to prevent exposure to contaminants and cross-contamination to the regional Ogallala Aquifer.

Groundwater monitoring is part of the Selected Remedy and is implemented through a Long-Term Monitoring (LTM) Groundwater Plan, developed as part of the RD, in accordance with the IAG. The LTM plan is reviewed for optimal performance periodically (2007, 2011, and 2017, and 2022) and recommendations incorporated into updated monitoring plans. The effectiveness of the Selected Remedy for the Pantex Plant Site is determined through evaluation of the groundwater monitoring results.

The Selected Remedy was modified as described in an ESD issued and approved by TCEQ and EPA in 2022. Several updates and expansions of the groundwater remedy have been implemented, and ongoing expansions are planned. Completed updates and expansion include two additional ISB systems (the SEISB Extension and Offsite ISB), additional treatment of perchlorate at the SEPTS, additional injection wells (IWs) at the Zone 11 ISB system, and deed restrictions from two properties southeast of the Pantex Plant. Planned updates and expansions include expanding the Offsite ISB and a mobile treatment system in the areas east of FM 2373. These updates have had a significant impact on remedy scope, performance, and cost. As such, an ESD was required to document the changes to the scope of the Selected Remedy. Additionally, the GWPS for perchlorate has been updated from 26 micrograms per liter (µg/L) to 15 µg/L. This has resulted in a slightly larger area of perched groundwater with perchlorate exceeding GWPS.

### 4.1.1 Remedial Action Objectives

RAOs were developed for soil and groundwater in the ROD to focus the design of individual RAs in a way that leads to achieving short-term protectiveness and fosters synergistic effects that will eventually progress toward long-term protectiveness.

#### *4.1.1.1 RAOs for Soil*

RAOs were developed for surface and subsurface soils to address risks to potential workers at the units and to prevent migration of residual contamination to groundwater. RAOs for surface and subsurface soil are:

- *Surface Soil RAO* – Reduce the exposure risk to industrial and construction/excavation workers at the Site through removal, treatment, or prevention of contact with COCs in the soil.
- *Subsurface Soil RAO* – Reduce potential impact to perched groundwater and the Ogallala Aquifer through source abatement and stabilization/control measures in the vadose zone.

#### *4.1.1.2 Perched Groundwater RAOs*

RAOs were developed for perched groundwater to address two separate groundwater issues: (1) restoration of perched groundwater to drinking water standards, and (2) protection of the underlying Ogallala Aquifer. While RAs address both objectives, protection of the Ogallala Aquifer, which is a water supply for the Pantex Plant, private landowners, rural communities, and the City of Amarillo,

Texas, is the primary goal of implementing RAs for groundwater at the Pantex Plant. RAOs for perched groundwater are:

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

## 4.2 REMEDY IMPLEMENTATION

Remedies for soil and groundwater have been implemented at the Pantex Plant as described in the ROD (i.e., the Selected Remedy). The Selected Remedy continues to be enforced by the standards set forth in the IAG as agreed upon by the USDOE/NNSA, EPA, and TCEQ.

### 4.2.1 Soil Remedy Implementation

The active remedies established for the soils throughout the Site consist of an SVE system at the BG; protective covers at the BG, Firing Site No. 5 (FS-5/SWMU 70), and landfills; and ditch liners at two Zone 12 ditches. The three remedies are described in detail in the following subsections.

#### *4.2.1.1 Burning Ground Soil Vapor Extraction System*

The BG SVE system was initiated as an ISM; it was pilot tested in 2001 and installed at full scale in February 2002. The system was designed to remove and destroy VOCs present in the shallow and intermediate depth vadose zone above the perched groundwater unit at the BG (SWMUs 47 and 38). The remedial objective of the SVE system was to prevent migration of VOCs to perched groundwater. Industrial operations at the BG are intermittent and workers occupy only one structure for short periods of time. This structure (a transportation container that houses the equipment comprising the SVE system) is located more than 1,000 ft from vapor EW SVE-S-20; therefore, the soil to indoor air exposure pathway is not considered complete, and indoor air is not an exposure medium at the BG.

The SVE system operated for a period of 40 months (February 2002 to May 2005) and recovered and treated approximately 12,000 pounds (lbs) of VOCs. The original SVE system consisted of 28 vapor EWs, conveyance lines, and a treatment system consisting of a natural gas fired CatOx and wet scrubber. The SVE wells were installed in the shallow soil zone (surface to caliche caprock about 85 ft bgs) and intermediate zone (caliche caprock to the FGZ).

By 2005, only one vapor EW (SVE-S-20) produced soil gas with a relatively high concentration of VOCs. All other vapor EWs were capped and taken offline. The large CatOx treatment system became inefficient at treating vapors extracted from a single well. In 2006, the full-scale CatOx/wet scrubber treatment system was replaced with a smaller granular activated carbon (GAC) treatment system that focused on SVE-S-20 adjacent to SWMU 47. The smaller-scale vapor treatment system consisted of a small blower and six GAC drums connected in series. The GAC system was replaced in the spring of 2012 with a small electric CatOx/wet scrubber vapor treatment system due to excessive O&M costs driven by GAC regeneration and replacement, and by the labor required for monitoring to comply with permit-by-rule requirements under 30 Texas Administrative Code (TAC) 106.533. This action was a modification of the vapor treatment portion of the SVE system that was selected as a presumptive remedy

under the ROD to address SWMU 47 and represents a re-tooling of the system, not a change in the Selected Remedy. Therefore, no ESD or ROD amendment was required.

The SVE system was further modified in 2017 to include aboveground piping to six inactive shallow zone EWs to allow ambient air to be drawn into the formation above the caprock zone (about 85 ft bgs). Additional air flow to the subsurface initially enhanced contaminant mass extraction and biodegradation of VOCs. More recently, operation of the system has been pulsed (several months of operation followed by several months of standby) to assess whether SVE operation can be terminated.

#### *4.2.1.2 Protective Covers*

The RA for landfills included installation and maintenance of protective covers for the Former BG Ash Disposal Trench (SWMUs 14 through 24), the former operational area of Firing Site (FS-5), and the following 27 units.

*Zone 10*

- Supplemental Verification Site (SVS) 8: Abandoned Zone 10 Landfill
- Zone 10 Building Construction Debris Landfills
- SWMU 68d: Active Sanitary Landfill

*Zone 11*

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

*Zone 12*

- SWMU 54: Landfill 3
- SWMU 55: Landfill 4
- SWMU 56: Landfill 5
- SWMU 57: Landfill 6
- SWMU 68a North: Original General Purpose Sanitary Landfill

*Burning Ground*

- SWMU 37: BG Landfill 1
- SWMU 38: BG Landfill 2
- SWMU 39: BG Landfill 3
- SWMU 40: BG Landfill 4
- SWMU 41: BG Landfill 5
- SWMU 42: BG Landfill 6
- SWMU 43: BG Landfill 7
- SWMU 44: BG Landfill 8

*Units in Miscellaneous Areas*

- SWMU 58: Landfill 7 Associated with Concrete Batch Plant
- SWMU 63: Landfill 12
- SWMU 64: Landfill 13
- SWMU 66: Landfill 15

- SWMU 68b: General Purpose Sanitary Landfill 1
- SWMU 68c: General Purpose Sanitary Landfill 2
- SVS 6: Unnumbered Zone 7 Landfills
- SVS 7a and 7b: Igloo Demolition Debris Landfills Zone 4 (SVS 7a) and Zone 5 (SVS 7b)

These protective covers were either placed after landfilling operations ceased or were installed as ICMs under State RCRA Authority to prevent worker contact and infiltration of water through the landfill materials that could lead to migration of contaminants to the underlying aquifer without mitigation. Construction of all the protective covers was completed and approved in 2009. In general, the condition of vegetation on the soil covers is sufficient to ensure the integrity of the covers. Evaluation of the protective covers indicates that they remain intact apart from some holes and settlement due to voids in construction debris landfills, burrowing animals, and settlement. Actions to address these finding are described in Section 7.

For this Third FYR, the protective covers were evaluated using the following methods and data:

- Landfill cover inspections performed by CNS personnel from 2017 through 2021 and the associated inspection report summaries (original reports are kept on file at the Plant).
- Site inspections performed by HGL on September 28 and 29, 2022.
- Topographic maps prepared from Light Detection and Ranging (LiDAR) surveys performed in 2011 and 2022. These maps are presented in Attachment 8.
- Comparison of LiDAR-based topography from 2022 to baseline elevation contours presented in the Interim Remedial Action Report (B&W Pantex, 2010) are in Attachment 8.

The physical inspections conducted by both CNS and HGL consisted of visual observation and documentation. Inspectors evaluated the following:

- Slope of the cover (looking for subsidence, exposed waste, evidence of ponding water, etc.).
- Vegetation coverage (looking for bare spots, visible erosion, sparse or stressed vegetation, unwanted deep-rooting vegetation).
- Evidence of burrowing animals (holes in the cover, prairie dogs, gophers, etc.).

The LiDAR survey results provide a quality check on the inspections and allow for quantitative comparison of changes to determine whether substantive changes in the contours of the covers have occurred since the covers were installed. The LiDAR survey results may also identify areas of suspected defects or anomalies that can be investigated with follow-up inspections.

The landfill visual inspection in September 2022 and the LiDAR data indicated some minor deficiencies in cover integrity including:

- Settlement at SVS 6, Landfill 4 (SWMU 55), Landfill 5 (SWMU 56), and Active Sanitary Landfill (SWMU 68d);
- Burrowing animal holes at SVS 6; and
- Erosion and exposed geotextile at Landfill 3 (SWMU 54).

Synthetic Closure Turf™ installed at Landfill 1 (SWMU 68b) and Landfill 2 (SWMU 68c) to address stressed vegetation resulting from drought conditions was functioning as intended to provide stable cover.

#### *4.2.1.3 Ditch Liners*

A total of five ditch sections representing SWMUs 2 and SWMU 5-05, with a total length of approximately 832 ft, were lined as an ICM in 2004 to prevent migration of leachate produced by contact with vadose zone soil contamination. The synthetic liner was installed in sections, constructed by welding together smaller sections in the factory using a single-track hot wedge fusion machine. The edges of the liner were anchored into the shoulders of the ditches at least one-foot deep to control against erosion and to guard the liner edges against uplift from strong winds. River rock was placed in the bottom of the lined ditches to provide ballast for the liner and protect against uplift.

In 2017, a new 45-millimeter Hypalon liner was installed over the existing SWMU 2 and SWMU 5-05 Ditch Liner. Before installing the new liner, sediment, debris, and water were removed from the SWMU 2 and 5-05 Ditch areas. An anchor trench roughly 1 ft wide by 2 ft deep was excavated around nearly all sides of the liner emplacement and used to secure the new liner around the outer edge of the ditch. A total of 163 Platipus anchors were installed at approximately 5-ft intervals, typically located at the bottom of the ditch to further secure the liner in place. The Platipus device consists of a flat metal anchor attached to a wire driven 2 ft vertically into the ground with a pivot set horizontally and a plastic plate tightened to the surface of the liner. At the anchor location, the surface of the liner is then patched to create a water-tight seal.

Anchors were installed to avoid existing utilities – in the eastern-most extent of the S-shaped section of the 5-05 Ditch 10 anchors were not installed as planned due to potential interference with utilities. The Hypalon liner was installed in sections and physically attached and sealed to existing penetrations (e.g., culverts, pipes). The liner was attached to concrete structures including the headwalls and the 12-83 building foundation. Seams were welded and sealed in the field. All liner welds were visually inspected, and air lance tested. The new liner installation is documented in Trihydro, 2017. Tears in the liner were observed during the 2021 inspection, and sedimentation and erosion of the anchor trench continue to be an issue.

### 4.2.2 Groundwater Remedy Implementation

Remedies were established for the Southeast Area perched groundwater and the Zone 11 perched groundwater. The Remedy for the Southeast Area originally consisted of three separate active RAs (SEPTS, P1PTS, and SEISB) that were designed to work together to achieve the RAOs. An additional two RAs (SEISB Extension and Offsite ISB) were added during the Third FYR period to address the HE plume migrating to the southeast and beneath neighboring properties. One active RA was implemented for Zone 11; the Zone 11 ISB. In addition, all properties with affected groundwater have ICs in the form of deed restrictions limiting drilling into the subsurface and utilizing perched groundwater for purposes other than RAs. All remedies are detailed further below.

#### *4.2.2.1 SEPTS*

The SEPTS was originally installed at the Pantex Plant in 1995 as part of a treatability study to address HE and Cr(VI). Since then, the P&T system has been expanded to meet the objectives of the environmental restoration project and final remedy established in the ROD and Compliance Plan 50284.

The SEPTS currently consists of a treatment building, 65 EWs, and 4 IWs (see **Figure 4.1**). This system treats the water through a series of GAC vessels and ion exchange resin beds to reduce COC concentrations below the GWPS. Details of the design and operation of the SEPTS can be found in the *Remedial Action Effectiveness Report* (**Attachment 7**).

The SEPTS was originally designed to inject treated groundwater back into the perched unit. All treated water was injected until May 2005 when the subsurface irrigation system was placed online to receive treated groundwater from the SEPTS and P1PTS through the Pantex Plant WWTF system. The subsurface irrigation system was expanded to 400 acres, as documented in the First FYR. Beneficial use of treated water also includes use of water in the SEISB, SEISB Extension, and Zone 11 ISB. The SEPTS has continued to inject water when the irrigation system or WWTF throughput was reduced or temporarily suspended; however, the goal is to continually reduce and eventually eliminate injection of treated water. Beneficial use of the treated water from SEPTS is expected to consistently allow the extraction goals of the system to be met through irrigation and mixing with amendments for maintenance of the SEISB, SEISB Extension, and Zone 11 ISB Systems. Due to mechanical problems with the subsurface irrigation system starting in June 2017, treated groundwater from the SEPTS was released to Playa 1. A new center-pivot irrigation system is being constructed east of FM 2373 and is planned to supplement the subsurface irrigation system for the beneficial use of treated groundwater in Summer 2023.

The SEPTS was upgraded between September 2014 and May 2015. The upgrade provided redundancy resulting in consistent operation over time and increased overall throughput of the system by allowing water to be routed through two Cr(VI) treatment vessels at the same time when greater throughput is needed to support crop irrigation. With these changes in the Cr(VI) treatment process, the system can exceed the original design criteria of 300 gallons per minute (gpm) when required. The system was again upgraded in 2022 to add an additional ion exchange unit for pretreatment of perchlorate that is being pulled from Zone 11. Groundwater from EWs with higher levels of perchlorate is segregated and directed through the perchlorate ion exchange prior to treatment for boron, Cr(VI), and HE.

An evaluation of the SEPTS was conducted by HGL as part of a remedy effectiveness evaluation required for this Third FYR. The complete evaluation is provided in **Attachment 7**. Overall, the SEPTS is meeting the design objective of reducing the saturated thickness of perched groundwater. A review of the monitoring data indicates that groundwater elevations continue to decline within the SEPTS area of influence; however, limited saturated thickness in some areas is causing pumps to cycle off. Statistical evaluation of concentrations at Zone 12 source area wells show generally *decreasing* long-term trends, while concentrations east of FM 2373 and south of Highway 60 show *increasing* trends, indicating movement of the plume to the southeast beyond the influence of the SEPTS. Despite this, the SEPTS is the most effective remedy for removing and treating HE from groundwater.

Seven groundwater EWs were installed in 2016 east of FM 2373 just south of the Pantex Plant property boundary in the vicinity of PTX06-1147. One well (PTX06-EW-82) was found to be insufficiently productive to be used at the time of installation, but the other wells (PTX06-EW-83 through PTX06-EW-88) were connected to the SEPTS system and began operation in 2019. In May 2020, farming equipment cut the overhead electrical line to the wells, which remained out of service until April 2021. Declining water levels in the area have resulted in only the eastern three EWs (PTX06-EW-86 through PTX06-EW-88) remaining operational.

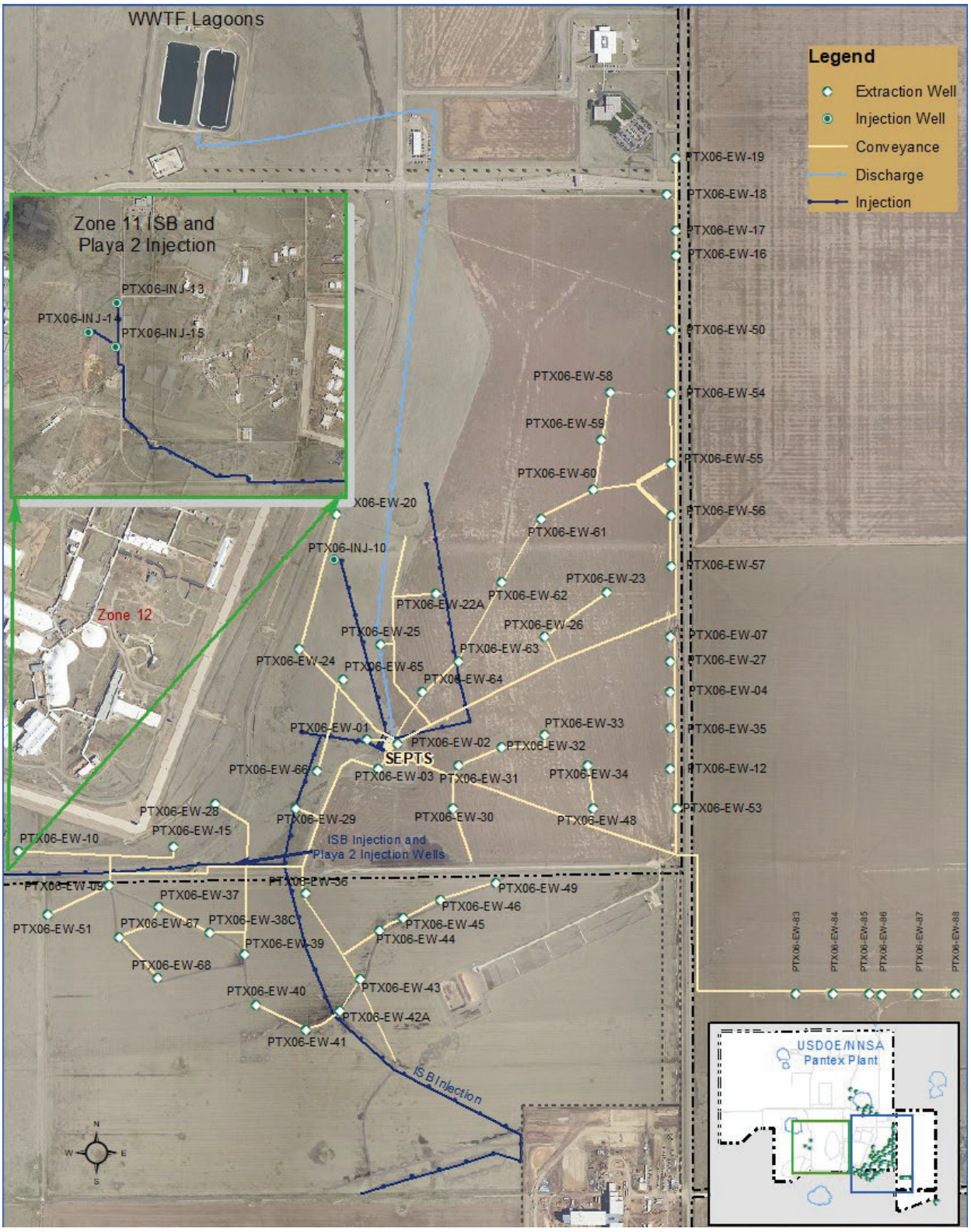


Figure 4.1. SEPTS Extraction Wells and Conveyance Lines

Overall, the SEPTS is progressing toward achieving RAOs by reducing saturation to lessen the driving force for vertical migration, stabilizing the contaminants within the influence of the EW network, and decreasing the flux of water moving downgradient toward the SEISB, SEISB Extension, and Offsite ISB. The system is achieving mass removal of COCs (primarily RDX and Cr[VI]), and concentration trends are generally *stable* or *decreasing* at monitoring wells that are within the area of influence of the system. Between January 2009 and the end of the Third FYR period (December 31, 2021), the SEPTS has removed 4,753 lbs of RDX, 2,749 lbs of other HEs, and 1,416 lbs of Cr(VI). HEs have moved downgradient to the southeast beyond the influence of the SEPTS. Recently, DNT4A was detected above the GWPS in Ogallala monitoring well PTX06-1056, indicating that some degree of vertical migration is occurring. Potential performance improvements are described in Section 7.

#### 4.2.2.2 P1PTS

The P1PTS was constructed in 2008 as an early action to address HE in perched groundwater, with operations starting in September 2008. The P1PTS extracts water from 11 wells near Playa 1 and treats the water through a series of GAC beds and ion exchange process units to reduce HE and metals below the GWPS established in the ROD. Figure 4.2 depicts the P1PTS wells and conveyance. This system focuses on reducing the mound of perched groundwater associated with Playa 1, affecting the movement of the southeast plume by reducing the hydraulic head, and achieving mass removal. Like the SEPTS, the P1PTS is designed to discharge treated water through the irrigation system. Since mechanical problems with the irrigation system arose in June 2017, treated water has been discharged to Playa 1 and operation of the P1PTS was substantially reduced.

An evaluation of the P1PTS was conducted by HGL as part of the remedy effectiveness evaluation required for the Second FYR. The complete evaluation is provided in Attachment 7. Overall, the P1PTS did not meet the design objective of reducing the saturated thickness of perched groundwater during the Third FYR period. Groundwater elevations increased near Playa 1 within the area of influence of the P1PTS. Water level trends indicate that saturated thickness was declining prior to the operation of the P1PTS because routine discharge of treated water to Playa 1 ceased in 2005 and water levels continued to decline while the P1PTS operated as designed during the First and Second FYR periods. Subsurface irrigation system failures beginning in 2017 led to discharges of treated groundwater to Playa 1 and to reduced operation of the P1PTS. These operational changes have caused water levels to increase around Playa 1 during the Third FYR period.

The P1PTS was making progress toward achieving RAOs by reducing the saturated thickness of perched groundwater to lessen the driving force for vertical migration and by decreasing the flux of water moving downgradient toward the SEPTS. During the Third FYR period, the P1PTS was operated in a more limited capacity and treated water was discharged to Playa 1 from the SEPTS and P1PTS causing the saturated thickness to increase. When operating, the P1PTS is also achieving contaminant mass removal from the perched unit; however, monitoring wells near the P1PTS had *increasing* trends of RDX, specifically PTX06-1050 which had *decreasing* trends during the Second FYR. Between system startup in September 2008 and the end of the Third FYR period, the P1PTS has removed 549 lbs of RDX and 221 lbs of all other HEs. Further potential performance improvements are described in Section 7.

#### 4.2.2.3 SEISB System

The SEISB System is on TTU property south of the Pantex Plant. The system was installed in 2007 as an early action and consists of 42 IWs within the treatment zone and six in situ performance monitoring (ISPM) wells. COCs targeted for treatment by this system are RDX, other HE COCs (DNTs and 1,3,5-TNB), and Cr(VI). No notable changes or difficulties occurred during the RD of this system.


Figure 4.2. P1PTS Extraction Wells and Conveyance Lines

An evaluation of the SEISB was conducted by HGL as part of the remedy effectiveness evaluation (**Attachment 7**). The goal of this system is to create an anaerobic treatment zone that reduces concentrations of COCs to below GWPS in an area where the FGZ is thinner and more permeable, which would allow COCs to migrate to the underlying Ogallala Aquifer within a relatively short time frame (modeling projected within approximately 40 years).

The SEISB is located in an area of thinning saturated thickness, due to the influence of the SEPTS. Saturation in performance monitoring well PTX06-1123 has diminished to the point where it has not been sampled since 2015. PTX06-1045 had previously been dry between 2011 and 2019 but has since had increasing water levels (possibly from the retention ponds at the John C. Drummond Center east of the SEISB). PTX06-1123 has not regained appreciable saturation even after injection of amendments and flush water and increasing perched groundwater levels near PTX06-1045.

Since March 2008, carbon substrate amendment has been injected into the SEISB seven times: March 2008; April 2010; May 2012; September 2013; April 2015; October 2016; and November 2019 to January 2020. As standard operating procedure, amendment injection occurs after completion of well

maintenance. Not all IWs are used during each injection event. For example, in the most recent 2019-2020 event, amendment, in the form of molasses, was injected into 25 of the 42 IWs. The selection of which wells to treat is based primarily on saturated thickness.

During the FYR period, COC concentrations were below GWPS in three of four sampled ISPM wells downgradient of the SEISB. At one well (PTX06-1153), the data suggests that RDX concentrations are not attenuating. This well is located south of the western side of the SEISB in what appears to be a localized depression in the FGZ with higher hydraulic conductivity and groundwater flux relative to surrounding areas (Trihydro, 2017). Investigation efforts to determine how untreated water may be migrating to PTX06-1153 have not provided definitive answers. Analysis continues in an effort to identify ways to optimize treatment at this location. The remainder of the SEISB has attained remedial objectives, and reduced amendment frequency during the Third FYR period did not negatively affect COC concentrations in those wells.

Figure 4.3 depicts the SEISB System IW field and ISPM wells.

The SEISB is currently meeting the design objective of creating and maintaining an anaerobic treatment zone capable of treating the target COCs to concentrations below the GWPS. Recommended actions are described in Section 7.

#### *4.2.2.4 SEISB Extension System*

The SEISB Extension was initially constructed in 2017 with 25 IWs. The system was expanded in 2020 with four additional IWs and again in 2021 with two additional IWs. The SEISB Extension is located just north of Highway 60 at the southeast Pantex Property boundary and is designed to treat RDX and other HEs prior to migrating offsite. The SEISB Extension system is illustrated on Figure 4.4.

Carbon substrate amendment composed of molasses has been injected into the SEISB Extension six times: January to March 2019; August to September 2019; July to August 2020; July to August 2021; October to December 2021; and September 2022.

An evaluation of the SEISB Extension was conducted by HGL as part of the remedy effectiveness evaluation (Attachment 7). The SEISB Extension is currently degrading RDX contamination to concentrations less than the cleanup goal within the treatment zone, and the injection schedule is maintaining elevated total organic carbon (TOC) concentrations. Additional time is required to determine if the attenuation is occurring in downgradient monitoring wells. It is expected that impacts from SEISB Extension injections will not be observable until 2022 to 2027 based on groundwater seepage velocities.

#### *4.2.2.5 Offsite ISB System*

The Offsite ISB currently consists of three sets of IWs located southeast of Pantex-owned property, south of Highway 60 on property leased to Pantex. Installed in phases beginning in 2020 and continuing into 2023, the Offsite ISB is designed to treat RDX and other HEs to the GWPS and prevent further migration offsite to the southeast. The Offsite ISB consists of ten IWs that form a northeast-southwest transect near the leading edge of the RDX plume (Figure 4.5), six IWs in a northeast-southwest transect along the northern boundary of the offsite property, and three IWs located due west of the southwestern end of the six-IW transect. The system also includes 11 EWs that provide treated injection water to the Offsite ISB and enhance flushing of contaminants between injection and EWs. The Offsite ISB system is illustrated on Figure 4.5.

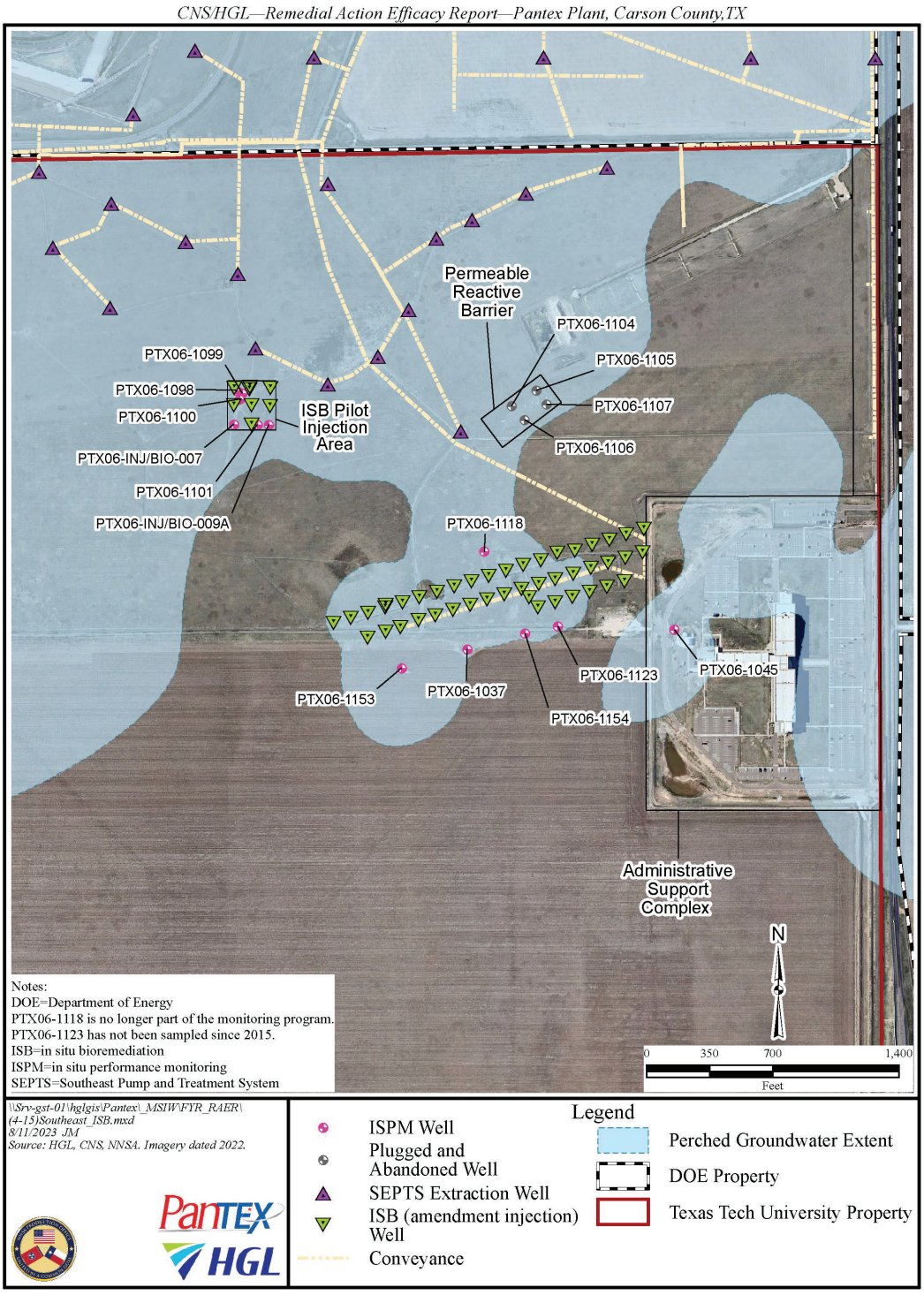


Figure 4.3. SEISB System IW Field and Performance Monitoring Wells

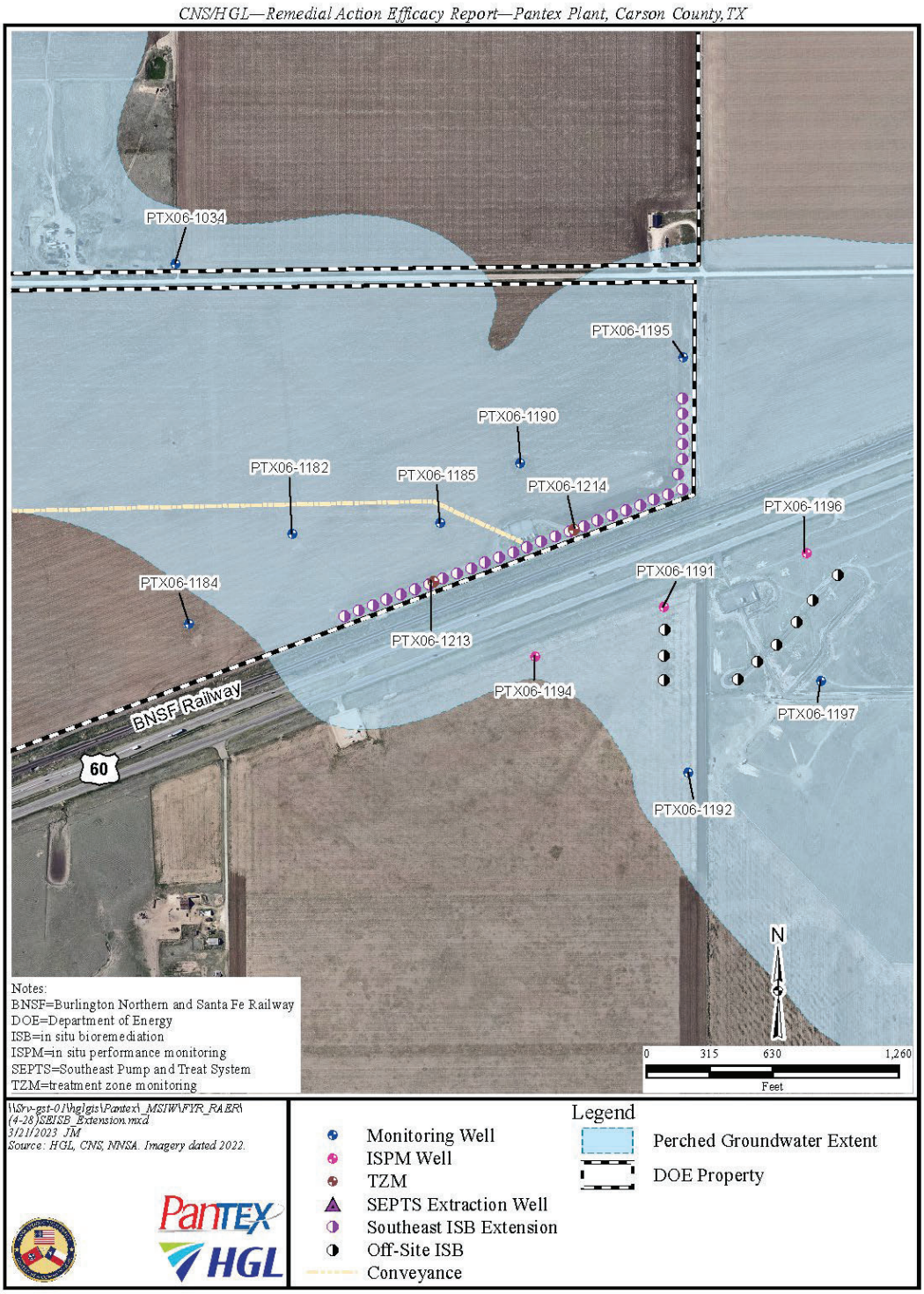


Figure 4.4. SEISB Extension System IW Field and Performance Monitoring Wells

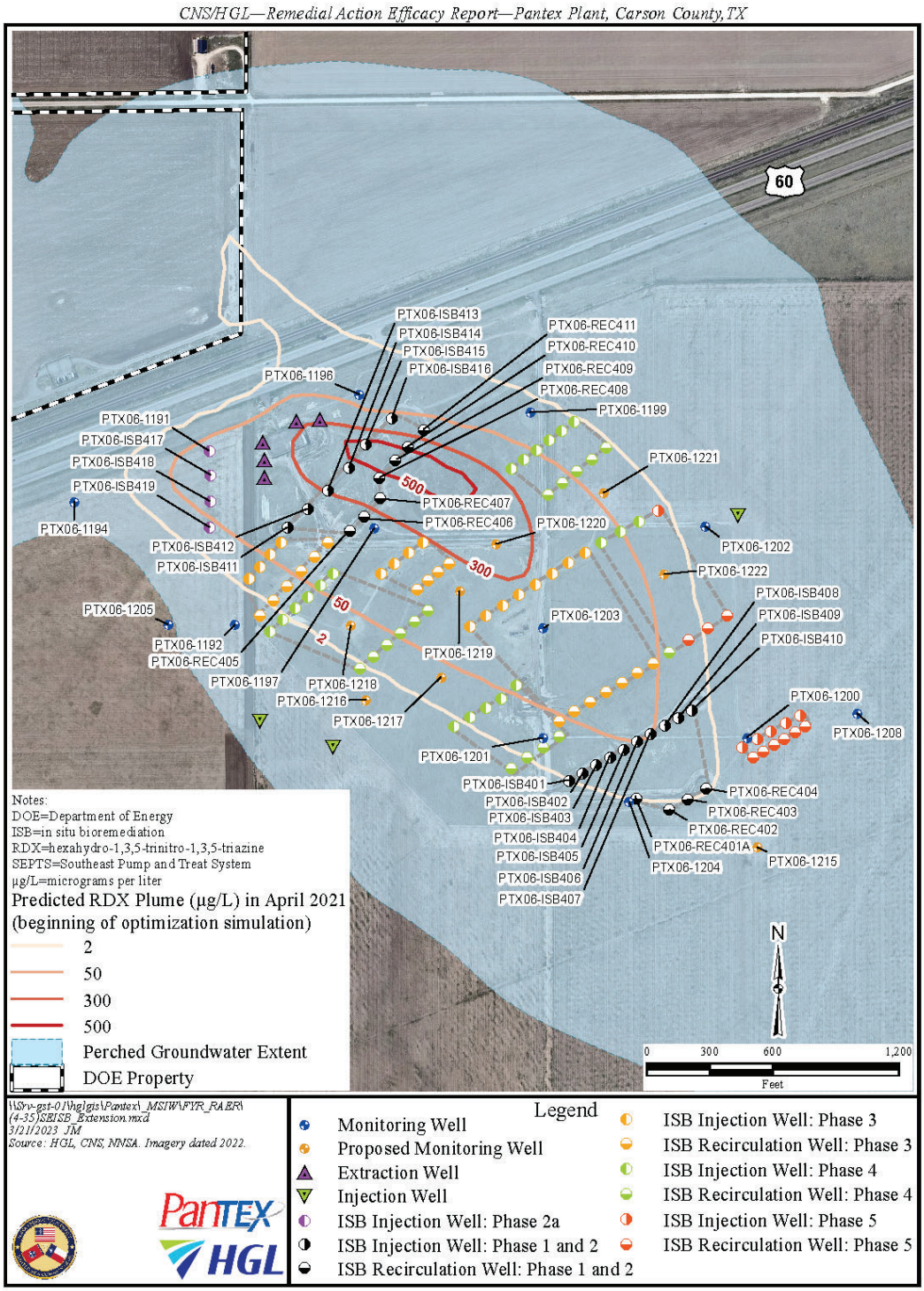


Figure 4.5. Offsite ISB System IW Field, Extraction Wells, and Performance Monitoring Wells

Carbon substrate amendment consisting of molasses has been injected into the Offsite ISB twice, from June through October 2021 in the ten southern IWs at the leading edge of the plume, and at both northern and southern IWs in 2022. Injections at the Offsite ISB are able to occur at a faster rate than groundwater extraction from the 11 offsite EWs; therefore, groundwater extraction has been the limiting factor in injection throughput of the system leading to injection times that are approximately three times longer than the SEISB Extension.

An evaluation of the Offsite ISB was conducted by HGL as part of the remedy effectiveness evaluation (Attachment 7). The Offsite ISB has not been operating long enough for an evaluation of COC degradation to be made. Hydraulically, the Offsite ISB performed as designed with each IW receiving the target volume of amendment during the initial injection event.

#### *4.2.2.6 Zone 11 ISB System*

The Zone 11 ISB, originally consisting of 23 wells, was installed by March 2009. An additional nine wells were installed in September 2009 to better treat the perchlorate plume on the eastern side and the TCE plume on the western side of the Zone 11 ISB. In 2014, two wells that had been installed for pump testing were converted to IWs, and 18 new IWs were installed to the west of the initial system. Six IWs were installed in 2019 to capture TCE and perchlorate contamination migrating past the northwestern edge of the ISB. In 2021, 26 IWs were installed as a second row across the southern side of the ISB system to treat higher TCE concentrations migrating to the southeast. The Zone 11 ISB system is illustrated on Figure 4.6.

Carbon substrate amendment has been injected into the Zone 11 ISB 12 times: June and November 2009; September 2010; October 2011; September 2012; July 2013; July 2014; November 2015; August 2016; April to June 2018; March to June 2019; June to August 2020; and April to July 2021. From 2009 through 2016, emulsified vegetable oil was used as the carbon substrate. In 2018, both emulsified vegetable oil and molasses were applied. In addition, a study was conducted to evaluate which amendment (emulsified vegetable oil or molasses) provided better distribution away from the IWs. It was determined that molasses, which is more soluble than emulsified vegetable oil, provided a greater radius of influence. As a result, molasses has been used as the carbon substrate since 2018. The 26 IWs installed in 2021 were spaced more closely (50 ft) to allow use of emulsified vegetable oil for future injections.

An evaluation of the Zone 11 ISB was conducted by HGL as part of the remedy effectiveness evaluation (Attachment 7). The Zone 11 ISB system is currently meeting the design objective of creating and maintaining an anaerobic treatment zone capable of treating the perchlorate plume to concentrations below the GWPS across most of the treatment zone and downgradient areas. There is ineffective TCE degradation near PTX06-1164 and PTX06-1169. Downgradient data indicate migration of TCE along the east side of the ISB and ineffective TCE degradation near PTX06-1155. Effective degradation is occurring near PTX06-1012, PTX06-1173, and PTX06-1174 with the potential for effective performance at PTX06-1175.

The most likely reason for the wide range of effectiveness in Zone 11 ISB performance is non-uniform distribution of the carbon substrate amendment. Recommendations for performance improvements are described in Section 7.

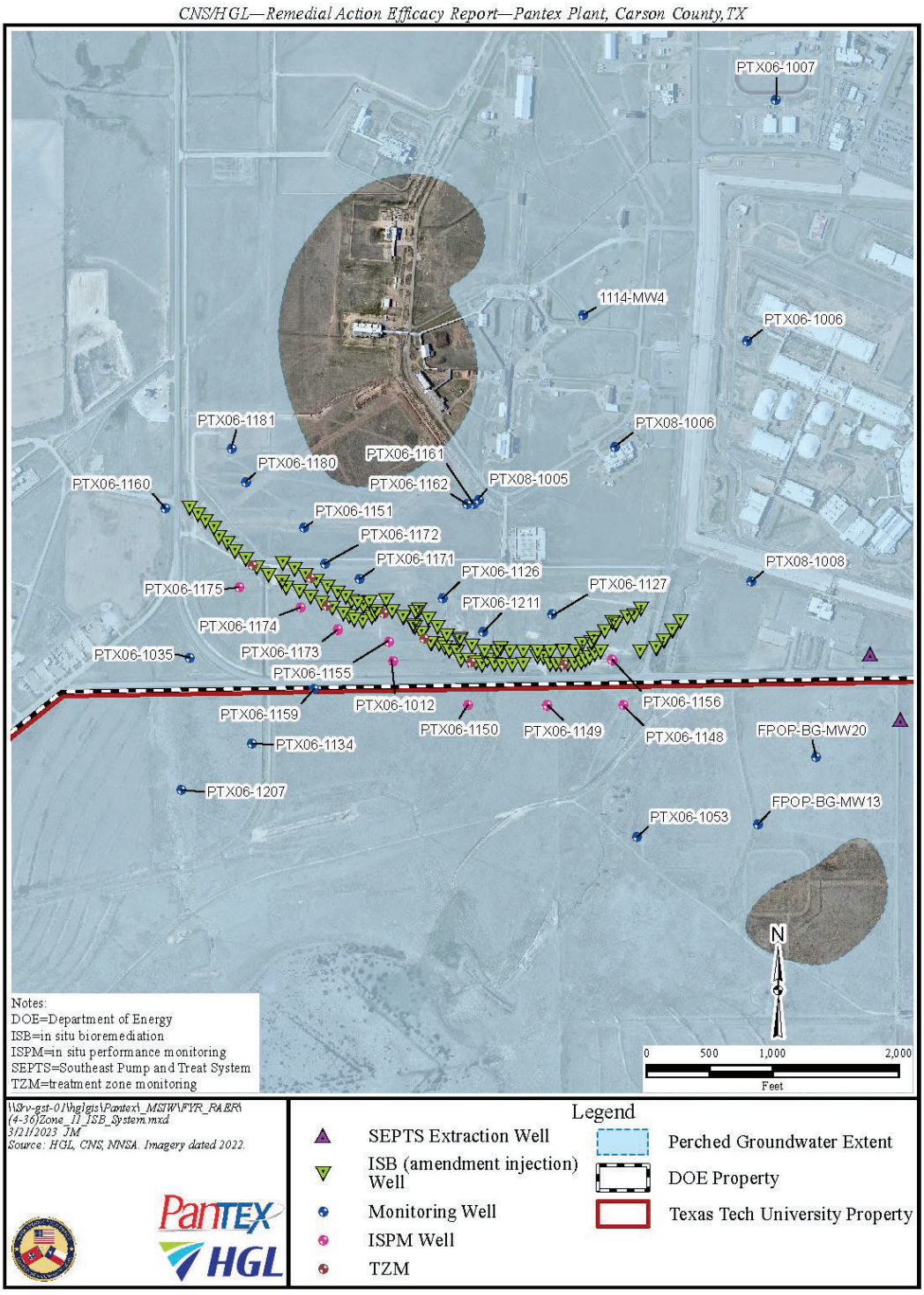


Figure 4.6. Zone 11 ISB IW Field and Performance Monitoring Wells

#### 4.2.2.7 Long-Term Monitoring Network

A comprehensive groundwater monitoring program is in place at the Pantex Plant to evaluate the effectiveness of the RAs, ensure the RAOs (from the ROD) are achieved, and confirm that conditions are not deviating from the expected conditions within the perched groundwater and the Ogallala Aquifer. The LTM design and evaluation criteria are provided in the *Update to the Long-Term Monitoring System Design Report* (CNS, 2019a). The original monitoring program (B&W Pantex, 2009a) was incorporated into CP-50284 when it was issued effective September 16, 2010. The design was further detailed in CP-50284 to include point-of-exposure and point-of-compliance wells where the GWPS is required to be met. The LTM program is updated periodically based on changing conditions.

The current LTM network consists of:

- 134 perched groundwater wells, of which 27 are monitored for continued dry or limited water conditions; 88 are sampled for indicator COCs and other applicable analytes including natural attenuation products, corrosion indicators, and general water quality indicators; and 19 are monitored as ISPM wells for the ISB systems and previous pilot study areas; and
- 24 monitoring wells screened in the Ogallala Aquifer as part of the uncertainty analysis detection monitoring program. A portion of these wells (six total) are sampled at multiple levels every five years.

An additional 38 wells in the perched groundwater that are not included in the LTM network are gauged semi-annually for water levels. In the Ogallala Aquifer, three additional monitoring wells not included in the LTM network are evaluated along the southern boundary to monitor groundwater quality upgradient of the Pantex Plant (CNS, 2022a).

Since the remedy effectiveness is determined through groundwater monitoring implemented through a Long-Term Groundwater Monitoring Plan, the perched groundwater LTM network was evaluated by HGL in October 2022 (Attachment 11). The goal of the evaluation was to review the network for its ability to support Site monitoring goals, including remedy effectiveness, plume stability, and uncertainty management, and to then make recommendations to improve the network. Well and groundwater analytical data (2017 through 2021) were analyzed using the Monitoring and Remediation Optimization System (MAROS) version 3.0 developed by the Air Force Civil Engineer Center (AFCEC, 2012). In this evaluation, perched groundwater was divided into three sectors for analysis. Then the network in each sector was evaluated for plume stability, monitoring well spatial redundancy and sufficiency, and sampling frequency analysis. Individual well statistics and trends were also evaluated. The full report is included in Attachment 11.

The overall conclusion of the evaluation was that the monitoring network is adequate to meet the Site monitoring goals. Several locations for potential new wells were identified, and sampling for additional COCs was identified for a subset of LTM wells. Recommendations for the LTM network are discussed in Section 9 and Attachment 11.

### 4.2.3 Institutional Controls Remedy Implementation

In accordance with RCRA and CERCLA, Pantex and regulatory agencies identified 254 units at the Pantex Plant 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 RFI Reports. Those investigation reports closed many units through interim RAs and no further controls other than deed recordation. Other units were evaluated in human health and ERAs to identify

units that required further RAs to protect human health and the environment. A detailed summary of actions for the 254 units can be found in the ROD (B&W Pantex, 2008). Of the 254 units, 159 contain contaminants at levels that do not allow for UU/UE. Accordingly, deed restrictions (ICs) were developed to define the requirements for access, soil disturbance, and drilling and use of perched groundwater.

The ICs focused on the areas listed below:

- BG Former Ash Disposal (SWMUs 14-24), operational area of FS-5 (SWMU 70) and the 27 Pantex Plant landfills.
- Zone 12 ditches (SWMUs 2 and 5-05).
- Limited Action Soil Units, Burn Pads 11-13 (SWMUs 25-27) and the Zone 12 Main Perimeter Ditch (SWMU 5/12a).
- Southeast Area and Zone 11 perched groundwater.

Design and planning of the ICs was completed in 2009. Access controls and restrictions associated with the Pantex Plant mission and postings/signage installed during the remedial investigation (RI) to notify Pantex Plant workers of contaminants formed the basis for the ICs. Much of the property east of FM 2373 underlain by contaminated perched groundwater was purchased from private landowners in 2008, to provide access to implement future remedies, as needed, and allow direct control for enforcing deed restrictions filed in the Carson County records. This resulted in the need to place deed restrictions on two properties that are not owned by USDOE/NNSA. Implementation of the deed restrictions was completed in 2010.

All Pantex ICs were reviewed by HGL (Attachment 7) as part of the FYR process in November 2022. All ICs have been implemented and are working as intended to prevent exposure. Additional deed restrictions for groundwater have been added in the area southeast of Highway 60 to address the expansion of the RDX plume to the southeast offsite area. This expansion of access controls involved two additional offsite property owners. No other deficiencies related to the implementation, maintenance, operation, or enforcement of the ICs were noted in the independent review.

## 4.3 SYSTEMS OPERATION / O&M

This section discusses the O&M of the soil and groundwater remedies (i.e., the Selected Remedy). It details any problems encountered during operations and any system modifications that were made as a result. It also provides the actual cost of O&M of the Selected Remedy since implementation.

### 4.3.1 Soils O&M

O&M of the SVE system in the BG, the ditch liner, and the protective covers installed for the 29 landfills and soil covers are described in the following subsections.

#### *4.3.1.1 Burning Ground Soil Vapor Extraction System Operation*

The BG SVE system, which addresses SWMU 47, operated fairly consistently for the first three years of the current FYR period and in a pulsed manner for the final two years of the FYR period. Figure 4.7 and Figure 4.8 summarize the SVE system operations over the FYR period. The system removed more than 2,400 lbs of soil gas VOCs during this period. Soil gas recovery has been declining throughout the review period, ranging from 133 lbs in Quarter 3 2020 to 361 lbs in Quarter 4 2017 (when the systems

operated for roughly the same number of hours). Estimated recovery is affected by system operational time, air flow rates, and influent analytical data.

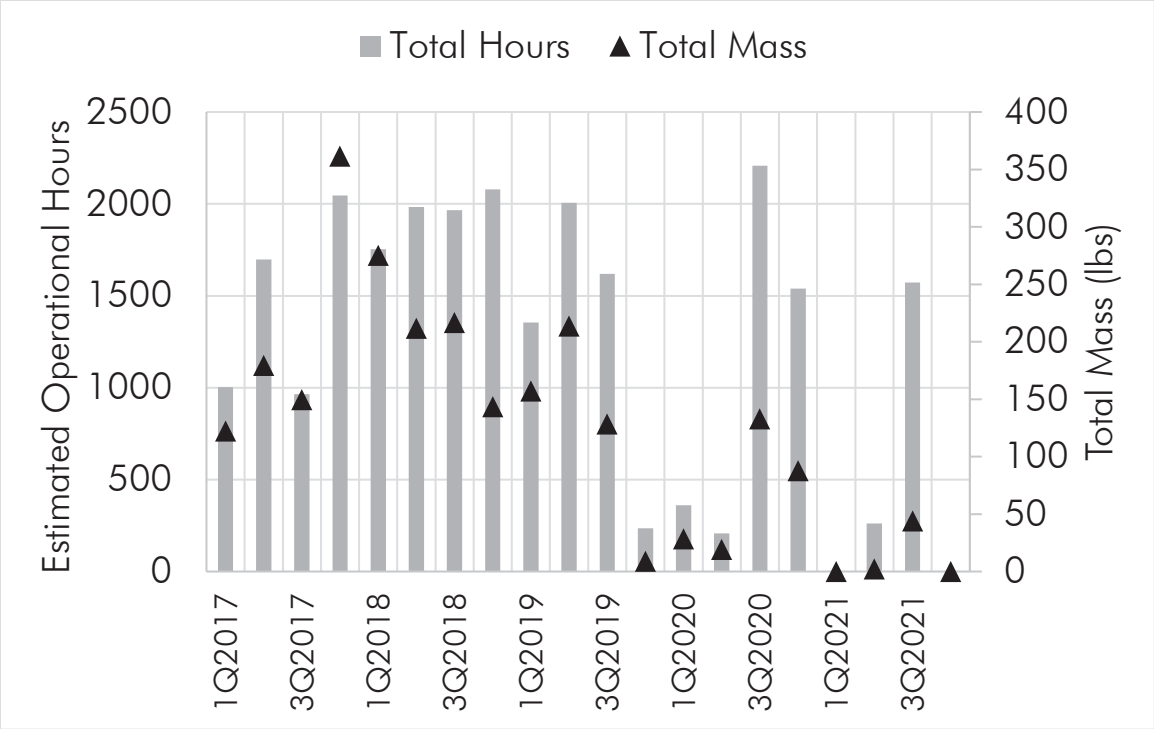


Figure 4.7. BG SVE System Operational Time and Total Mass Removal

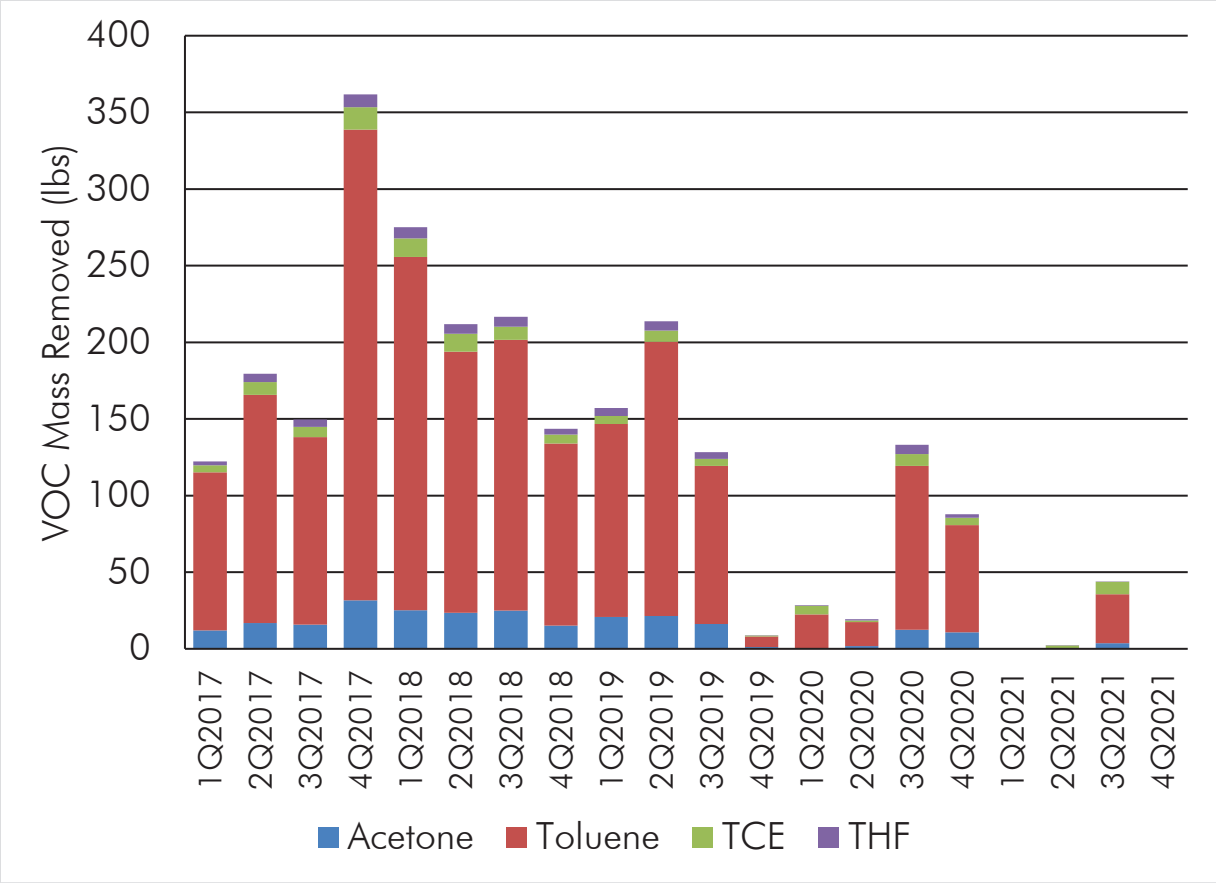


Figure 4.8. BG SVE VOC Recovery

#### 4.3.1.2 Landfill Cover O&M

Inspections of all protective covers, including the BG Former Ash Disposal Trench (SWMUs 14 through 24) and the FS-5 operational area, are conducted annually. As noted, a LiDAR survey was conducted in 2022 to aid in evaluation of the surfaces of the protective covers for this Third FYR. Subsequent LiDAR surveys will be conducted every five years as part of the O&M program for soil remedies. The resolution and efficiency of this survey focused field verifications to provide confidence in detection of areas requiring repair. Any holes in landfills that result from settling of construction debris or burrowing animal activity were identified and addressed using LiDAR comparisons and field verification. Minor repairs, such as filling small holes or animal burrows, are self-performed. For repairing larger holes or areas where erosion has occurred, work is typically subcontracted for maintenance as needed. A subcontract to control burrowing animals in the landfills is maintained.

#### 4.3.1.3 Ditch Liner O&M

The ditch liner is inspected on an annual basis, following severe storm events, and after ditch cleanout to identify tears and problems with sedimentation. An inspection conducted in 2021 indicated tears were present in the liner, and sedimentation and erosion of the anchor trench continue to be an issue. Contracting is currently underway to address liner repairs, anchor trench erosion, and sedimentation on an ongoing basis.

#### 4.3.1.4 Soils O&M Costs

O&M costs for Soil Remedies are presented in Table 4.1. These costs are primarily related to maintaining protective covers for the landfills and operating the BG SVE System. Costs for this program exceeded the estimate in fiscal year (FY)2018, FY2019, and FY2021 for three reasons; (1) repairs to the Landfill 3 soil cover system (SWMU 54), (2) repairs to the Zone 7 Landfill covers (SVS 6), and (3) repairs to the Zone 5 Landfill covers (SVS 7a and 7b).

Table 4.1. O&M Costs for Soil Remedies

| Dates | | O&M Cost ($K) Rounded to Nearest $1,000 |
|---|---|---|
| From | To | |
| Annual ROD Estimate | | 150 |
| Annual PCOR Estimate | | 246 |
| 10/1/2017 | 9/30/2018 | 1,387 |
| 10/1/2018 | 9/30/2019 | 1,643 |
| 10/1/2019 | 9/30/2020 | 169 |
| 10/1/2020 | 9/30/2021 | 1,496 |
| 10/1/2021 | 9/30/2022 | 391 |

*Notes:* PCOR = Preliminary Close Out Report

### 4.3.2 Groundwater O&M

#### 4.3.2.1 SEPTS

The operational goals for the P1PTS and SEPTS system were realigned in July 2014 to a prioritized schedule consisting of the following:

- Maintain 90 percent (%) operation time with no injection at SEPTS when the WWTF/irrigation system can receive all treated water.
- When the WWTF/irrigation system is limiting flow below 250 gpm from both systems, injection is used at SEPTS. A minimum flow of 125 gpm is needed for operation of the treatment units at each system to prevent channeling of the influent that would lead to ineffective treatment.
- Maintain 90% of system treatment or well field capacity, whichever is lower.

Operational goals and EW priorities are expected to be updated in the 2022 Annual Report. Additionally, Pantex recognizes that, over time, the reduction of saturation in the perched groundwater will lead to reduced production of the EW field and the inability to meet design flow at the treatment system.

Operational goals were established in order to reduce saturated thickness of the perched groundwater, as well as achieve mass removal. This approach will gradually reduce the volume of perched groundwater (and contamination) moving downgradient toward the extent of the perched unit and reduce the head (driving force) for vertical migration of perched groundwater into the FGZ and toward the underlying Ogallala Aquifer.

These goals provided for between 72 million gallons (Mgal) and 124 Mgal of perched groundwater to be removed and treated through the SEPTS each year during the Third FYR period. Figure 4.9, Figure 4.10, and Figure 4.11 summarize SEPTS operations during the FYR period and compare the operational time and treatment flow to operational goals. The design capacity of the treatment system is 300 gpm. The average influent to the treatment plant in gpd summarized on Figure 4.11 accounts for both system

flow and system downtime while the average gpm summarized on **Figure 4.10** does not account for system downtime and is thus a measure of the well field production.

As depicted on **Figure 4.9**, average operational time was below the 90% goal for three years and above the 90% goal for two years during the Third FYR period.

Significant downtime for the SEPTS occurred in Quarter 2 2020 as a result of the COVID-19 pandemic, and reduced operation resulted from equipment failures in the subsurface irrigation system throughout the FYR period.

As depicted on **Figure 4.10** and **Figure 4.11**, the SEPTS was below throughput goals throughout the Third FYR period. System throughput was primarily affected by permit discharge limitations to Playa 1, necessitated by breaks in the subsurface irrigation system. Initially both the P1PTS and SEPTS were operated at a limited throughput to accommodate discharge limitations, but the SEPTS was prioritized over the P1PTS in the later portion of the Third FYR period.

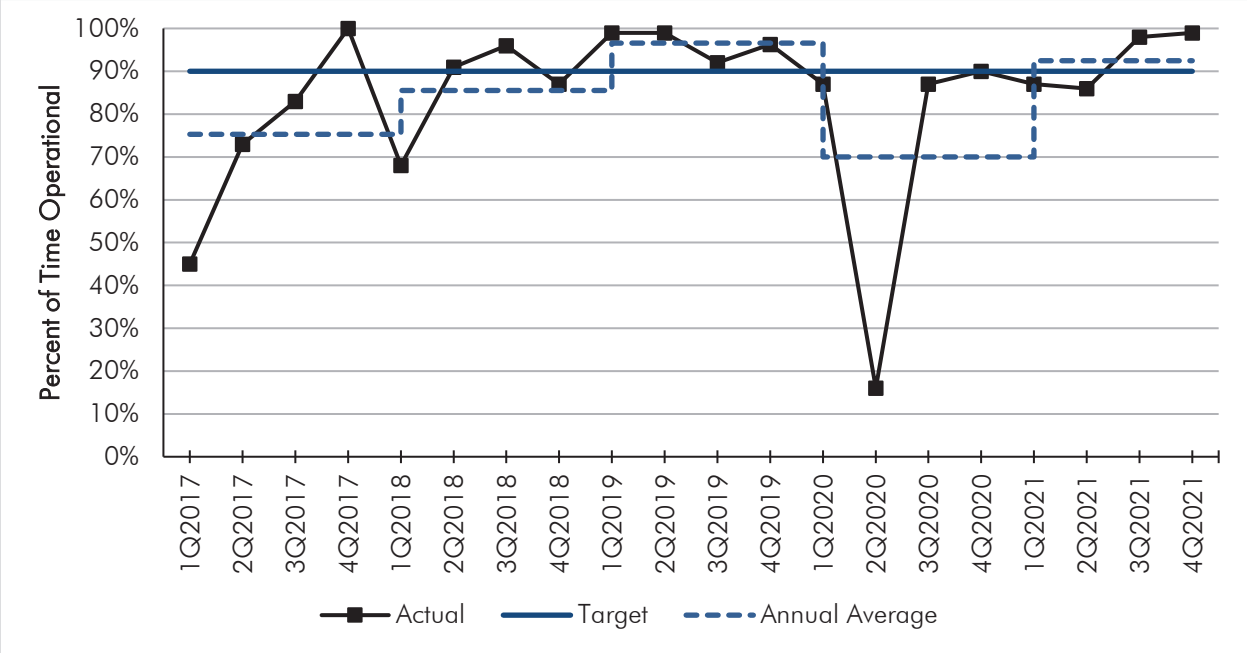


Figure 4.9. SEPTS Operational Time vs. Target

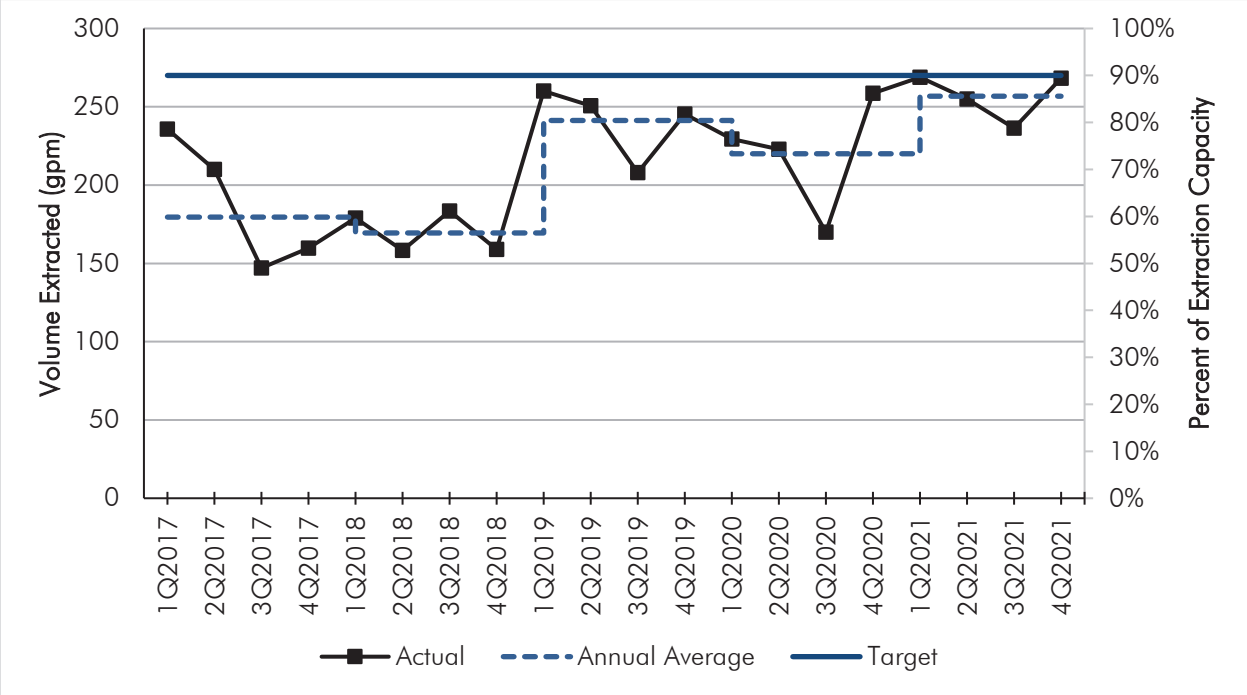


Figure 4.10. SEPTS GPM and % Capacity

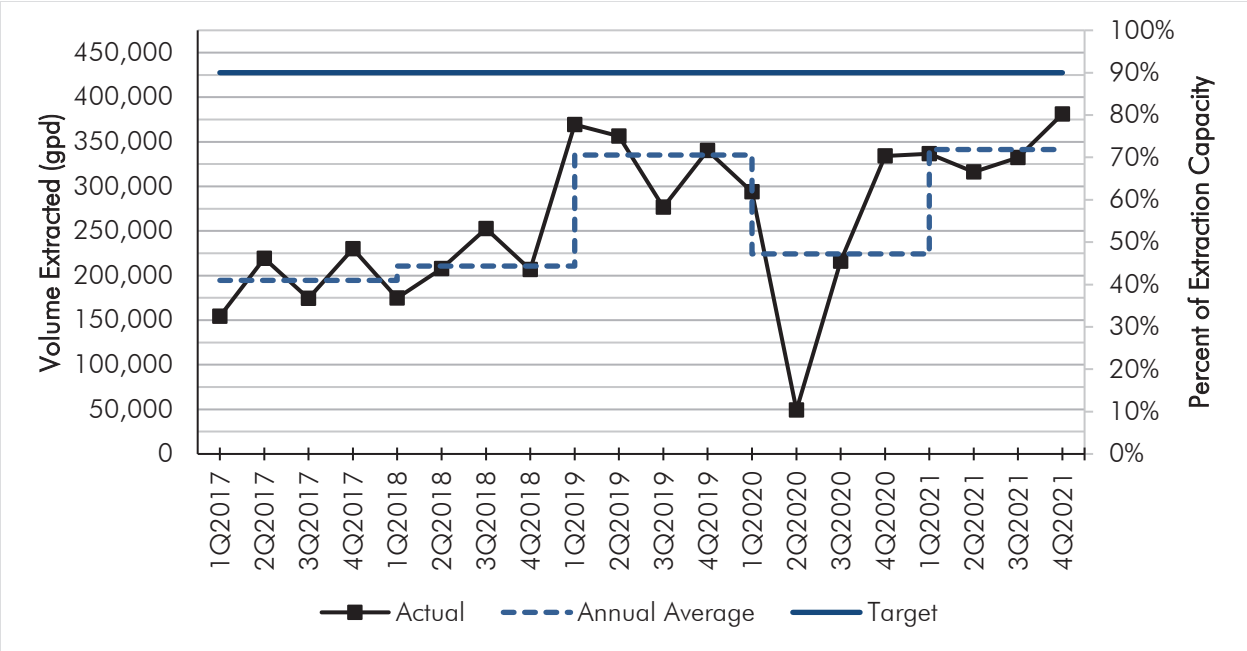


Figure 4.11. SEPTS GPD and % Capacity

As shown on **Figure 4.12**, almost all treated water was discharged through the irrigation system until Quarter 3 2017. After Quarter 3 2017, treated water from the SEPTS was discharged to IWs and increasingly discharged to Playa 1 in accordance with TCEQ Permit #WQ00002296000. A portion of treated water was used for injections in the SEISB system, SEISB Extension system, and Zone 11 ISB system.

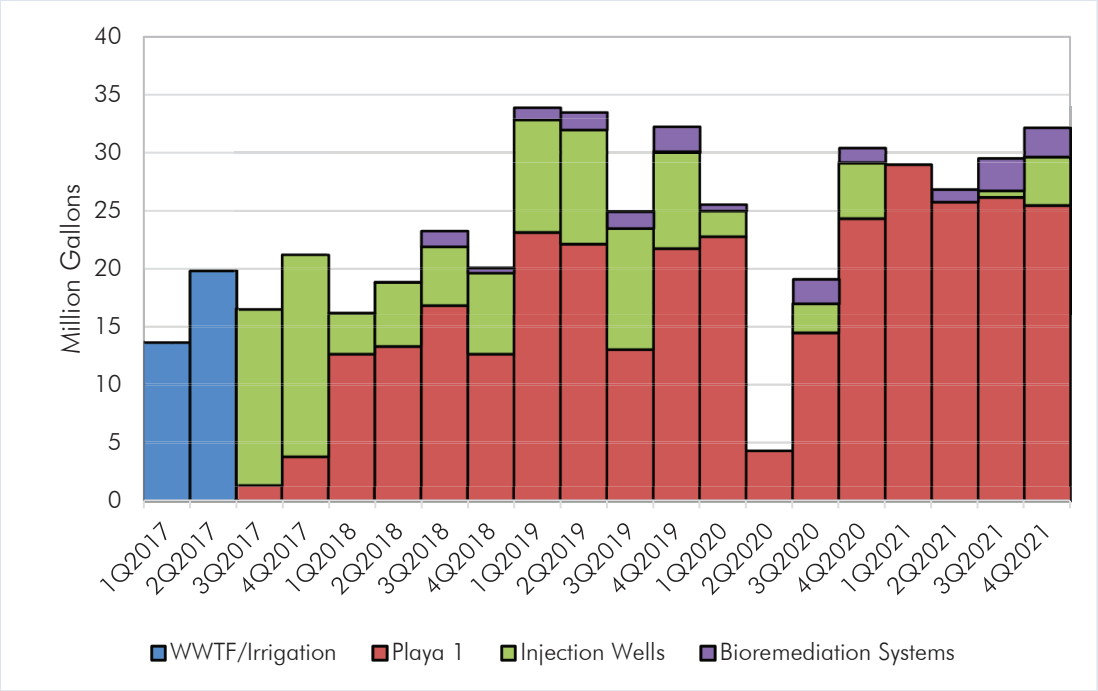


Figure 4.12. Disposition of SEPTS Effluent

System mass recovery has been variable over the FYR period as recovery is based on system throughput, as well as measured influent concentrations. The system removed a total of 348 lbs of Cr(VI) during the FYR period. As depicted on **Figure 4.13**, limited Cr(VI) was removed during Quarter 2 2020 because of COVID-19- related shutdowns. As depicted on **Figure 4.14**, 1,181 lbs of RDX and 805 lbs of other HEs were removed during the Third FYR period. All COCs were treated to concentrations below the GWPS. Comparison to previous FYR periods is provided in **Table 4.2**.

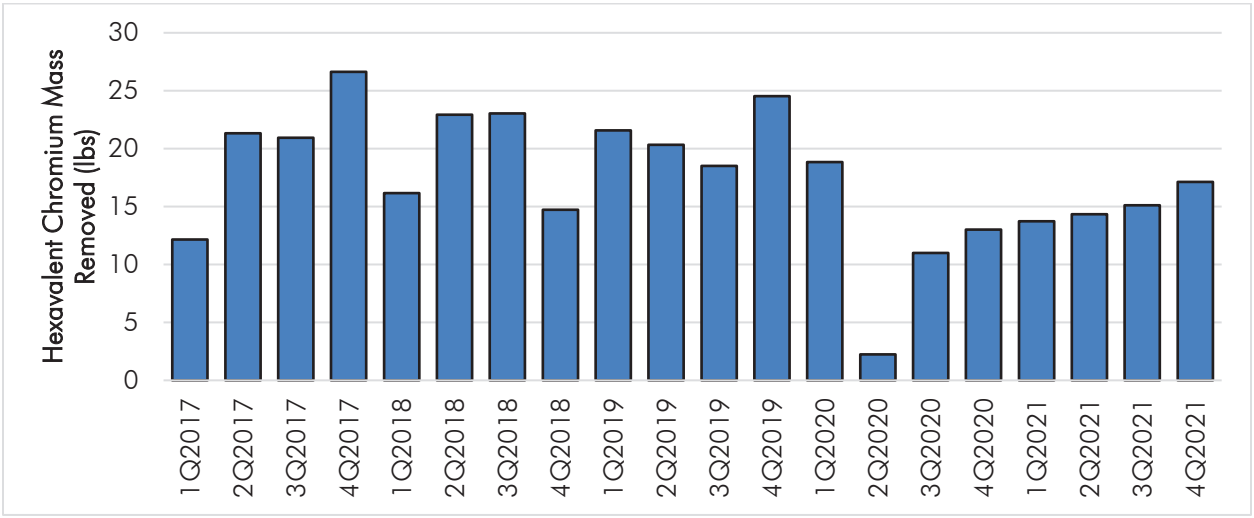


Figure 4.13. SEPTS Hexavalent Chromium Removal

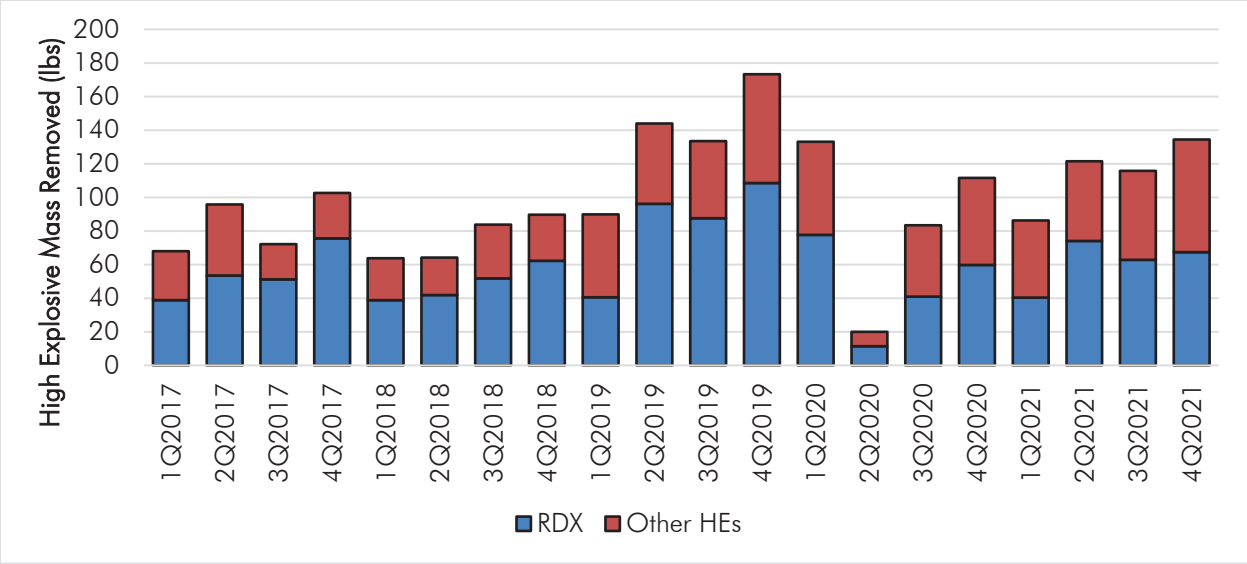


Figure 4.14. SEPTS HE Removal

Table 4.2. FYR Period SEPTS and P1PTS Volume and Mass Removal

| System | FYR Period | Volume Removed (Mgal) | HE Mass Removed (lbs) | Cr(VI) Mass Removed (lbs |
|---|---|---|---|---|
| SEPTS | 1st | 321 | 1,864 | 520 |
| | 2nd | 583 | 2,953 | 454 |
| | 3rd | 478 | 1,986 | 348 |
| P1PTS | 1st | 250 | 307 | - |
| | 2nd | 478 | 312 | - |
| | 3rd | 182 | 79 | - |

#### *4.3.2.2 P1PTS*

Operational goals described under Section 4.3.2.1 were established in order to reduce the mound of perched groundwater associated with Playa 1, which will affect the movement of the southeast plume by reducing the hydraulic head, as well as achieving mass removal. P1PTS beneficially used all treated water by sending it through the WWTF to the irrigation system in Quarters 1 and 2 2017. Breaks in the subsurface irrigation system after Quarter 2 2017 resulted in all treated water from the P1PTS being discharged to Playa 1. The 90% operational time and design capacity goals for the P1PTS provide for about 118 Mgal of perched groundwater to be removed and treated each year; however, permit discharge limitations to Playa 1 and prioritization of the SEPTS operation while the subsurface irrigation system was down resulted in significantly less perched groundwater extraction.

The operational time for the P1PTS over the previous five years is shown on **Figure 4.15**. Overall operational time for the P1PTS was close to the 90% goal through 2018 but decreased in 2019 to prioritize operation of the SEPTS. The primary O&M challenge for the P1PTS was operation of the irrigation system for discharge of treated groundwater. A new center-pivot irrigation system is being constructed east of FM 2373 and is expected to be operational in summer 2023. The center-pivot

irrigation system will supplement the subsurface irrigation system and allow discharges of treated water to Playa 1 to cease.

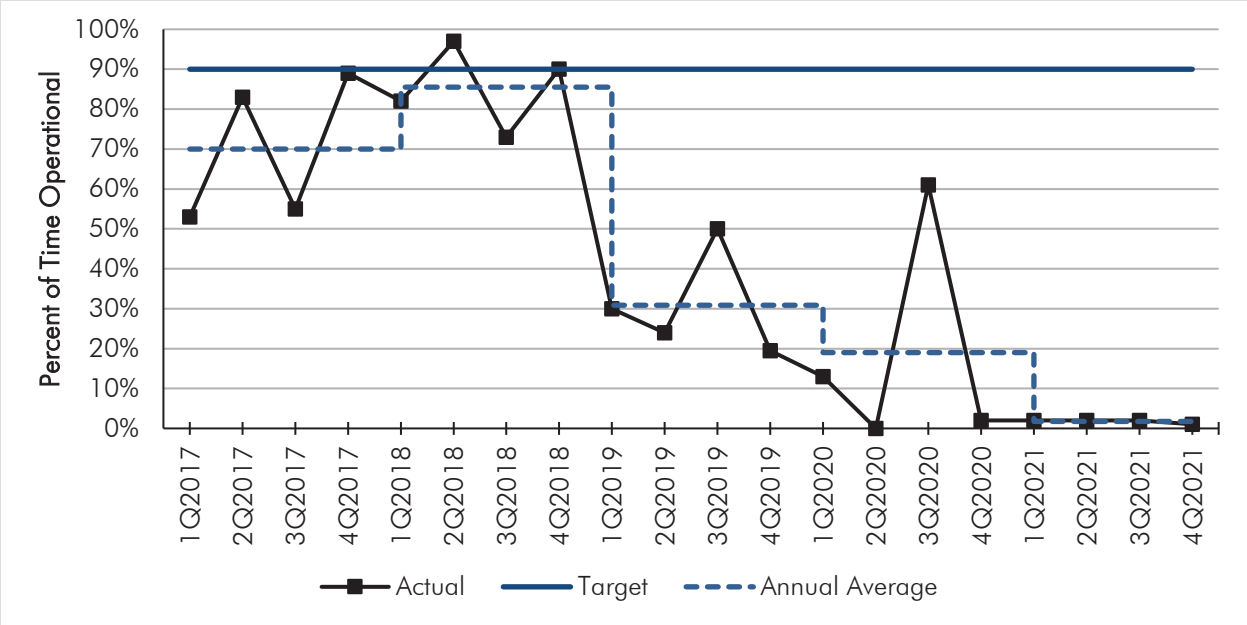


Figure 4.15. P1PTS Operational Time vs. Target

The calculated gpm depicted on **Figure 4.16** accounts for water extracted from the well field during the time the system operates and is affected by the yield from each well, well downtime, or reduced flow required by restrictions associated with the WWTF/irrigation system or permit discharge limits to Playa 1. As shown on **Figure 4.16**, the gpm goal was met for only one quarter during the FYR period in 2017.

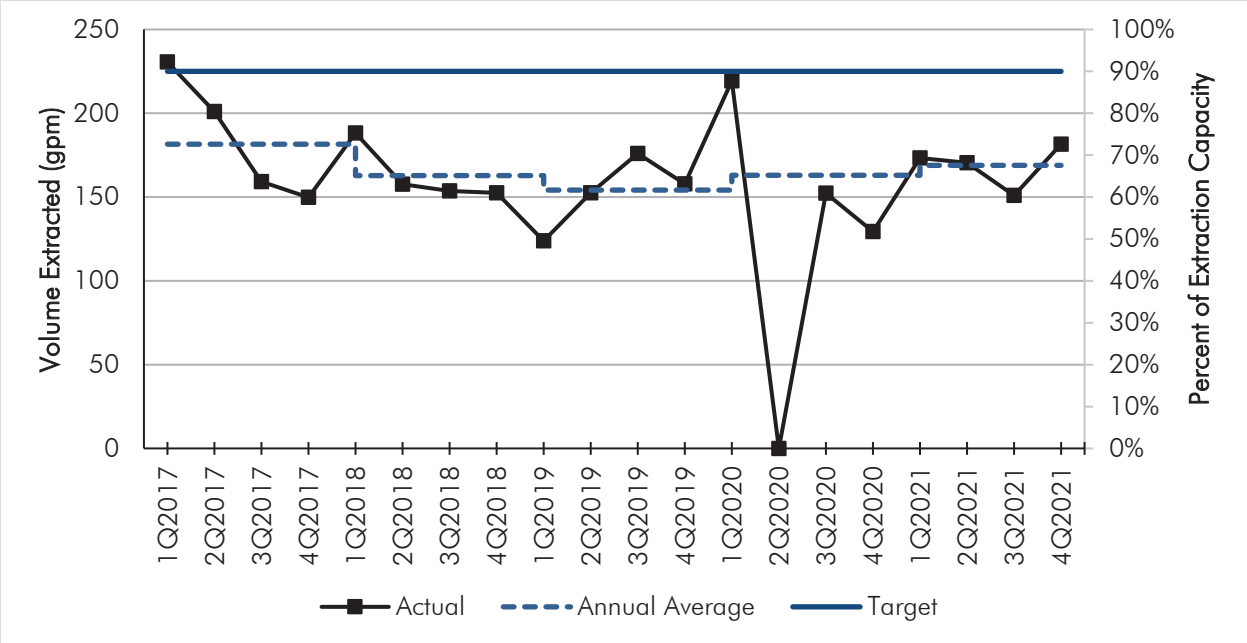


Figure 4.16. P1PTS Average GPM and % Capacity

Figure 4.17 depicts the average gpd by quarter, the percentage of total capacity achieved, and the goal for the system. The calculated gpd accounts for flow from the well field, as well as system operation time during the day, and is affected by system operational time, ability to extract water from the wells, and reduced flow to the WWTF/irrigation system and Playa 1. Therefore, the P1PTS gpd was affected by the aforementioned subsurface irrigation system equipment failures, permit discharge limitations, and prioritization of the SEPTS.

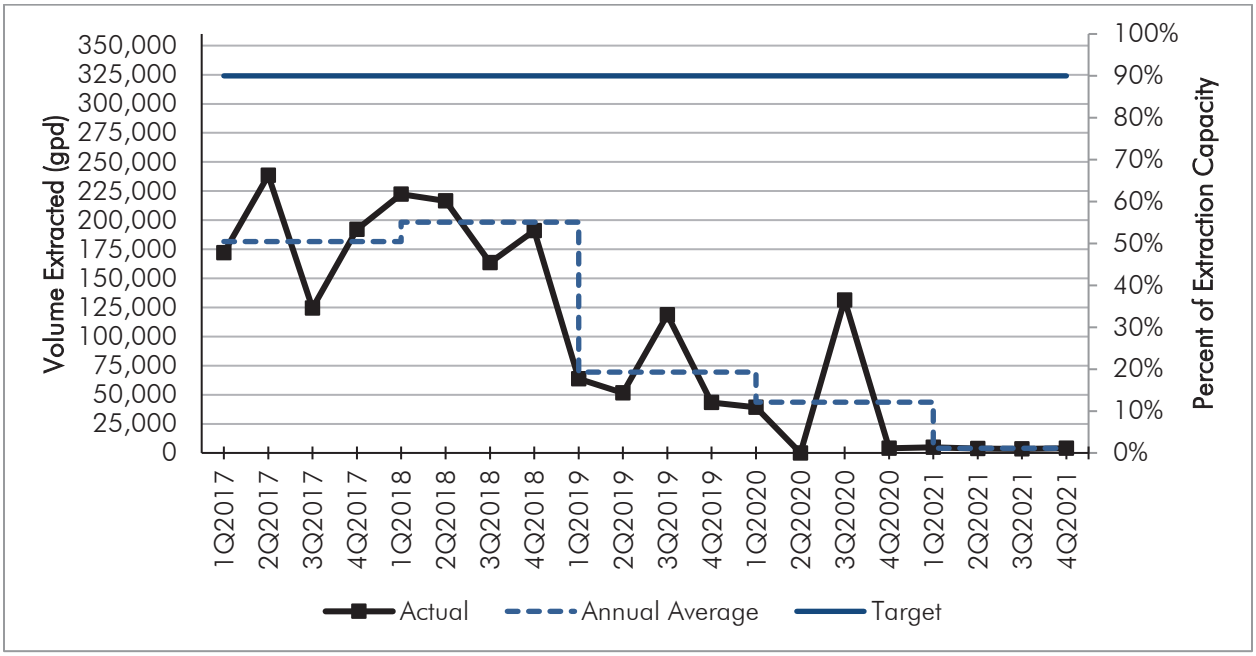


Figure 4.17. P1PTS Average GPD and % Capacity

System mass recovery has been limited over the Third FYR period as recovery is based on system throughput as well as measured influent concentrations. The system removed a total of 54 lbs of RDX and 25 lbs of other HEs during the Third FYR period. The system extracted 182 Mgal of groundwater and treated all COCs to concentrations below the GWPS. Comparison to previous FYR periods is provided in Table 4.2.

#### *4.3.2.3 SEISB System*

Carbon substrate injections were initially estimated to be necessary about every 12 to 24 months at the SEISB system based on baseline perched groundwater flow in the area and estimated longevity of the Newman Zone® amendment. Pantex has recently switched to using molasses during injection events as it distributes more effectively within the matrix, which will enhance the coverage of treatment conditions across this area of perched saturation. However, recent injections at the SEISB are now driven by data and the presence of water in the system. The injection events for the SEISB system are summarized in Table 4.3.

Before each injection event, the IWs are rehabilitated to address biofouling. Well maintenance chemicals, usually acid and caustic based products, are used to aid in the efforts. Surge, brush, and bail techniques as well as a combination of mechanical brushing and air-lift methods have been implemented to attempt to return the wells to pre-injection hydraulic connectivity with the formation. In 2019 rehabilitation procedures were altered slightly, airlifting was not conducted, and water was added to submerge well screens that were mostly dry. After well maintenance is conducted, a constant rate

injection test is performed to evaluate the anticipated performance of the well during the injection event. These techniques appear to be effective in preparing the well field for injection, as indicated by sustained injection rates and performance monitoring data collected from downgradient wells.

Both the SEISB IWs and downgradient ISPM wells are sampled at least every six months, and the data are evaluated in the Quarterly and Annual Progress Reports.

#### 4.3.2.4 SEISB Extension System

Based on the rate of perched groundwater flow and estimated amendment longevity of molasses, injections are estimated to be necessary every six to nine months at the SEISB Extension system. The injection events for the SEISB Extension system are summarized in Table 4.3.

Before each injection event, wells are rehabilitated using the techniques and well maintenance chemicals described in Section 4.3.2.3. Results have been similar to those observed at the SEISB system.

Both the SEISB Extension IWs and downgradient ISPM wells are sampled at least every six months, and the data are evaluated in the Quarterly and Annual Progress Reports.

#### 4.3.2.5 Offsite ISB System

Based on the rate of perched groundwater flow and estimated amendment longevity of molasses, injections are planned every six months at differing parts of the Offsite ISB system. The injection events for the Offsite ISB system are summarized in Table 4.3.

Before each injection event, wells are rehabilitated using the techniques and well maintenance chemicals described in Section 4.3.2.3. Results have been similar to those observed at the SEISB system.

Both the Offsite ISB EWs and TZM wells are sampled every six months, and the data are evaluated in the Quarterly and Annual Progress Reports.

#### 4.3.2.6 Zone 11 ISB System

Based on the rate of perched groundwater flow and estimated longevity of the Newman Zone® amendment, injections for this system were initially estimated to be necessary about every 12 to 18 months. Pantex has recently switched to using molasses at sections of the Zone 11 ISB where wells are spaced further apart (approximately 100 ft) to more widely distribute the carbon source, which will affect the coverage of the treatment zone. Injection events are now planned every nine months at these sections of the Zone 11 ISB system. Newly installed IWs that are spaced approximately 50 ft apart are planned for future Newman Zone® soybean oil injection every 24 to 36 months. Table 4.3 summarizes all the injection events to date.

Table 4.3. ISB Injection Events

| ISB System | Injection Event | Completion Date |
|---|---|---|
| SEISB | 1 | March 2008 |
| | 2 | March 2010 |
| | 3 | May 2012 |
| | 4 | September 2013 |
| | 5 | April 2015 |
| | 6 | October 2016 |
| | 7 | November 2019 |

Table 4.3. ISB Injection Events (continued)

| ISB System | Injection Event | Completion Date |
|---|---|---|
| SEISB Ext. | 1 | January – March 2019 |
| | 2 | August – September 2019 |
| | 3 | July – August 2020 |
| | 4 | April – May 2021 |
| | 5 | October – December 2021 |
| Offsite ISB | 1 | June – October 2021 |
| Zone 11 | 1 | June 2009 (original 23 wells) November 2009 (9 new wells) |
| | 2 | September 2010 |
| | 3 | October 2011 |
| | 4 | September 2012 |
| | 5 | July 2013 |
| | 6 | July 2014 |
| | 7 | November 2015 |
| | 8 | August 2016 |
| | 9 | April – June 2018 |
| | 10 | March – June 2019 |
| | 11 | June – August 2020 |
| | 12 | April – July 2021 |

Before each injection event, wells are rehabilitated using the techniques and well maintenance chemicals described in Section 4.3.2.3. During the 2020 well maintenance event, four chemical agents for well rehabilitation were tested. The chemical agents included Welgicide (removes biofilm), EOS Clean (removes organic matter), a combination of Nuwell 120 and Nuwell 310 (targets common mineral precipitates), and Scrud Remover™ (removes emulsified vegetable oil). Field results indicated that Welgicide was the most effective chemical rehabilitation agent, followed by Scrud Remover™. During subsequent rehabilitation, there was no substantial difference in performance between Welgicide and Scrud Remover™. Because alternative well rehabilitation agents did not perform better than Welgicide, subsequent well maintenance continued to use Welgicide.

Both the Zone 11 ISB IWs and downgradient ISPM wells are sampled at least every six months, and the data are evaluated in the Quarterly and Annual Progress Reports. Prior to the update of the Sampling and Analysis Plan in 2019, these wells were sampled quarterly (CNS, 2019b).

### *4.3.2.7 Long-Term Monitoring*

The LTM design and evaluation criteria are provided in the *LTM System Design Report* (B&W Pantex, 2009a), the 2014 *Update to the Long-Term Monitoring System Design Report* (B&W Pantex, 2014), and the 2019 *Update to the Long-Term Monitoring System Design Report* (CNS, 2019a). Monitoring occurs on a semi-annual basis near the ISB Systems and on a semi-annual, annual, or five-year basis elsewhere for perched groundwater COCs. CNS technicians sample the wells in accordance with the *Sampling and Analysis Plan for the USDOE/NNSA Pantex Plant Groundwater Remedial Action Project* (CNS, 2019b).

A subset of perched and Ogallala Aquifer wells is monitored for an expanded list of constituents every five years to manage uncertainties at the source areas. These lists are a modified subset of the Appendix IX groundwater parameters presented in 40 CFR 264 that include COCs and constituents of potential concern (COPCs – that is analytes not specifically cited in the ROD) that might be contributed by the

source areas. ISB well monitoring also contains specific lists of parameters to evaluate the geochemical conditions in the treatment zone and downgradient wells. Due to documented evidence of corrosion of stainless-steel wells, a subset of wells is also monitored for corrosion indicators.

The monitoring wells that comprise the LTM network are visually inspected for surface defects (well pad integrity, locking cap, etc.) during each sampling event and any anomalies (groundwater color and odor, unusual depth to water, obstruction in casing, etc.) are noted for further evaluation as needed. Also, each well is thoroughly inspected (including downhole video) on a schedule designed to account for its age, material of construction, and past maintenance history. These inspections form the basis for maintenance activities and well replacement determinations.

During this FYR period, 28 new perched monitoring wells were installed. Of the 28 new monitoring wells installed in the perched groundwater, four (PTX06-1207, PTX06-1209, PTX06-1210, and PTX06-1211) were installed to improve understanding in the Zone 11 ISB performance; four (PTX06-1187, PTX06-1188, PTX06-1189, and PTX06-1212) were installed to improve understanding of the perched extent (three near the SEISB and one east of PTX06-EW-88); and the remaining 20 wells were installed in the southeast to delineate the perched groundwater impacts and assess the performance of the SEISB Extension and Offsite ISB.

#### *4.3.2.8 Groundwater O&M Costs*

Overall, the cost of O&M for the groundwater remedies was achieved within the budget established for the Pantex Plant Long-Term Stewardship Program in FY2018 and FY2019. As presented in the discussion of cost for each of the individual RA components, one of the systems (the Zone 11 ISB) is costing more to operate and maintain than estimated in the ROD and two new systems were added to address expansion of the southeast lobe of the perched groundwater plume to the NNSA property boundary and beneath two neighboring properties south of Highway 60. Construction costs for modifications to SEPTS, installation of the SEISB Extension and Offsite ISB Systems, and modification of the Zone 11 ISB are factors for costs exceeding planned expenditure estimates. Also, costs for design and construction of the Pivot Sprinkler System are presented below.

Table 4.4. O&M Cost for the SEPTS

| Dates | | Total Cost ($K) Rounded to Nearest $1,000 |
|---|---|---|
| From | To | |
| Annual ROD Estimate | | 1,064 |
| Annual PCOR Estimate | | 1,240 |
| 10/1/2017 | 9/30/2018 | 1,940 |
| 10/1/2018 | 9/30/2019 | 1,768 |
| 10/1/2019 | 9/30/2020 | 2,673 |
| 10/1/2020 | 9/30/2021 | 1,666 |
| 10/1/2021 | 9/30/2022 | 2,170 |

The cost to operate and maintain the SEPTS was higher that the ROD/PCOR estimates (see Table 4.4). Operation of wells added in FY2015 east of FM 2373 to begin to address expansion of the plume by extraction of perched groundwater in this area, disposal of GAC due to elevated chromium concentrations, and increased costs for treatment media and replacement parts were common factors for all FYs. Also, in FY2020, the Playa 2 Injection System was constructed to provide another outlet for disposition of treated effluent. In FY2021, a modulating valve was installed to better balance pressures in the treatment process during adjustments to the discharges. In FY2022, a selective ion exchange

system was installed and began operation to treat perchlorate being received through a portion of the well-field.

Table 4.5. O&M Costs for the P1PTS

| Dates | | Total Cost ($K) Rounded to Nearest $1,000 |
|---|---|---|
| From | To | |
| Annual ROD Estimate | | 888 |
| Annual PCOR Estimate | | 1,064 |
| 10/1/2017 | 9/30/2018 | 795 |
| 10/1/2018 | 9/30/2019 | 756 |
| 10/1/2019 | 9/30/2020 | 664 |
| 10/1/2020 | 9/30/2021 | 696 |
| 10/1/2021 | 9/30/2022 | 507 |

The cost to operate the P1PTS has been consistently lower than estimates presented in the ROD/PCOR (**Table 4.5**), due to limited operation of the system because capacity to beneficially use the treated effluent unavailable since failure of the TLAP subsurface irrigation system in 2017. While work to repair the TLAP system has been implemented, it has not been able to return to a stable option for use of the treated waters. As a result, NNSA authorized a new pivot sprinkler irrigation system for beneficial reuse of the treated water from both of the P&T systems and the WWTF. Operation of this system is anticipated to begin in summer of 2023. Costs for design and construction of the new pivot sprinkler system are provided in **Table 4.6**, below.

Table 4.6. Costs for Installation of the Pivot Sprinkler

| Dates | | Total Cost ($K) Rounded to Nearest $1,000 |
|---|---|---|
| From | To | |
| Annual ROD Estimate | | NA |
| Annual PCOR Estimate | | NA |
| 10/1/2017 | 9/30/2018 | 0 |
| 10/1/2018 | 9/30/2019 | 0 |
| 10/1/2019 | 9/30/2020 | 0 |
| 10/1/2020 | 9/30/2021 | 505 |
| 10/1/2021 | 9/30/2022 | 7,368 |

The O&M cost for the SEISB System is now less than the estimate from the ROD/PCOR (**Table 4.7**). During injection years, the cost of injection has been approximately a third of the estimate because saturation has decreased in the area of the system, resulting in injection of fewer wells (about half are dry) and decreased amendment needs. Ongoing evaluation of the treatment zone and performance monitoring data will be the basis for planning future injection events.

Table 4.7. O&M Costs for the SEISB System

| Dates | | Total Cost ($K) Rounded to Nearest $1,000 |
|---|---|---|
| From | To | |
| Annual ROD Estimate | | 2,612 |
| Annual PCOR Estimate | | 1,830 |
| 10/1/2017 | 9/30/2018 | 106 |
| 10/1/2018 | 9/30/2019 | 431 |
| 10/1/2019 | 9/30/2020 | 571 |
| 10/1/2020 | 9/30/2021 | 49 |
| 10/1/2021 | 9/30/2022 | 406 |

Costs for the SEISB Extension are presented in **Table 4.8**; these costs were not anticipated in the ROD and PCOR. In 2017, data were acquired indicating that the perched groundwater plume had expanded to the southeast edge of the Pantex property. To stabilize this migration, another ISB System was added to address the southeast lobe of the plume. Much of the cost for the system during this 5-year period was invested in the capital to install IWs and infrastructure to support ongoing O&M. 25 IWs and infrastructure were installed in FY2018/FY2019, four more injections wells were added in FY2020, and another two wells were added in FY2021. Permanent electric service was also installed to the site in FY2020. The system was first injected in FY2019.

Table 4.8. O&M Costs for the SEISB Extension

| Dates | | Total Cost ($K) Rounded to Nearest $1,000 |
|---|---|---|
| From | To | |
| Annual ESD Estimate | | 600 |
| 10/1/2017 | 9/30/2018 | 1,065 |
| 10/1/2018 | 9/30/2019 | 1,700 |
| 10/1/2019 | 9/30/2020 | 2,468 |
| 10/1/2020 | 9/30/2021 | 848 |
| 10/1/2021 | 9/30/2022 | 866 |

Costs for the Offsite ISB System are presented in **Table 4.9**; these costs were not anticipated in the ROD and PCOR. Investigative wells were installed in FY2018 and FY2019 south of Highway 60 after obtaining access agreements with the neighboring landowners. Fate and Transport models were updated to aid in investigation and evaluation of RA design/optimization. In FY2020, additional monitoring wells were installed to verify planned placements of remedy wells and installation of the remedy commenced shortly thereafter. Installation of treatment wells and infrastructure to support O&M began the same year, as access was granted through a temporary Right of Entry Agreement with the landowner. In FY2021, Phases 1 & 2 of the remedy were completed and the initial injection of amendment occurred. In FY2022, Phase 3 wells were drilled and installation of associated infrastructure began after a full Right of Entry Agreement was established with the landowner. The second injection event was also completed.

Table 4.9. O&M Costs for the Offsite ISB System

| Dates | | Total Cost ($K) Rounded to Nearest $1,000 |
|---|---|---|
| From | To | |
| Annual ESD Estimate | | 1,000 |
| 10/1/2017 | 9/30/2018 | 150 |
| 10/1/2018 | 9/30/2019 | 452 |
| 10/1/2019 | 9/30/2020 | 3,407 |
| 10/1/2020 | 9/30/2021 | 4,549 |
| 10/1/2021 | 9/30/2022 | 6,116 |

The O&M cost for the Zone 11 ISB System was estimated based on ten IWs at the time the ROD was issued in 2008. Through RD, construction of the original system, and subsequent modifications to fully address the plume, the resulting system is now nine times larger, consisting of 90 IWs. Treatment zone and performance monitoring indicate that injection is needed annually where TCE is present. In FY2018, a tracer test was conducted to assist in understanding the radius of distribution and inform the plans for future injection. As a result of the study, molasses was chosen as the amendment to inject and planned injection volumes were increased to nearly 300% of design basis. In FY2019, six additional wells were drilled to extend the system to the west and encompass the TCE extent. In FY2021, 26 additional IWs were installed to improve treatment in the central area of the system, since others in this area are plugged from past injections and perform poorly during injection events. In FY2022, six more wells were installed to fill in areas where the highest concentrations of the TCE plume are intercepted and performance monitoring indicated incomplete treatment. O&M of these wells should restore treatment in this critical area of the system.

O&M costs for the Zone 11 ISB are presented in **Table 4.10**, below.

Table 4.10. O&M Costs for the Zone 11 ISB

| Dates | | Total Cost ($K) Rounded to Nearest $1,000 |
|---|---|---|
| From | To | |
| Annual ROD Estimate | | 1,234 |
| Annual PCOR Estimate | | 1,234 |
| ESD Additional Estimate | | 600 |
| 10/1/2017 | 9/30/2018 | 1,472 |
| 10/1/2018 | 9/30/2019 | 1,913 |
| 10/1/2019 | 9/30/2020 | 1,241 |
| 10/1/2020 | 9/30/2021 | 4,829 |
| 10/1/2021 | 9/30/2022 | 2,243 |

The costs for groundwater monitoring and well maintenance activities are presented in **Table 4.11**. Long-Term Monitoring Network O&M Costs. The *Sampling and Analysis Plan* (B&W Pantex, 2009m) approved as part of the RD package was implemented toward the end of FY 2009, and an update to the LTM plan including recommendations to optimize the monitoring network was developed in 2014 (B&W Pantex, 2014). With the expansion of the perched groundwater plume to the southeast, additional monitoring wells have been installed to better understand the nature and extent of contaminants in the region of the plume and to monitor efforts to treat and stabilize it. Additional treatment zone monitoring (TZM) was also added to the SEISB Extension and the Zone 11 ISB Systems. Costs for the past five years show an increasing level of effort, as expected (see **Table 4.8**).

Table 4.11. Long-Term Monitoring Network O&M Costs

| Dates | | Total Cost ($K) Rounded to Nearest $1,000 |
|---|---|---|
| From | To | |
| Annual ROD Estimate | | 583 |
| Annual PCOR Estimate | | 679 |
| 10/1/2017 | 9/30/2018 | 799 |
| 10/1/2018 | 9/30/2019 | 1,094 |
| 10/1/2019 | 9/30/2020 | 1,430 |
| 10/1/2020 | 9/30/2021 | 1,507 |
| 10/1/2021 | 9/30/2022 | 1,551 |

### 4.3.3 Institutional Controls

O&M of the ICs usually focuses on identifying and replacing SWMU signs, inspecting fencing, actively watching for signs of unauthorized drilling in areas outside of the Pantex Plant, and continued training of onsite workers and contractors. The O&M of protective covers, SVE system, and liners are discussed in previous sections.

- Protective Covers: IC O&M includes inspecting protective covers and ensuring access restriction controls are in good condition per the *Maintenance Plan for Landfill Covers.*
- Zone 12 ditches (SWMUs 2 and 5/5): IC O&M includes inspecting integrity of liners and ensuring access restriction measures are in good condition per *Final Maintenance Plan: Zone 12 ICMs for SWMUs 2 and 5/5 Ditch Lining.*
- Limited Action Soil Units, Burn Pads 11-13 (SWMUs 25-27) and SWMU 5/12a: IC O&M includes maintenance of fencing, signage, training, and implementation of SWMU Interference Notifications if a need arises to disturb soils in SWMUs across the Plant.
- Southeast Area and Zone 11 perched groundwater: IC O&M includes ensuring access restriction measures (e.g., notices of restricted areas; fencing) are in good condition and employee training per the Land and Groundwater Use Control Implementation Plan (LGWUCIP*).*

#### *4.3.3.1 Institutional Controls O&M Costs*

O&M costs include labor needed to review upcoming construction projects and planned maintenance activities supporting the Pantex mission to mitigate soil disturbance in SWMUs and avoid damage of RA system components and monitoring wells. Other aspects of each project are also evaluated, such as whether the project would lead to increased recharge potential in SWMU areas or involve drilling activities to the depths of the perched groundwater. Maintenance of postings (SWMU signs) and development and oversight of SWMU Interference controls are also accomplished through this funding.

For this FYR period, these costs include establishing access and right of entry agreements with temporary restrictions and two new long-term deed restrictions for neighboring properties that contain the Offsite ISB System. As depicted in Table 4.12, the annual O&M costs slightly exceeded the ROD estimate because of the need to implement these new ICs. Although the annual cost for this FYR period exceeded the ROD estimate during the last years of the period, it is expected to be sufficient to maintain and enforce the controls annually into the future.

Table 4.12. ICs O&M Costs

| Dates | | O&M Cost ($K) Rounded to Nearest $1,000 |
|---|---|---|
| From | To | |
| Annual ROD Estimate | | 150 |
| Annual PCOR Estimate | | 150 |
| 10/1/2017 | 9/30/2018 | 132 |
| 10/1/2018 | 9/30/2019 | 142 |
| 10/1/2019 | 9/30/2020 | 185 |
| 10/1/2020 | 9/30/2021 | 158 |
| 10/1/2021 | 9/30/2022 | 227 |

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# 5.0 PROGRESS SINCE LAST REVIEW

The Second FYR for the Pantex Selected Remedy, conducted in 2018, identified several issues and recommendations to improve the response action. Information contained herein represents evaluation of the progress of the operation, maintenance and performance of RA components conducted since the Second FYR.

## 5.1 ISSUES IDENTIFIED IN THE SECOND FIVE-YEAR REVIEW

### 5.1.1 Deficiencies in Soil Covers

The Second FYR noted some minor deficiencies in soil covers, including settlement, burrowing animal holes, and erosion and slope instability. These minor deficiencies were addressed by onsite maintenance in most areas, with the exception of erosion and slope instability at Landfill 3 (SWMU 54). Erosion at Landfill 3 was addressed in March 2019 through the installation of geocell and improvements to culverts. Contracting was used to complete work at SVS 7a and SVS 6.

Areas of minor deficiencies in soil covers were identified during the 2022 landfill inspections to support the FYR, including areas of erosion, animal burrows, and settling (described in Attachments 7 and 8). These deficiencies will be addressed through soil addition, compaction, and regrading as necessary. A contract will be issued to accomplish this work.

### 5.1.2 Dose-Based ARARs for Radionuclides

EPA issued new guidance on assessing radiation risk in 2014 (EPA, 2014). The document titled *Radiation Risk Assessment at CERCLA Sites: Q&A* changed the Superfund recommendation for what is considered a protective, dose-based, applicable, relevant, and appropriate requirement (ARAR) for radionuclides from 15 to 12 millirems per year (mrem/yr). The new recommendation of 12 mrem/yr is based on using an updated risk assessment to achieve the same $3 \times 10^{-4}$ cancer risk as the previous recommendation using 15 mrem/yr.

Cleanup activities for FS-5 (SWMU 70) and the NWAR Sites (SWMU 82) were conducted in the 1990s. Pantex conducted a full risk assessment of the two sites following cleanup and collection of confirmation samples to ensure that the cleanup was protective of human health and the environment or to determine if further cleanup or other protective measures may be required. NWAR had calculated cumulative cancer risks of less than 1.0E-06 and non-cancer risks were below a hazard index of 1.

Due to the magnitude and complexity of risk assessments and historical RAs, Pantex Site managers recommended that a meeting be held between EPA and Site project managers to discuss methods and results of the risk assessments. This discussion was held on November 14, 2018 to explain that dose-based calculations were used to guide fieldwork during cleanup activities, but a full assessment of risk was performed to demonstrate that cumulative risk remaining at the FS-5 was below the CERCLA prescribed threshold and protective of human health and the environment. EPA requested a letter to close out the radionuclide issue for the record, which was sent on December 11, 2019.

### 5.1.3 HE Plumes Expanding East of FM 2373 and South of Highway 60

The Second FYR identified that perched groundwater COC plumes were migrating to the southeast in the perched groundwater. These areas are not under the long-term influence of the SEPTS due to limited saturated thickness and other hydrogeologic conditions.

Two primary responses have been implemented to address HE plume migration in the southeast perched unit, and a third response continues to be expanded. Six additional perched unit EWs were installed in 2016 east of FM 2373 and connected to the SEPTS in March 2019. Currently, only the western three EWs remain active due to limited perched groundwater saturation in the eastern three wells. An additional ISB system, the SEISB Extension, was constructed along Highway 60 east of FM 2373 in 2018 with the first injection event completed in February 2019. A second ISB system, the Offsite ISB, has been partially constructed and will continue to be expanded. The first injection event in the Offsite ISB was completed in October 2021.

Ongoing characterization and installation of monitoring wells were effective in further delineating the plume in the southeast perched unit during the Third FYR period. The conceptual site model (CSM) was updated in 2021, and groundwater modeling was performed to optimize treatment of the southeast HE plume (HGL, 2021a; 2021b).

Additional groundwater ICs were enacted for the two offsite properties impacted by perched groundwater COC plumes. These deed restrictions were recorded on December 31, 2021, and June 9, 2022.

### 5.1.4 TCE Plume North and West of Zone 11 ISB

The First FYR identified plumes of TCE and perchlorate extending north and west of the Zone 11 ISB area, outside of the optimal treatment zone. Five additional wells were installed north and west of the Zone 11 ISB treatment zone in September 2012 to acquire hydrogeologic information needed to evaluate the options for addressing the plumes west of the Zone 11 ISB. Results from this investigation and subsequent evaluation indicated that the ISB system should be extended. Six new ISB wells were installed to the northwest of the Zone 11 ISB between December 2019 and January 2020. Two injections were completed in those wells in August 2020 and July 2021, respectively.

Groundwater monitoring data will continue to be evaluated for COC concentration trends and groundwater elevations and gradients to determine if additional updates to the RA in the area of the Zone 11 plumes are required.

### 5.1.5 Incomplete Treatment of HE at SEISB PTX06-1153

One ISPM well, PTX06-1153, located on the west end of the SEISB has not responded in a manner similar to other downgradient wells believed to be currently under the effect of the SEISB. Data indicate that treated water had reached this well by late 2010 as documented by field parameters and volatile fatty acid concentrations; however, subsequent data indicate that untreated water is migrating to the area.

Passive flux meters were deployed in fall 2016 to assess the impact of dewatering within and around the SEISB. Measurable groundwater flux was observed in PTX06-1153, although flow to the well is limited. At the time it was thought that groundwater flow could be moving around the western end of the SEISB system. PTX06-1188 was installed in 2017 to confirm this, but the well was dry at the time of installation and has remained dry throughout the Third FYR period.

Although PTX06-1153 continues to exhibit RDX concentrations above the GWPS, a steep decline in RDX concentrations has occurred since the peak observed in August 2019. Cr (VI) concentrations continue to decrease and have remained below the GWPS since 2016. Pantex is continuing to investigate the cause of the unexpected results in PTX06-1153, which could be due to a number of hydrologic conditions that may make determining the cause of the unexpected conditions difficult. Several

confounding issues complicate the investigation efforts in the area, including significant heterogeneity in the FGZ, potential changes in formation properties due to biologic growth or other injection effects, and the potential reduction of saturated thickness upgradient due to the P&T operations (CNS, 2022a).

### 5.1.6 Additional Contaminants of Potential Concern

#### *5.1.6.1 Cadmium*

Based on data collected in 2011 in uncertainty management wells for the FYR, cadmium was identified as a new COPC, not identified in the ROD. Cadmium was detected at 10.8 µg/L in PTX06-1010 in early 2011, which exceeds the maximum contaminant level (MCL) of 5 µg/L. A subsequent sample collected for this well in December 2011 indicates that concentrations have dropped below the MCL. This COPC is not associated with a new source area, but monitoring data indicate that leaching from soils in this area (from previously investigated releases in Zone 12) has been slower than for other COCs. Cadmium has been previously detected in this well but had not been identified as a COC based on the data collected to support the investigations and risk assessment. Recent sample results in 2016 were nondetect at the detection limit of 1 µg/L. Sitewide, no exceedances of the GWPS for cadmium were recorded during the Second FYR period.

Cadmium in PTX06-1010 remained below the detection limit of 1 µg/L throughout the Third FYR period. Sitewide, cadmium was below GWPS during the Third FYR period and cadmium was detected in a single well, PTX08-1007, at an estimated (J value) concentration of 0.327 µg/L. As a result of cadmium not being detected above the GWPS over both the Second and Third FYR periods, sampling for cadmium should return to every five years prior to each FYR.

#### *5.1.6.2 Hexavalent Chromium*

Cr(VI) was detected in Zone 11 well PTX08-1005 in 2011 at a concentration of 90 µg/L, close to the GWPS of 100 µg/L. Sampling during 2000 through 2003 showed nondetect results for Cr(VI); however, method detection limits were between 10 and 15 µg/L. For sampling conducted between 2011 and 2016, method detection limits for Cr(VI) were between 10 and 30 µg/L. Detection limits have been lowered for sampling conducted in and after 2017.

Sampling data collected between 2012 and 2021 for PTX08-1005 show a maximum detected concentration (MDC) for Cr(VI) of 20.3 µg/L and a minimum of 3.31 µg/L with no concentrations above the GWPS of 100 µg/L. Reported concentrations since 2015 have been below 5.5 µg/L. Trend results for the Third FYR period indicate that the Cr(VI) and total Cr concentrations in PTX08-1005 are both *probably increasing*.

Concentrations in this area continue to be below the GWPS, but Cr(VI) and total Cr data will be evaluated and trended in the future to determine if the Cr detections persist. Reducing conditions created through the Zone 11 ISB will effectively treat Cr(VI) if it is present. If concentrations of Cr(VI) are observed above the GWPS in the area, Zone 11 ISB remedy performance wells will be monitored for Cr species to evaluate remedy effectiveness. Cr(VI) in this area does not present a threat to short-term or long-term protectiveness and sampling frequency should return to every five years prior to each FYR.

#### *5.1.6.3 Metals Solubilized through ISB Treatment*

Reducing conditions established through ISB treatment cause some naturally occurring metals in the formation to solubilize. Arsenic, barium, and manganese are three metals observed downgradient of

both ISB systems that could prevent attainment of the RAO for restoring perched groundwater to drinking water standards if the metals remain in a dissolved state and do not attenuate.

Concentrations of secondary metals in perched groundwater are expected to decrease as the geochemistry of the water reverts to more oxidizing conditions downgradient of the systems. Therefore, additional monitoring for these metals was recommended in the Second FYR (HGL and CNS, 2018) to confirm that concentrations eventually decrease as expected. Changes to the monitoring program were included in the update to the Sampling and Analysis Plan in 2019 and included adding arsenic, barium, and manganese analyses needed to evaluate the potential for impacts to the Ogallala Aquifer from metals solubilized through ISB treatment. The update to the Sampling and Analysis Plan went into effect for sampling beginning in 2020.

#### *5.1.6.4 1,4-Dioxane in Zone 11*

Concentrations of 1,4-dioxane in the Zone 11 plume were previously screened out in the HHRA, indicating risk from this COC was less than 1.0E-6 for the perched groundwater and, by extension, the Ogallala Aquifer. Concentrations of 1,4-dioxane collected since the start of RA indicate that risk would now exceed 1.0E-06 in the perched groundwater near Zone 11. The effectiveness of Zone 11 ISB in treating 1,4-dioxane has not been demonstrated in the scientific literature.

Throughout the Third FYR period, 1,4-dioxane continued to be monitored and trends evaluated in the Zone 11 ISB area for both perched and Ogallala Aquifer monitoring wells. Concentrations of 1,4-dioxane exceed the GWPS of 7.7 µg/L in 20 wells in the perched unit with concentrations ranging between 7.83 µg/L to 70.3 µg/L. Trends for 1,4-dioxane during the Third FYR period were primarily *increasing* with *decreasing* trends observed in upgradient wells PTX06-1126 and PTX06-1127. Wells PTX06-1148, PTX06-1149, and PTX06-1156, downgradient of the eastern Zone 11 ISB, all had concentrations of 1,4-dioxane exceeding GWPS and *increasing* trends during the Third FYR period.

While 1,4-dioxane does not exceed its GWPS in the Zone 11 plume as much as TCE or perchlorate, it is still of interest as the ISB remedy is not documented to treat 1,4-dioxane. Monitoring will continue to confirm that the 1,4-dioxane plume is not increasing, presenting a potential long-term challenge to protectiveness. Currently, the risk from 1,4-dioxane is less than 1.0E-04 and is not expected to increase, based on monitoring conducted at wells around Zone 11. The need for further actions will be determined based on results of routine sampling and in accordance with the *Pantex Plant Ogallala Aquifer and Perched Groundwater Contingency Plan* (B&W Pantex, 2009b; CNS 2019c).

#### *5.1.6.5 TCE Degradation Products*

The products of TCE anaerobic degradation, including cis-1,2-dichloroethene (DCE) and vinyl chloride, were identified as having the possibility to accumulate at concentrations above MCLs as degradation intermediates in the Zone 11 ISB system in the Second FYR. These contaminants were not specifically identified in the ROD as primary COCs. However, they are included in the monitoring program to evaluate the efficacy of the ISB remedy for TCE. These COPCs were compared against their MCLs of 70 µg/L and 2 µg/L, respectively. Current exceedances for cis-1,2-DCE and vinyl chloride are located within and immediately downgradient of the center of the Zone 11 ISB. Monitoring wells further downgradient of the Zone 11 ISB have concentrations below MCLs and primarily *decreasing* trends.

Chlorinated intermediates of VOC degradation products such as cis-1,2-DCE and vinyl chloride will continue to be monitored within and downgradient from the Zone 11 ISB to confirm that they are transient degradation intermediates and that the remedy is not generating a plume capable of downgradient migration.

### 5.1.7 Migration of the Perchlorate Plume to the East

Since initiation of the SEPTS, the groundwater divide historically located south of Zone 12 has moved to the west, creating conditions whereby perchlorate is drawn into the SEPTS. The SEPTS was upgraded in 2022 to include treatment of perchlorate with an additional resin vessel for western SEPTS wells where perchlorate is being drawn into the system. Added treatment for perchlorate in the SEPTS is expected to control future migration of the perchlorate plume to the southeast and to be protective in the short-term and long-term.

Monitoring of groundwater south of Zones 11 and 12 for perchlorate migration and in the SEPTS EWs to the southwest of the SEPTS treatment plant will continue to ensure that any further plume migration is identified.

### 5.1.8 Perchlorate GWPS

EPA has established an Interim Lifetime Drinking Water Health Advisory (LHA) of 15 µg/L for perchlorate, which represents a concentration in drinking water that is not expected to cause any adverse, non-carcinogenic effects for a lifetime of exposure. EPA is in the process of developing an MCL for perchlorate in drinking water under the Safe Drinking Water Act (SDWA). The Texas Risk Reduction Program (TRRP) has established a residential groundwater protective concentration level (PCL) of 17 µg/L and a concentration of 51 µg/L for commercial/industrial property for Class 1 or 2 groundwater.

The Pantex Plant was grandfathered under the Texas Risk Reduction Rule (RRR) (30 TAC 335 Subchapter S) for completion of the RI/FS, which preceded the TRRP. When the ROD was issued in 2008, the aforementioned PCLs and LHA for perchlorate were not available for consideration as ARARs. As such, the GWPS was calculated consistent with the RRR. The GWPS identified in the ROD for perchlorate is 26 µg/L, a value between the TRRP PCLs for residential and commercial/industrial property.

An ESD was issued in December 2022, which redefined the GWPS for perchlorate from 26 µg/L to the EPA LHA of 15 µg/L (CNS, 2022b). The Zone 11 ISB system has demonstrated the ability to treat substantial levels of perchlorate to less than the detection limit of 5 µg/L in perched groundwater. It is anticipated that the protectiveness of the Zone 11 ISB will not be affected by implementation of the updated GWPS. Assessment of the effluent from the SEPTS should continue to ensure that it meets the new GWPS.

### 5.1.9 Significant Updates to Selected Remedy

The Second FYR noted that the remedy selected in the ROD had not been modified by a ROD amendment or an ESD, despite significant changes to remedies and planned changes to remedies. An ESD was issued in December 2022 and included the following:

- Additional EWs and perchlorate treatment in the SEPTS;
- Addition of a mobile treatment system in areas east of FM 2373;
- Addition of the SEISB Extension;
- Addition of the Offsite ISB;
- Addition of 34 IWs in the Zone 11 ISB;
- Addition of perched groundwater deed restrictions to two properties southeast of the Pantex Plant;

- Planned addition of an ISB at Country Road 8 to treat HE contaminant mass based on optimization modeling results; and
- Planned addition of an ISB northwest of the SEISB system, near PTX06-1183, to treat perchlorate and Cr(VI).

## 5.2 ADDITIONAL REMEDY UPDATES

### 5.2.1 Updates to the Burning Ground Soil Vapor Extraction System

During the Third FYR period, the BG SVE system operation was changed to planned pulsing events in 2020 in response to significant reductions in influent COC concentrations. Data indicated that pulsed operation of approximately 2 consecutive months per year provides good remedial performance.

Details of changes to the SVE system over the FYR period are provided in the *Remedial Action Effectiveness Report* (Attachment 7).

### 5.2.2 Installation of the SEISB System Extension

As noted in Section 4.2.2, 31 ISB IWs were installed along the Pantex Plant southeast property boundary during the Third FYR period. Five injection events were completed during the FYR period and are evaluated in the *Remedial Action Effectiveness Report* (Attachment 7).

### 5.2.3 Installation of the Offsite ISB System

As noted in Section 4.2.2, 19 ISB IWs were installed on offsite property located southeast of the SEISB Extension during the Third FYR period. One injection event was completed during the FYR period and are evaluated in the *Remedial Action Effectiveness Report* (Attachment 7). Continued expansion of the Offsite ISB system is planned through 2023.

### 5.2.4 Optimization of the Groundwater Pump and Treat Systems

Optimization of the P1PTS operation and SEPTS operation was completed (per recommendation from the Second FYR) to maximize both perched groundwater removal and contaminant mass removal through the adjustment of individual well extraction rates and potential inclusion of new EWs (HGL, 2021b). Six scenarios were evaluated (including a baseline, current operation scenario) using the updated numerical groundwater flow and contaminant fate and transport model (HGL, 2021a). Physics-Based Management Optimization (PBMO™) software was used optimize each scenario. Opportunities to maximize mass removal included simultaneous evaluation of RDX, Cr(VI), and perchlorate. Pumping rates for existing system wells were limited to system capacity and assumed the irrigation system was fully operational (no treated effluent was injected into the perched groundwater or discharged to Playa 1). Additional capacity for new wells included consideration of two limited mobile P&T systems, each with an 80-gpm treatment capacity.

Results from the optimization identified opportunities to reduce contaminant mass migration towards the edge of the perched groundwater by 49% (65.3 kilogram [kg] of RDX, Cr(VI), and Perchlorate in the baseline scenario compared to 33.6 kg of RDX, Cr(VI), and Perchlorate in scenario 5d). Opportunities to improve mass removal by 12.5% (from 67% total mass removal in the baseline scenario to 75% in scenario 5d). Much of the remaining mass in perched groundwater occurs in areas of thin (<15 ft) of saturation where P&T is not feasible or beneath secure areas with no access for installation of vertical EWs. Optimization also identified opportunities for increased perched groundwater extracted from the

P&T systems by 13.7% from 3,380 Mgal to 3,840 Mgal. Operation of the P&T systems based on the results of optimization are planned to start during the next FYR period as funding allows.

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# 6.0 FIVE-YEAR REVIEW PROCESS

## 6.1 ADMINISTRATIVE COMPONENTS OF THE FIVE-YEAR REVIEW PROCESS

The Third FYR began on August 1, 2022, and was completed on April 17, 2023.

The CNS review team included:

- Martin Amos – Project Manager/Regulatory Liaison
- Michelle Jarrett – Risk Assessor/RA Progress Specialist
- Maeghan Brundrett – Hydrogeologist
- Matt Monroe – SWMU Interference/Landfill Cover Specialist

In addition, several subcontractors were hired to perform specific tasks as outlined below. The subcontractors included:

- HGL – Conducted a MAROS evaluation of the perched groundwater LTM network (completed in September 2022) and performed a Remedial Action Effectiveness evaluation of the Selected Remedy.
- Carollo – Updated trending software tools and evaluated resulting output.
- Leidos – Conducted the evaluation of risk.

The draft final FYR Report was provided to TCEQ and EPA for review in May 2023. Comments were received from EPA and TCEQ through correspondence in July 2023. This Final Report incorporates changes resulting from resolution of the aforementioned comments. EPA and TCEQ concurrence with the Final FYR Report is anticipated by September 13, 2023.

## 6.2 COMMUNITY NOTIFICATION AND INVOLVEMENT

Public notifications of the initiation of the FYR were published in the *Amarillo Globe-News* and *Panhandle Herald* on July 28, 2022, to notify potentially interested parties of the start of the FYR. Copies of the notices are included in Attachment 1. TCEQ and the Pantex Plant host annual public meetings to share information about the Long-Term Stewardship Program (November of each year) in accordance with the approved Community Involvement Plan. RA progress is presented as part of each of these meetings. FYR information and progress was presented at the Long-Term Stewardship Public Meeting conducted on November 1, 2022.

Since remedy selection, many of the landowners adjacent to the Pantex Plant have changed. Efforts to share information with this part of the community should be improved. Although environmental cleanup documents like Annual Progress Reports and environmental data are posted on the Pantex website [Environmental Cleanup Documents | Pantex Plant (energy.gov)], new stakeholders would probably find it difficult and time consuming to learn the history and progress of the cleanup efforts at Pantex by reading these materials. Pantex developed and posted a Cleanup Summary Booklet on the aforementioned website for interested stakeholders that should help those seeking to overcome this challenge. Also, the distribution list for the neighbor newsletter and annual public meeting invitations will be updated to ensure effective sharing of pertinent information on cleanup activities.

## 6.3 DOCUMENT REVIEW

Documents reviewed as part of the Third FYR process included the Pantex Plant decision documents, regulatory guidance documents, and other documents. A full list of documents reviewed is presented in Attachment 2.

RAOs were defined in the ROD (B&W Pantex, 2008).

ARARs for soil alternatives were defined in the ROD and determined from:

- RCRA (40 CFR parts 260-280, 42 U.S.C. § 6901-6933).
- Pantex Plant Permit for Industrial and Solid Waste Management, Hazardous Waste Permit No. 50284 (HW-50284) (TSWDA, Texas Health & Safety Code, Chapter 361; 30 TAC Chapters 305, 335 and 350).
- Texas Health & Safety Code, Section 382.085: Unauthorized Emissions Prohibited.
- Procedures for Planning and Implementing Offsite Response Actions [The EPA Offsite Rule] (40 CFR §300.440).
- Shipping and Reporting Procedures Applicable to Generators of Hazardous Waste or Class 1 Waste and Primary Exporters of Hazardous Waste (30 TAC §335.10).
- Hazardous Material Transportation Act (49 USC § 5101-5127).
- Hazardous Materials Regulations (49 CFR §171.1 et seq.).
- Underground Injection Control (40 CFR Parts 144-148, et. seq.; 30 TAC 331).

GWPS (i.e., cleanup levels) were defined in the ROD in 2008 and incorporated into CP-50284 (TCEQ, 2010) through a modification to recognize the RAs as final corrective action systems. As part of a renewal in 2014, CP-50284 has now been incorporated into HW-50284. The ARARs for perched groundwater alternatives were defined in the ROD and determined from:

- SDWA (P. L. 104-182, 40 CFR Part 141, et. seq.).
- RCRA (40 CFR parts 260-280, 42 USC § 6901-6933).
- Pantex Plant Permit for Industrial and Solid Waste Management, HW-50284 (TSWDA, Texas Health & Safety Code, Chapter 361; 30 TAC Chapters 305, 335 and 350).
- General Regulations Incorporated into Permits (30 TAC 305 and 30 TAC 319) and Chapter 26 of the Texas Water Code.
- Texas Water Code, Chapter 26, 30 TAC 305.
- Section 402 of the Clean Water Act and Chapter 26 of the Texas Water Code (TPDES Multi Sector General Permit, TXR 150000).
- Underground Injection Control (40 CFR Parts 144-148, et. seq.; 30 TAC 331).

A review of regulatory changes since issuance of the ROD resulted in changes to the GWPS for perchlorate from 26 µg/L to 15 µg/L. The change is documented in an ESD (CNS, 2022b). (A review of risk calculation parameters and methods is included in Attachment 14).

## 6.4 DATA REVIEW

### 6.4.1 Data Reviewed

All perched groundwater and Ogallala Aquifer data collected during the FYR period (January 1, 2017, through December 31, 2021), as well as older groundwater data that provided historical context (samples collected and analyzed as early as 1996), were evaluated in this review. All data reviewed is provided in Attachment 6. Groundwater data were evaluated in multiple sections of this FYR and can be found in Section 4, Section 7, Attachment 7, and Attachments 9 through 14.

In addition, remedy performance data, consisting of influent and effluent concentrations and mass removal for the P1PTS, SEPTS, and SVE, were reviewed. Remedy performance data consisting of groundwater geochemical parameters in the area of the SEISB, SEISB Extension, Offsite ISB, and Zone 11 ISB were evaluated.

### 6.4.2 Relevant Trends and Levels

Short-term, long-term, and FYR period COC concentration trends and water level trends were calculated for this review. Statistical trends were estimated based on the best available data, but trend results can vary based on assumptions and the specific method of the statistical test employed. Methodologies for performing the statistical trends differed slightly between trends calculated for Attachment 11 and those presented elsewhere in this FYR Report. These differences included the way in which duplicate data were handled (averaged or excluded) and whether trending was performed for locations with four or more samples but fewer than four detections.

The data range for trending was over the Third FYR period (January 2017 through December 2021). For wells sampled annually and semiannually, enough measurements were available to trend, but the trends were susceptible to skewing by a single measurement if it varied substantially from the rest of the measurements. Accordingly, data outside the FYR period were used, when available, to aid in interpretation of trends and provide the appropriate context. Two additional time frames were considered for trending, all available data (1996 through 2021) and data collected since the start of remedial activities (2009 through 2021). All COC concentration and perched groundwater level trends/hydrographs for individual monitoring wells can be found in Attachments 9 and 10, respectively, and the raw data can be found in Attachment 6 (electronic files).

As reported in Attachment 7 – *Remedial Action Effectiveness Report* (HGL, 2023), most groundwater trends and concentrations are already meeting expected conditions outlined in the LTM Design (B&W Pantex, 2009a). A brief summary of findings from this evaluation for each of the main RA systems follows.

- The SEPTS is meeting the design objective of reducing the saturated thickness in its area of influence. Groundwater elevations declined at monitoring locations in the SEPTS area during the FYR period. The SEPTS is removing more groundwater than is estimated to be flowing into the upgradient side of the well field and, thus, is reducing saturation in the SEISB area.
- The P1PTS did not meet the design objective of reducing the saturated thickness within its area of influence. Groundwater elevations increased at monitoring locations in the P1PTS area during the FYR period as a result of subsurface irrigation system equipment failures that necessitated discharge of treated water to Playa 1. The discharge to Playa 1 was limited by permit and led to the SEPTS being prioritized over the P1PTS.

- The SEISB System is meeting the design objective of creating an anaerobic treatment zone capable of degrading/converting target COCs so that concentrations fall below the GWPS. COC concentrations have dropped below GWPS at three of the four downgradient in situ performance monitoring wells. Residual COC concentrations are above remedial goals at the fourth ISPM well, PTX06-1153. Reduced concentrations and lower levels of saturation support the conclusion that there is reduced potential for vertical or lateral migration of the plume.
- The SEISB System Extension is meeting the design objective and creating an anaerobic treatment zone capable of degrading RDX and other HEs. Downgradient monitoring well concentrations have not yet begun to attenuate. Based on seepage velocity estimates, it is expected that treated groundwater from the SEISB Extension will not reach downgradient monitoring wells until between 2022 and 2027.
- The Offsite ISB System is operating as designed with respect to hydraulic performance; however, the system has not operated long enough for a determination of its short-term efficacy in degrading COCs to be made.
- The Zone 11 ISB System is largely meeting the design objective of creating an anaerobic treatment zone capable of degrading target COCs to achieve concentrations below the GWPS. The Zone 11 ISB is effective at attaining GWPS in groundwater downgradient of the injections for perchlorate with some possible movement of perchlorate past the treatment zone on the east side of the ISB system. The remedy, as currently implemented, is somewhat less effective at treating TCE with varying degrees of effectiveness along the length of the ISB system. The varying effectiveness of the Zone 11 ISB system along its length may be influenced by injections being stopped prior to target volumes being reached because of slow amendment injection.

### 6.4.3 Long-Term Monitoring Network Recommendations

#### *6.4.3.1 MAROS Evaluation of Perched Groundwater Network*

Remedy effectiveness is determined through groundwater monitoring implemented through an LTM Plan. The perched groundwater LTM network was evaluated by HGL to review the network for its ability to support site monitoring goals, including remedy effectiveness, plume stability, and uncertainty management, and then make recommendations to improve the network (Attachment 11). Well and groundwater analytical data (using a period from 2017 through 2021) were analyzed using the MAROS version 3.0 developed by the AFCEC. In this evaluation, perched groundwater was divided into three sectors to account for radial groundwater flow in the perched unit. Then the network in each sector was evaluated for plume stability, well spatial redundancy and sufficiency, and sampling frequency analysis. Individual well statistics and trends were also evaluated. The full report is included in Attachment 11. The overall conclusions of the evaluation included:

- At least two additional monitoring wells are recommended for the area east of the SEISB Extension to reduce uncertainty and identify the northeastern plume boundary near Highway 60.
- An additional monitoring well is recommended east of PTX06-1042 to track higher RDX concentrations moving towards the SEISB Extension and EWs PTX06-EW-83 through PTX06-EW-88.
- The networks monitoring the P&T EW fields and ISB systems were determined to be adequate to evaluate remedy performance.

- At least one additional monitoring well is recommended for the area downgradient from the Zone 11 ISB to manage uncertainty about migration of the TCE and perchlorate plumes if concentrations show *increasing* or *probably increasing* trends in PTX06-1207.
- Continue monitoring perchlorate and 1,4-dioxane at PTX08-1008 and in wells to the south and east to track plume movement toward the SEPTS.
- *Increasing* perched groundwater levels and RDX concentrations in PTX06-1050 should be watched, and PTX06-1136 should be checked periodically to ensure that it remains dry.
- Overall, there is very low spatial uncertainty within the network, and no wells in the routine sampling network are recommended for elimination.
- There are no strong recommendations to change the current sampling frequencies; however, sampling frequency analysis indicates a low rate of change of concentrations in some areas supporting potential future reductions in sampling frequency.

#### 6.4.3.2 Ogallala Aquifer (High Plains Aquifer) Monitoring Network

HGL reviewed the sufficiency of the monitoring network in the Ogallala Aquifer and made the determination that the network is not sufficient to address the goals and objectives of the monitoring program in light of recent GWPS exceedances. Additional monitoring wells should be installed in the area around PTX06-1056 to attempt to identify locations where breakthrough of the FGZ is occurring and define the extents of Ogallala impacts above GWPS.

## 6.5 SITE INSPECTION

The FYR EPA Site Inspection was conducted on September 27 and 28, 2022. The inspection was conducted by CNS and USDOE/NNSA personnel with EPA Project Manager Kevin McNeely and TCEQ Project Managers Maria Sifuentes-Chavez and Wyatt Hooks. HGL personnel included Tad Fox and James Montague. The inspection focused on evaluating the groundwater and soil RAs. Inspection forms were developed using the EPA FYR guidance and were tailored for the specific RAs at the Pantex Plant. The completed forms and pictures taken during the Site Inspection are presented in Attachment 3.

The P1PTS, SEPTS, BG SVE, SEISB System Extension, Offsite ISB System, and Zone 11 ISB System were inspected and discussions were held with the O&M Managers for each of these systems. The SEISB System was not inspected with TCEQ and EPA because the system was not being actively injected. CNS personnel inspected the SEISB well field independently in September 2022.

The BG SVE System and the BG (SWMUs 37 through 44) were inspected during the September 2022 Site Inspection. The BG SVE System was not operational at the time of inspection due to planned system pulsing. Additional landfill and soil cover remedies were inspected by HGL and CNS personnel on September 28 and 29, 2022. The SWMU 2 and 5-05 Ditch Liner were inspected by CNS personnel due to access constraints in February 2023 as part of preparation for contracted repairs.

The SEPTS was observed to be operating and in good condition. The P1PTS was observed, but it was not operating at the time of the Site Inspection to allow for the SEPTS to operate at full capacity due to discharge limits to Playa 1. The facilities are well maintained, and operating personnel were knowledgeable about the systems and the objectives they are striving to attain. Automated process tracking systems and O&M documentation were in good order. The EWs at each system are constructed in below-ground vaults with insulated lids to provide freeze protection from winter weather, allowing for year-round operation.

The Zone 11 ISB and Offsite ISB were undergoing active injection of bio-amendment at the time of the Site Inspection. The injection trailers were inspected, and the mechanical components, programmable logic controller interface, and O&M documentation appeared to be in good order. During active injection at the Zone 11 ISB, the SEISB, and the SEISB Extension, treated groundwater is obtained via conveyance line from the SEPTS and stored in a series of three 20,000-gallon portable tanks adjacent to the injection trailer near the well field. Injection water for the Offsite ISB is obtained from downgradient recovery wells and stored in a series of three 20,000-gallon portable tanks adjacent to the injection trailer near the well field. The Offsite ISB recovery wells are not capable of extracting at a high enough rate for continuous injection to occur; therefore, the portable tanks are refilled overnight, and injection is performed during the day.

The BG SVE system consisted of a CatOx unit and wet scrubber (installed in 2012) to treat the solvent vapors extracted from SVE-S-20, the single well installed adjacent the former solvent evaporation/chemical burn pit (SWMU 47), and associated equipment and chemicals. The vapor treatment and scrubber are housed in a Conex container. The EW is connected through underground piping to a manifold, which was part of the original system installed and operated as an ISM implemented under state RCRA authority and is attached to the CatOx unit by an industrial-grade hose. The modifications to inactive SVE wells to increase air flow to the subsurface were inspected and appeared to be in good order.

Landfill covers were observed to be adequate. Ongoing maintenance to control damage associated with holes resulting from other burrowing animals and settling within construction debris voids pose continuing challenges. Erosion and exposure of the geotextile cover at Landfill 3 (SWMU 54) appears to be the result of mowing activities and may continue to pose an issue because of the requirement that the vegetative cover be kept short to maintain lines of sight for security.

The replacement SWMU 2 and 5-05 ditch liners from 2017 were observed to be showing some wear with tears and sedimentation and erosion of the anchor trench noted.

## 6.6 INTERVIEWS

Interview questions were drafted, and surveys were sent by mail to neighbors, interested parties, and public officials on October 17, 2022.

To understand the perspective of the adjacent landowners, the general public, and other government officials, USDOE/NNSA initiated a survey to determine how well the Selected Remedy progress has been communicated. The interview questions and survey forms that were sent out to the stakeholders are included in Attachment 4.

The survey was completed by mail; survey forms were sent to 70 stakeholders on October 17, 2022, and responses were requested to be postmarked by November 21, 2022. CNS also provided stakeholders with an opportunity to complete the interview by phone or in person. Responses were received from four stakeholders and are summarized below by stakeholder type.

### 6.6.1 Input from General Public

Based on survey responses, the general public perceives that cleanup activities at the Pantex Plant are achieving progress and are performed in good faith. The RA efforts are visible, particularly in response to the expansion of the perched groundwater remedy to the southeast and the installation of the pivot sprinklers and storage pond east of FM 2373. The general public appears to be pleased with communication regarding the cleanup activities at the Pantex Plant and complimented leadership on

the communication of the cleanup progress and actions undertaken to address legacy contamination. A desire was expressed to better understand measures implemented to prevent new activities from releasing contaminants to the environment and to hear more about the involvement of the TCEQ and the EPA in the ongoing cleanup efforts at the site.

### 6.6.2 Input from Adjacent Landowners

The two adjacent landowners that responded are generally pleased with the cleanup efforts and how they are communicated. One landowner remarked that communications are structured so an individual can be as informed as they want to be. Another remarked that the cleanup effort is complex, but Pantex personnel are available and answer questions truthfully and to the best of their knowledge.

TTRF, one of the largest adjacent landowners, leases its property to USDOE/NNSA for a security buffer and also conducts some work on Pantex Plant. Annual meetings are held between Pantex Plant representatives and TTRF to ensure effective communication and coordination of efforts. During these meetings, the TTRF Manager encourages CNS and USDOE/NNSA to maintain these open lines of communication regarding activities at the Pantex Plant, as has been the case historically.

### 6.6.3 Input from Government Officials

The government official that responded noted that the operations at the Pantex Plant appear to be effective and are communicated well. He has not been contacted about any concerns, complaints, or violations since issuance of the ROD in 2008. He also stated he is well-informed by the routine communications occurring in the form of Public Meetings, Agreement-in-Principle Meetings (held annually), and periodic meetings with Pantex leadership. He was generally pleased with the how the Selected Remedy is implemented and adapted to address conditions as they change.

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# 7.0 TECHNICAL ASSESSMENT

The Site-wide soil and groundwater remedies were designed to be a comprehensive action to eliminate human and ecological exposure pathways and to remediate affected media to protective cleanup levels. This assessment focuses on the soils and groundwater remedies separately, with a technical assessment summary of the entire action at the end of this section.

Detailed supporting information and data for this assessment can be found in Attachments 6 through 14.

## 7.1 SOIL REMEDIES

The RAOs for soil are:

- Reduce the exposure risk to industrial and construction/excavation workers at the Site through removal, treatment, or prevention of contact with COCs in the soil.
- Reduce potential impact to perched groundwater and the Ogallala Aquifer through source abatement and stabilization/control measures in the vadose zone.

For this assessment, all soil remedies were evaluated comprehensively. The following soil units and remedies are included in this evaluation:

- Containment and ICs for Former Ash Disposal Trench (SWMUs 14 through 24), FS-5 (SWMU 70), and Landfills (consisting of 27 other Pantex landfills).
- Containment and ICs in the Zone 12 ditches.
- ICs for select soil sites (SWMUs 25, 26, and 27 and 5/12a). Fencing at FS-5 (SWMU 70).
- SVE system at the BG (SWMU 47).

### 7.1.1 Question A: Is the remedy functioning as intended by the decision documents?

Yes. The remedies have been maintained to achieve the RAOs as intended. In general, the condition of vegetation on the soil covers has improved greatly since the First FYR Site Inspection in 2012 and has been maintained since the Second FYR Site Inspection in 2017. The soil remedies are functioning as intended and are still protective.

#### *7.1.1.1 Remedial Action Performance*

All soil remedies are performing as designed and expected.

*Landfills and Landfill Covers*

Containment of landfill materials has been effective. Areas of the protective covers where holes were identified have been filled, and a program for burrowing animal control is in place. Minor deficiencies at individual remedies are noted in the discussions below.

Some minor deficiencies in soil covers (settlement, burrowing animal holes, and erosion) were identified by the landfill cover inspections performed from 2017 through 2022 and the LiDAR inspection conducted in 2022. These minor deficiencies were noted in six of the landfill covers (described in Section 4.2.1) and do not present any near-term loss of remedy protectiveness. Proposed actions to address

these deficiencies are described in Attachment 7 (Section 3.1.2, Table 3.3). A contract will be issued and implemented (as funding allows) to address the deficiencies identified in the six soil covers. The repairs/actions will be completed in a timely manner to ensure that erosion of the protective covers does not occur and long-term effectiveness of this remedy is maintained.

*Zone 12 Ditches*

Containment of COCs below the Zone 12 SWMU 2 and 5-05 Ditches is effective, as indicated by *stable* to *decreasing* COC concentrations in groundwater downgradient of the remedy. PTX06-1088 had abnormal concentration spikes of RDX and Cr(VI) in 2020 that are likely related to plume movement influenced by injection of treated water from SEPTS at higher rates than typical into INJ-10. Subsequent reduced injection rates at this well have allowed the plume to flow back to the east and concentrations have since declined.

Wastewater is no longer discharged to Zone 12 ditches and their only source of water is precipitation runoff. Synthetic liners were placed in the Zone 12 ditches as an ICM in 2004. During a 2015 inspection, several deficiencies were observed, including tears along headwall connections, degradation of liner material, and some liner segments pulling out of anchor trenches. Due to the age and condition of the original liner, Pantex decided to place a new liner over the original liner. Between December 2016 and March 2017, a new 45-millimeter Hypalon liner was installed over the existing SWMU 2 and 5-05 Ditch Liner. Recent inspections in 2021 indicated that the liner had tears and sedimentation and erosion of the anchor trench.

Based on the analysis of O&M records, groundwater data, and the Site inspection, the Ditch Liner remedy addresses the RAOs of prevention of human contact with affected media and preventing surface water infiltration from the ditches to the underlying perched groundwater. A contract has been issued and repairs will be implemented in 2023 to address tears in the liner and sedimentation of the anchor trench.

*ICs for SWMUs 25, 26, and 27 and SWMU 5/12a*

ICs for SWMUs 25, 26, 27, and 5/12a are performing as expected and are effective at preventing worker exposure to residual COCs.

All Pantex ICs were reviewed during this FYR and are described in Attachment 7. ICs implemented for the Site include work protocols, signage, defined roles and responsibilities of managers, and controlled access in addition to deed restrictions. All soil ICs have been implemented and are working as intended to prevent exposure. No deficiencies related to the implementation, maintenance, operation, and enforcement of the soil ICs were noted.

*Burning Ground SVE System (BG SVE)*

The detailed performance evaluation of the BG SVE is included in Attachment 7. The BG SVE System is functioning as intended in the ROD based on the system performance and groundwater monitoring results. The system is continuing to remove soil gas and reduce the mass of VOCs in the vadose zone. Groundwater monitoring indicates the system has been effective in protecting the underlying Ogallala Aquifer, which is the main objective of this system. SVE was selected as the presumptive remedy for SWMU 47 and is continuing to achieve VOC mass reduction in the vadose zone. The BG SVE System has been operated with a pulsed strategy since 2020, and initial results indicate that the performance has not declined and influent concentrations did not rebound after long periods of system shutdown. A

request to discontinue BG SVE System operation will be made when the current operating permit is renewed.

### 7.1.1.2 System Operations/O&M

O&M in accordance with the established procedures for the remedies will ensure continued effectiveness of the soil remedies.

*Landfills and Landfill Covers*

Maintenance of soil covers includes annual visual inspections and LiDAR analysis once every five years. Observed deficiencies, such as loss of vegetative cover, holes, erosion, and settling, are addressed by development and implementation of work plans as needed.

*Zone 12 Ditches*

O&M of the Zone 12 SWMU 2 and 5-05 ditch liner consists of ensuring the Hypalon liner installed in March 2017 remains in place with no tears or punctures that would allow infiltration of surface water beneath the liner. Pantex has developed and is implementing a maintenance plan for the liner (CNS, 2017a). As part of routine maintenance, visual inspections of the liner are performed on an annual basis, following severe storm events, and after ditch cleanouts (performed as needed). A checklist of items to examine during an inspection has been developed and is completed during each annual inspection. The most recent annual inspection is documented in the 2021 Annual Progress Report (CNS, 2022a). It noted tears in the liner and sedimentation and erosion of the anchor trench.

*BG SVE*

Total mass removal is strongly influenced by the operational effectiveness of the SVE system and mass remaining in the vadose zone. The operational strategy of the SVE system was changed from continuous operation to pulsed operation in 2020. Pulsed operation did not negatively impact remedy performance and indicates that remedial goals may have been or are close to being achieved. Specific recommendations for SVE system operation are presented in Attachment 7.

### 7.1.1.3 Opportunities for Optimization

No opportunities have been identified to improve the performance and/or reduce costs of the Soil Remedy during this FYR other than pulsed operation of the BG SVE System while awaiting regulatory approval to terminate the system. Details of optimization recommendations are provided in Attachment 7.

*Landfills and Landfill Covers*

The updated *Maintenance Plan for Landfill Covers* (CNS, 2017b) published in June 2017 optimized the inspection schedule from quarterly and after significant rainfall events to annually. The completed installation of the Closure Turf™ at SWMUs 68b and 68c has reduced the requirements for vegetation maintenance at these sites. Further optimization of landfill covers should be focused on efforts that will reduce maintenance and repairs in response to variable weather conditions; possible measures include installing additional Closure Turf™ or similar material(s) and/or constructing shoring in areas prone to erosion.

LiDAR surveys conducted once every five years, in conjunction with the FYR schedule, are an effective way to quantitatively evaluate the condition of landfill covers and identify areas that may need maintenance.

*Zone 12 Ditch Liners*

The Zone 12 Ditch Liner is a physical containment system, and, as such, once properly installed is not as amenable to optimization as active remedies. The primary optimization approaches for containment would be the maintenance or replacement schedule for the liner and the exit strategy for maintenance. Potential optimization considerations include reassessing life cycle costs of continued maintenance/ replacement of the liner material and long-term durability over the life span of the remedy. Additional details on this recommendation are presented in Attachment 7. To help identify potential liner integrity problems and maintenance needs early and thereby prolong liner life, this FYR recommends specifically inspecting the liner in the eastern end of the S-shaped portion of the SWMU 5-05 ditch where 10 Platipus anchors were planned but not installed along the bottom of the ditch because of potential interference with buried utilities.

*BG SVE*

The First FYR recommended establishing criteria for terminating SVE system operations. Performance data from the Second FYR supported moving forward with converting the SVE from active to passive operation as a precursor to terminating operations. Based on evaluation of system performance under a pulsed operational mode during the Third FYR, optimization of the BG SVE System can be obtained through pulsed system operation with approximately two consecutive months per year while awaiting regulatory approval to terminate the system. Reduced operational time of the SVE system will free up resources to address other elements of the overall environmental remediation program at Pantex. Details of system performance under pulsed operation are provided in Attachment 7.

#### 7.1.1.4 Early Indicators of Potential Issues

No early indicators of potential issues for soil remedies were discovered during this FYR.

#### 7.1.1.5 Implementation of ICs and Other Measures

All Pantex ICs were reviewed as described in Attachment 7. All soil ICs have been implemented and are working as intended to prevent exposure. No deficiencies related to the implementation, maintenance, operation, and enforcement of the soil ICs were noted.

### 7.1.2 Question B: Are the exposure assumptions, toxicity data, cleanup levels, and RAOs used at the time of remedy selection still valid?

Yes. Exposure assumptions and RAOs still remain valid. As described in Attachment 14, no changes in the RA or RAOs are recommended for soil sites.

#### 7.1.2.1 Changes in Standards

EPA issued guidance titled "*Radiation Risk Assessment at CERCLA Sites: Q&A*" in 2014. The guidance recommended a reduction in the protective dose-based ARAR for radionuclides from 15 to 12 mrem/yr. The new recommendation of 12 mrem/yr regarding what dose-based ARARs are protective is based on using an updated risk assessment to achieve the same 3.0E-04 cancer risk as the previous recommendation using 15 mrem/yr.

Pantex did not use the risk assessment to set the cleanup levels for FS-5 (SWMU 70) or the NWAR (SWMU 82) Site. Those cleanups occurred in an early time frame (1990s) and were set using other considerations. Therefore, Pantex conducted a full risk assessment of the two sites following cleanup and collection of confirmation samples to ensure that the cleanup was protective of human health and the environment or to determine if further cleanup or other protective measures may be required. NWAR had calculated cumulative cancer risks of less than 1.0E-06 and non-cancer risks were below a hazard index of 1. At FS-5, cumulative cancer risks above 1.0E-06 (cumulative risk of 4E-05) were calculated for an industrial worker, with DU being the contaminant of concern that was the risk driver. Cumulative non-cancer risks were below a level of 1. However, the industrial worker scenario was extremely conservative for the site as the site is no longer operational and the only worker that is present in the area is the maintenance worker that mows the site. Based on site-specific considerations, cumulative cancer risk to that worker is below 1.0E-06.

No additional changes in cleanup standards for soils were identified during this review. No additional "to be considered" (TBC) analytes for soil were identified during the FYR period.

Cleanup levels were developed and documented in the *Final Risk Reduction Rule Guidance to the Pantex Plant RFI, (BWXT, 2002 and updates in 2004)* based on calculated health-based standards under the RRR (30 TAC 335 Subchapter S)/EPA Preliminary Remediation Goal (PRG) Calculator. The Medium Specific Concentration (MSC) table that supported the Texas RRR program is no longer supported by TCEQ, so other methods and toxicological information sources are used to develop updated site-specific values for SWMU Interference screening. Cleanup criteria were initially developed for radionuclide sites; however, final decision of whether the cleanup was protective of human health and the environment was based on a final HHRA and ERA. Changes to slope factors, toxicity criteria, or other criteria used in those assessments or development of cleanup values for the RRR are considered below.

#### *7.1.2.2 Changes in Exposure Pathways*

No changes in exposure pathways were identified during this review.

Land at the Pantex Plant is used for industrial operations and as a security buffer. This use is anticipated to continue for the foreseeable future, so there has been no change in the land use considered in the risk assessments. No new human or ecological receptors, pathways, soil contaminants, or sources were identified during this FYR.

#### *7.1.2.3 Changes in Toxicity and other Contaminant Characteristics*

Soil sites are controlled at Pantex and are reviewed to evaluate worker protection needs and necessary soil control measures on a continual basis.

Work procedures must be approved prior to any activity that will disturb the soil, and protective measures are developed based on calculated risk. Based on the recommendations from the First FYR, Pantex regularly updates the toxicity values and cleanup values for use in the worker protection review for construction activities. These updates are documented in Site work plans and are maintained at the plant as a part of the IC remedy for soils (see **Attachment 7** for IC review). Therefore, new toxicity changes were not evaluated for soil sites during this FYR.

TCEQ benchmarks for ecological risk were updated in August 2018. As described in **Attachment 14**, a number of updates were made during the current FYR period for soil, surface water, and sediment. Of the 57 updates since 2018, the majority have been for surface water. There have only been three

updates for soil and eight updates for sediment. In fact, for soil only one of the three updates resulted in a change to a value; the benchmarks for all polycyclic aromatic hydrocarbons (PAHs) were removed and replaced with the lowest conservative wildlife PCL.

For sediment, only five updates affected actual values. Two of the five updates concerned PFOS, which was not evaluated historically, but will be evaluated in future efforts at Pantex. The three other numerical updates were for copper (benthic PCL corrected), vinyl chloride (benchmark corrected), and 3-methyl-4-chlorophenol (benchmarks were re-evaluated). The copper PCL was not used in the Sitewide ERA and the other two chemicals were not part of the analytical suite at the Playas.

While surface water has received the majority of the updates since the Second FYR, these updates would not substantially affect the previous ERA conclusions at Pantex. The primary surface water bodies at Pantex are the playas and they were evaluated in *The Site-Wide Ecological Risk Assessment Report* (Pantex, 2005).

One major guidance change in 2018 focused on the evaluation of PAHs in soil and sediment. PAHs almost always occur in the environment as mixtures. Therefore, TCEQ indicated that the benchmarks and PCLs provided for total PAHs (TPAHs) are the most relevant for evaluating risk in an ERA. Values for individual, low molecular weight, and high molecular weight PAHs should only be used where there are no benchmarks or PCLs available for TPAHs (e.g., for surface water). As a result, the TCEQ has replaced the soil benchmarks for low and high molecular weight PAHs (LPAHs and HPAHs) with a TPAHs benchmark. This focus on TPAH also would have limited effect on the soil evaluations conducted previously at Pantex.

The radionuclide benchmarks are biota concentration guides (BCGs) from DOE's *A Graded Approach for Evaluating Radiation Doses to Aquatic and Terrestrial Biota* (USDOE, 2002) and were updated in 2019 (USDOE, 2019). A comparison between the two versions indicated that none of the BCGs had changed; therefore, no rescreening of radiological data at Pantex is necessary for the ERA.

Other toxicity reference values (TRVs) were derived through use of dose-based no observed adverse effect level (NOAELs) and lowest observed adverse effect level (LOAELs). Sources for NOAEL and LOAEL TRVs are not typically specified in ERA guidance. The NOAEL and LOAEL TRVs for wildlife used in the ERA were derived from laboratory or field studies reported in literature that were evaluated for population scale or relevant responses (e.g., growth, reproductive success, fecundity, offspring impacts, and mortality). No new information was found regarding the original sources of TRVs used in the ERA; therefore, no recalculation of risk is necessary for the ERA.

Even in the 2018 guidance, TCEQ only makes limited suggestions about potential sources of TRVs. However, TCEQ and its contractor (West Texas A&M University) have developed an Ecological PCL Database or "PCL Database" that provides default ecological PCLs for soil and sediment for a variety of wildlife receptors and COCs (https://pcl.wtamu.edu/pcl/PCL_Calculator.jsp). The PCL Database was officially released to the public in January 2017 and is updated periodically. TCEQ (2018) refers to the PCL Database as a source for assessment levels, toxicity profiles, TRVs, life history information, and uptake factors (e.g., bioaccumulation factors). Specifically, the guidance notes that "TRVs are available from the PCL Database for use in Tier 2 and Tier 3 ERAs and follow a standard methodology for development." As a result of the TRV information available in the PCL Database, any future ERAs at Pantex would primarily use this information for consistency purposes.

#### 7.1.2.4 Changes in Risk Assessment Methods

No changes to TCEQ HHRA guidance were found during this Third FYR. In 2019, EPA published *Guidelines for Human Exposure Assessment* (EPA, 2019). This document replaces the 1992 *Guidelines for Exposure Assessment*. The updated guidelines include information about planning exposure assessments, models that predict exposure, details on planning human exposure studies, and uncertainty and variability in exposure assessments. Much of this content focuses on actions before or during the RI phase. Where changes to exposure guidance are specific and substantive, they are reflected in updated EPA Regional Screening Levels and updated Texas RRR MSCs. Thus, these changes are captured by comparison of site concentrations/GWPSs to the updated MSCs (Table 5). After review of the new guidance, it was determined that no changes in the GWPS or RA are recommended based on changes in risk assessment methods. Pantex conducted the ERAs using guidance from the State of Texas, as well as considering EPA guidance. The *Guidance for Conducting Ecological Risk Assessments at Remediation Sites in Texas* (TNRCC, 2001) was published in 2001, with 2006 (TCEQ, 2006), 2014 (TCEQ, 2014), and 2017 (TCEQ, 2017c) updates. The most significant technical updates were incorporated into the January 2017 version and discussed during the Second FYR. The Third FYR focuses on the 2018 updates. One major update to risk assessment methods was identified:

- Major – Evaluating Risk from PAHs in soil and sediment. See previous discussion in Section 7.1.2.3.

ERAs for soil, surface water, and sediment media were completed using methods described in the 2001 guidance. As a result, the sites were re-evaluated for risk at Pantex Plant in light of the new guidance. As the revised PAH evaluation methodologies would not result in any changes to the conclusions of the ERA, further evaluation is not recommended. No other changes in risk assessment methods have impacted previous risk assessments or conclusions.

The soil remedy is progressing as expected and is currently meeting RAOs intended to protect workers. The remedy is expected to protect future groundwater resources. Detailed performance evaluations of soil remedies are presented in Attachment 7.

### 7.1.3 Question C: Has any other information come to light that could call into question the protectiveness of the remedy?

No. The soil remedy is currently protective and is expected to remain protective in the future. No changes are needed relative to worker and ecological exposures and risks, natural disasters, or land use changes.

## 7.2 GROUNDWATER REMEDIES

RAOs for perched groundwater are:

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

For this FYR assessment, all groundwater remedies were evaluated comprehensively for questions relating to O&M and remedy performance, with a more detailed assessment of the remedy components

following each question. An independent evaluation of remedy performance and efficacy is found in Attachment 7. The following groundwater remedies are included in this evaluation:

- Southeast Area Perched Groundwater Remedy (includes north and east perched unit remedies)
  - P&T Systems (SEPTS and P1PTS)
  - SEISB System
  - SEISB System Extension
  - Offsite ISB System
  - ICs for groundwater
  - LTM to confirm effectiveness.
- Zone 11 Perched Groundwater Remedy
  - Zone 11 ISB System
  - ICs for groundwater
  - LTM to confirm effectiveness.

### 7.2.1 Question A: Is the remedy functioning as intended by the decision documents?

The groundwater remedy is largely functioning as intended in the short-term. The complete remedy for groundwater has been functioning since 2009, and long-term goals are not expected to be met at this time.

Four issues have been identified that could affect long-term protectiveness of the remedy:

Increasing perched groundwater levels around Playa 1 resulting from decreased P1PTS operation during the Third FYR period and discharges of treated water to Playa 1 as a result of subsurface irrigation system equipment/mechanical failures.

- Incomplete treatment of contaminants (HE and Cr[VI]) downgradient of the west end of the SEISB (PTX06-1153).
- Detections of DNT4A exceeding the GWPS in Ogallala monitoring well PTX06-1056.
- Mixed results in the central portion of the Zone 11 ISB, with some performance monitoring wells showing *decreasing* concentrations and concentrations below GWPS. Other data indicate less complete reduction of TCE.

Also, additional groundwater analytes (COPCs), not identified in the ROD as COCs, were identified in the First, Second, and Third FYRs requiring continued monitoring. These analytes are:

- Metals solubilized as a result of ISB treatment systems (arsenic, barium, and manganese).
- 1,4-Dioxane near the Zone 11 ISB.
- Solvent degradation products cis-1,2-DCE and 1,1-DCE identified above MCLs.

Also, Pantex historical information and an initial study of the GAC treatment at the SEPTS and P1PTS indication that per- and polyfluoroalkyl substances (PFAS) need additional characterization in perched groundwater near Playa 1 and the SEPTS.

Each of these issues require continued monitoring as documented in Section 8.

Also, note that areas outside the direct influence of the groundwater remedy, such as the area of perched groundwater east of FM 2373, require continued collection of data to assess the remedy performance with respect to the long-term goal of restoring the perched groundwater.

#### *7.2.1.1 Southeast Area Perched Groundwater Remedy*

The Southeast Area Perched Groundwater Remedy that also includes affected groundwater in the north and east perched unit includes the following individual RAs:

- Two groundwater P&T systems (P1PTS and SEPTS),
- Three ISB systems (SEISB, SEISB Extension, and Offsite ISB),
- ICs to prevent exposure to groundwater, and
- LTM to confirm remedy effectiveness.

##### *7.2.1.1.1 Remedial Action Performance: Southeast Groundwater*

An overview of each of the individual systems that comprise the Southeast Area Perched Groundwater Remedy is provided as follows.

P1PTS

The P1PTS was not functioning as designed during the Third FYR period due to breaks in the subsurface irrigation system that necessitated limited operation of the P1PTS and discharges of treated water to Playa 1. During the Third FYR period, perched groundwater levels and concentrations of COCs increased near the P1PTS. Data since the start of RAs indicate that, when operating as designed, the P1PTS system is effective at reducing contaminant mass, reducing the saturated thickness of the perched groundwater, and helping to control plume migration.

Groundwater elevations increased at monitoring locations within the P1PTS area of influence. Hydrographs of P1PTS monitoring wells can be found in Attachment 10. The hydrographs (Attachment 7, Figure 4.7) from wells PTX08-1002 (near Playa 1) and PTX06-1041 (near the eastern edge of the perched unit) show that the water table elevation increased near the P1PTS, but decreased near the SEPTS related to the reduced operation of the P1PTS and sustained operation of the SEPTS during the Third FYR period. Since 2009, the water level has decreased by about 12 ft near the SEPTS, but it has rebounded to pre-RA levels near the P1PTS in response to reduced operation of P1PTS and discharges of treated water to Playa 1 caused by equipment/mechanical failures in the subsurface irrigation system. When the subsurface irrigation system was down or should the center pivot irrigation systems go down, treated water recharge can exceed runoff recharge in Playa 1, particularly when precipitation is at or below normal runoff totals. However, above normal precipitation can result in runoff recharge exceeding treated water recharge based on modeling results (HGL, 2021a).

Details of the P1PTS operational time are provided in Section 4. The P1PTS is currently operating at approximately 1% capacity until the center-pivot irrigation system is operational in Summer 2023. Until then, the P1PTS will operate at reduced capacity and discharge treated groundwater to Playa 1. From 2012 through 2014, the P1PTS exceeded its goal of 90% operational time and was online over 89% of the time in 2015. Downtime in 2016 limited uptime operations to 65% of capacity. After the irrigation system is repaired, the system is expected to consistently operate at design levels (90% of capacity).

This system is also achieving mass removal from water that is extracted and treated. The P1PTS removed 79 lbs of RDX and other HE contaminants during the Third FYR period. Many monitoring locations in the P1PTS area either have low or no detections of Site COCs. Overall, the magnitude and extent of

contamination in the north is less than the southeast. Wells along the northeastern extent of the perched unit also show *stable* trends, indicating the plume is not migrating in the northeastern area. COC concentration trends at PTX06-1050 northwest of Playa 1 have reverted back to statistically *increasing* trends after *decreasing* during the Second FYR period. *Increasing* concentration trends west and northwest of Playa 1 are likely related to limited P1PTS operation and discharges of treated water to Playa 1 during the Third FYR period. Concentration trend analysis indicates that the P1PTS is capable of maintaining overall stable plume conditions when operating as designed and when treated water is not discharged to Playa 1. Operation of the P1PTS during the First and Second FYR periods demonstrated that P1PTS is capable of balancing extraction of contaminant mass with any further discharge of COCs from the vadose below Playa 1.

SEPTS

The SEPTS system is functioning as designed. As described in Section 5, the SEPTS is achieving progress toward RAOs by reducing saturation to lessen the driving force for vertical migration, stabilizing the contaminants within the influence of the well field, and decreasing the flux of water moving downgradient toward the SEISB and SEISB Extension. The system is achieving mass removal of COCs (primarily RDX and Cr[VI]) and concentrations are generally demonstrating signs of stabilization or reduction at wells that are within the area of influence of the system.

However, the SEPTS does not completely control perched groundwater plume migration to the east/southeast of FM 2373 and south of Highway 60. Perched groundwater east/southeast of FM 2373 is limited in saturated thickness and at a lower elevation than SEPTS EWs. Remedy optimization modeling indicated that the SEPTS would not be able to completely control movement of the HE plume to the southeast and provided alternatives that have been used to develop the Offsite ISB System (HGL, 2021b). Potential new extraction well locations were identified using the existing understanding of conditions at the potential locations. Observed conditions from new data collected during installation may differ from the modeled conditions, and potential new wells may not be able to achieve predicted performance.

Details of the SEPTS operational time are provided in Section 4. The treatment system was shut down as a result of the COVID-19 pandemic in Spring 2020, but restarted in June 2020. The SEPTS exceeded its operational goal of 90% operational time in 2019 and 2021, with operational time above 70% throughout the FYR period. Treated water was diverted to irrigation systems beginning in 2005 and continued through June 2017. Beneficial use, including the ISB systems and irrigation system (also used by the P1PTS) is the preferred method for discharging treated water; however, the SEPTS retains the capability for injection of treated water back into the perched zone and for discharge to Playa 1. The irrigation system experienced mechanical failure in June 2017, and treated water from the SEPTS is currently discharged to Playa 1, reinjected, and beneficially used in the SEISB System, SEISB System Extension, and Zone 11 ISB System.

The SEPTS removed 1,986 lbs of RDX and other HE contaminants and 348 lbs of Cr(VI) during the Third FYR period. Statistical concentration trends at Zone 12 source area wells are *stable* or *no trend* with the exception of one *increasing* trend while concentrations directly east of the Plant along FM 2373 show all *stable* or *decreasing* trends, indicating control of plume migration within the SEPTS area of influence. The SEPTS is the most effective remedy for removing and treating HE from groundwater.

Groundwater monitoring data over the past five years indicate statistically *increasing* trends of HEs in the southeast offsite area of the plume outside the influence of the current SEPTS.

SEISB

The SEISB system is performing as designed and has been effective at reducing concentrations of COCs below GWPS in many locations. The combination of the SEISB and SEPTS has dramatically reduced the likelihood of plume migration in this area of the remedy.

The analytical data indicate effective biodegradation of RDX and reduction of Cr(VI) within the SEISB treatment zone (Attachment 7). Treatment occurring within the SEISB system has had positive impacts on downgradient groundwater quality near PTX06-1037 and PTX06-1154. COC concentrations at these two wells are less than the chromium GWPS and RDX cleanup goal.

At PTX06-1153, chromium concentrations were consistently less than the GWPS between 2017 and 2021 and indicate a *decreasing* trend from the elevated detections reported from 2013 to 2015. The RDX contamination at PTX06-1153 has decreased, however, it remains above GWPS, and the reason for the persistent RDX contamination at this well has not been conclusively determined. The available data suggest that perched groundwater is not by-passing the SEISB along its western edge and that PTX06-1153 is not isolated from the SEISB system in a stagnant zone. The interpolated FGZ surface based on well logs in the area indicate that a small high in the FGZ is present between the SEISB and PTX06-1153 that could be influencing groundwater flow between the SEISB and PTX06-1153. The CSM in the area of the SEISB is being updated as data are collected to clarify the migration pathway of contamination to PTX06-1153 and to guide optimization of ISB amendments in this area.

Several of the monitoring wells surrounding the SEISB are dry including upgradient wells PTX06-1103, PTX06-1118, and PTX06-1167; and cross-gradient wells PTX06-1051, PTX06-1119, PTX06-1122, and PTX06-1188. PTX06-1123 has had about 0.5 ft of water above the screen bottom, an insufficient volume for technicians to collect a sample. These results indicate that the SEPTS is reducing saturation in the SEISB area, limiting the likelihood of plume mobilization in this area.

SEISB Extension

The SEISB Extension is performing as designed and has been effective in degrading RDX, but concentrations in the downgradient monitoring wells have not begun to attenuate. Based on seepage velocity estimates, it is expected that treated groundwater from the SEISB Extension will not reach the downgradient monitoring wells until between 2022 and 2027 (Attachment 7).

Geochemical data indicate that the in situ amendments are generating anaerobic conditions conducive to contaminant destruction in TZM wells, and transient generation of RDX degradation byproducts (i.e., MNX, DNX, and TNX that eventually decrease to concentrations below the GWPS) indicates that RDX is degrading.

Offsite ISB

Due to the recency of the initial injection event, the Offsite ISB's performance with respect to COC degradation and short-term efficacy was not evaluated. Hydraulically, PTX06-ISB401 through PTX06-ISB410 appeared to perform well as each well received the target volume of amendment solution.

#### *7.2.1.1.2 System Operations/O&M Southeast Groundwater Remedy*

P1PTS and SEPTS

O&M of the two P&T systems are described in Section 4, and detailed evaluation information can be found in **Attachment 7**. The SEPTS is operating as intended in the ROD and is expected to maintain its effectiveness. The P1PTS was not operating as intended in the ROD during the Third FYR period as a result of subsurface irrigation system equipment/mechanical failures that necessitated reduced operational time of the P1PTS to limit discharge of treated water to Playa 1.

The operational goals for the P1PTS and SEPTS were realigned in July 2014 to a prioritized schedule consisting of the following:

- Maintain 90% operation time with no injection at SEPTS when the WWTF/irrigation system can receive all treated water.
- When the WWTF/irrigation system is limiting flow, no injection at SEPTS with minimum flow rates (125 gpm) maintained at both systems. Injection is used at SEPTS to maintain minimum flow if flow is otherwise limited below 250 gpm for the two systems.
- Maintain 90% of system treatment or well field capacity, whichever is lower.

Approximately 7% (33 Mgal) of the treated water produced from the SEPTS during the 2017 through 2021 period was discharged to the irrigation system. Discharges of treated water to Playa 1 accounted for 67% (313 Mgal) of water produced from the SEPTS. Approximately 22% (106 Mgal) of the treated water produced from the SEPTS was reinjected into the perched unit, and the remaining 4% (18 Mgal) was beneficially used for the ISB systems.

As described previously, performance goals for the SEPTS with respect to operational run time were generally met except during the COVID-19 plant shutdown. Performance goals for the P1PTS for operational run time were generally not met as a result of decreased P1PTS operation during the FYR period resulting from subsurface irrigation system breaks that required treated water to be discharged to Playa 1 under permit restrictions. After 2019, the SEPTS operation was prioritized over the P1PTS in an effort to capture and treat more COC mass and reduce water elevations driving plume mobility.

The operational goal for the average quarterly pumping rate (expressed in gpm) is affected by the yield from each well, well downtime, and/or reduced flow required by restrictions associated with the WWTF/irrigation system. As the P1PTS does not have reinjection capability, the system must be paused or shut down if the subsurface irrigation system cannot accept treated discharge, or treated water is required to be discharged to Playa 1. Because of permit-limited discharges to Playa 1, the 90% of the designed system flow capacity target was met in 1 of the 20 quarters during the 2017 to 2021 period at the SEPTS and in 0 of the 20 quarters at the P1PTS. However, the throughput exceeded 75% of design capacity at the SEPTS for half of the current FYR period.

SEISB

O&M of the SEISB is described in Section 4, and a detailed evaluation can be found in **Attachment 7**. The system is operating as intended in the ROD within the area of influence and is expected to maintain its effectiveness.

Based on the baseline rate of perched groundwater flow and estimated amendment longevity, the design injection frequency was initially estimated to be once every 12 to 24 months at the SEISB. Pantex has

recently switched to using molasses during injection events to more widely distribute the carbon source, which will affect the longevity of the treatment zone; however, recent injections at the SEISB are now informed by the presence of contaminants and saturated thickness of the perched groundwater across the system. One injection event was performed for the SEISB during this FYR period (November 2019). Treated water from the SEPTS is used to mix amendments for injection. Before each injection event, the IWs are rehabilitated to address biofouling. The rehabilitation efforts appear to be effective based on the resulting sustained injection rates, injection volumes, and performance monitoring data collected from treatment zone and downgradient monitoring wells.

SEISB Extension

O&M of the SEISB Extension is described in Section 4, and a detailed evaluation can be found in Attachment 7. The system is operating as intended in the ESD within the area of influence and is expected to maintain its effectiveness.

Based on the rate of perched groundwater flow and estimated amendment longevity of molasses, injections are estimated to be necessary every six to nine months at the SEISB Extension system. Five injection events were performed for the SEISB Extension during this FYR period (January 2019, August 2019, July 2020, April 2021, and October 2021). The intervals between injection events ranged from approximately six to 11 months at the SEISB Extension. Treated water from the SEPTS is used to mix amendments for injection. Before each injection event, the IWs are rehabilitated to address biofouling. During the FYR period, the rehabilitation efforts appeared to be effective based on the resulting sustained injection rates, injection volumes, and performance monitoring data collected from the treatment zone (the influence of amendments is not expected to reach downgradient monitoring wells until sometime between 2022 and 2027 based on estimated perched groundwater seepage velocities).

Offsite ISB

O&M of the Offsite ISB is described in Section 4, and a detailed evaluation can be found in Attachment 7. The system is operating as intended in the ESD within the area of influence and is expected to maintain its effectiveness.

Based on the rate of perched groundwater flow and estimated amendment longevity of molasses, injections are planned every six months in different areas of the Offsite ISB system. One injection event was performed during the FYR period (June 2021). Water extracted from recovery wells and treated at a mobile treatment trailer was used to mix amendments for injection for the first injection event. Rehabilitation is planned prior to subsequent injection events. For the first event at each IW, rehabilitation is not required.

#### *7.2.1.1.3 Opportunities for Optimization Southeast Groundwater Remedy*

Several opportunities have been identified for individual RAs that would improve the overall performance of the Southeast Area Perched Groundwater Remedy. Detailed descriptions of optimization opportunities are presented in Attachment 7 and summarized below.

P1PTS and SEPTS

The primary O&M challenge for the P1PTS during the Third FYR period was operation of the subsurface irrigation system for discharge of treated groundwater. The irrigation system was not specified as part of the Selected Remedy in the ROD, but was added to optimize remedial efficacy of the P&T systems and provide beneficial use of treated groundwater.

Maintenance problems with the subsurface irrigation system limited the total amount of groundwater that could be treated and resulted in reinjection of treated water from the SEPTS and discharge of treated water from P1PTS and SEPTS to Playa 1. This challenged achievement of the remedial goal of reducing saturated thickness of the perched groundwater unit. A new center-pivot irrigation system is being constructed east of FM 2373 and is expected to be operational in Summer 2023. The center-pivot irrigation system is expected to supplement the subsurface irrigation system and will allow for the beneficial use of treated water without recharging the perched zone and the P&T systems to achieve operational goals. It is recommended that the practice of discharging treated water to Playa 1 be minimized once the new irrigation system is operational (implemented only during special circumstances[2]) and that the P1PTS should return to using extraction rates consistent with target rates to allow the perched groundwater near Playa 1 to decrease again, consistent with the RAOs. It is expected that rates of perched groundwater elevation decline consistent with those observed from approximately 2009 to 2015 near Playa 1 will be re-established under those conditions and result in the saturated thickness reaching 2015 levels around Playa 1 in approximately six years (by 2029). Additional O&M protocols, such as freeze prevention or maintenance of backup parts for the irrigation system, may be pursued as part of those efforts.

Operation of the SEPTS and P1PTS at target extraction rates (and without discharge of treated water to Playa 1) has been demonstrated to reduce saturated thickness both around Playa 1 and near the SEPTS because net outflows (i.e., mostly pumping) exceed net inflows (i.e., natural recharge) under those conditions. However, saturated thickness will eventually become too low to allow the EWs to continue to operate at the current target, which is 90% of system (designed) treatment or well field capacity (whichever is lower). Saturated thickness may already be near these critical levels in the SEPTS area, resulting in EWs cycling on and off. It is recommended that operational goals for extraction be modified/clarified to address when and how operational goals will change when saturated thickness becomes sufficiently low. Transitioning away from the current extraction rate goal might include consideration of the following:

- The optimum gap between low- and high-level controls in each well with respect to pump cycling;
- The potential for different pumps that allow water intake at lower elevations when replacing existing pumps that have failed;
- A plan for EW redevelopment based on decreases in specific capacity over time to improve extraction rates in wells that have sufficient water levels for sustained pumping; and
- The potential that EWs without a Variable Frequency Drive (VFD) (if any) would benefit from VFD implementation or a smaller capacity pump when replacing existing pumps that have failed.

A recent optimization study (HGL, 2021b) recommended an optimal extraction network and EW prioritization using the existing EWs and identifying potential new EWs for consideration that are predicted to provide the most benefit to the remedies. That evaluation incorporated an updated, calibrated groundwater flow model for the perched groundwater. The model used PBMO™ software to assess and optimize multiple pumping and in situ treatment scenarios to efficiently treat perched groundwater. None of the more than 250,000 simulations across all the scenarios resulted in attainment

[2] In the case where the capacity of injection and irrigation systems are not sufficient to meet treated water discharges, prioritizing extraction at the SEPTS and recharge of treated water at Playa 1, as was done during the current FYR period, maintains capture at the SEPTS and removal of contaminant mass. However, it should also be a high priority to limit the duration of those events (e.g., keep spare parts for irrigation system on hand).

of RAOs, even with addition of new EWs. This is due in part to much of the contaminant mass being inaccessible via pump and treat. For example, much of the RDX plume exists in areas of limited perched groundwater saturation (<15 ft) and cannot be effectively recovered with pump and treat technology. Other areas of the RDX plume are inaccessible due to Plant operations. The pump and treat optimization effort demonstrated that incremental improvement of mass removal and mitigation of contaminant migration are possible; however, the cost/benefit for installation of new extraction wells should be evaluated prior to any new well installation. A summary of that evaluation and recommended well prioritization is presented in Attachment 7.

SEISB

Overall, the SEISB has been effective at degrading RDX and reducing Cr(VI) concentrations below GWPS. However, the area near monitoring well PTX06-1153 has not responded as well as other areas of the SEISB. Optimization of injection in the area of PTX06-1153 is recommended to address residual contamination in this area.

Upgradient groundwater data was not available for the Third FYR period because upgradient wells (PTX06-1103, PTX06-1118, PTX06-1167, and PTX06-1206) have gone dry as a result of SEPTS progress in removal of perched groundwater. Obtaining upgradient groundwater data would be helpful to determine influent concentrations which would aid in evaluating the extent of contaminant removal by the SEISB and the need for additional amendment injection.

SEISB Extension

Overall, the SEISB Extension has been effective at degrading RDX within the treatment zone. Concentrations in downgradient monitoring wells have not yet begun to attenuate and treated groundwater from the SEISB Extension is not expected to reach downgradient monitoring wells until between 2022 and 2027. Since the first injection event in 2019, most TOC detections have been greater than 100 milligrams per liter. The consistently elevated TOC concentrations suggest that the time between amendment injection events can be lengthened. It is recommended that the duration until the next amendment injection event be increased to provide data to evaluate decreasing the amendment injection frequency. Additionally, pH measurements should be taken periodically in select IWs to assess the need for adding a buffering agent, such as sodium bicarbonate, to the amendment solutions.

Offsite ISB

The Offsite ISB has not had enough time since its injection event to assess its effectiveness at degrading Site COCs. The initial injection event demonstrated that the Offsite ISB system was able to inject the target volumes, indicating that it is performing as designed, hydraulically. Additional phases of the remedy have been constructed since the end of this FYR period and will be finished in 2023 (see Section 4.4 of Attachment 7 for additional details). Because of its recent and ongoing development, there are no opportunities for optimization at this time.

#### *7.2.1.1.4 Early Indicators of Potential Issues*

Three potential issues associated with the Southeast Groundwater Remedy were identified in Section 7.2.1 and are documented in Section 8:

- Increasing perched groundwater levels around Playa 1 resulting from decreased P1PTS operation during the Third FYR period and discharges of treated water to Playa 1 as a result of subsurface irrigation system equipment/mechanical failures.

- Incomplete treatment of HE downgradient of the west end of the SEISB (PTX06-1153).
- Detections of DNT4A exceeding the GWPS in Ogallala monitoring well PTX06-1056.

Short-term protectiveness is not affected by these issues, but long-term protectiveness may be affected if enhancements to the Selected Remedy are not implemented. Recommended enhancements to RAs to address these issues are discussed in Section 9 and in Attachment 7.

#### *7.2.1.1.5 Implementation of ICs and Other Measures*

All Pantex ICs were reviewed as described in Attachment 7. All ICs have been implemented and are working as intended to prevent exposure.

Additional deed restrictions were executed in December 2021 and June 2022 on two properties in the area of Highway 60, based on results from the characterization of the southeast RDX plume extents in perched groundwater. No other deficiencies related to the implementation, maintenance, operation, and enforcement of the ICs were noted in the review.

Results of the review of the LTM network for the Southeast Area Groundwater Remedy are presented in Attachment 11. Additional groundwater monitoring locations were recommended for southeast areas of perched groundwater to manage uncertainty and assess remedy performance. No other major changes in the LTM network were recommended.

### *7.2.1.2 Zone 11 Perched Groundwater Remedy*

The Zone 11 Perched Groundwater Remedy includes the following individual RAs:

- Zone 11 ISB System;
- ICs to prevent exposure to groundwater; and
- LTM to confirm remedy effectiveness.

A summary of Zone 11 remedies is provided below.

#### *7.2.1.2.1 Remedial Action Performance Zone 11 ISB*

The Zone 11 ISB system is functioning as designed, and concentrations of COCs are decreasing in many locations, progressing toward cleanup goals. Overall, the Zone 11 ISB system has been effective at reducing contaminant mass and helping to control plume migration.

The primary groundwater COCs at the Zone 11 ISB are TCE and perchlorate. Although 1,4-dioxane is also present above remedial goals, it is not widespread and calculated risk is less than 1.0E-04.

Sampling results from 15 IWs and 21 monitoring wells were used to assess the performance of the Zone 11 ISB (Attachment 7, Section 4.5.3.1). The findings of this assessment showed the following:

- The eastern side of the Zone 11 ISB, where perchlorate is dominant, is effective at eliminating and controlling the spread of perchlorate that is within the influence of the ISB, but has had *increasing* concentrations of TCE during the current FYR period.
- The central portion of the Zone 11 ISB demonstrates mixed results, with some performance monitoring wells showing *decreasing* concentrations and concentrations below GWPS. Other data indicate less complete reduction of TCE. Overall, TCE concentrations are *stable* to

*decreasing*, indicating that the remedy is effective at controlling plume migration, but degradation may be stalling at the generation of cis-1,2-DCE in some areas

- The expansions of the western portion of the Zone 11 ISB in 2014 and 2019/2020 have been effective in controlling and delineating the extent of TCE contamination in the area.
- Perchlorate data from the northeastern edge of the Zone 11 plume and from the SEPTS influent indicate that perchlorate continues to migrate around the Zone 11 ISB system to the north and is now partially captured and treated by the SEPTS.
- The Zone 11 ISB remedy does not address 1,4-dioxane, which is emanating from Zone 11.

Natural attenuation parameters, along with pH, dissolved oxygen (DO), and oxidation reduction potential (ORP), were measured in select wells and used to assess whether the groundwater geochemistry is suitable for biological reduction of TCE and perchlorate. The data suggest that the carbon substrate amendment may not be adequately distributed throughout the treatment zone in some locations where the target amendment injection volume was not met as a result of low flow rates.

#### *7.2.1.2.2 System Operations/O&M*

O&M procedures at the Zone 11 ISB system, as implemented, are working in a manner that will ensure continued efficacy.

Carbon substrate amendment has been injected into the Zone 11 ISB four times during the current FYR period (April 2018, March 2019, June 2020, and April 2021), with frequency ranging from 10 to 15 months. Treated water from the P&T systems is used to mix amendments for injection. Before each injection event, the IWs undergo maintenance for biofouling. During the 2021 well maintenance program, 42 IWs were surged, brushed, and bailed and chemically treated with Welgicide.

During the Third FYR period, many of the injected wells received less than the target injection volume. A field test was conducted in 2018 to assess amendment distribution within the treatment zone using fluorescein dye and a Newman Zone®/molasses solution. The test determined that increased injection volumes (195% to 372% of the target volumes) were needed for dye and TOC breakthrough to occur in monitoring wells. In 2021, 19 of 64 wells injected received less than the target injection volume. The injection flow rate per well ranged from 1.1 gpm to 20 gpm with an average of 7 gpm.

#### *7.2.1.2.3 Opportunities for Optimization*

The following recommendations are provided to optimize performance of the Zone 11 ISB:

- Review amendment injection volumes to confirm that they are sufficient to distribute amendment away from the IWs. For example, amendment solution volumes applied to the ISB wells on either side of PTX06-1164 were lower from 2019 to 2021 than in 2018, when the highest TOC detection between 2017 and 2021 was reported.
- Consider addition of a buffering agent to the amendment solutions to increase pH in the IWs and counter future acid production by microorganisms.
- Install a performance monitoring well downgradient of IWs PTX06-ISB132 through PTX06-ISB137 to provide spatial coverage along this section of the ISB system.
- It is expected that IWs installed in 2021 will reduce the TCE contamination migrating downgradient from the east side of the ISB system. Amendment was first applied through these

wells in fall 2021. Consider adding two of these new IWs (e.g., PTX06-ISB161, PTX06-ISB145) to the monitoring program to support determination of amendment injection frequency and evaluation of IW performance.

- During recent injection events, multiple wells received less than the target volume of amendment solution due to low flow rates, and the average flow rate for many wells was approximately 5 gpm or less. With such low flow rates, it can take many days to administer the target injection volume to a given well and the duration of each field event is lengthened. Consider options to improve in situ treatment such as:
  - Testing existing IWs to serve as recirculation wells to enhance amendment distribution; and
  - Testing alternative well maintenance approaches, such as sequential application of different chemical agents, longer surge times, or a heated water maintenance approach.
- Prepare groundwater potentiometric contours localized to the Zone 11 ISB and at a smaller interval (e.g., 1-ft) than the 5-ft interval currently used to allow a more precise evaluation of potential changes in groundwater flow direction due to SEPTS operation. Because in situ treatment zones are typically most effective when oriented perpendicular to the direction of groundwater flow, long-term changes in groundwater flow direction will affect the ISB system's effectiveness. For future amendment injection events, changes in groundwater flow direction should be considered during the selection of wells to receive treatment.

#### *7.2.1.2.4 Early Indicators of Potential Issues*

One potential issue related to the Zone 11 groundwater plumes was identified in Section 7.2.1 and discussed in detail in Section 8:

- The central portion of the Zone 11 ISB demonstrates mixed results, with some performance monitoring wells showing *decreasing* concentrations and concentrations below GWPS. Other data indicate less complete reduction of TCE.

In addition, 1,4-dioxane has been observed comingled with the TCE plume at concentrations higher than indicated during initial characterization. The 1,4-dioxane plume is within the footprint of the TCE plume and does not exceed the calculated 1E-04 risk level. Continued monitoring of 1,4-dioxane is recommended for the coming FYR period to confirm that the source is not increasing. If 1,4-dioxane is detected at concentrations near GWPS in SEPTS effluent, additional treatment using chemical oxidation or changes in pumping rates at specific EWs may be considered.

#### *7.2.1.2.5 Implementation of Institutional Controls and Other Measures*

All Pantex ICs were reviewed as described in **Attachment 7**. All ICs have been implemented and are working as intended to prevent exposure. No other deficiencies related to the implementation, maintenance, operation, and enforcement of the ICs were noted in the independent review.

Results of the review of the LTM network for the Zone 11 Groundwater Remedy are presented in **Attachment 11**. Additional groundwater monitoring locations were recommended for areas downgradient to manage uncertainty and assess remedy performance if increasing COC trends continue downgradient. No other major changes in the LTM network were recommended.

### 7.2.2 Question B: Are the exposure assumptions, toxicity data, cleanup levels, and RAOs used at the time of remedy selection still valid?

Yes, with the exception of PFAS. Potential sources of PFAS exist at Pantex, including areas of AFFF use and possible PFAS containing materials in legacy high explosive releases. EPA has revised many of the standard default residential exposure parameters to reflect changes in the United States population. These changes were evaluated as described in Attachment 14, and the evaluation results indicate that the existing cleanup levels provide conservative protective concentrations and appropriate remedial goals, with the exception of perchlorate. The GWPS for perchlorate was updated from 26 µg/L to 15 µg/L as a result and is documented in the 2022 ESD.

#### *7.2.2.1 Changes in Standards and TBCs*

As noted in the ROD, Pantex used the promulgated EPA primary MCL as the GWPS when one is available. For RDX, the published LHA was used as the GWPS because this COC was the primary risk driver in groundwater and was widespread across the southeast plume.

There have been no changes to MCLs used as the GWPS, and the LHA for RDX has not changed. New MCLs have not been added. The perchlorate GWPS was revised to 15 µg/L based on the EPA Interim LHA.

No additional changes are recommended for the GWPS values identified in the ROD and updated values for perchlorate identified in the ESD at this time.

No new COCs were identified for risk evaluation during the Third FYR period. Per- and Polyfluoroalkyl substances, known as PFAS, are a group of compounds that are emerging contaminants that will be evaluated as the health effects are better determined and as Pantex obtains concentration data before the next FYR. Several TBC analytes, referred to elsewhere in this document as COPCs not identified in the ROD, were identified near or above EPA primary MCLs during the First and Second FYR periods. In addition, some COCs identified in the ROD were found at concentrations higher than expected or in areas not previously identified during initial Site characterization. These TBC analytes are:

- Selenium near Pantex Lake
- Cadmium beneath Zone 12 South (WMG 6/7)
- 1,4-Dioxane near Zone 11 ISB
- Metals solubilized as a result of ISB treatment systems (arsenic, barium, and manganese)
- Solvent degradation products cis-1,2-DCE and 1,1-DCE identified above MCLs

These TBC analytes are reviewed in Attachment 14 to determine if risk is decreasing or to determine if further analysis is required. Results are as follows:

- Selenium concentrations above the MCL (50 µg/L) were limited to PTX06-1083 near Pantex Lake and all other results were below the background concentration. Because selenium is not related to the release of legacy wastes and is likely associated with nearby agricultural practices, it is not identified as a COC.
- Cadmium concentrations were below the MCL (5 µg/L) during the Third FYR period and data indicates concentrations have decreased. Given the limited detection of cadmium and the absence of any concentrations above MCLs, the current sampling frequency can be decreased to a five-year frequency, as originally planned for these wells.

- 1,4-dioxane concentrations were overall decreasing during the Third FYR period and data support that partial degradation is occurring, but monitoring should continue until concentrations decline further.
- Arsenic, barium, and manganese remain elevated in ISB treatment zones and downgradient monitoring wells; although, concentrations in downgradient monitoring wells are generally lower than treatment zone concentrations indicating that these metals will continue to attenuate as they move downgradient. Monitoring for these metals in perched groundwater and the Ogallala Aquifer should continue to confirm that concentrations above GWPSs are not reaching the Ogallala Aquifer.
- Cis-1,2-DCE concentrations have declined overall in the Third FYR period, but monitoring should continue until the GWPS is achieved for all wells.
- 1,1-DCE concentrations are expected to decline with TCE concentrations; however, monitoring for 1,1-DCE should continue until maximum concentrations decline below the MCL (7 µg/L).

The additional TBC analytes are discussed in detail in Attachment 14.

#### *7.2.2.2 Changes in Exposure Pathways*

No changes in exposure pathways were identified during this review.

The Pantex Plant property is used for industrial purposes and access is strictly controlled because of the Plant mission.

No new potentially complete exposure pathways have been identified for perched groundwater. However, plume migration to the southeast has resulted in expanding ICs to two additional properties. These groundwater deed restrictions prevent use of perched groundwater for non-remedial activities and restrict drilling into the perched unit. Two additional ISB systems were added and expanded during the Third FYR period, the SEISB System Extension and Offsite ISB. Both systems were included in the 2022 ESD and will continue to be optimized to ensure HE contamination on the neighboring property is addressed.

Early detection wells completed in the Ogallala Aquifer are monitored to identify breakthrough of constituents to the Ogallala Aquifer from overlying perched groundwater, if present. Seven COCs have been detected in these wells in recent (2017 to 2021) groundwater monitoring:

Cr(VI) was detected below the GWPS of 100 µg/L in all 22 sampled intervals of 17 Ogallala Aquifer monitoring wells in 2021. The detections in all but four of the wells were below the background level of 3.2 µg/L. It is likely that increasing concentrations of chromium may be related to the stainless-steel screens and the confirmed presence of bacterial growth that has been found in many of the perched groundwater and Ogallala Aquifer wells at Pantex, as discussed in the 2021 Annual Progress Report: Remedial Action Progress in Support of Hazardous Waste Permit 50284 and Pantex Plant Interagency Agreement (CNS, 2022a).

Total chromium was detected below the GWPS of 100 µg/L in 12 Ogallala Aquifer monitoring wells in 2021. All of the detections were below the background level of 31.8 µg/L.

DNT4A (a breakdown product of the HE 2,4,6-TNT) has been detected at PTX06-1056 since April 2014. DNT4A was detected in both semi-annual samples in 2021 at values of 0.624 and 0.723 µg/L, below the GWPS of 1.2 µg/L. These continued detections indicate possible migration of perched

groundwater to the Ogallala Aquifer. Although a potential source of contamination (i.e., perched monitoring well PTX06-1108) has been plugged, the concentrations persist in PTX06-1056 and have not declined since plugging and abandonment of PTX06-1108.

Although not detected in the 2021 sampling events, DNT4A was detected for the first time below the practical quantitation limit (PQL) and GWPS in PTX06-1076 in the June 2020 sample at a concentration of 0.0933 µg/L; in the August 2020 verification sample at a concentration of 0.0834 µg/L; and in the October 2020 sample at a concentration of 0.0903 µg/L.

1,2-Dichloroethane has been detected consistently at PTX06-1056 since August 2015 and was detected in both semi-annual samples in 2021; all detections were below the PQL and GWPS. Samples were collected from the upper portion of the screen to provide the best opportunity for detecting contaminants migrating vertically from perched groundwater through the unsaturated zone between the Ogallala Aquifer and the FGZ. 1,2-Dichloroethane was also detected in PTX06-1139 and PTX06-1157 in August 2018 at or below the PQL and below the GWPS; but not detected in subsequent semi-annual sampling events from 2019-2021 in either well.

1,4-dioxane has been detected in PTX06-1068 in October 2017 at a concentration of 1.05 µg/L, slightly above the PQL, but below the GWPS. 1,4-dioxane was not detected in this well previously or in the subsequent 9 rounds of sampling from 2018-2021. In addition, 1,4-dioxane was detected in PTX07-1R01 in October 2017 at a concentration of 0.897 µg/L, below the PQL and GWPS. 1,4-dioxane was not detected previously or in the subsequent 6 rounds of 2018-2021 sampling from this well.

RDX has been detected in PTX01-1101 in July 2019 at a concentration of 0.154 µg/L and in PTX07-1R01 in July 2020 at a concentration of 0.212 µg/L, both detections were below the PQL and GWPS. RDX was not detected in these wells previously or in subsequent sampling events.

Perchlorate was detected below the GWPS of 15 µg/L in 31 sampled intervals in 21 Ogallala Aquifer monitoring wells in 2021. The detections in all but one of the wells were below the background level of 0.96 µg/L. The detected concentration of 0.966 µg/L in PTX06-1061 slightly exceeded the background level (0.96 µg/L) and likely represents background variability.

Pantex has proactively evaluated potential sources for contamination at PTX06-1056. A nearby perched well (PTX06-1108) that was drilled in 1996 deeply into the FGZ through a dry area was plugged to address the potential source. An outside review conducted by Daniel B. Stephens & Associates, Inc. in 2016, indicated that the adjacent perched well was the most likely source of the contamination based on fate and transport modeling. As the concentrations of DNT4A have increased and are close to the GWPS in the January 2022 sampling event (1.1 µg/L, just below the GWPS of 1.2 µg/L) (Pantex, 2022a), additional evaluation (e.g., additional monitoring, source identification, implementation of interim protective measures [if necessary], and delineation of extent) will be conducted, in accordance with the Groundwater Contingency Plan. Pantex continues to proactively evaluate and address potential sources and has performed a time-series sampling event with a high-volume purge of PTX06-1056 in August 2022. The results of the sampling will be reviewed and Pantex will evaluate the need for additional wells to monitor the Ogallala Aquifer. Sampling of the potential new and established wells will continue in accordance with the approved Sampling and Analysis Plan (SAP) to determine if further action is needed and will follow actions described in the Groundwater Contingency Plan.

#### 7.2.2.3 Changes in Toxicity and other Contaminant Characteristics

Toxicity factors for COCs and TBCs have changed for four COCs, DNT2A, DNT4A, RDX, and manganese over the FYR period. Current MSCs were compared to the 2021 MDCs to identify any analytes for which risk might need to be calculated. As a result of the comparison presented in Attachment 14, Pantex concluded that none of the detected analytes were of concern from a risk perspective.

The current GWPSs were compared to the 2021 MSCs. The 2021 MSCs are less than the current GWPSs for 1,4-dioxane and perchlorate; and the 2021 adjusted MSCs are less than the current GWPSs for DNT2A and DNT4A.

- For 1,4-dioxane, although the 2021 MSC of 0.85 µg/L is less than the current GWPS, the GWPS remains at 7.7 µg/L because it is approximately equal to a 1E-05 cancer risk, which is within the target cancer risk range.
- For perchlorate, the 2021 MSC is the EPA interim health advisory of 15 µg/L; the interim HA was adopted as the GWPS in the 2022 ESD.
- For DNT2A and DN4A, the 2021 adjusted MSCs of 0.7 µg/L are less than the current GWPSs of 1.2 µg/L. However, the values are similar and in addition, there is uncertainty associated with the screening toxicity values used to calculate the 2021 adjusted MSCs. There are no EPA verified toxicity values or provisional toxicity values for these two chemicals due to a paucity of chemical-specific information. EPA employed an alternative analogue approach, which uses data from a related compound (i.e., 2,4,6-TNT), to calculate the screening toxicity values and cautions the user concerning the uncertainty associated with these values (EPA, 2020). Therefore, the GWPSs remain at 1.2 µg/L.

In summary, only the GWPS for perchlorate will change.

#### 7.2.2.4 Changes in Risk Assessment Methods

During the First and Second FYRs, the evaluation of new guidance released by the EPA and TCEQ since the baseline HHRAs indicated that further risk evaluation was not necessary and no changes in GWPS or RA were recommended. No changes to TCEQ risk assessment guidance were found during this Third FYR. In 2019, EPA published Guidelines for Human Exposure Assessment (EPA, 2019). This document replaces the 1992 Guidelines for Exposure Assessment. The updated guidelines include information about planning exposure assessments, models that predict exposure, details on planning human exposure studies, and uncertainty and variability in exposure assessments. Much of this content focuses on actions before or during the RI phase. Where changes to exposure guidance are specific and substantive, they are reflected in updated EPA Regional Screening Levels (RSLs) and updated Texas RRR MSCs. Thus, these changes are captured by comparison of site concentrations/GWPSs to the updated MSCs (Attachment 14). After review of the new guidance, it was determined that no changes in the GWPS or RA are recommended based on changes in risk assessment methods.

Groundwater remedies are progressing toward achieving RAOs in the following ways:

- ICs are effectively preventing exposure of human and animal receptors to affected groundwater.
- Overall, the P1PTS and SEPTS are reducing groundwater elevations in the perched unit, when operating.

- The P1PTS and SEPTS and the ISB remedies are reducing the concentrations of COCs in groundwater. While remedial goals have not been attained, concentrations are progressing toward remedial goals in many areas of the perched unit.
- Migration of plumes is being controlled by the P1PTS in the north and by the SEPTS to the east in the perched groundwater unit.
- The SEPTS, SEISB, SEISB Extension, and Offsite ISB control plume migration in the southern part of the perched unit.
- The Zone 11 ISB is showing signs of destroying contaminant mass and controlling migration of the TCE plume and is effectively reducing and controlling the perchlorate plume in the central and eastern part of the Zone 11 ISB system.
- LTM data indicate that the remedies are limiting impacts to the Ogallala Aquifer; although, recent data suggests limited breakthrough is occurring in areas predicted by numerical modeling performed to support the Baseline HHRA in 2006.

### 7.2.3 Question C: Has any other information come to light that could call into question the protectiveness of the remedy?

Yes. Recent detections of DNT4A above the GWPS in Ogallala monitoring well PTX06-1056 indicate that COCs have migrated through the FGZ in this area. PTX06-1056 is located more than four miles upgradient of municipal supply wells and more than 1.5 miles from the Pantex Plant property boundary. Pantex has fully implemented conditions specified in the Pantex Plant Ogallala Aquifer and Perched Groundwater Contingency Plan (CNS, 2019c) and has proactively evaluated potential sources for contamination at PTX06-1056. A nearby perched well (PTX06-1108) that was drilled in 1996 deeply into the FGZ in an area of limited perched saturation was plugged to address the potential for that well to act as a conduit through the FGZ. The groundwater remedy is currently protective and is expected to remain protective in the near future as the Pantex Plant installs additional wells to gather more data that will aid in evaluating potential risk of contaminants in the Ogallala Aquifer.

Enhancement of the Selected Remedy, by expansion of the P&T and ISB remedies is anticipated to address issues affecting long-term protectiveness in the southeast area of perched groundwater. Recommendations for ensuring long-term protectiveness of the Selected Remedy are presented in Section 9.

## 7.3 TECHNICAL ASSESSMENT SUMMARY

The Site-wide remedy for the Pantex Plant consists of remedies for soil and groundwater. The soil remedies are designed to be protective of workers and future groundwater resources. The groundwater remedies are designed to be protective of the public as well as current and future drinking water supplies. The groundwater remedy is also designed to restore the currently unused impacted perched groundwater to drinking water standards.

The Site-wide remedy is functioning as intended for the short-term. The ICs and engineered controls (e.g., fencing, protective covers, and ditch liner) currently protect workers and the general public from exposure to soil and perched groundwater that is impacted, and these actions are expected to continue to be protective. The SVE is removing soil gas and residual non-aqueous phase liquids (NAPLs) in soils to protect the underlying drinking water aquifer.

Groundwater monitoring has demonstrated that the perched groundwater remedy is performing as expected and concentrations of COCs and water levels are declining in most areas. Groundwater levels in the area of Playa 1 are expected to decline again once the center-pivot irrigation system is operational in Summer 2023 and treated water is no longer discharged to Playa 1.

Some regions of the perched groundwater are not responding as expected and planning is in progress to evaluate options for enhancing existing remedies. Each of the issues identified with respect to the remedy are described in further detail in Section 8. Also, opportunities for improvement of the remedy and the LTM network are explained in Section 9.

The Selected Remedy will continue to be implemented as designed during the next five years. Remedy O&M will continue while evaluations are conducted to develop and/or implement options for enhancing the existing systems as funding allows. These enhancements, including:

- Operation of a mobile P&T system to address areas of high COC concentration east of FM 2373 where perched saturation is sufficient for groundwater extraction.
- Planned installation of approximately 12 IWs near County Road 8, east of FM 2373 to treat HE plumes moving to the southeast.
- Planned installation of approximately 12 IWs between the Zone 11 ISB system and the SEISB system to treat perchlorate and Cr(VI) that are not being actively addressed.
- Evaluation of the CSM and performance monitoring data is under way to identify options to improve the effectiveness of the remedy in the west end of the SEISB and assess a path forward for cleanup.
- Continued monitoring of TBC analytes in perched and Ogallala Aquifer monitoring wells.

Also, data will continue to be collected through the LTM network to better define the anticipated performance of the overall remedy on the long-term period of restoration. Additional data are also needed to refine the CSM in the SEISB region in perched groundwater and the Ogallala Aquifer to identify migration pathways through the FGZ and options to treat the contaminant plumes in that area where vertical migration may be occurring. Evaluation of these data will provide a better understanding of the timing associated with the long-term goal of achieving restoration of the perched groundwater and protectiveness of the remedy for the Ogallala Aquifer. Sampling plans will be updated to include additional COPCs identified during this FYR. Sampling and analysis for PFAS will be accomplished as funding allows, with a primary focus on obtaining information needed for O&M of the Selected Remedy.

# 8.0 ISSUES

Table 8.1 lists the issues identified during the Third FYR and how each affects the protectiveness of the Selected Remedy.

Table 8.1. Issues Identified

| Issue No. | Issues | Affects Current Protectiveness | Affects Future Protectiveness |
|---|---|---|---|
| Soil Remedies | | | |
| 1 | Minor deficiencies in protective soil covers including erosion, animal burrows, and settling. | No | Yes |
| 2 | Tears observed in the SWMU 2 and 5-05 Ditch Liner during the 2021 inspection, and sedimentation and erosion of the anchor trench continues. | No | Yes |
| Groundwater Remedies | | | |
| 3 | Perched groundwater elevations and RDX concentrations are increasing around Playa 1. | No | Yes |
| 4 | Incomplete treatment of contaminants (HE) downgradient of the west end of the SEISB (PTX06-1153). | No | Yes |
| 5 | DNT4A was detected above the GWPS in Ogallala monitoring well PTX06-1056. | No | Yes |
| 6 | Additional groundwater analytes identified in the First, Second, and Third FYR requiring continued monitoring include:<br>• Metals solubilized as a result of ISB treatment systems (arsenic, barium, and manganese)<br>• 1,4-Dioxane near Zone 11 ISB<br>• Solvent degradation products cis-1,2-DCE and 1,1-DCE identified above MCLs<br>• Potential presence of PFAS | <br><br><br><br>No<br>No<br>No<br><br>No | <br><br><br><br>Yes<br>Yes<br>Yes<br><br>Yes |
| 7 | Sections of the Zone 11 ISB demonstrate mixed results, with incomplete degradation of TCE near TZM wells PTX06-1164 and PTX06-1169. | No | No |

## 8.1 DEFICIENCIES IN SOIL COVERS (ISSUE 1)

As noted in Section 4 and detailed in Attachment 7 and Attachment 8, some minor deficiencies in soil covers were identified during the 2022 Site Inspection and LiDAR analysis.

The minor deficiencies do not present any near-term loss of remedy protectiveness. However, minor deficiencies in soil covers, if left unrepaired, may result in long-term loss of protectiveness. A combination of onsite resources and contracts for repair and maintenance will be implemented to address minor deficiencies in soil covers including erosion, settling, and animal burrows. This work will be completed before the next FYR begins in 2027 to ensure that erosion of the protective covers does not occur and long-term effectiveness of this remedy is maintained.

## 8.2 TEARS IN THE SWMU 2 AND 5-05 DITCH LINER (ISSUE 2)

A 2021 inspection of the SWMU 2 and 5-05 Ditch Liner identified tears in the liner. The inspection also noted erosion and sedimentation of the anchor trench. A new liner was installed in 2017 over the

original liner, so tears in the new liner may not cause near-term loss of remedy protectiveness. However, the deficiencies should be addressed soon to minimize the effort needed to maintain effectiveness.

## 8.3 INCREASING PERCHED GROUNDWATER ELEVATIONS AND RDX CONCENTRATIONS NEAR PLAYA 1 (ISSUE 3)

Performance assessments indicate the P1PTS did not operate as intended in the design and decision documents during the Third FYR period because operations were reduced to accommodate an irrigation system failure. Both COC concentrations and groundwater elevations increased near Playa 1. During this time, the treated water recharge in Playa 1 associated with the WWTF and P1PTS exceeded stormwater runoff recharge and exacerbated the rebound of water levels beneath the area. Perched groundwater elevations in monitoring wells within the P1PTS increased to approximately the same elevation as when remediation began in 2009, after declining by about 15 ft between 2009 and 2015.

The increase in perched groundwater elevations near Playa 1 after 2015 has delayed the timing to achieve low levels of saturated thickness in the P1PTS wells and reduce the driving head both laterally to the southeast and vertically through the FGZ. Had the decline in groundwater elevations at PTX08-1002 from approximately 2009 to 2015 continued (i.e., no reduction in extraction rates and no discharge of treated water to Playa 1), the saturated thickness of the perched zone near Playa 1 would likely have reached approximately 15 ft by approximately 2018. Once the center-pivot irrigation system is operational and if system operation moving forward is similar to that in the period from 2009 to 2015 (i.e., achieving target extraction rates and no discharge of treated water to Playa 1), the saturated thickness of the perched zone near Playa 1 could reach 15 ft by approximately 2030. Once the saturated thickness is low enough, P1PTS extraction rates conceptually would need to decline to maintain water levels at steady levels (i.e., where inflows from natural recharge are balanced by extraction plus other outflows).

## 8.4 INCOMPLETE TREATMENT AT SEISB WELL PTX06-1153 (ISSUE 4)

One ISPM well, PTX06-1153, located on the west end of the SEISB has not responded in a manner similar to other downgradient wells believed to be currently under the effect of the SEISB. Data indicate that treated water had reached this well by late 2010 as documented by field parameters and volatile fatty acid concentrations. Chromium concentrations have been consistently less than the GWPS between 2017 and 2021 and indicate a *decreasing* trend from the elevated detections reported from 2013 to 2015; however, RDX contamination at PTX06-1153 has not reached the GWPS. The reason for persistent RDX contamination still has not been determined despite efforts to identify a cause.

Incomplete treatment at PTX06-1153 does not present a threat to short-term protectiveness because the area is deed restricted to prevent drilling into the perched groundwater for purposes other than RAs. Residual contamination at PTX06-1153 presents limited threats to long-term protectiveness. Saturated thickness in the area is very low and has decreased under the influence of the SEPTS. Limited saturation reduces the likelihood of lateral migration. PTX06-1153 is in an area where the FGZ is coarser and potentially more porous, which presents opportunity for migration to the Ogallala Aquifer over the long-term.

Significant efforts have been undertaken to understand the CSM for the area around PTX06-1153 to optimize the remedy response. These efforts include commissioning a report to document factors that may explain the anomalous response in this location (Trihydro, 2017).

In 2019, the SEISB system was injected with molasses to attempt better distribution of amendment. Additionally, to affect treatment at PTX06-1153, perched groundwater was extracted from the well at a flow rate of approximately 1.25 gpm for 2 weeks. In 2020, PTX06-1153 demonstrated signs of partial treatment with a sharp decline in RDX, and breakdown products of RDX were detected at concentrations above the GWPS (CNS, 2022a). Additionally, TOC concentrations increased in the well to higher levels than previously observed after the 2019 injection event.

Several scenarios could be causing these observations:

- PTX06-1153 appears to be in a topographic low. The estimated perched extent defined by dry wells PTX06-1051 and PTX06-1122 is actually a localized high in the FGZ creating a "dry spot" in the perched groundwater and allowing untreated water to flow south of or around the dry spot toward PTX06-1153.
- Untreated water may be flowing beneath the treatment zone, in a lens of higher permeability below what was identified as the top of the FGZ when the SEISB was installed.
- Untreated water may be flowing through the well field, possibly through a preferential flow path of coarse-grained material.

Multiple additional monitoring wells (PTX06-1188, PTX06-1189, and PTX06-1212) were installed northwest of the SEISB well field to better delineate the Cr(VI) and RDX plume boundaries, as well as improve understanding of groundwater flow patterns in the area during the Third FYR period. Each of the newly installed wells were dry at the time of installation and have continued to be dry since. Groundwater elevation and analytical data will continue to be evaluated to determine why PTX06-1153 is not responding in the same manner as the other SEISB ISPM wells and to evaluate options for optimized injection of amendments to address contamination in this area.

## 8.5 DNT4A DETECTED ABOVE GWPS IN OGALLALA MONITORING WELL PTX06-1056 (ISSUE 5)

In 2022, after the Third FYR period but prior to the completion of this Third FYR Report, DNT4A was detected in PTX06-1056 just over the GWPS of 1.2 µg/L. Prior to 2022, concentrations (below the GWPS) of DNT4A, DCA12, and Cr(IV) were observed to be *increasing* in PTX06-1056.

Pantex has fully implemented conditions specified in the *Pantex Plant Ogallala Aquifer and Perched Groundwater Contingency Plan* (B&W Pantex, 2009b; CNS 2019c) and has proactively evaluated potential sources for contamination at PTX06-1056. A nearby perched well (PTX06-1108) that was drilled in 1996 deeply into the FGZ in an area of limited perched saturation was plugged to address the potential for that well to act as a conduit through the FGZ. A high-volume purge/time-series sampling event was conducted in August 2022 in PTX06-1056. Results indicated that concentrations of DNT4A dropped off rapidly during the test, indicating that PTX06-1056 is near the edge of any contamination (CERCLA 5-Year Review Site Inspection, September 2022).

The detection of DNT4A exceeding the GWPS triggers actions in the contingency plan to determine the source of contamination and establish response actions, as necessary. Additional Ogallala Aquifer monitoring wells are planned to be installed to determine the extent of contamination within the Ogallala Aquifer (CNS, 2022c). If plume development is identified through installation of the additional monitoring wells, a work plan will be prepared to determine nature and extent of the contamination.

## 8.6 ADDITIONAL CONTAMINANTS OF POTENTIAL CONCERN (ISSUE 6)

### 8.6.1 Metals Solubilized through ISB Treatment

Reducing conditions established through ISB treatment cause some naturally occurring metals in the formation to solubilize. Arsenic, barium, and manganese are three metals observed downgradient of the ISB Systems that could prevent attainment of the RAO for restoring perched groundwater to drinking water standards if the metals remain in a dissolved state and do not attenuate.

Arsenic, barium, and manganese concentration ranges and upper confidence limits (UCLs) were compared to the GWPSs. For this comparison, the EPA ProUCL software (Version 5.1) (EPA, 2016) was used and the recommended UCL was used as the EPC at each well. As expected, the treatment zone continues to contribute higher concentrations of these metals. The closest downgradient concentrations generally indicate lower concentrations than the treatment zone. However, many of the downgradient concentrations continue to exceed the protective concentrations used to evaluate the data. Current conditions (as represented by 2017 to 2021 data) for each of these metals are discussed below:

- Arsenic: The median arsenic concentration from 391 samples from treatment zone wells is 33 µg/L, with a MDC of 620 µg/L and 68% of the results greater than the GWPS of 12 µg/L. By comparison, the median arsenic concentration from 228 downgradient samples is 20 µg/L, with an MDC of 220 µg/L and 55% of results greater than GWPS. A summary of the frequency of detection, range of detected concentrations, UCL, and comparison to the GWPS is provided in Attachment 14, Table 1 for each of the treatment zone and downgradient wells.
- Barium: The median barium concentration from 244 samples from treatment zone wells is 760 µg/L, with an MDC of 9,900 µg/L and 11% of the results exceeding the GWPS of 2,000 µg/L. By comparison, the median barium concentration from the 238 downgradient samples is 675 µg/L with an MDC of 21,000 µg/L and 24% of downgradient sample results exceed the GWPS of 2,000 µg/L. A summary of the frequency of detection, range of detected concentrations, UCL, and comparison to the GWPS is provided in Attachment 14, Table 2 for each of the treatment zone and downgradient wells.
- Manganese: The median manganese concentration from 380 samples from treatment zone wells is 550 µg/L, with an MDC of 99,000 µg/L. By comparison, the median manganese concentration from 238 downgradient samples was 435 µg/L, with an MDC of 9,400 µg/L. Twenty-three percent of treatment zone results and 9% of downgradient sample results exceed the GWPS of 1,700 µg/L. A summary of the frequency of detection, range of detected concentrations, UCL, and comparison to the GWPS is provided in Attachment 14, Table 3 for each of the treatment zone and downgradient wells.

As noted in the First and Second FYRs, results in several downgradient wells demonstrate signs of expansion of the treatment zone. Data collected for this Third FYR (from 2017 through 2021) show similar results. The SEISB system metal concentrations continued to increase; for example, the arsenic UCL at PTX06-1037 increased from 10.3 µg/L in First FYR data to 34.2 µg/L in Second FYR data to 93.13 µg/L in the Third Five FYR data (Attachment 14, Table 1). Because the SEISB system is near the extent of the perched groundwater saturated thickness, it is possible the treatment zone will completely expand to the extent of the perched groundwater and metal concentrations will never reach a protective concentration in the perched groundwater in that area.

The Zone 11 ISB system has a greater aquifer extent and saturated thickness than at the SEISB system; therefore, concentrations can be monitored at this system to demonstrate that the metals will decline to

protective concentrations as the treated water moves downgradient into more-oxidizing conditions. Metal concentrations downgradient of the Zone 11 ISB system appear to be increasing compared to those reported in the First and Second FYRs. For example, the arsenic UCLs at PTX06-1155 and PTX06-1156 increased from 33.3 and 46.8 µg/L, respectively, in First FYR data to 47.6 and 49.8 µg/L, respectively, in Second FYR data to 60.9 µg/L and 58.1 µg/L, respectively in the Third FYR data (**Attachment 14, Table 1**). While it is clear there is some elevated risk due to metals that have been released because of reducing conditions in the Zone 11 ISB treatment zone, the downgradient risks are only slightly elevated. Data indicate that downgradient concentrations are generally lower than treatment zone concentrations indicating that these metals will continue to attenuate as they move downgradient. It is expected that most of these concentrations will reduce below levels that would cause a health-based concern.

It is unclear how the SEISB system will respond with time because of the limited extent of the perched groundwater and saturated thickness. The metals will require continued monitoring to determine whether arsenic, barium, and manganese concentrations persist or if concentrations decline over time.

Additionally, sampling of the soluble metals at the Ogallala monitoring wells after the First FYR have confirmed these metals have not impacted the Ogallala Aquifer. Concentrations of arsenic, barium, and manganese are below GWPSs and current detections are similar to or below background concentrations. These metals should continue to be sampled in the Ogallala Aquifer to confirm the aquifer has not been impacted by the soluble metals in the perched groundwater.

### 8.6.2 1,4-Dioxane in Zone 11

Concentrations of 1,4-dioxane in the Zone 11 plume were previously screened out in the HHRA, indicating risk from this COC was less than 1.0E-6 for the perched groundwater and, by extension, the Ogallala Aquifer. Current (2017-2021) data support partial degradation of 1,4-dioxane and overall decreasing concentrations upgradient and in the source area. Locations with the highest historic concentrations (PTX06-1126 and PTX06-1127) upgradient of the ISB system have continued to decrease from their peak concentrations in 2011. Concentrations at the well located near the source area (PTX08-1006) have continued to decrease since 2009, with all reported concentrations below the GWPS in 2016.

Trending of all data indicated concentrations at some of the farthest downgradient locations are increasing (e.g., concentrations of 1,4-dioxane were below the GWPS of 7.7 µg/L until 2013 and have consistently remained above the GWPS with a November 2021 concentration of 30.7 µg/L in PTX06-1012). Increasing concentrations in the downgradient wells are a result of the plume migrating to the southeast, with the southern leading edge now crossing onto Texas Tech property and the eastern edge moving toward the SEPTS.

Despite this, all concentrations remained below a 1E-04 risk level (85 µg/L). Concentrations at two downgradient locations (maximum of 47 µg/L at PTX06-1155 and 41 µg/L at PTX06-1143) were lower than historical maximum concentrations observed at upgradient locations (2011 maximum of 120 µg/L and 100 µg/L) and are generally lower than current 2017-2021 concentrations (maximum of 19 µg/L and 70 µg/L) at upgradient locations PTX06-1126 and PTX06-1127. One downgradient well has remained below the GWPS since the start of sampling in 2009.

There is no short-term loss of protectiveness as the area of affected groundwater is covered by access and deed restrictions to prevent use of perched groundwater for purposes other than RAs. Long-term threats to protectiveness are the same as those considered for other COPCs listed in Section 8.6.

The COC 1,4-dioxane will continue to be monitored and trends evaluated in the Zone 11 ISB area for both perched and Ogallala Aquifer monitoring wells during the next FYR period. While 1,4-dioxane does not exceed GWPS in the Zone 11 plume to the same extent as TCE or perchlorate, it is still of interest as the ISB remedy is not documented to treat 1,4-dioxane, although recent samples suggest that partial degradation is occurring. Monitoring will continue to confirm that the 1,4-dioxane plume is not migrating downgradient, presenting a potential long-term challenge to protectiveness. The need for further actions will be determined based on results of sampling and in accordance with the *Pantex Plant Ogallala Aquifer and Perched Groundwater Contingency Plan* (B&W Pantex, 2009b; CNS 2019c). During the periodic review of the Contingency Plan that occurs after each FYR, potential deviation from expected conditions (i.e., increasing downgradient concentrations) will be identified and recommended actions will be included to address such deviations, should they be realized.

### 8.6.3 TCE Degradation Products

The products of TCE anaerobic degradation, including cis-1,2-DCE, 1,1-DCE, and vinyl chloride, may accumulate at concentrations above MCLs as degradation intermediates in the Zone 11 ISB system. These contaminants were not specifically identified in the ROD as primary COCs. However, they are included in the monitoring program to evaluate the efficacy of the ISB remedy for TCE. The recommendation is that these COPCs should be compared against MCLs and evaluated for trends going forward to ensure that they are transient and exceedances of MCLs do not extend beyond the current TCE plume footprint.

During the Third FYR period (represented by 2017 to 2021 data), cis-1,2-DCE was detected at Zone 11 above the GWPS (i.e., MCL of 70 µg/L) in six treatment zone wells (PTX06-ISB075, PTX06-1177, PTX06-1176, PTX06-1170, PTX06-1169, and PTX06-1164) and four downgradient wells (PTX06-1174, PTX06-1173, PTX06-1155, and PTX06-1012). Since the Second FYR period (represented by 2012 to 2016 data), concentrations of cis-1,2-DCE have declined in the Zone 11 ISB system and in 2021, exceedances of the GWPS were limited to one treatment well MDC of 190 µg/L in PTX06-1169) and one downgradient well (MDC of 269 µg/L in PTX06-1155)

The VOC 1,1-DCE was identified in the Zone 11 area and detected sporadically during review of data for the First FYR. In 2011, it was detected slightly above the MCL of 7 µg/L upgradient of the Zone 11 ISB system at PTX06-1126. In the Second FYR period, 1,1-DCE was detected well below the MCL at PTX06-1126 (2.6 µg/L in 2016). During the Third FYR period, 1,1-DCE was detected in treatment well PTX06-1169 at a concentration of 7.1 µg/L and in downgradient well PTX06-1155 at a concentration of 7.04 µg/L (slightly above the MCL of 7 µg/L. This COPC is usually a degradation product of 1,1,1-trichloroethane but is also a potential degradation product of PCE and TCE, which are the most likely sources in the Zone 11 area. There are indications that some natural attenuation is occurring in the Zone 11 area. However, the ISB system greatly enhances the attenuation process and is expected to treat this COC. Continued sampling for this COPC is recommended to confirm that it is not widespread above the MCL.

There is no short-term loss of protectiveness as the area of affected groundwater is covered by access and deed restrictions to prevent use of perched groundwater for purposes other than RAs. Long-term threats to protectiveness are the same as those considered for other COPCs listed in Section 8.6.

Chlorinated intermediates of VOC degradation products such as cis-1,2-DCE, vinyl chloride, and 1,1-DCE should continue to be monitored within and downgradient from the Zone 11 ISB to confirm that they are transient degradation intermediates and that the remedy is not generating a plume capable of downgradient migration.

### 8.6.4 PFAS

PFAS is an emerging contaminant of concern. During the Third FYR period, health advisory levels and RSLs have been developed for select PFAS compounds for drinking water and soil. An enforceable standard has not yet been adopted by EPA, but an MCL for several PFAS is planned to be finalized by the end of 2023. PFAS with current RSLs for drinking water, and likely candidates for MCLs, are perfluorooctanoic acid (PFOA), perfluorooctane sulfonic acid (PFOS), perfluorononanoic acid (PFNA), perfluorobutane sulfonic acid (PFBS), perfluorohexane sulfonic acid (PFHxS), and hexafluoropropylene oxide-dimer acid (HFPO-DA), sometimes referred to as GenX. Additionally, USDOE has released a strategic roadmap that includes initial assessments of historical and current uses of PFAS and sampling of USDOE-owned water systems (USDOE, 2022).

PFAS has historically been used in aqueous film-forming foam (AFFF) at the Pantex Plant. Fire training activities were conducted just northwest of Zone 12, and a demonstration of AFFF was performed in Zone 4 just west of Playa 1. AFFF usage in these areas may have caused PFAS to infiltrate to perched groundwater through areas of high recharge in ditches and the playa lakes (specifically Playa 1). Additionally, polytetrafluoroethylene (PTFE, sometimes referred to by its trade name of Teflon) may have been used as a binder for HEs such as RDX (Gaines, 2022). PFOA was used in the production of PTFE and was present in the final polymer as a byproduct of manufacture (Larsen et al., 2005).

PFAS use has been ubiquitous in many commercial products. A non-exhaustive list of product types that may have been used at and/or disposed of at the Pantex Plant includes the following from Gaines (2022):

- Adhesives,
- Building materials,
- Cleaning products,
- Coatings, waxes, paints, varnishes, and inks,
- Metal plating,
- Packaging, paper, and cardboard,
- Pesticides and fertilizers, and
- Textiles.

At the Pantex Plant, the SEPTS was sampled for PFAS in 2022 as part of a study regarding GAC breakthrough. PFAS was detected, indicating that it is present in perched groundwater in the area of the SEPTS. Additional investigations and sampling are planned in line with the USDOE strategic roadmap.

PFAS detected in perched groundwater does not affect the short-term protectiveness of the Selected Remedy because of existing deed restrictions. PFAS may affect the long-term protectiveness of the remedy because it is not degraded by the ISB remedies at the leading edges of the current RDX plume. GAC is a proven technology to remove PFAS from groundwater, so the SEPTS and P1PTS have likely been removing PFAS from within their areas of influence. However, without routine effluent sampling, the effectiveness of PFAS treatment by the SEPTS and P1PTS cannot be determined.

Additional data for PFAS is planned to be collected from select monitoring wells to improve knowledge of the presence of these chemicals in perched groundwater at Pantex. These data will be used to adjust operations and maintenance of the remedial actions and prepare an investigation work plan for determining nature and extent of PFAS.

## 8.7 INCOMPLETE TCE DEGRADATION IN SECTIONS OF THE ZONE 11 ISB (ISSUE 7)

Effective TCE degradation is occurring in the immediate vicinities of the IWs and near PTX06-1170, PTX06-1176, and PTX06-1177, on the western side of the Zone 11 ISB. There is ineffective TCE degradation near PTX06-1164 and PTX06-1169. Downgradient data indicate downgradient migration of TCE along the east side of the ISB system; ineffective TCE degradation near PTX06-1155; effective TCE degradation near PTX06-1012, PTX06-1173, and PTX06-1174; and the potential for effective performance at PTX06-1175. See Attachment 7 for a more detailed analysis.

The varying treatment effectiveness in the central area of the Zone 11 ISB is most likely attributable to non-uniform distribution of the carbon substrate amendment. TOC concentrations in wells with ineffective TCE degradation decreased between 2016 and 2021, indicating that amendments are not reaching those wells during injection events.

Radius of influence testing was performed in 2018 in the Zone 11 ISB system and concluded that injection volumes needed to increase to distribute carbon substrate to the midpoints between IWs. Since then, however, several wells per injection event have not received the target volume due to low flow rates. Comparison of injection flow rate and transmissivity results for 20 wells treated in 2018 and 2020 showed a substantial decrease in transmissivity flow rate between the two sampling events (see Attachment 7). These decreases in transmissivity and flow rates suggest that biofouling may be affecting well performance in spite of the well maintenance activities.

# 9.0 RECOMMENDATIONS AND FOLLOW-UP ACTIONS

Improvements required to address issues that could affect the long-term protectiveness of the Selected Remedy are listed in Table 9.1. This table lists actions and milestones important to achieving the objectives of the Selected Remedy and RAOs and addressing the issues identified in Section 8. Other improvements identified through this FYR for optimizing the RA systems and LTM Network are presented in Table 9.2.

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Table 9.1. Recommendations and Follow-up Actions for Issues Identified in the FYR

| Issue | Recommendations & Follow-up | Party Responsible | Oversight Agency | Milestone Date | Affects Protectiveness Without Action | |
|---|---|---|---|---|---|---|
| | | | | | *Short-Term* | *Long-Term* |
| **Soil Remedies** | | | | | | |
| Minor deficiencies in protective soil covers, including erosion, animal burrows, and settling. | • Prepare and implement a work plan to fill holes on soil cover surfaces and investigate erosion around a culvert at Landfill 5 (SWMU 56). | Pantex | EPA/TCEQ | September 2025 | No | Yes |
| Tears observed in the SWMU 2 and 5-05 Ditch Liner during the 2021 inspection, and sedimentation and erosion of the anchor trench. | • Prepare and implement contracting to repair tears in the ditch liner. | Pantex | EPA/TCEQ | April 2024 | No | Yes |
| **Groundwater Remedies** | | | | | | |
| Perched groundwater elevations and RDX concentrations are increasing around Playa 1. | • Eliminate all treated perched groundwater discharges to Playa 1 and resume operating the P1PTS at operational goals once the center-pivot irrigation system is operational.<br>• Continue to monitor LTM wells near Playa 1 to verify that perched groundwater elevations drop during the next FYR period and that RDX concentrations decrease. | Pantex | EPA/TCEQ | July 2024 | No | Yes |
| Incomplete treatment of contaminants (HE and Cr[VI]) downgradient of the west end of the SEISB (PTX06-1153). | • Continue to collect and evaluate data from the SEISB area and consider targeted injections in the area of PTX06-1153. Evaluate options for optimized injection of amendments to address contamination in this area. | Pantex | EPA/TCEQ | September 2025 | No | Yes |

Table 9.1. Recommendations and Follow-up Actions for Issues Identified in the FYR (continued)

| Issue | Recommendations & Follow-up | Party Responsible | Oversight Agency | Milestone Date | Affects Protectiveness Without Action | |
|---|---|---|---|---|---|---|
| | | | | | *Short-Term* | *Long-Term* |
| Groundwater Remedies (continued) | | | | | | |
| DNT4A was detected above the GWPS in Ogallala monitoring well PTX06-1056. | • Install additional Ogallala monitoring wells near PTX06-1056 and upgradient between the SEISB and PTX06-1056 to define the extent of impacts to the Ogallala Aquifer and evaluate migration potential toward Site boundaries.<br>• Prepare a workplan to complete the investigation of DNT4A in the Ogallala Aquifer. | Pantex | EPA/TCEQ | September 2025<br>March 2026 | No | Yes |
| 1,4-Dioxane is present in the perched aquifer and is not treated by active remedies. | • Incorporate 1,4-dioxane into the next Contingency Plan update with steps to take if concentrations increase. | Pantex | EPA/TCEQ | March 2025 | No | No |
| PFAS were present in products used at the Pantex Plant and have been detected in SEPTS influent groundwater. | • Sample a strategic subset of existing perched groundwater LTM wells to determine the extent of PFAS impacts at the Pantex Plant.<br>• Assess whether existing remedies are removing PFAS, and assess if existing remedies are spreading PFAS through injection of treated water or in waste streams for spent ion exchange resin or GAC.<br>• Prepare a work plan to complete a PFAS site investigation. | Pantex | EPA/TCEQ | September 2024<br>March 2026 | No | Yes |
| Sections of the Zone 11 ISB demonstrate mixed results, with incomplete degradation of TCE near TZM wells PTX06-1164 and PTX06-1169. | • Review amendment injection volumes to confirm that they are sufficient to distribute amendment away from the IWs.<br>• Test alternative well maintenance approaches, such as sequential application of different chemical agents, longer surge times, or a heated water maintenance approach, to improve transmissivities around the well screens. | Pantex | EPA/TCEQ | September 2024 | No | No |

Table 9.2. Recommendations for Remedy Optimization and Monitoring

| Recommendation | Follow-up Action | Party Responsible | Oversight Agency | Milestone Date |
|---|---|---|---|---|
| **Soil Remedies** | | | | |
| Request that the current operating permit for the SVE system be modified to terminate operation of the system. | • Provide evaluation of the BG SVE system performance and request concurrence to cease operations.<br>• Continue the groundwater sampling program at wells PTX01-1001, PTX01-1010, and PTX01-1011 to obtain data to support termination of the BG SVE system. | Pantex | EPA/TCEQ | September 2024 |
| **Groundwater Remedies** | | | | |
| Consider reassessing P&T system operational goals as water levels in EWs reach practical limits for extraction. | • Develop a planned approach to transition away from the current extraction rate goal when extraction rates can no longer feasibly be met. | Pantex | EPA/TCEQ | September 2025 |
| Prioritize locations for groundwater extraction from recommendations in the 2021 optimization study (HGL, 2021b). | • Operate the P1PTS and SEPTS with wells prioritized based on the results of the 2021 optimization study.<br>• Continue evaluating the benefit of adding new wells in areas recommended in the 2021 optimization study. | Pantex | EPA/TCEQ | September 2025 |
| Consider periodically measuring pH in IWs and adding buffering agents as needed. | • Add pH to monitoring of ISB wells during pre-injection activities and add a buffering agent such as sodium bicarbonate as needed, to counteract the acid production by microorganisms. | Pantex | EPA/TCEQ | September 2024 |
| Consider increasing the duration between injection events at the SEISB System Extension. | • Increase the time until the next injection event at the SEISB System Extension to assess if TOC concentrations remain elevated for longer than expected and the system can be injected less frequently. | Pantex | EPA/TCEQ | September 2024 |
| **LTM Network** | | | | |
| Update LTM Network design and SAP documents to capture changes and recommendations from the Third FYR, after regulatory approval. | • LTM Network and SAP documents need to be updated to reflect applicable recommendations from the 2022 LTM optimization review after approval by TCEQ/EPA. Adjust sampling frequencies and add analytes where identified. Other needed revisions resulting from this FYR should be incorporated in this effort. | Pantex | EPA/TCEQ | December 2024 |

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# 10.0 PROTECTIVENESS STATEMENTS

The Selected Remedy at the Pantex Plant as implemented currently protects human health and the environment because:

- All soil remedies are functioning as designed and performing as expected.
- Risk of exposure to contaminated soils and affected perched groundwater is being minimized through contact prevention (maintenance and enforcement of ICs).
    - Access to contaminated surface soil is prevented through a combination of protective covers, fencing, and other access controls associated with the active mission of the site.
    - Access to contaminated perched groundwater is prevented through a combination of use, drilling, and access restrictions.
- The P&T systems, when operated as designed, reduce the saturated thickness of the perched groundwater, thus reducing the potential for vertical movement of affected perched groundwater and protecting the underlying Ogallala Aquifer.
- The SEPTS is removing significant quantities of contaminant mass, controlling plume migration to the east, and reducing saturation in the area of the SEISB.
- The SEISB system is reducing COC concentrations below GWPS in an area sensitive to vertical movement of affected perched groundwater, thus protecting the underlying Ogallala Aquifer.
- The SEISB Extension is reducing COC concentrations in the treatment zone and will likely result in reduced concentrations in downgradient monitoring wells given enough time for perched groundwater from the IWs to travel that far.
- The Offsite ISB system is hydraulically operating as designed, and target volumes were injected at the leading edge of the RDX plume.
- The Zone 11 ISB system has established a reducing zone in the perched groundwater, treating perchlorate to concentrations below the GWPS, and degrading TCE in areas where microbial communities have evolved in response to repeat additions of amendments. Additional IWs on the western end are effectively treating the TCE plume that was previously migrating around the Zone 11 ISB system, and a second line of more tightly spaced IWs on the southeastern end are more effectively distributing carbon substrate amendment.

However, in order for the remedy to be protective in the long-term, the following actions need to be taken:

- Continue O&M of the soil remedies, including repairing deficiencies in soil covers and ditch liners.
- Continue operation of the groundwater remedies to achieve cleanup standards in the perched groundwater.
- Gather additional information to assess the potential impacts to the Ogallala Aquifer from recent detections of DNT4A above GWPS in PTX06-1056. Determine nature and extent as needed, and evaluate remedial options as appropriate.

- Continue to maintain and enforce the established ICs.
- Address the issues identified in Section 8 by implementing follow-up actions described in Table 9.1.

# 11.0 NEXT REVIEW

The next FYR will be conducted in 2027 covering Site RAs conducted between 2022 and 2026. The final report will be completed in 2028, with concurrence by regulatory agencies no later than five years after concurrence with this report.

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Appendices available upon request

Email ERProgramAdminRecord@pxy12.doe.gov