Pantex Plant

Five-Year Review Report

Second Five-Year Review Report

Remedial Action Progress

Pantex Plant

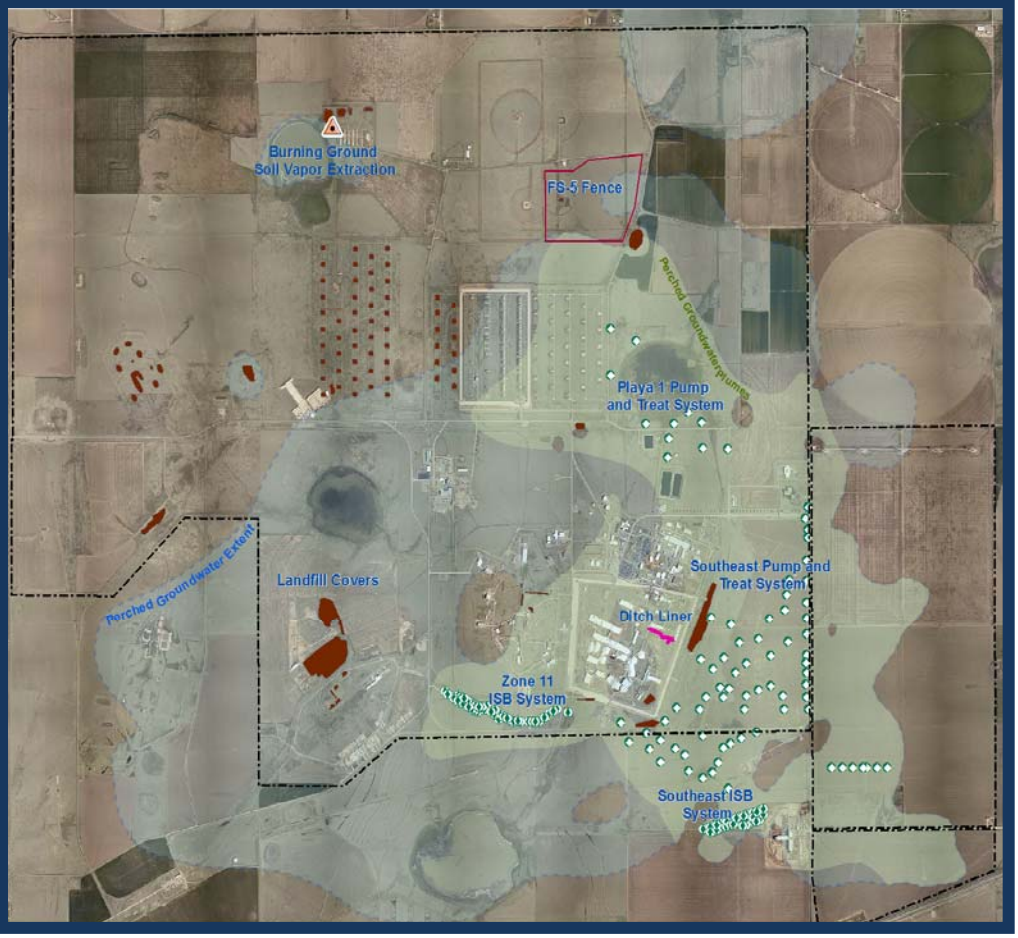
August 2018

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)

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

Pantex Plant Remedial Action Systems



SECOND FIVE-YEAR REVIEW REPORT
PANTEX PLANT SUPERFUND SITE
EPA ID#: TX4890110527
CARSON COUNTY, TEXAS

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

Summary of the Second Five-Year Review Report

The Site is currently managed as a government-owned, contractor-operated facility, overseen by the U.S. Department of Energy/National Nuclear Security Administration (USDOE/NNSA) and operated by Consolidated Nuclear Security, LLC. Consistent with Executive Order 12580, federal agencies are responsible for ensuring that five-year reviews are conducted at federal facilities regulated under CERCLA. Roles and responsibilities of EPA and USDOE/NNSA pertaining to remedial action oversight at the Site 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.

Results of the five-year review indicated 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 though 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.

Environmental Indicators

Human Exposure Status: Current human exposure controlled and protective remedy in place.
Contaminated Groundwater Status: Contaminated groundwater migration is under control.
Site-Wide Ready for Reuse: Yes.

Actions Needed

The following actions must be taken for the remedy to be protective in the long term: See ES-5.1 Conclusions and Recommendations and Section 9.0 Recommendations and Follow-Up Actions.

Determination

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

for Ronald D Curtland

Carl E. Edlund, P.E.
Director, Superfund Division
U.S. Environmental Protection Agency Region 6

9/13/18
Date

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Second Five-Year Review Report

Remedial Action Progress

For Pantex Plant

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

8/23/2018

James C. Cantwell — Date
Director
Pantex Environmental & Safety Programs
Consolidated Nuclear Security, LLC

Susan D. Morris 8/28/18

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

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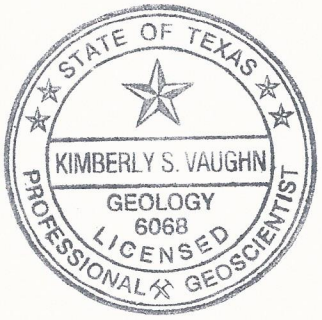
Second Five-Year Review
in Support of Pantex Plant Interagency Agreement
and Compliance Plan No. 50284
for the Pantex Plant, Amarillo, Texas

August 2018

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.



Kimberly Vaughn, P.G. 8-17-18 Date

Project Team

CNS: Martin Amos, Michelle Jarrett, Matt Monroe

HGL: Dr. Mindy Vanderford, Roy Evans, P.E., Tad Fox, P.G., Dr. Douglas Sutton, P.E., Dr. Cindy Crane, P.E.

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ES-1 EXECUTIVE SUMMARY

The U.S. Department of Energy/National Nuclear Security Administration (USDOE/NNSA) has conducted the Second Five-Year Review (FYR) of the remedial action (RA) implemented at the Pantex Plant Superfund Site (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 May 1, 2017, to February 15, 2018, and its findings and conclusions are documented in this report.

ES-1.1 Regulatory Framework

The Pantex Plant Site (Site) was proposed for addition to the National Priorities List (NPL) under the Comprehensive Environmental Response, Compensation, and Liability Act (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.) § 9621(c), 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 RA's to address hazardous substances in Site soil and groundwater was issued in September 2008. Selected RAs that have resulted in hazardous substances remaining in place consist of:

- Institutional controls (ICs) for both soil and groundwater;
- Soil vapor extraction (SVE) in the Burning Ground (BG) area;
- Synthetic liners installed in Zone 12 ditches;
- Protective covers installed on the BG Former Ash Disposal Trench and Pantex Plant Landfills
- 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;
- Construction and operation of the Playa 1 pump and treat system (P1PTS) to reduce mounding of perched groundwater under Playa 1;
- 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 trichloroethene (TCE) and perchlorate.

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

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 CERCLA. Roles and responsibilities of U.S Environmental Protection Agency (EPA) and USDOE/NNSA pertaining to remedial action 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 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 conducted in 2018 and considers remedial performance between January 1, 2012, and December 31, 2016.

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 constituents of concern (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 has not been modified by a ROD Amendment or Explanation of Significant Difference (ESD).

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

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

- 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 28 units).
- Ditch liners for Zone 12 ditches (SWMU 2 and SWMU 5-05).
- 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 is:

- Two Pump and Treat (P&T) Systems: the SEPTS and the P1PTS for the Southeast Area.
- Two ISB Systems to treat HE contaminants and hexavalent chromium (Cr[VI]) for the Southeast Area and TCE and perchlorate contaminants for Zone 11.
- 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, in accordance with the IAG.

The monitoring network provides data for evaluation of both the soil and groundwater remedies.

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 Burning Ground 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. The system currently includes one extraction well (SVE-S-20) with sufficient extracted VOC concentrations to operate the treatment system. 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. A BG SVE Performance Monitoring approach will be developed to define expected conditions and a path toward determining when the RA is complete (i.e. an exit strategy).

A catalytic oxidation (CatOx) treatment unit was installed in 2012 to address system inefficiencies associated with breakthrough of previously used granular activated carbon (GAC) units, as well as higher O&M costs than anticipated. O&M costs and level of effort for maintenance have decreased from costs in the First FYR timeframe.

Recent modifications to the SVE system include reworking six inactive shallow zone extraction wells to allow ambient air to be drawn into the formation. Additional air flow to the subsurface is intended to enhance extraction and biodegradation of VOCs.

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 2017 identified some minor deficiencies such as holes, erosion and slope instability. Contracts to address minor deficiencies will be issued in the coming year.

The ditch liner for Zone 12 ditches (SWMU 2 and SWMU 5-05) has been effective at preventing infiltration of water through the ditch mobilizing residual soil contaminants. Concentrations of COCs in perched groundwater below the ditches showed decreasing statistical trends supporting the conclusion that the ditches are not leaching additional contamination to perched groundwater. Between December 2016 and March 2017, a new 45-millimeter Hypalon™ liner was installed over the existing SWMU 2

and 5-05 ditch liner to address signs of degradation of liner material and displacement of anchors. A total of 163 new Platipus™ anchors were installed to secure the liner. The ditch liner is inspected annually to confirm the integrity of the remedy.

ES-4.1.2 Groundwater Remedy Performance

The two perched groundwater P&T systems (SEPTS and P1PTS) are operating and functioning as designed. The P1PTS reduces flux of both contaminants and groundwater into the SEPTS area, and the SEPTS reduces 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 in the southeast lobe of the perched groundwater unit through areas of low saturated thickness (less than 15 feet). These areas are not under the short-term influence of the SEPTS and may not be under the long-term influence due to limited saturated thickness or other limiting hydrogeologic conditions. The SEPTS is being expanded with the addition of five new extraction wells east of Farm-to-Market (FM) 2373 intended to reduce the flux of contaminants into the area of low saturation. An additional ISB system is in concurrent design and construction phases for the southeast lobe of the perched unit, north of Highway 60. The additional extraction wells and ISB system 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. Pantex is currently collecting data that should lead to improved quantification of natural attenuation processes in the perched aquifer in the future. Ongoing evaluations of these data will be conducted to determine if future inclusion of Monitored Natural Attenuation as a part of the Selected Remedy is appropriate.

The SEISB and Zone 11 ISB (ZN11ISB) 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 ZN11ISB is effectively treating the perchlorate plume in the eastern part of the ISB system. Data indicate improved performance of the ISB for treating TCE in the central portion of the system. Areas within the central part of the system are showing complete treatment of TCE, but other areas show a lagging rate of degradation for the cis-1,2-dichloroethene (DCE) daughter product. During the FYR period, the ZN11ISB was expanded to the west with several

more injections wells. It is anticipated that as the system evolves and the anaerobic microbial community becomes better established, TCE treatment will improve. Several recommendations for optimizing the ZN11ISB have been developed, including increasing the soluble fraction 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 P&T groundwater remedy is performing as expected and concentrations of COCs and water levels are declining in most areas. However, HE and Cr(VI) contamination is migrating to areas of low saturation, outside of the influence of the SEPTS in the southeast lobe of the perched unit. Efforts are currently underway to design and install an additional ISB treatment system in this area.

The SEISB system is performing as expected with significant reductions in contaminant mass below GWPS 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 GWPS. Understanding of the local conceptual site model and approaches to enhancing treatment of COCs in this limited area are currently being investigated.

The ZN11ISB system is effectively treating perchlorate in the eastern section of the system and is evolving to treat TCE in the central portion. The system was expanded to the west in 2014 through 2016, and limited data are available to evaluate the performance of the expanded portion. Remedy optimization strategies are being investigated to improve performance of the ZN11ISB for treatment of TCE.

The Selected Remedy will continue to be implemented as designed during the next five years to allow for a more complete expression of its effects on the perched groundwater. Data will continue to be collected through the LTM network to assess remedy effectiveness and to document natural attenuation to better define the long-term period of restoration.

ES-5.1 Conclusions and Recommendations

The FYR indicates that the Selected Remedy is 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 (maintenance and enforcement of ICs).
    - Access to contaminated surface soil is prevented through a combination of protective covers, fencing, signage, work plans, 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 continue to reduce saturated thickness of the perched aquifer, 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, controlling plume migration to the east, and reducing saturation in the area of the SEISB.
- The SEISB system is reducing COC concentrations to below GWPS in an area sensitive to vertical movement of affected perched groundwater, thus protecting the underlying Ogallala Aquifer.
- The ZN11ISB has established a reducing zone, which has decreased perchlorate to concentrations below the GWPS, and shows signs of significant degradation of TCE in several locations where amendments have been injected over the past five years. The ZN11ISB has been expanded to the west to treat TCE in the western part of the Zone 11 plume.

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 covers have eroded or have holes.
- Operate and maintain groundwater remedies to continue achieving progress toward cleanup standards in the perched aquifer.

- Enhance existing remedies and install an additional ISB system in the southeast lobe of the perched groundwater unit.
- 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 and pursue issuing an ESD sometime before the next FYR to document remedy changes.
- Discuss with EPA potential changes in toxicity values and regulatory guidance that may impact GWPS and soil remedial goals for radionuclides.
- 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 **If "Other Federal Agency" was selected above, enter Agency name:** USDOE/NNSA		
Author name (Federal or State Project Manager): Susan Morris		
Author affiliation: USDOE/NNSA Production Office		
Review period: May 1, 2017 through February 15, 2018		
Date of site inspection: August 15 and 16, 2017		
Type of review: Statutory		
Review number: 2		
Triggering action date: September 25, 2008 – ROD Signature		
Due date *(ten years after triggering action date)*: September 25, 2018		

Five-Year Review Summary Form (continued)

Issues/Recommendations

OU(s) without Issues/Recommendations Identified in the Five-Year Review:
Not Applicable

Issues and Recommendations Identified in the Five-Year Review:

Media Type: Soil	**Issue Category: Changed Site Conditions**			
	Issue: Minor deficiencies in protective soil covers including erosion, slope instability, animal burrows and settling.			
	Recommendation: Restore slopes and fill holes on soil cover surfaces.			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Implementing Party**	**Oversight Party**	**Milestone Date**
No	Yes	Federal Facility	EPA/State	September 2020

Media Type: Soil	**Issue Category: Changed Guidance on ARARs**			
	Issue: EPA guidance on protective dose-based ARARs for radionuclides changed from 15 to 12 millirem per year in 2014			
	Recommendation: Conduct meeting between Pantex project managers and EPA to discuss baseline risk assessment, historical remedial responses, and current management practices.			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Implementing Party**	**Oversight Party**	**Milestone Date**
No	No	Federal Facility	EPA/State	December 2019

Media Type: Groundwater	**Issue Category: Changing Site Conditions**			
	Issue: Plumes of high explosives (primarily RDX) are expanding in the southeast lobe of the perched groundwater unit in areas of low saturated thickness.			
	Recommendation: Continue characterization efforts in the southeast lobe of the perched unit. Plume migration is anticipated to be addressed by both expanding the SEPTS with six new extraction wells east of FM 2373 and adding an ISB remedy just north of Highway 60. Additional institutional controls may be required if the plume extends beyond the current deed restrictions.			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Implementing Party**	**Oversight Party**	**Milestone Date** Phased approach through 2020
No	Yes	Federal Facility	EPA/State	

Media Type: Groundwater	**Issue Category: Changing Site Conditions**			
	Issue: The Zone 11 TCE plume extends west and outside of the Zone 11 ISB system.			
	Recommendation: Continue evaluating alternatives for treatment of the western Zone 11 TCE plume. Remedial systems to be considered include expanding or enhancing the ISB system or implementing a pump and treat system.			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Implementing Party**	**Oversight Party**	**Milestone Date**
No	Yes	Federal Facility	EPA/State	September 2020

Five-Year Review Summary Form (continued)

Media Type: Groundwater	Issue Category: Remedy Performance			
	Issue: Incomplete treatment of contaminants (high explosives and hexavalent chromium) 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.			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Implementing Party**	**Oversight Party**	**Milestone Date**
No	Yes	Federal Facility	EPA/State	September 2019

Media Type: Groundwater	Issue Category: Changed Site Conditions -			
	Issue: Induced anaerobic conditions in ISB systems can mobilize secondary metals (arsenic, barium and manganese) resulting in dissolved metals concentrations above MCLs.			
	Recommendation: Continue to analyze for metals in the Zone 11 and SEISB areas so adequate data is obtained to confirm the expectation that concentrations decline as the dissolved metals precipitate downgradient. Injection, in-situ performance monitoring and downgradient wells should be monitored to delineate the extent of dissolved secondary metals. In areas where extent of the perched is immediately downgradient, data should be collected to evaluate the potential impacts to the Ogallala Aquifer.			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Implementing Party**	**Oversight Party**	**Milestone Date**
No	Yes	Federal Facility	EPA/State	Annually through Progress Reports

Media Type: Groundwater	Issue Category: Changed Site Conditions -			
	Issue: The perchlorate plume emanating from Zone 11 is migrating under the influence of the SEPTS to the east. The current SEPTS does not include treatment for perchlorate.			
	Recommendation: Continue monitoring the perchlorate plume. Consider optimization of the SEPTS extraction network to limit mobilization. Addition of a perchlorate treatment unit to the SEPTS would be warranted if perchlorate is detected in SEPTS influent at concentrations near the GWPS of 26 parts per billion (ppb).			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Implementing Party**	**Oversight Party**	**Milestone Date**
No	Yes	Federal Facility	EPA/State	September 2019

Five-Year Review Summary Form (continued)

Media Type: Groundwater	**Issue Category: Changed Guidance and Toxicity Evaluation-**			
	Issue: The GWPS for perchlorate is 26 μg/L. EPA has issued a lifetime health advisory (LHA) for perchlorate at 15 μg/L, and the TRRP PCL for groundwater for residential property is 17 μg/L.			
	Recommendation: Changes to the perchlorate ARARs that have occurred since the ROD was issued in 2008 will be evaluated and discussed with EPA and TCEQ. The outcome of the evaluation will be selection of an updated GWPS for perchlorate which will be documented in the ESD anticipated to be issued before the next FYR. When EPA specifies an MCL for perchlorate, the long-term protectiveness of the perchlorate GWPS will be reviewed using the final toxicological data supporting the MCL.			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Implementing Party**	**Oversight Party**	**Milestone Date**
No	Yes	Federal Facility	EPA/State	September 2021

Media Type: Groundwater	**Issue Category: Changed Site Conditions**			
	Issue: Cadmium concentrations above MCL were detected at PTX06-1010 in 2011, Hexavalent chromium (Cr [VI]) detected at Zone 11 well PTX08-1005 near the MCL in 2011. 1,4-Dioxane is present in the footprint of the Zone 11 TCE plume.			
	Recommendation: Continue monitoring cadmium at PTX06-1010 and down-gradient well PTX06-1088 and Cr(VI) at PTX08-1005 over the next five years to confirm concentrations below remedial goals. Continue to monitor 1,4-dioxane in the Zone 11 TCE plume to evaluate potential plume migration.			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Implementing Party**	**Oversight Party**	**Milestone Date**
No	Yes	Federal Facility	EPA/State	September 2019

Media Type: Groundwater	**Issue Category: Remedy Updates -**			
	Issue: Several updates and expansions of the Selected Remedy have been implemented and/or proposed. The Selected Remedy has not been modified by a decision documents since the ROD was issued in 2008.			
	Recommendation: An Explanation of Significant Difference (ESD) is recommended before the next FYR. The ESD would document expansions and updates to remedies implemented since the ROD and any modifications to remedial goals. Many of these updates are currently underway, and sufficient data should be available to evaluate updated remedy efficacy within the next three years.			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Implementing Party**	**Oversight Party**	**Milestone Date**
No	Yes	Federal Facility/EPA	EPA/State	September 2021

Five-Year Review Summary Form (continued)

Media Type: **Soil**	*Protectiveness Determination:* **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:* **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 aquifer) - 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 aquifer. Plume migration directly east has stabilized. While perched groundwater is expanding, options for modifying the existing extraction system and adding a new ISB system to extend active remediation are being implemented for the part of the perched groundwater east of FM 2373 and north of Highway 60.

Sitewide Protectiveness Statement (if applicable)

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

Protectiveness Determination: **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
µg/L	micrograms per liter
ft	feet/foot
L/day	liters per day
mg/L	milligrams per liter
mrem/yr	millirems per year
AFCEC	Air Force Civil Engineer Center
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-50284	Compliance Plan No. 50284 [HW-50284]
Cr(VI)	hexavalent chromium
CSIA	Compound-Specific Isotope Analysis
CSM	conceptual site model
DCE	dichloroethene
DNT	dinitrotoluene
DNX	hexahydro-1,3-dinitroso-5-nitro-1,3,5-triazine
DO	dissolved oxygen
DU	depleted uranium
EPA	U.S. Environmental Protection Agency
ERA	Ecological Risk Assessment
ESD	Explanation of Significant Difference
EVO	emulsified vegetable oil
EW	extraction well
FFA	Federal Facility Agreement
FGZ	fine-grained zone
FM	Farm-to-Market
FS	Feasibility Study

LIST OF ACRONYMS AND ABBREVIATIONS (continued)

FS-5	Firing Site 5
FY	fiscal year
FYR	Five-Year Review
GAC	granular activated carbon
gpd	gallons per day
gpm	gallons per minute
GWPS	Groundwater Protection Standard
HE	high explosives
HGL	HydroGeoLogic, Inc.
HHRA	Human Health Risk Assessment
HMX	high melting explosive (cyclotetramethylene tetramine)
HQ	hazard quotient
HSWA	Hazardous 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	investigation well
kg	kilogram
lb	pound
Leidos	Leidos, Inc.
LGWUCIP	Land and Groundwater Use Control Implementation Plan
LHA	life-time drinking water health advisory
LiDar	Light Detection and Ranging
LTM	long-term monitoring
MAROS	Monitoring and Remediation Optimization System
MCL	maximum contaminant level
Mgal	million gallons
MHC	Mason & Hanger Corporation
MNA	monitored natural attenuation
MNX	hexahydro-1-nitroso-3,5-dinitro-1,3,5-triazine

LIST OF ACRONYMS AND ABBREVIATIONS (continued)

NAPL	non-aqueous phase liquid
NCP	National Contingency Plan
NPL	National Priorities List
NWAR	nuclear weapon accident residue
O&M	operation and maintenance
ORP	oxidation reduction potential
OSTP	Old Sewage Treatment Plant
OU	operable unit
P&T	Pump and Treat
P1PTS	Playa 1 Pump and Treat System
PCE	tetrachloroethene
PCL	protective concentration level
PCOR	Preliminary Close Out Report
ppb	parts per billion
PQL	practical quantitation limit
PRG	Preliminary Remediation Goal
RA	Remedial Action
RAO	Remedial Action Objective
RCRA	Resource Conservation 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
ROD	Record of Decision
RRR	Risk Reduction Rule
SDWA	Safe Drinking Water Act
SEISB	Southeast ISB
SEPTS	Southeast Pump and Treat System
SVE	soil vapor extraction
SVS	Supplemental Verification Site
SWDA	Solid Waste Disposal Act
SWMU	solid waste management unit
TAC	Texas Administrative Code
TBC	to be considered (analytes)
TCE	trichloroethene
TCEQ	Texas Commission on Environmental Quality
TLAP	Texas Land Application Permit
TNB	trinitrobenzene
TNRCC	Texas Natural Resource Conservation Commission (forerunner to TCEQ)
TNT	trinitrotoluene

LIST OF ACRONYMS AND ABBREVIATIONS (continued)

TNX	hexahydro-1,3,5-trinitroso-1,3,5-triazine
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
U.S.C.	United States Code
UCL	upper confidence limit
USDOE/NNSA	U.S. Department of Energy/National Nuclear Security Administration
UU/UE	unlimited use/unrestricted exposure
VOC	volatile organic compound
WMG	Waste Management Group
WWTF	wastewater treatment facility
ZN11ISB	Zone 11 ISB

1.0 INTRODUCTION

This report documents the findings of the Second Five-Year Review (FYR) for the Pantex Plant Superfund Site (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.

This Second 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/National Nuclear Security Administration (USDOE/NNSA) conducted this FYR in accordance with requirements in the Pantex Plant Interagency Agreement (IAG) and the Pantex Compliance Plan (CP-50284) [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 (NCP) [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 May 1, 2017 through February 15, 2018 and this report documents the results of the review. The FYR schedule was implemented such that it would be approved within five years from the issuance of the ROD.

The purpose of the FYR is to:

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

The Second 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 over the FYR period.
- **Section 5** discusses progress and updates to RAs since the First 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 remedial actions 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 remedial actions.
- **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, operation and maintenance 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 protect the integrity of the liners to prevent exposure to contaminants.
- Containment (presumptive remedy) and ICs for the 26 Pantex Plant landfills identified in the ROD and three additional units 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 to treat high explosive (HE) and hexavalent chromium [Cr(VI)] contaminants.
- 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 (ZN11ISB) System to treat trichloroethene (TCE) and perchlorate contaminants.
- 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, Table 1. Sixteen of those units are active and 79 were investigated and closed either administratively or by removal / remediation of contaminants to background concentrations. Soils at the remaining 159 units contain contaminants at concentrations that do not allow for unlimited use and unrestricted exposure (UU/UE) and 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 16 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 of the units and their closure status are depicted in Figure 1-1. The extent of affected groundwater and RAs locations for groundwater are depicted in 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 ICs evaluation.

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.

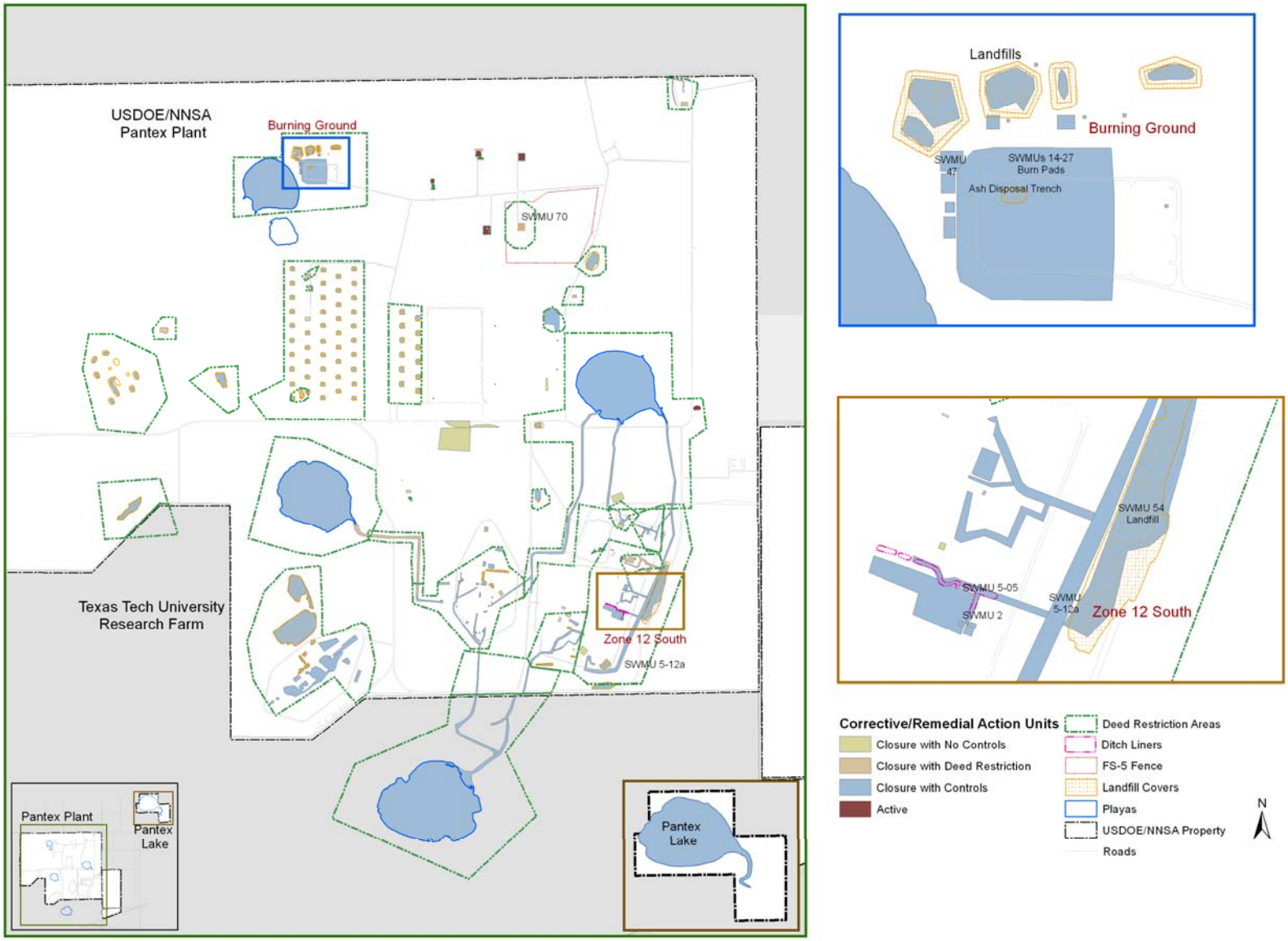

Figure 1-1. Status of Remedial Action Units

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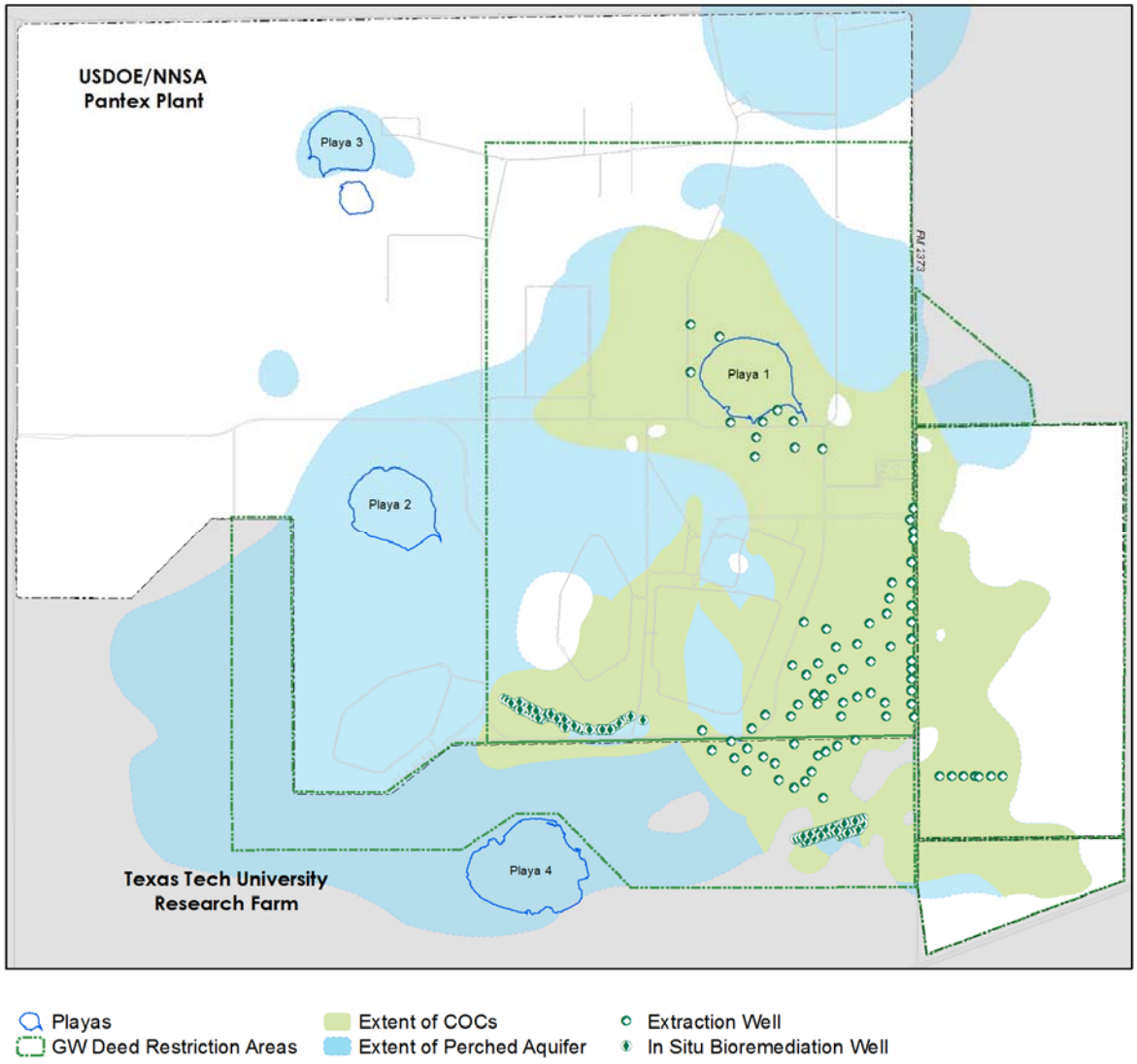

Figure 1-2. Status of Groundwater Remedial Action

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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. The ROD has not been amended since it was signed in 2008 and there have not been any Explanation(s) of Significant Differences (ESDs).

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 signature (Benchmark for Five-Year Review Completion) *	September 25, 2008
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

*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). 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.

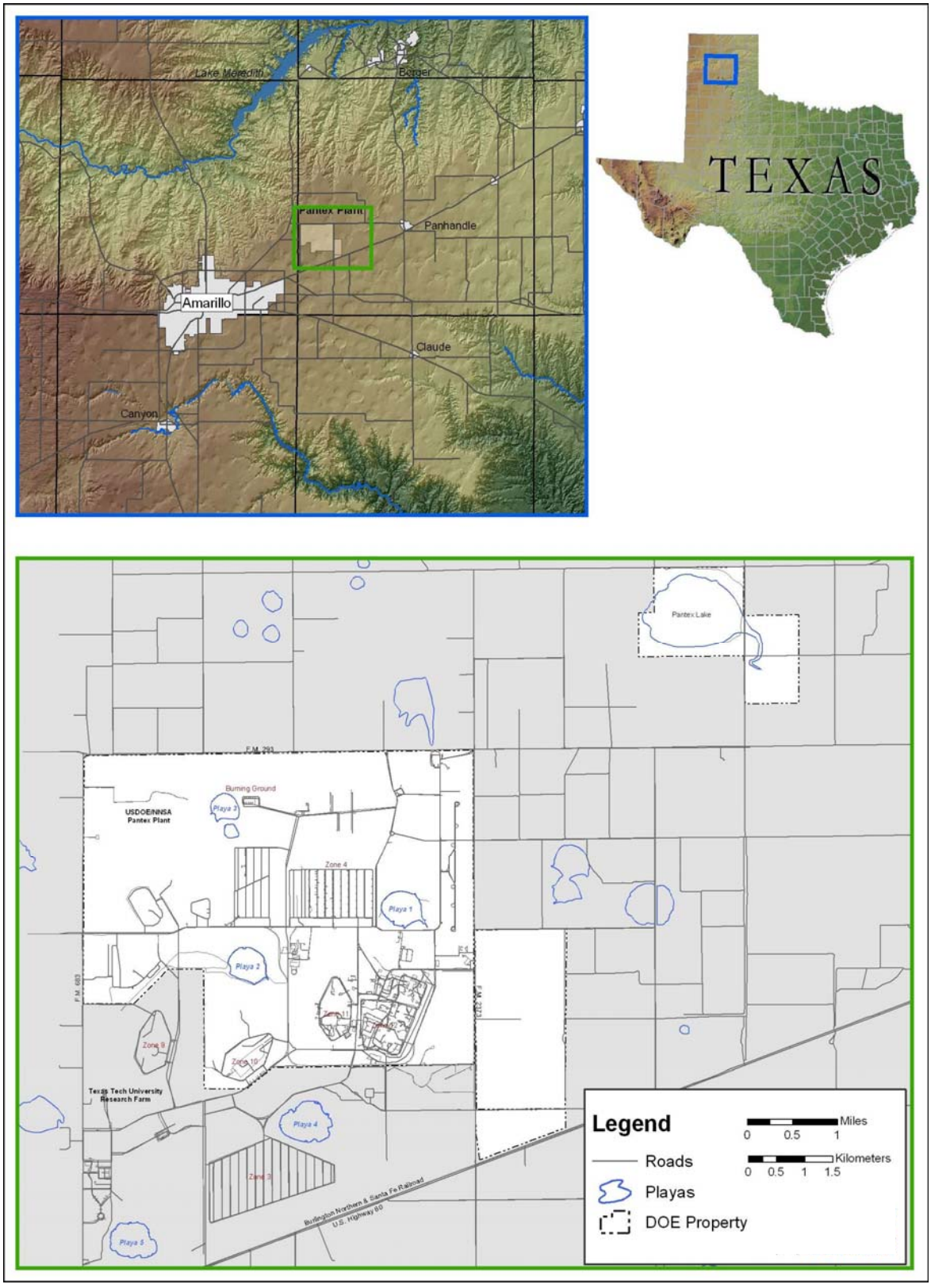

Figure 3-1. Pantex Plant Location and Site Features

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.

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 feet below ground surface (bgs) and 100 to 200 feet above the Ogallala drinking water aquifer. 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 feet 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.

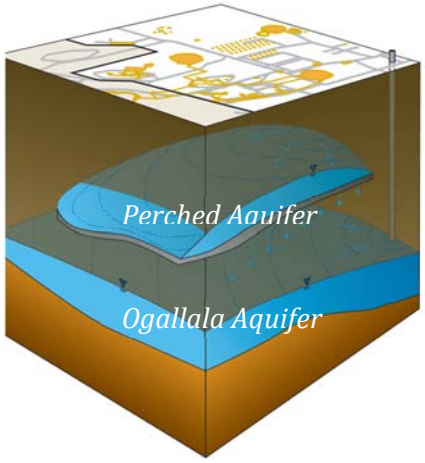

Figure 3-2. Groundwater Beneath Pantex Plant

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 gradient. 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 (Figure 3-3). Untreated perched groundwater at the Pantex

Plant Site is not used for any purpose and future use is restricted by deed restrictions and ICs. TTU and one off-site property owner to the east 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.

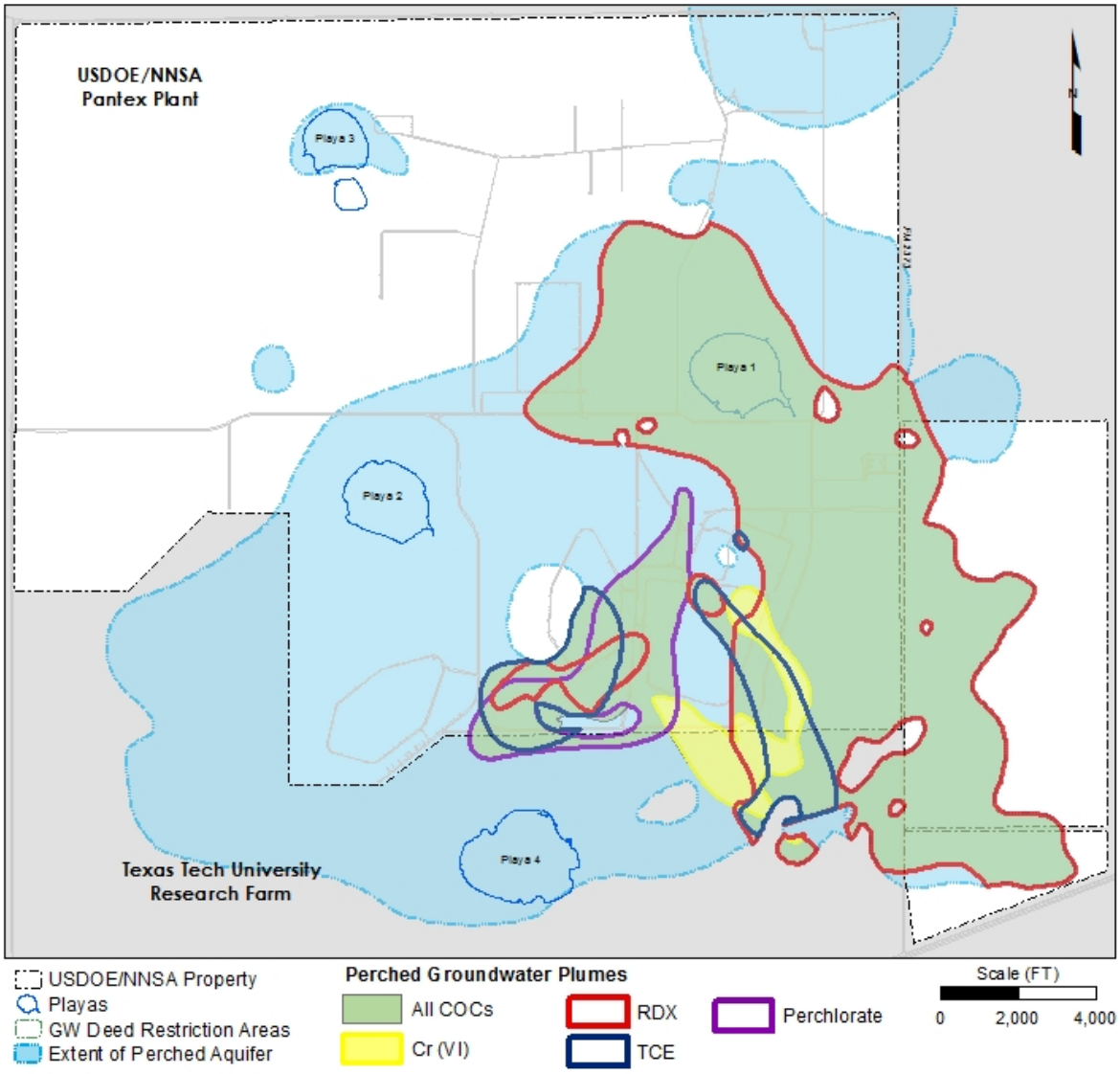

Figure 3-3. Perched Groundwater Extent and Major Constituent of Concern (COC) Plumes

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 bgs; saturated thickness is approximately 1 to 100 feet in the southern regions of the Site and approximately 250 to 400 feet 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.

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 at 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); 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 extent of perched groundwater and groundwater plumes at the Pantex Plant.

Discharges of untreated industrial wastewater to the ditch system were eliminated in the late 1980s to implement improved environmental controls and to comply with permit requirements. During the 1990s, the 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 feet from Playa 1. A new subsurface irrigation system for the beneficial reuse of treated wastewater was constructed, and routine discharge to Playa 1 has been eliminated, except when the 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.

Infrequent future discharge of treated sanitary wastewater could still occur when the subsurface irrigation is unavailable, in accordance with the Texas Pollution Discharge Elimination System (TPDES) permit requirements. The elimination of discharge to the ditches and Playa 1 has removed the primary driving force for further movement of constituents of potential concern (COPCs) through the ditches and Playa 1 soils, as well as the driving force that caused the expansion of the perched groundwater to its current extent.

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 depleted uranium [DU] and thorium)
- Other sources not produced at the Pantex Plant (stored U.S. Department of Defense nuclear weapon accident debris and DU components for high explosive 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 was 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, U.S. Environmental Protection Agency (EPA) conducted a RCRA Facility Assessment (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 Administrative Order (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 (U.S. EPA Docket Number VI-002(h)-89-H) was issued pursuant to Section 3008(h) of the Solid Waste Disposal Act (SWDA), 42 U.S.C. 6928(h), as amended by RCRA, and HSWA of 1984. The final AO was signed by 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 Texas Commission on Environmental

Quality (TCEQ) jointly issued Hazardous Waste Permit No. 50284 (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, Compliance Plan (CP-50284) was issued to maintain the RFI and corrective action requirements and establish a RCRA Interim Stabilization Measure (ISM) program for the Pantex Plant. The ISM program implemented two specific 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 Compliance Plan 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, 95 are either active or were investigated and closed either administratively or by remediating them to background. 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 future risks from soil and groundwater.
    - 90 units required limited RA – ICs with long-term groundwater monitoring was 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 Remedial Action 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 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 feet bgs, continues to yield sustained solvent vapor concentrations. 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 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 the First FYR.

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 in 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 on-site workers.
    - Contaminants include volatile organic compounds (VOCs), semi-volatile organic compounds, depleted uranium, 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 (GWPS).
- Perched groundwater is impacted above GWPS and requires RAs. Perched groundwater COCs[1] by area include:
    - Southeast plumes: hexavalent chromium [CR(VI) shown on map as Cr6]; total chromium (Cr); trichloroethene (TCE); 2-amino-4,6-dinitrotoluene (2ADNT); 4-amino-2,6-dinitrotoluene (4ADNT); 1,3-dinitrobenzene; 2,4-dinitrotoluene; 2,6-dinitrotoluene; HMX; hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX); 1,3,5-trinitrobenzene; and 2,4,6 trinitrotoluene (TNT).
    - Zone 11 plumes: 1,2-dichloroethane; 1,4-dioxane; tetrachloroethene (PCE); TCE; RDX; and perchlorate.
- 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 in situ bioremediation (ISB) technologies that work together to reduce the driving forces for lateral and vertical migration and reduce the total mass of the contaminants, particularly in areas sensitive to vertical migration. 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

[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 subsurface irrigation tracts where the treated perched groundwater from the pump and treat systems is beneficially used, so it is monitored.

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 concern is the potential for perched groundwater to act as a source of future impacts to the underlying Ogallala Aquifer. Contaminant concentrations in the perched groundwater exceed GWPSs throughout all or most of the plume for many COCs, including: RDX, the primary risk driver for the southeast plume; Cr(VI); TNT; 2-amino-4,6-dinitrotoluene (DNT); 4-amino-2,6-DNT; 2,4-DNT; perchlorate; and TCE. Most importantly, if no action is taken, vertical migration of perched groundwater contaminants to the Ogallala Aquifer is likely in the southeast area. The RA was designed to reduce and stabilize (e.g. prevent migration) the perched groundwater contaminants upgradient of this critical area. If contaminants migrate downward to the Ogallala Aquifer, a groundwater exposure pathway to receptors onsite or offsite would be complete with potential for impacts to human health. Therefore, protecting the Ogallala Aquifer from future impact is one of the primary goals of the RA.

The RAs for soils, identified in the ROD, eliminate direct contact risks to on-site workers and minimize further migration of contaminants into the soil column and perched groundwater beneath the site. The RA for soils includes containment for sites with those potential risks, and includes protective covers and liners installed as ICMs under the State RCRA authority. 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 RA.

ICs are also a part of the RA 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 off site. 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, barriers) and security measures such as signage and work plans minimize access, and protect components, of the active RA.

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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 operation and maintenance (O&M). Annual inspections and ongoing O&M ensure continued integrity of the protective covers.
- Ditch Liners:
  - Zone 12 ditches (SWMU 2 and SWMU 5-05). The installed synthetic liners, including the new Hypalon liner installed in 2016/2017, 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 treat perched groundwater contaminants.

- 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.
- SEISB System to treat high explosive (HE) contaminants and Cr(VI).
- ICs to prevent exposure to contaminants and cross-contamination to the regional Ogallala Aquifer.

The Selected Remedy for the Zone 11 perched groundwater is:

- The In Situ Bioremediation System (ZN11ISB) to 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 (LTM) Groundwater Monitoring Plan, developed as part the Remedial Design, in accordance with the IAG. The LTM plan is reviewed for optimal performance periodically (2007, 2011, and 2017) 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 has not been modified by a ROD amendment or ESD since the ROD was issued in 2008. Several updates and expansions of the groundwater remedy have been implemented or are planned for the near future. These updates are anticipated to have a significant impact on remedy scope, performance and cost. As such, an ESD is likely needed to document the changes to the scope of the Selected Remedy. A discussion of a potential ROD modification through an ESD is presented in Section 8 and Section 9 of this report.

4.1.1 Remedial Action Objectives

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

4.1.1.1 RAOs for Soil

RAOs were developed for surface and subsurface soils to address risk 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 Ogallala Aquifer. While RAs address both objectives, protection of the Ogallala Aquifer, which is a water supply for 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 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, 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 is located more than 1,000 feet from the SVE-S-20 extraction well (EW); 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 of VOCs. The original SVE system consisted of 28 vapor extraction wells, 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 feet [ft] bgs) and intermediate zone (caliche caprock to the FGZ).

By 2005, only one well (SVE-S-020) 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.

Recent modifications to the SVE system include reworking 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 is intended to enhance contaminant mass extraction and biodegradation of VOCs.

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 7a and 7b: Igloo Demolition Debris Landfills Zone 4 (SVS 7a) and Zone 5 (SVS 7b)
- SVS 6: Unnumbered Zone 7 Landfills

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 has improved greatly since the first FYR Site Inspection in 2012. Evaluation of the protective covers indicates that they remain intact with the exception of some holes due to voids in construction debris landfills and burrowing animals. Actions to address these finding are described in Chapter 7.

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

- Landfill cover inspections performed by CNS personnel from 2013 through 2017 and the associated inspection report summaries (original reports are kept on file at the Plant).
- Site inspections performed by HGL on August 15 and 16 and September 19, 2017.
- Topographic maps prepared from Light Detection and Ranging (LiDAR) surveys performed April 6, 2017. These maps are presented in Attachment 8.
- Comparison of LiDAR-based topography from 2017 to baseline elevation contours presented in the Interim Remedial Action Report (B&W Pantex, 2010) to support the first FYR 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, 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 first FYR. 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 2017 and the LiDAR data indicated some minor deficiencies in cover integrity including:

- Settlement at SVS 5, Landfill 5 (SWMU 56), Landfill 15 (SWMU 66) and Active Sanitary Landfill (SWMU 68d);
- Burrowing animal holes at SVS 7a and SVS7b; and
- Erosion and slope instability 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 feet, were lined as an ICM in 2004 to prevent migration of vadose

zone soil contamination to the perched groundwater. 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.

Between December 2016 and March 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 foot wide by 2 feet 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-foot 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 feet 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, 2017a.

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 consists of three separate active RAs (SEPTS, P1PTS, and SEISB) that were designed to work together to achieve the RAOs. One active RA was implemented for Zone 11; the ZN11ISB. 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 remedial actions. 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 CP-50284.

The SEPTS currently consists of a treatment building, 62 EWs, and three injection wells (see Figure 4-1). This system treats the water through a series of GAC vessels and ion exchange resin beds to reduce 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 aquifer. All treated water was injected until May 2005 when the original irrigation system was placed online to receive treated groundwater from the SEPTS and P1PTS through the Pantex Plant WWTF system. The original irrigation system has been expanded to 400 acres, as documented in the First FYR. Beneficial reuse of treated water also includes use of water in the ISB injection system. 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 as beneficial use of the water can consistently support the extraction goals. Due to mechanical problems with the irrigation system starting in June 2017, treated groundwater from the SEPTS is being reinjected into the perched unit and released to Playa 1.

The SEPTS was shut down for upgrades to reduce the injection of treated water starting in September 2014 and resumed operation in 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.

An evaluation of the SEPTS was conducted by HGL (2018) as part of a remedy effectiveness evaluation required for this second FYR. The complete evaluation is provided in Attachment 7. Overall, the SEPTS is meeting the design objective of reducing perched aquifer saturated thickness. A review of the monitoring data indicates that groundwater elevations declined at each monitoring location within the SEPTS area of influence. Statistical concentration trends at Zone 12 source area wells are generally decreasing, while concentrations directly east of the Plant along FM 2373 show *stable* trends, indicating stabilization and control of plume migration. The SEPTS is the most effective remedy on Site for removing and treating HE from groundwater.

Groundwater monitoring data over the past five years indicate statistically *increasing* trends of HE and Cr(VI) in the southeast lobe of the plume outside the influence of the current SEPTS. Between 2016 and 2017, additional groundwater investigation wells were installed in the southeast lobe of the perched unit (PTX06-1182, PTX06-1184, PTX06-1185, PTX06-1186, and PTX06-1190). Data from these locations indicate that the HE plume has migrated south to Highway 60.

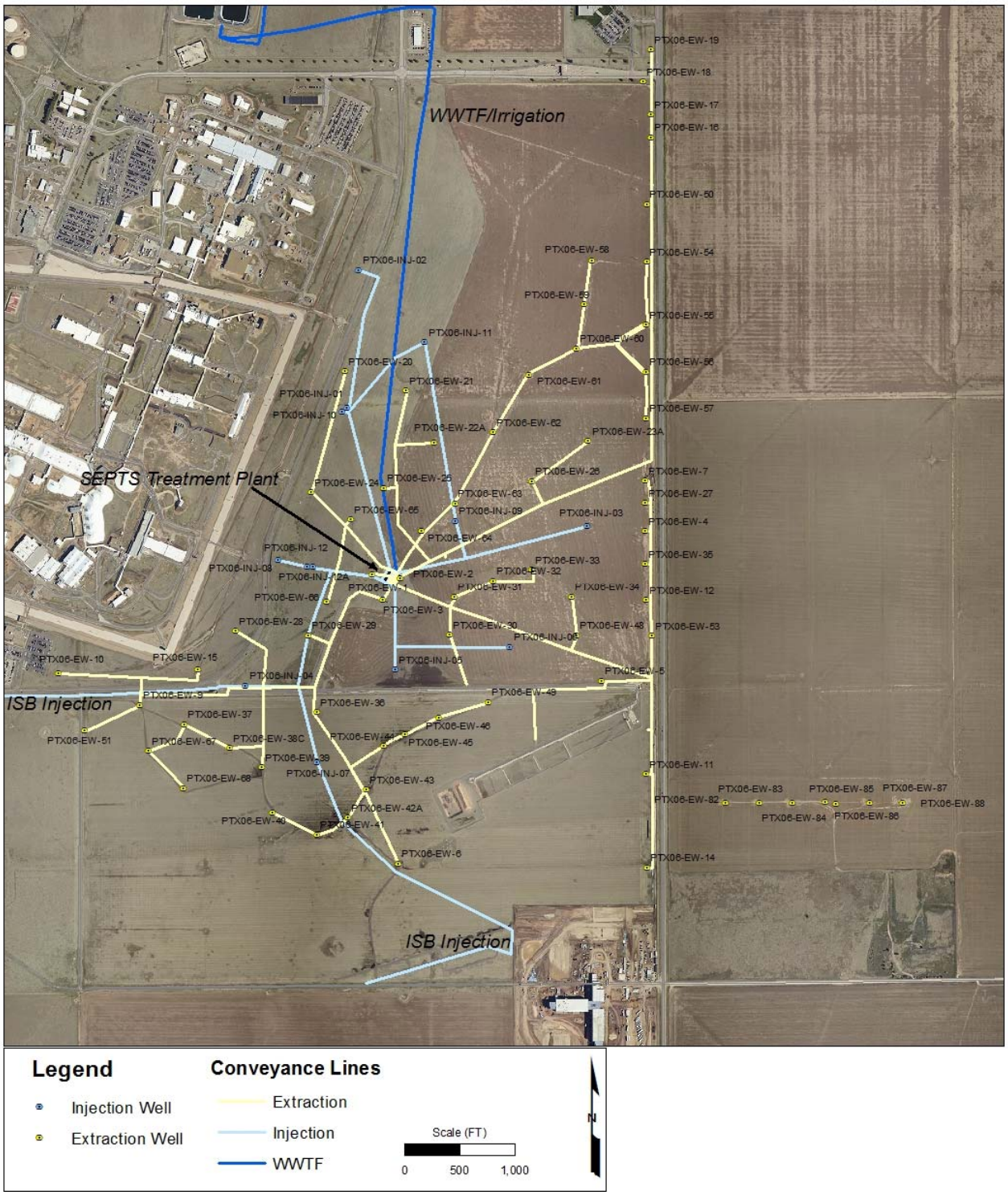

Figure 4-1. SEPTS Extraction Wells and Conveyance Lines

Seven additional 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 but the other wells (PTX06-EW83 through PTX06-EW-88) are anticipated to be connected to the SEPTS system in July 2018. These new EWs are anticipated to improve control of plume migration to the southeast.

The far southeast lobe of the perched unit has low saturated thickness (typically less than 15 feet), indicating that additional EWs south of the new EWs wells are unlikely to be effective at remediating the plume in this area. Because of this, an additional ISB system is being planned and designed for the southeast lobe of the perched groundwater unit along Highway 60.

Additional plume characterization, delineation as well as additional remedial components are anticipated north of Highway 60 over the next five years. Expansion of ICs to the southeast may be required if affected groundwater extends outside of the current IC boundaries.

Overall, the SEPTS is achieving progress 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. 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. Potential performance improvements are described in Chapter 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 surface discharged to Playa 1.

An evaluation of the P1PTS was conducted by HGL (2018) as part of the remedy effectiveness evaluation required for the second FYR. The complete evaluation is provided in Attachment 7. Overall, the P1PTS is meeting the design objective of reducing perched aquifer saturated thickness. Groundwater elevations declined at each monitoring location within its area of influence. 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, except when there are problems with the irrigation system.

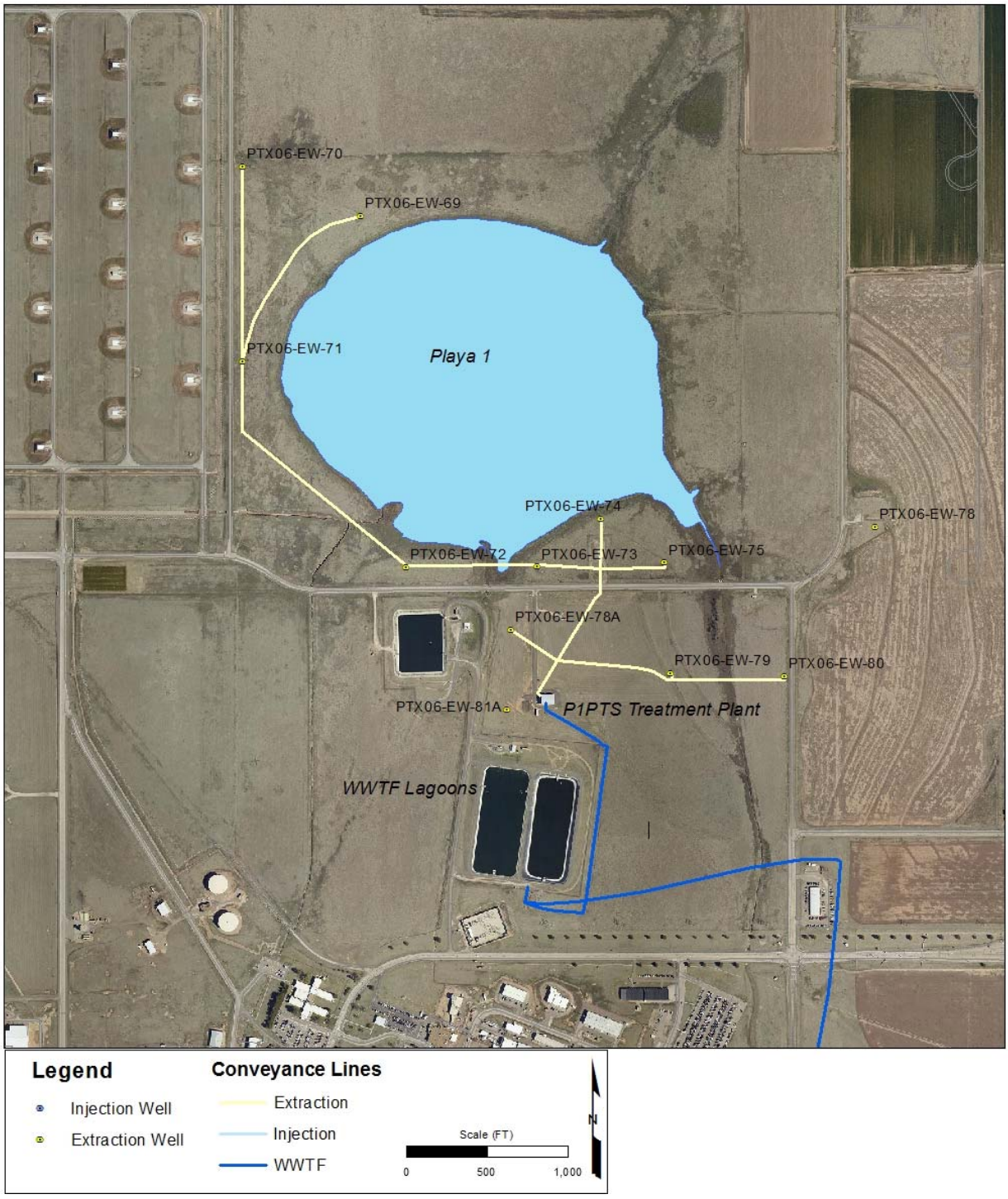

Figure 4-2. P1PTS Extraction Wells and Conveyance

An additional EW (PTX06- EW-81A) and conveyance piping was added to the P1PTS near the treatment plant during the FYR period. The well became operational in 2016. The purpose of this additional EW is to ensure continued operation at throughput goals, reducing groundwater elevations, and controlling plume migration south of Playa 1 when other wells are offline being repaired or maintained.

The P1PTS is making progress toward achieving RAOs by reducing saturation to lessen the driving force for vertical migration and decreasing the flux of water moving downgradient toward the SEPTS. This system is also achieving mass removal from water that is extracted and treated. Additionally, the COC concentration trends at PTX06-1050 northwest of Playa 1 have gone from increasing to *decreasing*, limiting potential plume migration in this area over the recent FYR period. Further potential performance improvements are described in Chapter 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 injection wells 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-trinitrobenzene [TNB]), and CR(VI). No notable changes or difficulties occurred during the RD of this system.

An evaluation of the SEISB was conducted by HGL (2018) 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 timeframe (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 two performance monitoring wells (PTX06-1045 and PTX06-1118) has diminished to the point where they have not been sampled since 2009 and one well (PTX06-1123) was dry in 2016. These wells have not regained saturation even after injection of amendments and flush water during the FYR period.

Since March 2008, carbon substrate amendment has been injected into the SEISB six times: March 2008; April 2010; May 2012; September 2013; April 2015; and October 2016. As standard operating procedure, amendment injection occurs after completion of well maintenance. Not all injection wells are used during each injection event. For example, in 2016, amendment was injected into 21 of the 42 injection wells. The selection of which wells to treat is based primarily on saturated thickness.

During the FYR period, COC concentrations decreased below GWPS in three of four ISPM wells that have sufficient saturation to be sampled. At one well (PTX06-1153) the

data suggest an increase in the RDX concentration. 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, 2017b). 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, so reduced amendment frequency and/or number of injection locations appears appropriate during the next FYR period.

Figure 4-3 depicts the SEISB System Injection Well field and ISPM wells.

Figure 4-3. SEISB System Injection Well Field and Performance Monitoring 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 Chapter 7.

4.2.2.4 Zone 11 ISB System

The ZN11ISB, 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 ZN11ISB. In 2014, two wells that had been installed for pump testing were converted to injection wells, and 18 new injection wells were installed to the west of the initial system. The ZN11ISB system is illustrated on Figure 4-4.

Carbon substrate amendment has been injected into the ZN11ISB eight times: June and November 2009; September 2010; October 2011; September 2012; July 2013; July 2014; November 2015; and August 2016. In 2014, 14 injection wells were bioaugmented with a commercial microbial culture capable of fully degrading TCE.

An evaluation of the ZN11ISB was conducted by HGL (2018) as part of the remedy effectiveness evaluation (Attachment 7). The ZN11ISB 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. The original, central section of the ZN11ISB is inducing anaerobic conditions and is effectively dechlorinating TCE in several locations. Areas within the central part of the system are showing complete treatment of TCE, but other areas show a lagging rate of degradation for the cis-1,2-dichloroethene (DCE) daughter product. It is anticipated that as the system evolves and the anaerobic microbial community becomes better established, TCE treatment in the western expansion area will be effective.

A 1,4-dioxane plume is present in the area of the ZN11ISB, larger than initially characterized before the ROD. The ISB system was not designed to treat 1,4-dioxane. Concentrations of 1,4-dioxane are in the range of the GWPS (7.7 micrograms per liter [µg/L]) and statistically stable in most areas (see Section 5.1.9). Monitoring for 1,4-dioxane will continue in the next five-year period to confirm low concentrations in the Zone 11 plume.

4.2.2.5 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 to confirm the expected future conditions within the perched aquifer and the Ogallala Aquifer. The LTM design and evaluation criteria are provided in the *Update to the Long-Term Monitoring System Design Report* (B&W Pantex, 2014). The original monitoring program (B&W Pantex, 2009) 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.

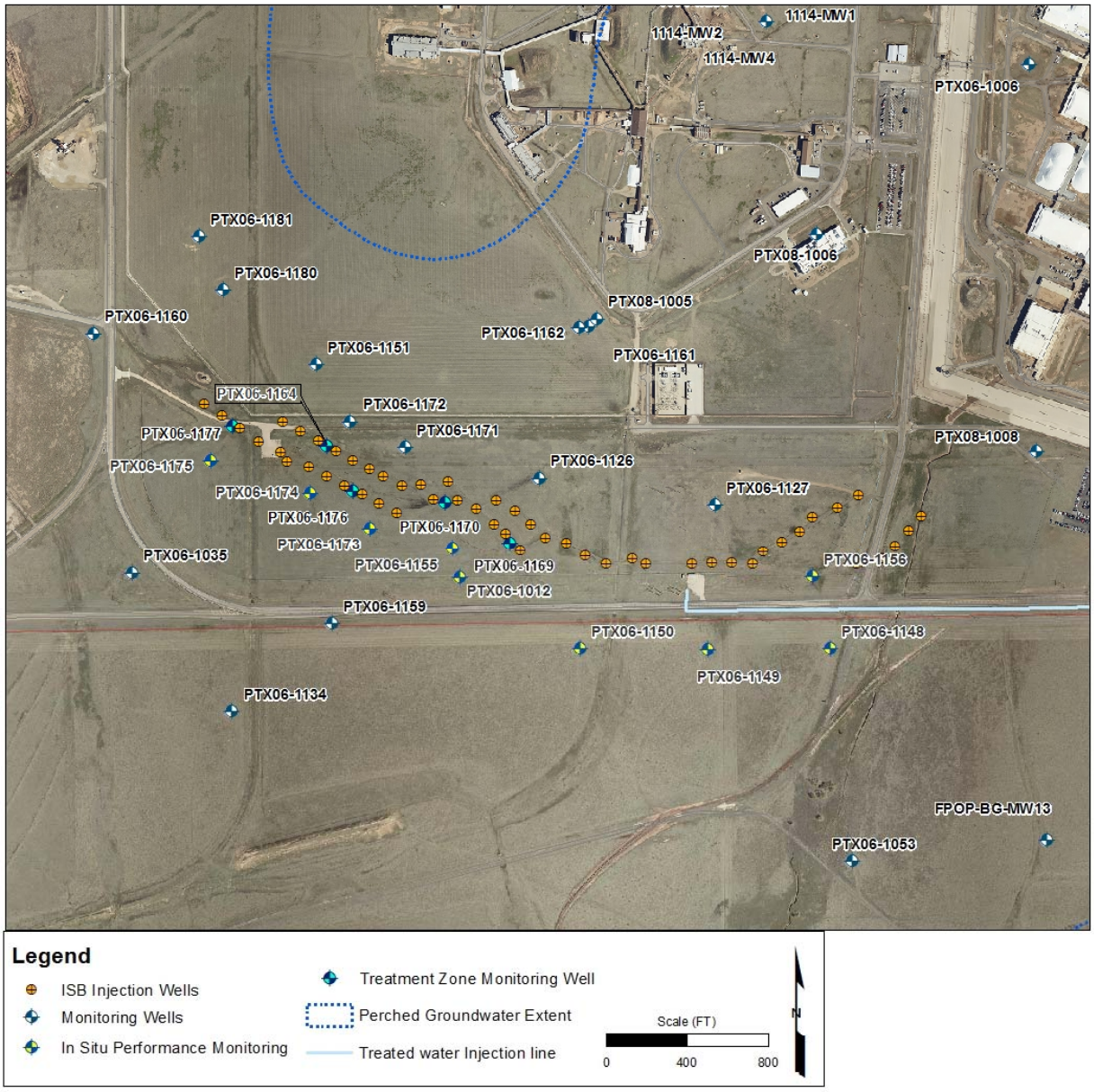

Figure 4-4. ZN11ISB Injection Well Field and Performance Monitoring Wells

The final network consists of:

- 214 different sampling locations that monitor water levels and/or COC analytes including investigation wells (IWs), EW, and ISB wells;
- 112 perched aquifer investigation wells to monitor water levels and COC analytes;

- 26 IWs are screened in the Ogallala Aquifer as part of the uncertainty analysis detection monitoring program. A portion of these wells (seven total) are monitored at multiple levels.

Since the remedy effectiveness is determined through groundwater monitoring implemented through a Long-Term Groundwater Monitoring Plan, the perched aquifer LTM network was evaluated by HGL in August 2017 (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 (2012 through 2016) were analyzed using the Monitoring and Remediation Optimization System (MAROS) version 3.0 (beta) 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. Recommendations for the LTM network are discussed in Chapter 6.

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 and Sapere Consulting 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 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 only 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 2017. All ICs have been implemented and are working as intended to prevent exposure. Depending on results from the characterization of the plume migrating in the southeast lobe of the perched groundwater unit, additional deed restrictions may be required in the area of Highway 60. This expansion of access controls may involve off-site property owners and stakeholders that hold easements. 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, has been operated fairly consistently during the FYR period. Figure 4-5 and Figure 4-6 summarize the SVE system operations over the FYR period. The system removed over 2,620 pounds (lbs) of soil gas VOCs during this period. Soil gas recovery has been variable throughout the review period, ranging from none in February 2012 to almost 90 lbs in September 2013. Estimated recovery is affected by system operational time, air flow rates, and influent analytical data.

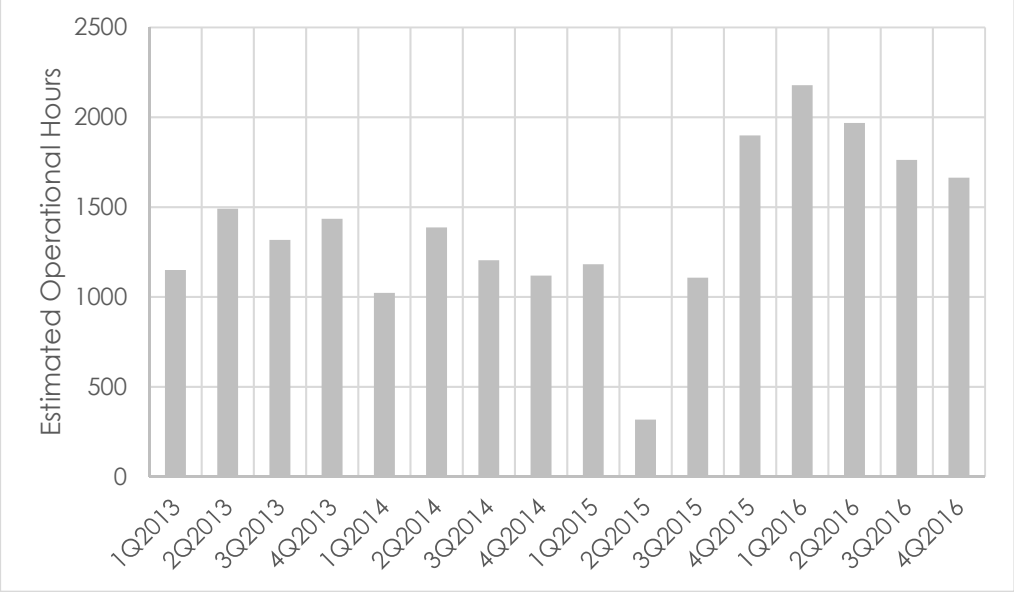

Figure 4-5. BG SVE System Operational Time

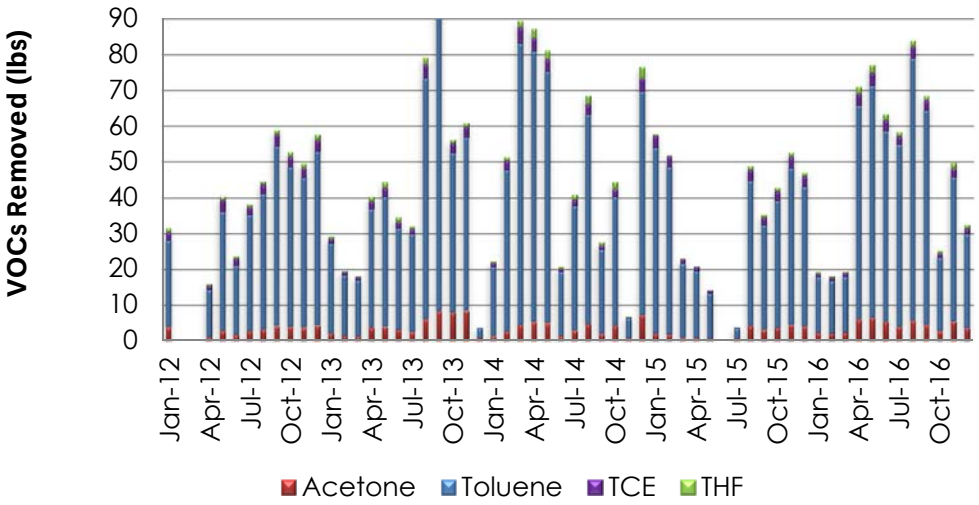

Figure 4-6. BG SVE VOC Recovery

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 2017 to aid in evaluation of the surfaces of the protective covers for this second FYR. Subsequent LiDAR surveys will be conducted every 5 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 are identified and addressed. 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 periodically to identify tears and problems with sedimentation. Between December 2016 and March 2017, a new 45-millimeter Hypalon liner was installed over the existing SWMU 2 and 5-05 Ditch Liner, representing a capital improvement cost above routine maintenance.

4.3.1.4 Soils O&M Costs

O&M costs for the Soil Remedies are presented in Table 4-1. These costs are primarily related to maintaining protective covers and operating the BG SVE System. Costs for this program exceeded the estimate in FY2013, FY2015, and FY2017 for three reasons; (1) installation of a geosynthetic cover system known as ClosureTurf® on General Purpose Sanitary Landfill 1 (SWMU68b), (2) installation of ClosureTurf® on General Purpose Sanitary Landfill 2 (SWMU68c), and (3) replacement of the SWMU 2 and 5/5 ditch liner. Annual analysis of maintenance costs for the soil remedies resulted in two actions to reduce long-term costs that have already been implemented: (1) modification of six shallow extractions wellheads that surround SVE-S-20 to enhance soil vapor extraction at the BG SVE System and stimulate aerobic degradation processes and (2) design of erosion control repairs at Landfill 3 (SWMU 54) to mitigate cover erosion where ditches drain storm water from Zone 12 south into the 5/12 ditch and eventually to Playa 1. Landfill 3 repairs are being subcontracted for implementation in 2018.

Table 4-1. O&M Costs for Soil Remedies

Dates		O&M Cost Rounded to Nearest $1,000
From	To	
Annual ROD Estimate		150
Annual PCOR Estimate		246
10/1/2012	9/30/2013	625
10/1/2013	9/30/2014	175
10/1/2014	9/30/2015	424
10/1/2015	9/30/2016	222
10/1/2016	9/30/2017	590

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:

- 90 percent (%) operation time with no injection 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 limited below 250 gpm for the two systems, and
- 90% of system treatment or well field capacity, whichever is lower.

Operational goals were established in order to reduce saturated thickness of the perched aquifer, 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 aquifer, and reduce the head (driving force) for vertical migration of perched groundwater into the FGZ and toward the underlying Ogallala Aquifer.

These goals provide for about 142 million gallons (Mgal) of perched groundwater to be removed and treated through the SEPTS each year. Figures 4-7, 4-8, and 4-9 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 gallons per minute (gpm). The average influent to the treatment plant in gpd summarized in Figure 4-9 accounts for both system flow and system downtime while the average gpm summarized in Figure 4-8 does not account for system downtime and is thus a measure of the well field production.

As depicted in Figure 4-7, average operational time consistently was near the 90% goal in the 2012 through 2014 time frame and after the third quarter of 2015.

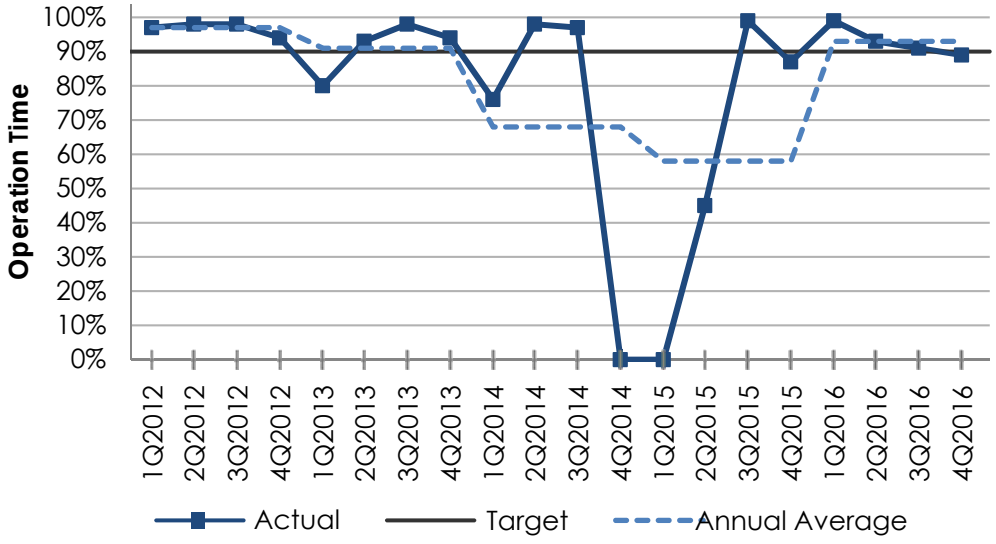

Figure 4-7. SEPTS Operational Time vs. Target

The SEPTS was shut down for upgrades to reduce the injection of treated water starting in September 2014 and resumed operation in May 2015. The upgrade provides for redundancy resulting in consistent operation over time and increases 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 irrigated crops. With the changes in Cr(VI) treatment process, the system can exceed the original design criteria of 300 gpm when required.

As depicted in Figure 4-8 and Figure 4-9, the SEPTS met throughput goals during the same effective operational time as shown in Figure 4-7. System throughput was affected by system upgrades with values falling to zero in the fourth quarter of 2014 through the first quarter of 2015.

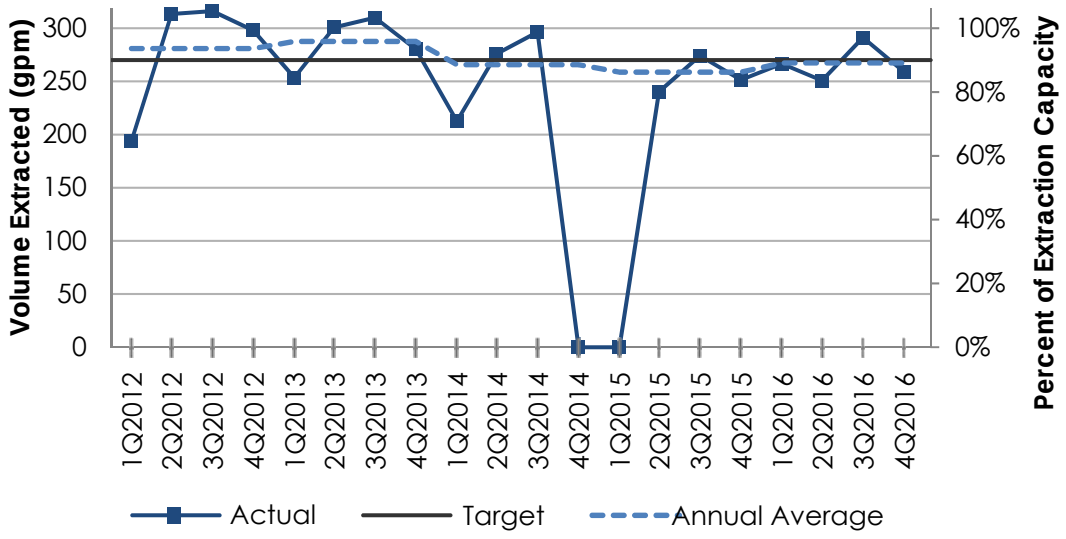

Figure 4-8. SEPTS GPM and % Capacity

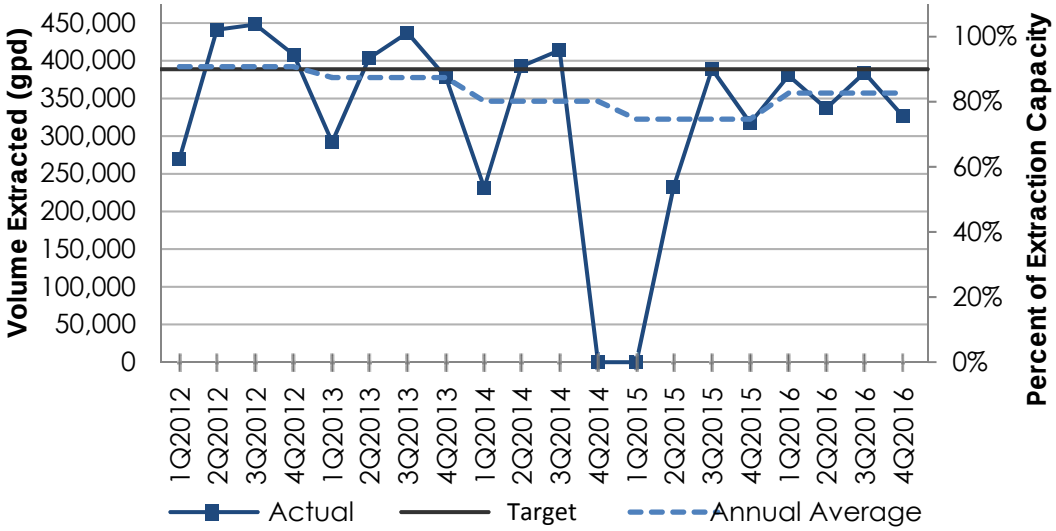

Figure 4-9. SEPTS GPD and % Capacity

As shown in Figure 4-10, almost all treated water was discharged through the irrigation system, with some water used for injection of ISB amendments, thus, achieving operational goals of beneficial reuse of water.

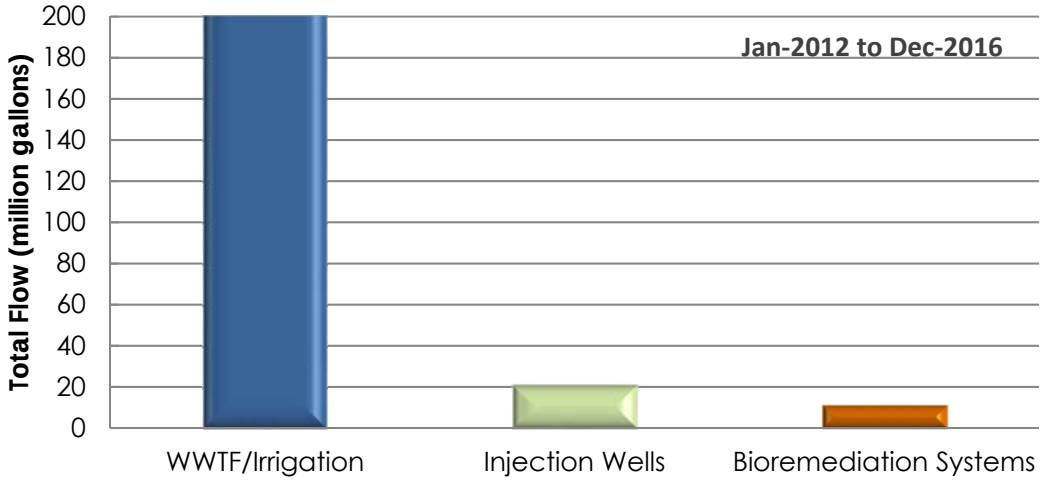

Figure 4-10. Disposition of SEPTS Effluent

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 454 lbs of Cr(VI) during the reporting period. As depicted in Figure 4-11, no Cr(VI) was removed during the fourth quarter 2014 and first quarter 2015 and removal was lower than targets before and after the shutdown period. As depicted in Figure 4-12, 1,843.9 lbs of RDX and 1,109.4 lbs of other HE were removed during the FYR reporting period. All COCs were treated to concentrations below the GWPS.

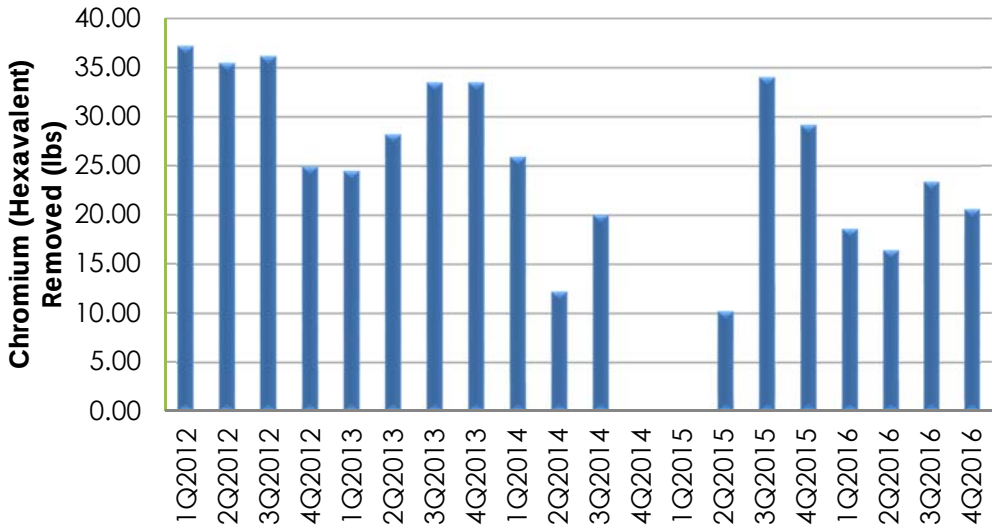

Figure 4-11. SEPTS Hexavalent Chromium Removal

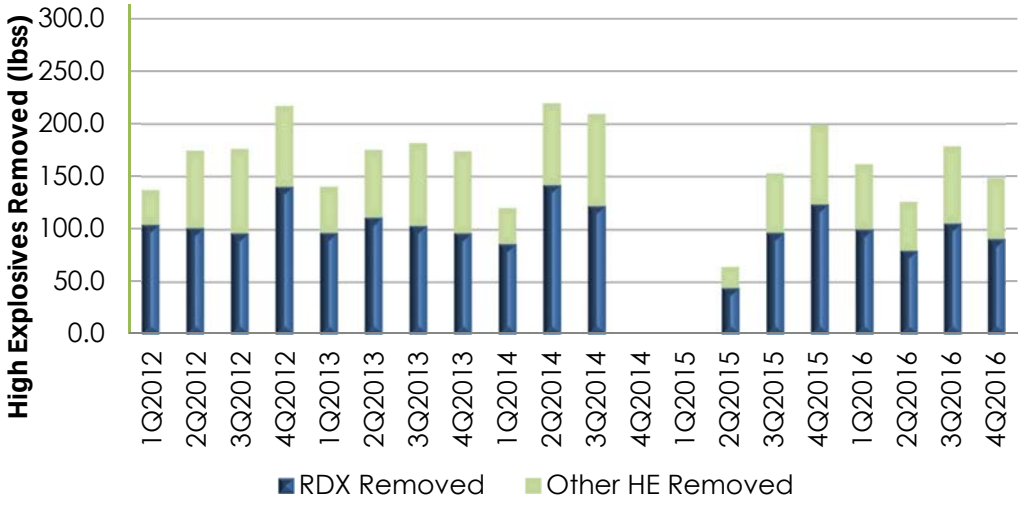

Figure 4-12. SEPTS HE Removal

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 uses all treated water by sending it through the WWTF to the irrigation system. 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. Because this system does not have the capability to inject the treated water back into the perched aquifer, the treatment throughput must be adjusted or discontinued to meet the demands of the WWTF or irrigation system.

The operational time for the P1PTS over the previous five years is shown in Figure 4-13. Overall operational time for the P1PTS was close to the 90% goal through 2015 but decreased in the first quarter of 2016 resulting in 65% of the operational goal for 2016. The primary O&M challenge for the P1PTS is operation of the irrigation system for discharge of treated groundwater. A GAC vessel for the P1PTS was replaced during planned maintenance in April 2016. As the P1PTS does not have reinjection capability, the system must be paused or shut down if the beneficial reuse system cannot accept treated discharge.

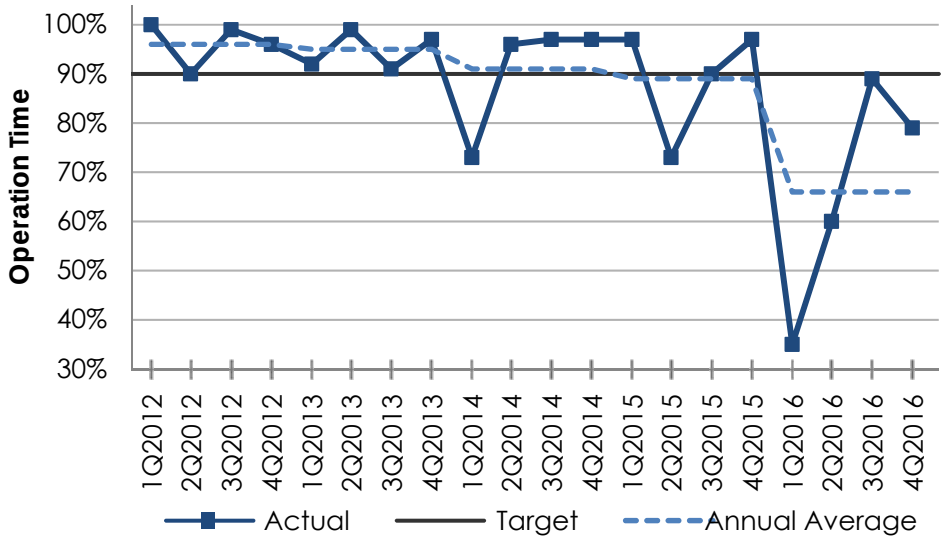

Figure 4-13. P1PTS Operational Time vs. Target

The calculated gpm depicted in Figure 4-14 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. As shown in Figure 4-14, the gpm goal has been met for seven quarters during the FYR period.

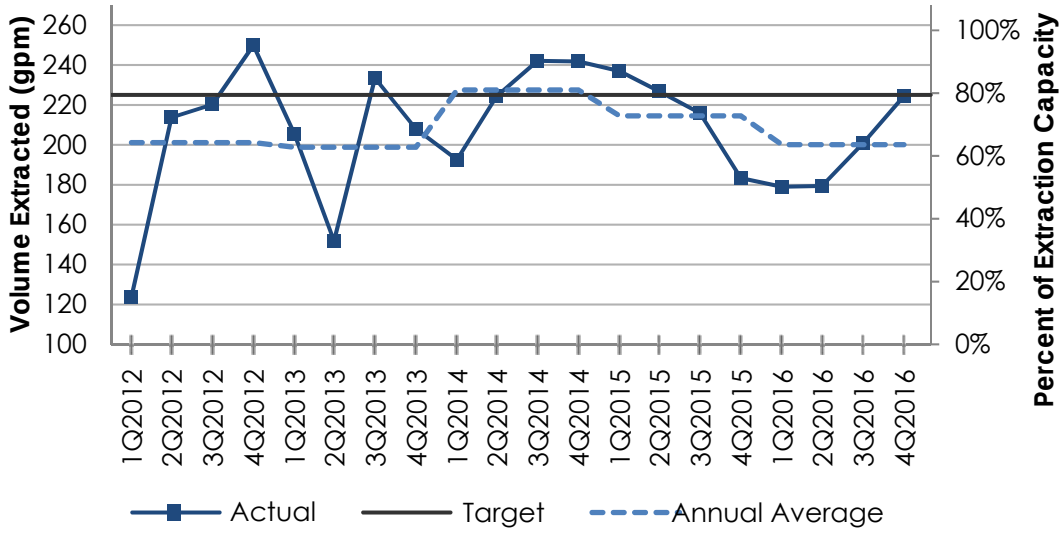

Figure 4-14. P1PTS Average GPM and % Capacity

Figure 4-15 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 and irrigation system. Therefore, the P1PTS gpd was affected by the aforementioned plant maintenance issues.

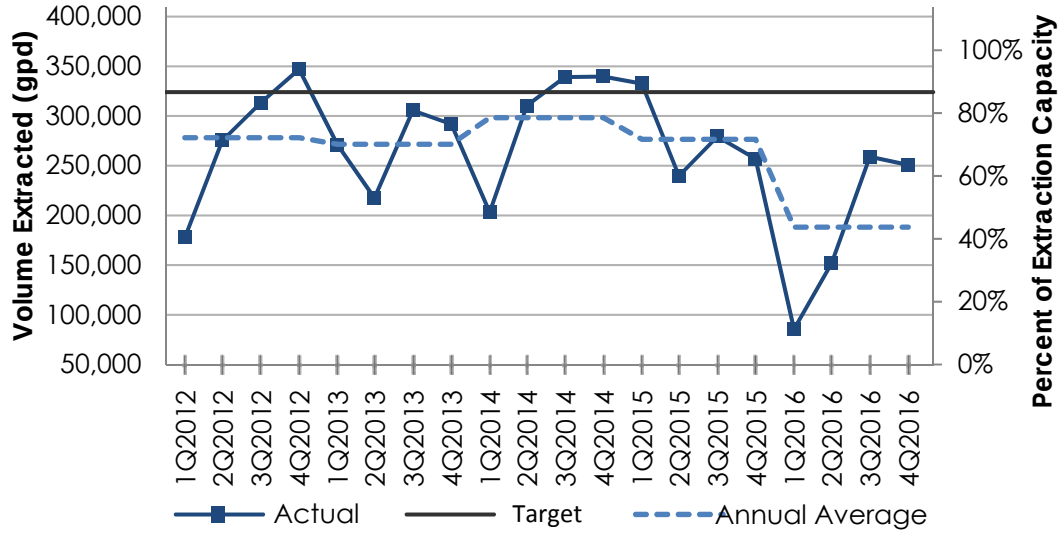

Figure 4-15. P1PTS Average GPD and % Capacity

System mass recovery has been variable over the FYR reporting period as recovery is based on system throughput as well as measured influent concentrations. The system removed a total of 218.8 lbs of RDX and 91.8 lbs of other HEs during the FYR reporting period. The system extracted almost 478 Mgal of groundwater and treated all COCs to concentrations below the GWPS.

4.3.2.3 SEISB System

Based on the baseline rate of perched groundwater flow and estimated amendment longevity, injections were estimated to be necessary about every 12 to 24 months. The injection events for the SEISB system are summarized in Table 4-2. ISB Injection Events.

Before each injection event, the injection wells 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. 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 injection wells and downgradient ISPM wells are sampled quarterly and the data are evaluated in the Quarterly and Annual Progress Reports.

4.3.2.4 ZN11ISB System

Based on the rate of perched groundwater flow and estimated amendment longevity, injections for this system were estimated to be necessary about every 12 to 18 months. Rehabilitation and injection activities have been scheduled every 12 months because of greater saturated thickness and higher groundwater velocity encountered in the well field. Five injection events have been completed for this system during this FYR period. Table 4-2 summarizes all the injection events to date.

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. During this FYR period, two injection wells damaged as a result of maintenance activities (PTX06-ISB066 and PTX06–ISB075) were replaced in September 2012.

Both the ZN11ISB injection wells and downgradient ISPM wells are sampled quarterly and the data are evaluated in the Quarterly and Annual Progress Reports.

Table 4-2. 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
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

4.3.2.5 Long-Term Monitoring

The LTM design and evaluation criteria are provided in the *LTM System Design Report* (B&W Pantex, 2009a) and in the 2014 *Update to the Long-Term Monitoring System Design Report*. Monitoring occurs on a quarterly basis near the ISB Systems and on a semi-annual or annual 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* (B&W Pantex, 2014).

A subset of perched and Ogallala Aquifer wells is monitored for an expanded list of constituents every five years to monitor for 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 contaminants 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. Specific parameters were also added at wells in the southeast area groundwater to assist with future evaluation of natural attenuation and estimation of indigenous degradation rates for HEs.

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, 5 perched monitoring wells were replaced, and 21 new perched wells were installed. The five perched-aquifer monitor wells were replaced to ensure representative samples and water level measurements could continue to be obtained as follows:

- PTX08-1001 was 20 years old and dry due to P1PTS progress,
- PTX08-1002 was 20 years old and dry due to P1PTS progress,
- PTX06-1149 was replaced because its integrity was uncertain due to a separated casing,
- PTX06-1051 had a potential plugged screen, so its saturation was uncertain, and
- PTX06-1071 was replaced because it had a failed screen.

Of the 21 new monitoring wells installed in the perched aquifer, 18 (PTX06-1159 through PTX06-1181) were installed to improve the understanding in the ZN11ISB area: 4 for performance monitoring, 5 for treatment zone monitoring, and 9 for hydrogeologic and plume information. The other three new perched monitoring wells (PTX06-1158, PTX06-1182, and PTX06-1183) were installed to improve the understanding of the far southeast extent of the perched groundwater plume.

4.3.2.6 Groundwater O&M Costs

Overall, the cost of O&M for the groundwater remedies has been achieved within the budget established for the Pantex Plant Long-Term Stewardship Program. As presented in the discussion of cost for each of the individual RA components, one of the systems (the ZN11ISB) is costing more to operate and maintain than estimated in the ROD.

Table 4-3. O&M Cost for the SEPTS

Dates		Total Cost ($K) Rounded to Nearest $1,000
From	To	
Annual ROD Estimate		1064
Annual PCOR Estimate		1240
10/1/2012	9/30/2013	1037
10/1/2013	9/30/2014	1254
10/1/2014	9/30/2015	2906
10/1/2015	9/30/2016	1708
10/1/2016	9/30/2017	1062

The cost to operate and maintain the SEPTS has been consistent with the ROD/Preliminary Close Out Report (PCOR) estimates except for Fiscal Year 2015 (10/1/2014 to 9/30/2015) (see Table 4-3. O&M Cost for the SEPTS). During fiscal year (FY) 2015, the SEPTS was reconfigured to improve flow and control processes in the treatment facility. Also, in FY 2015, new wells were drilled east of FM 2373 to expand the

SEPTS well field and begin to address expansion of the plume by extraction of the perched groundwater. In FY 2016, pump tests were conducted on these same wells and a design was completed to install conveyance piping, electrical service, pumps, and EW controls.

The cost to operate the P1PTS has been consistent with estimates presented in the ROD/PCOR (Table 4-4). Since the system only has a single outlet for the treated perched groundwater (subsurface irrigation by way of the WWTF) throughput was reduced at times, resulting in lower costs related to media exchanges. In FY 2016 (10/1/2015 to 9/30/2016) another EW (PTX06-EW81A) was installed and connected to the treatment facility.

Table 4-4. O&M Costs for the P1PTS

Dates		Total Cost ($K) Rounded to Nearest $1,000
From	To	
Annual ROD Estimate		888
Annual PCOR Estimate		1064
10/1/2012	9/30/2013	889
10/1/2013	9/30/2014	889
10/1/2014	9/30/2015	725
10/1/2015	9/30/2016	1667
10/1/2016	10/1/2017	590

The O&M cost for the SEISB System is now less than the estimate from the ROD/PCOR (Table 4-5. O&M Costs for the SEISB System). During injection years, the cost of injection has been approximately half of the estimate. Based on evaluation of the treatment zone and performance monitoring data, the injection frequency for future events will be about once every 24 to 36 months.

Table 4-5. O&M Costs for the SEISB System

Dates		Total Cost ($K) Rounded to Nearest $1,000
From	To	
Annual ROD Estimate		2612
Annual PCOR Estimate		1830
10/1/2012	9/30/2013	1119
10/1/2013	9/30/2014	186
10/1/2014	9/30/2015	1894
10/1/2015	9/30/2016	542
10/1/2016	9/30/2017	658

The O&M cost for the ZN11ISB System was estimated based on just ten injection wells at the time the ROD was issued in 2008. The initial concept for the system was to install a smaller well field. Through remedial design and construction, the resulting system is about five times larger, consisting of 52 injection wells. Subsequent treatment zone and performance monitoring indicate that injection is needed annually on the west half where TCE is present.

In FY 2014, it was also determined that the TCE portion of the original wellfield would benefit from bioaugmentation with microbial culture. Bioaugmentation is planned for the expansion area to the west in FY2019. O&M costs for ZN11ISB are presented in Table 4-6. O&M Costs for the ZN11ISB.

Table 4-6. O&M Costs for the ZN11ISB

Dates		Total Cost ($K) Rounded to Nearest $1,000
From	To	
Annual ROD Estimate		1234
Annual PCOR Estimate		1234
10/1/2012	9/30/2013	2556
10/1/2013	9/30/2014	3837
10/1/2014	9/30/2015	1903
10/1/2015	9/30/2016	3882
10/1/2016	9/30/2017	211

The costs for groundwater monitoring and well maintenance activities are presented in. The Sampling and Analysis Plan (B&W Pantex, 2009m) approved as part of the Remedial Design 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). Costs for the five years indicate a consistent level of effort for the Program, as fully implemented (see Table 4-7. LTM Network O&M Costs).

Table 4-7. LTM Network O&M Costs

Dates		O&M Cost ($K) Rounded to Nearest $1,000
From	To	
Annual ROD Estimate		583
Annual PCOR Estimate		679
10/1/2012	9/30/2013	365
10/1/2013	9/30/2014	402
10/1/2014	9/30/2015	265
10/1/2015	9/30/2016	482
10/1/2016	9/30/2017	343

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 projects and maintenance activities to determine whether soil disturbance will occur or if RA system components and monitoring wells could be damaged. 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 implementation of SWMU Interference controls are also accomplished through this funding. As depicted in Table 4-8, the annual O&M costs are within the ROD estimate. Although, the annual cost fluctuates somewhat, it appears to be sufficient to maintain and implement the controls.

Table 4-8. ICs O&M Costs

Dates		O&M Cost($K) Rounded to Nearest $1,000
From	To	
Annual ROD Estimate		150
Annual PCOR Estimate		150
10/1/2012	9/30/2013	62
10/1/2013	9/30/2014	82
10/1/2014	9/30/2015	95
10/1/2015	9/30/2016	78
10/1/2016	9/30/2017	77

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5.0 PROGRESS SINCE LAST REVIEW

The First FYR for the Pantex Selected Remedy, conducted in 2012, 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 First FYR.

5.1 ISSUES IDENTIFIED IN THE FIRST FIVE-YEAR REVIEW

5.1.1 Vegetated Soil Covers

The First FYR noted that vegetation on some of the protective soil covers had been impacted by drought. Drought conditions were especially acute in 2011, but regional rainfall has been normal to above average during the current FYR period. Normal to above average rainfall has improved survival of vegetation on soil covers.

Closure Turf™ was installed at Landfill 1 (SWMU 68b) and Landfill 2 (SWMU 68c) in 2017 to address the lack of vegetation due to extreme drought conditions. At SWMU 68b, a total of 3.15 acres was covered and at SWMU 68c approximately 1 acre was covered. The Closure Turf™ consists of a 50-mil linear low-density polyethylene grip-net geomembrane liner installed directly over the prepared surface, Duraturf (tufted polyethylene artificial turf) installed over the geomembrane liner, and a 0.5-inch thick sand ballast layer placed and spread evenly over the turf.

Areas of minor deficiencies in soil covers were identified during the 2017 landfill inspections to support the FYR, including areas of erosion, slope instability, animal burrows, and settling (described in Attachment 8). These deficiencies will be addressed through soil addition, compaction, and regrading as necessary. A contract will be issued to accomplish this work with completion anticipated by March 2019.

5.1.2 Ecological Risk for Firing Site 5

Previous ERAs for the SWMU 70 FS-5 include a TCEQ Tier 1 ERA Checklist submitted in 1998, a Tier 2 ERA for soil pathways completed with the First FYR in 2012, and a revised Tier 1 ERA Checklist submitted in 2014.

In the TCEQ review of the Tier 1 and Tier 2 ERA for the soil pathway, it was noted that the *de minimus* criteria could not be used to exclude the intermittently saturated depression east of the berm as *de minimus* criteria are applicable only to soil. As a result, TCEQ recommended that a Tier 2 ERA be conducted for the surface water/sediment pathway.

The complete supplemental ERA for the FS-5 depression is in Attachment 14c. The assessment concluded that derivation of site-specific protective concentration levels

(PCLs) was not necessary for the depression and no further remedial action is necessary for ecological receptors at FS-5.

5.1.3 Groundwater Contamination East of FM 2373

The First FYR identified plumes of high explosives (primarily RDX) in perched groundwater expanding east of FM 2373 and in the southeast lobe of the perched aquifer. Groundwater was monitored for COC concentrations and elevations and aquifer tests performed to address and assess potential remedial responses.

Data collected over the current FYR period indicate that the plume migration directly east of FM 2373 has stabilized under the influence of SEPTS pumping. The performance and efficacy of the SEPTS is reviewed in the *Remedial Action Effectiveness Report* (Attachment 7) and concentrations trends and plume stability are evaluated in the perched aquifer monitoring evaluation (Attachment 11).

The analysis of the perched aquifer monitoring network found that concentration trends at wells east of FM 2373 are statistically *stable* over the FYR period. However, the concentration trends in the southeast lobe of the perched unit are *increasing*. The center of plume mass for RDX in the southeast is gradually moving south, indicating plume expansion to the south/southeast.

Six additional groundwater EWs were installed in 2016 east of FM 2373 in the vicinity of PTX06-1147, about 1 mile north of Highway 60. The wells are anticipated to be connected to the SEPTS system in July 2018. These wells are anticipated to improve control of plume migration to the southeast. The far southeast lobe of the perched unit has low saturated thickness (typically less than 15 ft), indicating that additional EWs are unlikely to be effective at remediating the plume in this area.

Between 2016 and 2017, additional groundwater investigation wells have been installed in the southeast lobe of the perched unit (PTX06-1182, PTX06-1184, PTX06-1185, PTX06-1186, and PTX06-1190) and an additional ISB system is in the design phase. The ISB system is anticipated to be installed along and north of Highway 60.

Additional plume characterization, delineation as well as additional remedial components are anticipated adjacent and north of Highway 60 over the next five years. Expansion of ICs to the southeast may be required if affected groundwater extends outside of the current ICs.

5.1.4 Zone 11 TCE and Perchlorate Plumes

The First FYR identified plumes of TCE and perchlorate extending north and west of the ZN11ISB, outside of the optimal treatment zone. The ZN11ISB system was expanded to the west with 18 new injection wells installed and 2 former monitoring wells converted to injection wells. Also, several new monitoring wells were installed by early 2015 (as

documented in the 2015 and 2016 *Annual Progress Reports* and discussed in the *Remedial Action Effectiveness Report* in Attachment 7). Monitoring well PTX06-1160, installed in 2012, delineated the TCE plume to the west at concentrations below GWPS. Additional monitoring well PTX06-1181, installed in 2016, completed delineation to the northwest.

Eight injection events have been completed at the central and eastern ZN11ISB since 2009. The first injection event occurred in the northwest expansion zone in 2015 and the second in August 2016 coinciding with the eighth injection event for the main ZN11ISB. Yearly injections of amendments are anticipated within the expansion area until the microbial habitat and anaerobic conditions are established. Monitoring data will continue to be evaluated to determine appropriate timing for bioaugmentation with *Dehalococcoides* microbes to enhance complete dechlorination of TCE.

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 is required.

5.1.5 Incomplete Treatment of HE at SEISB PTX06-1153

The first FYR identified the area around SEISB ISPM well PTX06-1153 as an area of incomplete treatment of HE and Cr(VI). PTX06-1153 is the western-most ISPM well south of the SEISB. Recent concentrations of RDX exceed the GWPS at this location. In addition, Cr(VI) and total Cr concentrations are higher than 2009 results, although there has been a decrease since the maximum detections were reported in January 2014 (Cr[VI]) and April 2012 (total Cr).

An extensive review of the conceptual site model (CSM) for the SEISB, including the area around PTX06-1153, was conducted in 2017 (Trihydro, 2017b). In addition, a review of the SEISB remedy is included in the *Remedial Action Effectiveness Report* (Attachment 7). Extensive data reviews to date have not identified the precise source of untreated water at PTX06-1153, and this remains an area of uncertainty in evaluating the RA.

PTX06-1153 is positioned in, what appears to be, a localized depression in the FGZ with higher hydraulic conductivity and groundwater flux relative to surrounding areas. The SEISB area has exhibited significant reductions in groundwater elevations and has become unsaturated in some areas due to the action of the SEPTS. Because of the topography of the FGZ, the area around PTX06-1153 is still saturated. Geochemical data indicate that other wells within and downgradient of the SEISB System have remained strongly reducing, with the exception of PTX06-1153.

Because of diminishing saturation and limited migration potential of plumes in the SEISB area, a reduced level of remedial effort is anticipated in this area going forward. An

injection frequency of every 36 months and potential selective injection in areas with greater saturation and higher concentrations, such as PTX06-1153, is expected to be adequate to continue achieving progress toward meeting RAOs.

Groundwater monitoring and data review will continue in this area, with results used to evaluate alternatives for modified remedial actions at PTX06-1153

5.1.6 Solubilization of Metals in ISB Systems

Injections of ISB amendments that stimulate anaerobic conditions can also mobilize secondary metals naturally present in the subsurface. Metals solubilized as a result of both ISB treatment systems (arsenic, barium, manganese) could result in residual risk. Arsenic has a primary Maximum Contaminant Level (MCL) of 10 µg/L for toxicity and barium has a primary MCL of 2 milligrams per liter (mg/L). The Site-specific background for arsenic at the Pantex Plant is 12 µg/L, which is the GWPS since it is greater than the MCL. Manganese has a secondary MCL of 50 µg/L for aesthetic considerations in drinking water.

Arsenic concentrations exceeding the GWPS have been detected at both the SEISB and ZN11ISB systems. Sampling results from several SEISB injection wells show elevated concentrations of arsenic. PTX06-ISB048 had the highest recorded concentration of arsenic in 2016 of 160 µg/L. It also had an elevated concentration of manganese with a maximum of 4.7 mg/L in 2015 dropping to 0.730 mg/L in 2016. Other SEISB wells show transiently elevated concentrations of secondary metals.

Of the SEISB ISPM wells, well PTX06-1154 showed the highest arsenic concentrations during the FYR period, with concentrations of 100 to 120 µg/L as well as barium concentrations above 2 mg/L. While manganese shows a *decreasing* trend, concentrations of arsenic and barium are statistically *increasing* (based on Mann-Kendall trends) over the FYR period. Other ISPM wells showed lower concentrations down to levels below the GWPSs. The perched groundwater unit is unsaturated south of the ISPM wells and the SEISB shows reduced saturation under the influence of the SEPTS.

Arsenic has been detected in ZN11ISB injection wells such as PTX06-ISB075 up to 590 µg/L (2015). However, downgradient, outside of the influence of ISB amendments, concentrations drop below MCLs. PTX06-1155, about 230 ft downgradient from PTX06-ISB075 has shown arsenic concentrations in the range of 30 to 60 µg/L, while PTX06-1012 about 300 ft downgradient has concentrations results at or below the GWPS of 12 µg/L. Barium concentrations at PTX06-1012 are around 450 µg/L and manganese concentrations are in the range of 10 µg/L, both below MCLs. Concentrations trends for PTX06-1155 are statistically *increasing* for arsenic and *decreasing* for both manganese and barium. At PTX06-1012, concentrations for arsenic and manganese are statistically *increasing* while data for barium show a *decreasing* trend.

Overall data for secondary metal concentrations show variable trends. These data indicate that while secondary metals are being produced in the ISB area, elevated concentrations can be transient and persistent downgradient metals plumes are not currently observed. However, monitoring of secondary metals in the SEISB and ZN11ISB areas will continue in the next FYR period.

Concentrations of arsenic, barium and manganese in perched groundwater relative to risk is discussed in the Attachment 14 Risk Evaluation.

5.1.7 Cadmium Beneath Zone 12

Cadmium concentrations exceeded the MCL in 2011 in perched groundwater beneath Zone 12 South (WMG 6/7) at PTX06-1010. In 2016, cadmium was detected once at PTX06-1010 at 0.116 µg/L, below the quantitation level and below the GWPS (5 µg/L). Two other sample results in 2016 were nondetect at the detection limit of 1 µg/L Site-wide, no exceedances of the GWPS for cadmium were recorded during the FYR period.

Cadmium concentrations in perched groundwater relative to risk is discussed in the Attachment 14 Risk Evaluation.

5.1.8 Hexavalent Chromium Detections in Zone 11

Cr(VI) was detected in Zone 11 well PTX08-1005 in 2011 at a concentration near the MCL. Sampling during 2000 through 2003 showed nondetect results for Cr(VI) with a detection limit of 10 µg/L. The analytical detection limit in 2011 was 3 µg/L.

Sampling data collected between 2012 and 2016 showed a maximum detected concentration for CR(VI) of 24.3 µg/L and a minimum of 3.31 µg/L with no concentrations above GWPS (100 µg/L). Concentrations obtained since 2015 have been below 4 µg/L. These data indicate that there is no Cr(VI) plume at PTX08-1005, and the detection near the MCL in 2011 was transient. Periodic sampling for Cr(VI) should continue for the next FYR period to confirm the expectation that the 2011 result is not indicative of an emerging problem.

5.1.9 Detections of 1,4-Dioxane in Zone 11 ISB

Sampling data collected between 2012 and 2016 indicate concentrations of 1,4-dioxane above the GWPS of 7.7 µg/L in Zone 11 wells in the vicinity of the ISB system. Wells PTX06-1126 and PTX06-1127, located north of the ISB system, showed the highest concentrations in the area between 50 µg/L and 77 µg/L. Mann-Kendall statistical concentration trend results for these wells for 1,4-dioxane were *stable*. PTX06-1151 up gradient of the western ISB showed low exceedances of the GWPS between 7.8 µg/L and 9.4 µg/L and a *stable* statistical trend. Two wells downgradient of the ISB PTX06-1012 and PTX06- 1155 showed concentrations above the GWPS and statistically *increasing* concentration trends. Average concentrations at these wells for the FYR period are 10

µg/L (PTX06-1012) and 15 µg/L (PTX06-1155). Wells PTX06-1173 and PTX06-1174 showed single detections of 1,4-dioxane in the range of 11 µg/L to 12 µg/L.

Well PTX06-1156 is downgradient of PTX06-1127 and downgradient of the eastern section of the ISB. PTX06-1156 shows low-level detections of 1,4-dioxane with intermittent non-detect values. Concentrations do not exceed the GWPS and no increasing trend is observed even though the well is downgradient from an area of elevated concentrations. Overall, the ISB area appears to be controlling migration of the 1,4-dioxane plume. High TCE concentrations have been shown to inhibit degradation of 1,4-dioxane, so the lower concentrations of TCE in the eastern ISB area may benefit 1,4-dioxane degradation pathways.

A risk review for 1,4-dioxane was conducted with results shown in Attachment 14. The review concluded that no update to GWPS was required.

1,4-Dioxane will continue to be monitored and trends evaluated in the ZN11ISB area during the next five-year 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 known to treat 1,4-dioxane.

5.2 ADDITIONAL REMEDY UPDATES

5.2.1 Updates to the Burning Ground Soil Vapor Extraction System

Recent modifications to the BG SVE system include reworking six inactive shallow zone SVE EWs to allow ambient air to be drawn into the formation. Additional air flow to the subsurface is intended to enhance extraction and biodegradation of VOCs. Shallow zone wells were modified with addition of aboveground piping including a sampling port, closure valve, and a goose-necked pipe top with screened end to allow passive flux of air to the subsurface. The modified wells will be sampled for baseline conditions to evaluate the efficacy of the modifications.

Details of upgrades and O&M of the SVE system over the FYR period is provided in the *Remedial Action Effectiveness Report* (Attachment 7).

5.2.2 Upgrades to the Zone 12 SWMU 5-05 Ditch

During a 2015 inspection, several deficiencies were observed with the SWMU 2 and 5-05 Ditch Liner, 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.

Details of the upgrade to the Zone 12 SWMU 5-05 Ditch Liner are provided in Section 4.2.1.3 and in the *Remedial Action Effectiveness Report* (Attachment 7) and Annual Progress Reports.

5.2.3 Additional SEPTS Extraction Wells

As noted in Section 5.1.3, six new SEPTS perched groundwater EWs were drilled east of FM 2373 in 2016 to extend extraction at the eastern edge of the perched unit. These wells will be connected to the SEPTS treatment plant and are expected to be operational by July 2018.

5.2.4 Additional P1PTS Extraction Well

An additional EW, PTX06-EW-81A, and conveyance lines were installed in 2013 near the P1PTS treatment plant but did not become operational until November 2016.

5.2.5 Advanced Characterization and Microbial Amendments in Zone 11 ISB

To ensure the presence of the microbes capable of complete reductive dechlorination of TCE, the central portion of the ZN11ISB was bioaugmented with a commercial inoculum containing *Dehalococcoides* in November 2015. In 2016, groundwater samples from select injection wells and treatment zone monitoring wells were analyzed for microbial populations and functional genes associated with complete degradation of TCE. The analyses detected *Dehalococcoides* in all groundwater samples, but at low population densities. Several other microbes and enzyme systems capable of partial degradation of TCE were also detected in the analyses. Several remedy optimization recommendations are presented in the *Remedial Action Effectiveness Report* (Attachment 7) to improve habitat for *Dehalococcoides* and enhance remedy effectiveness.

In addition, Compound-Specific Isotope Analysis (CSIA) was performed on groundwater samples to positively identify the extent of degradation of parent VOC compounds. The data show that reductive dechlorination of TCE is occurring throughout the ZN11ISB, but progress to complete mineralization is variable across the system. In some areas, degradation is stalling after generation of the cis-1,2-DCE daughter product.

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6.0 FIVE-YEAR REVIEW PROCESS

6.1 ADMINISTRATIVE COMPONENTS OF THE FIVE-YEAR REVIEW PROCESS

The Second FYR began on May 1, 2017 and was completed on February 15, 2018.

The CNS review team included:

- Martin Amos – Project Manager/Regulatory Liaison
- Michelle Jarrett – Risk Assessor/RA Progress 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 aquifer LTM network (completed in August 2017).
- Carollo – Conducted an independent evaluation of the results of the FYR.
- Leidos – Conducted the evaluation of risk.

The draft final FYR Report was provided to TCEQ and EPA for review in April 2018. Comments were received from EPA and TCEQ through correspondence of July 13, 2018 (EPA) and August 13, 2018 (TCEQ). 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 25, 2018.

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 April 27, 2017, 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 Long-Term Stewardship Public Meetings conducted on November 6, 2017.

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 (pantex.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 Second 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).

Applicable or relevant and appropriate requirements (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:

- Safe Drinking Water Act (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, Hazardous Waste Permit No. 50284 (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 MSGP, 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 no changes to the aforementioned ARARs for soil and groundwater. (A review of risk calculation parameters and methods is included in Attachment 14).

6.4 DATA REVIEW

6.4.1 Data Reviewed

All perched and Ogallala Aquifer data collected during the FYR period (January 1, 2012, through December 31, 2016), as well as older groundwater data that provided historical context (samples collected and analyzed as early as 1996) were evaluated in this review. Groundwater data were evaluated in multiple sections of this FYR report and can be found in Chapter 4, Chapter 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 and ZN11ISB as well as microbial and CSIA data from ZN11ISB 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. Since this is the Second FYR, the data range for trending was over five years (January 2012 through December 2016). 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. All COC concentration and perched aquifer water level trends/hydrographs for individual monitoring wells can be found in Attachments 9 and 10, respectively.

As reported in Attachment 7 – *Remedial Action Effectiveness Report* (HGL, 2018) the majority of groundwater trends and concentrations are already meeting expected conditions outlined in the LTM Design (B&W Pantex, 2009d). 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 each of the 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 is meeting the design objective of reducing the saturated thickness within its area of influence. Groundwater elevations declined at each of the monitoring locations in the P1PTS area during the FYR period.
- 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 limited potential for vertical or lateral migration of the plume.
- The ZN11ISB System is meeting the design objective of creating an anaerobic treatment zone capable of degrading target COCs to achieve concentrations below the GWPS. ZN11ISB conditions are still evolving, but during the FYR period, perchlorate concentrations at downgradient monitoring wells were either below GWPS or strongly ***decreasing***. Concentrations of TCE have declined in the center of the ZN11ISB with evidence of complete mineralization of TCE in some areas. In other areas, TCE is transformed to cis-1,2-DCE which is then degraded more slowly. The westward expansion area of the ZN11ISB is generating anaerobic conditions, but data collection to date has not generated sufficient data to evaluate TCE degradation. Concentrations of TCE above the GWPS farther downgradient of the treatment zone are attributed to desorption and back-diffusion and are expected to decrease to below the GWPS over time.

6.4.3 Long Term Monitoring Network Recommendations

6.4.3.1 MAROS Evaluation of Perched Aquifer Network

Remedy effectiveness is determined through groundwater monitoring implemented through an LTM Plan. The perched aquifer 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 2012 through 2016) were analyzed using the MAROS version 3.0 (beta) developed by the AFCEC. In this evaluation, perched groundwater was divided into 3 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 one additional monitoring well is required in the southeast lobe of the perched unit to delineate the extent of the HE plume north of Highway 60.
- The networks monitoring the pump and treat extraction well 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 ZN11ISB to manage uncertainty about migration of the TCE and perchlorate plumes if concentrations do not stabilize or begin decreasing in the next two years.
- Continue monitoring perchlorate at PTX08-1008 for potential mobilization of the plume outside of the ZN11ISB treatment area toward the SEPTS.
- 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 sampling frequencies detailed in the LTM Design Report (B&W Pantex, 2009d); however, sampling frequency analysis indicates a low rate of change of concentrations 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 sufficient to address the goals and objectives of the monitoring program. No modifications to the Ogallala Aquifer monitoring network are recommended at this time. However, several analytes are recommended for addition to the routine monitoring program including the metals arsenic, barium and manganese, that are liberated from the formation as a result of the altered geochemistry of perched groundwater within and leaving the ISB remedies.

6.5 SITE INSPECTION

The Five-Year Review EPA Site Inspection was conducted on August 15 and 16, 2017. The inspection was conducted by CNS and USDOE/NNSA personnel with EPA Project Manager, Camille Hueni (by phone) and TCEQ Project Manager, Kristian Livingston. HGL personnel included Mindy Vanderford and Roy Evans. The inspection focused on evaluating the groundwater and soil RAs. Inspection forms were developed using the EPA Five-Year Review 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, and ZN11ISB 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 injection trailer had been moved to the ZN11ISB System and was inspected at that location. CNS personnel inspected the SEISB well field independently in September 2017.

The BG SVE System (including the CatOx unit and scrubber), the SWMU 2 and 5-05 Ditch Liner, and the BG (SWMUs 37-44) were inspected during the August 2017 Site Inspection. Additional landfill and soil cover remedies were inspected by HGL and CNS personnel September 18 and 19, 2017.

The SEPTS and P1PTS were observed to be operating and in good condition. 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 extraction wells 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 vault for the new P1PTS extraction well PTX06-EW81A was inspected in detail.

The ZN11ISB was not undergoing active injection of bio-amendment at the time of the Site inspection. The injection trailer was inspected and mechanical components, the programmable logic controller interface and O&M documentation appeared to be in good order. During active injection at both the ZN11ISB and the SEISB, 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.

The BG SVE system consisted of a relatively new 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 extraction well 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. Vegetation had recovered significantly since the 2011 through 2012 drought conditions. Ongoing maintenance to control damage associated holes resulting from other burrowing animals and settling within construction debris voids pose continuing challenges.

The replacement SWMU 2 and 5-05 ditch liners were observed to be in good condition with no apparent silt accumulation.

6.6 INTERVIEWS

Interview questions were drafted, and surveys were sent by mail to neighbors, interested parties, and public officials on October 12, 2017.

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 47 stakeholders on October 12, 2017, and responses were requested to be postmarked by November 17, 2017. CNS also provided stakeholders with an opportunity to complete the interview by phone or in person. Responses were received from six 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, but one respondent expressed a "lack of confidence" that cleanup will ever be completed. The general public appears to be pleased with communication regarding the cleanup activities at the Pantex Plant, but one respondent expressed a desire for more frequent communications. Some were pleased that Pantex officials are straightforward in sharing information, even about new or unexpected situations. One respondent noted that officials seem to be immediately defensive when presenting such information.

6.6.2 Input from Adjacent Landowners

The one adjacent landowner that responded is generally pleased with the cleanup efforts and how they are communicated.

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. Semiannual 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

Government officials noted that the operations at the Pantex Plant are both professional and effective. The government officials stated that they have not been contacted about any concerns, complaints, or violations since issuance of the ROD in 2008. Most reported being well-informed by the routine communications occurring in the form of Public Meetings and Agreement-in-Principle Meetings (held semiannually) and stated they were pleased with the proactive nature of how the Selected Remedy is implemented and adapted to address conditions as they change.

One respondent expressed concern about interaction and communication with the Local Groundwater District. Pantex has taken this as an action for improvement. Most respondents indicated concern regarding movement of the perched groundwater plume toward the southeast corner of the property adjacent to Highway 60 and cited protection of the underlying aquifer as the common priority for the region. One respondent desired more frequent status updates.

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 chapter.

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. 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.

The First FYR indicated that a plan would be developed to address vegetation loss associated with extreme drought conditions from 2011 and 2012. The plan objectives were to ensure that erosion of the protective covers does not occur and long-term effectiveness is maintained. In response to the vegetation loss, Pantex developed a phased plan for revegetation. Reseeding was performed in 2013 and evaluated annually through 2016. The results have shown significant improvement in the landfill covers. In addition to reseeding, Pantex installed Closure Turf™ at SWMUs 68b and 68c in 2013 and 2017, respectively.

Some minor deficiencies in soil covers (settlement, burrowing animal holes, and erosion and slope instability) were identified by the landfill cover inspections performed from 2013 through 2017 and the LiDAR inspection conducted in 2017. These minor deficiencies were noted in seven of the landfill covers (described in Chapter 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 in 2018 and 2019 to address the deficiencies identified in the seven soil covers. The repairs / actions 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 below the remedy.

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. Details of the new liner installation are provided in Attachment 7 (Section 3.3).

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.

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

ICs for SWMUs 25, 26, and 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.

A perimeter fence was installed around the FS-5 (SWMU 70) impact area, including the landfill cover. The SWMU signs and FS-5 fence are maintained to control access to those soils which pose a health risk to industrial and construction/excavation workers.

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. A BG SVE Performance Monitoring approach will be developed to define expected conditions and a path toward determining when to cease operation (i.e. an exit strategy).

A new CatOx treatment unit was proposed in 2011 and installed in 2012 to address system improvements needed because of inefficiencies associated with breakthrough of the GAC units, as well as O&M costs that were greater than anticipated (see Section 4.2.1.1 of Chapter 4). O&M costs for this system have decreased appreciably as monitoring costs decreased and GAC replacement and regeneration costs of the former system have been eliminated. Six unused SVE wells were modified during the Second FYR period to improve air flow through the subsurface to enhance contaminant extraction and stimulate biodegradation of VOCs.

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 periodic 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 new 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, 2017c). 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 will be completed during each annual inspection. Annual inspections will be documented in the annual progress report. Given the recently completed (March 2017) new liner installation, the first annual inspection report is scheduled for completion by April 2018.

BG SVE

Total mass removal is strongly influenced by the operational effectiveness of the SVE system. Operational time can be improved by providing additional protection from extremes of heat or cold. Specific recommendations to improve the operational performance and mitigate effects from weather extremes 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 the weather protection for the BG SVE System and the development of criteria for shutdown of the BG SVE system. Details of optimization recommendations are provided in Attachment 7.

Landfills and Landfill Covers

The updated *Maintenance Plan for Landfill Covers* (CNS, 2017c) 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 should

reduce 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 re-assessing 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 support 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 passive operational mode, additional optimization measures may be identified and/or developed or a trial shutdown period may be initiated if mass removal rates plateau or decrease.

The BG SVE system was recently modified by reworking six inactive shallow zone SVE EWs to allow ambient air to be drawn into the formation. Additional air flow to the subsurface is intended to enhance extraction and biodegradation of VOCs. Details of upgrades and O&M of the SVE system over the Second FYR period is provided in the *Remedial Action Effectiveness Report* (Attachment 7). Monitoring mass removal over the coming five-year period will indicate the efficacy of additional air flow to the subsurface. If significant improvements in mass removal are observed as the result of the rework of the old SVE EWs, then the decision to pursue a trial shutdown period may be delayed.

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 millirem per year (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 Nuclear Weapons Accident Residue Sites (SWMU 82 [NWAR]). Those cleanups occurred in an early timeframe (1990's) 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 depleted uranium 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 Risk Reduction Rule (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.

The ERA for FS-5 (SWMU 70) was updated (Attachment 14c) to address a TCEQ request to evaluate a potentially complete exposure pathway for aquatic receptors in a small depression east of FS-5, in order to comply with recent TCEQ ERA Guidance updates. The Tier 1 ERA was revised in March 2014 to include evaluation of the depression under Subpart A - Surface Water/Sediment Exposure of the Checklist (Pantex, 2014). Pantex did not recommend continued evaluation of the aquatic pathway in a formal Tier 2 or 3 ERA as the only surface water feature at FS-5 (the depression) in intermittently saturated only during significant rainfall and constitutes poor quality habitat (Pantex letter dated March 10, 2014). Attachment 14c provides a detailed assessment concluding that additional development of site-specific PCLs for the depression associated with FS-5 is not required and no further RA is necessary for the protection of ecological receptors at FS-5.

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 soils and protective measures are developed based on calculated risk. 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 January 2017. Previously, screening-level benchmark tables were incorporated in the TCEQ ERA guidance. As described in Attachment 14, updates were made to munitions benchmarks for soil, surface water, and sediment, with some HE benchmarks higher and some lower. Evaluation of risk to terrestrial plants and macroinvertebrates did not result in a decision to implement additional remedial actions at any of the sites, as risk to higher trophic-level receptors did not indicate a need for cleanup. The radionuclide benchmarks have not been updated; therefore, no rescreening of radiological data at Pantex is necessary for the ERA. During this FYR, no new information was found regarding the original sources of toxicity reference values (TRVs) used in the ERA; therefore, no recalculation of risk is necessary for the ERA.

7.1.2.4 Changes in Risk Assessment Methods

As stated above, the soil sites were not reevaluated for human health risk at the Pantex Plant because there is a process in place to review worker protection at sites where soils will be disturbed through work practices or construction/excavation practices. Updates to those worker protective values were completed and implemented in 2014. Changes in the guidance will be considered in the development of screening levels for worker protection at the sites in future work plans.

ERAs for soil, surface water, and sediment media were completed using methods described in the 2001 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 update. Three significant changes to risk assessment methods released after Pantex conducted the original ERAs were identified:

- New guidance eliminated body weight scaling to adjust TRVs for the body weight differences between the test species and wildlife species being evaluated.
- Guidance was developed for evaluating contaminant hotspots.
- Default ecological PCLs for soil and sediment for a variety of wildlife receptors and COCs were made available.

As a result, the sites were re-revaluated for risk at the Pantex Plant based on the new guidance. Consideration of revised methods on elimination of body weight scaling and evaluation of hotspots is provided in Attachments 14a and 14b, respectively. The default ecological PCLs were used in the hotspot evaluations (Attachment 14b).

Because the revised body scaling and hotspot evaluation methodologies would not result in any changes to the conclusions of the ERA, recalculation of hazard quotient(HQs)s and further evaluation of hotspots are not recommended.

No other changes in risk assessment methods impacted previous risk assessments or conclusions.

7.1.2.5 Expected Progress Toward Meeting RAOs

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
    - ICs for groundwater

  - LTM to confirm effectiveness
- Zone 11 Perched Groundwater Remedy
  - ZN11ISB
  - 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 functioning as intended in the short-term. The complete remedy for groundwater has only 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;

- Plumes of HE (primarily RDX) are expanding in the southeast lobe of the perched aquifer toward Highway 60.
- The Zone 11 TCE plume extends northwest outside of the influence of the ZN11ISB treatment system.
- The perchlorate plume is potentially migrating from Zone 11 to the east under the influence of the SEPTS. The SEPTS does not currently have a treatment unit for perchlorate.
- Incomplete treatment of contaminants (HE and Cr[VI]) downgradient of the west end of the SEISB (PTX06-1153).

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

- Metals solubilized as a result of ISB treatment systems (arsenic, barium, and manganese)
- Cadmium beneath Zone 12 South (WMG 6/7)
- Cr(VI) near ZN11ISB
- 1,4-Dioxane near ZN11ISB
- Solvent degradation products cis-1,2-DCE and 1,1-DCE identified above MCLs.

Each of these issues require action as documented in Chapter 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 aquifer.

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 pump and treat systems (P1PTS and SEPTS)
- SEISB
- ICs to prevent exposure to groundwater
- 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 system is functioning as designed and concentrations of COCs are decreasing in many locations, progressing toward cleanup goals. Overall, the P1PTS system has been effective at reducing contaminant mass, reducing the saturated thickness of the perched aquifer, and helping to control plume migration.

Groundwater elevations declined at each monitoring location within the P1PTS area of influence. Hydrographs of P1PTS monitoring wells can be found in Attachment 10. The hydrograph (Attachment 7, Figure 4.6) from well PTX06-1041 at the eastern edge of the perched unit shows the sharp decrease in the water table elevation related to the combined operation of the P1PTS and the SEPTS. Since 2009, the water level has decreased by more than 10 ft. Water levels rebounded somewhat during 2015 through 2016 relative to the previous FYR period, likely in response to changes in rainfall and recharge and to the shutdown of P1PTS for maintenance.

Details of the P1PTS operational time are provided in Chapter 4. The P1PTS is currently operating at approximately 50% capacity until mechanical problems with the irrigation system that began in June 2017 can be resolved. 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 311 pounds of RDX and other HE contaminants during the Second 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*

to *decreasing* trends, indicating the plume is not migrating in the northern area. COC concentration trends at PTX06-1050 northwest of Playa 1 have gone from statistically *increasing* to *decreasing* trends, limiting potential plume mobility in this area over the current FYR period. Concentration trend analysis indicates that the P1PTS is maintaining overall stable plume conditions, balancing extraction of contaminant mass with any further discharge of COCs from the vadose below Playa 1.

An additional EW (PTX06- EW-81A) and conveyance piping was added to the P1PTS near the treatment plant during the Second FYR period. The well became operational in November 2016. The goal of the additional well is to reduce groundwater elevations and improve control of plume migration south of Playa 1 by allowing more consistent extraction, even when more than one well is offline for need repairs or maintenance.

SEPTS

The SEPTS system is functioning as designed. As described in Chapter 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. 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 is not currently controlling plume migration to the Southeast Area of perched groundwater.

Details of the SEPTS operational time are provided in Chapter 4. The treatment system was shut down for upgrades to reduce the injection of treated water starting in September 2014 and resumed operation in May 2015. With the exception of 2015, the SEPTS exceeded its operational goal of 90% operational time throughout the FYR period. Treated water was diverted to irrigation systems beginning in 2005 and continued through June 2017. Beneficial reuse, including mix water for the ISB systems and the irrigation system also used by the P1PTS is the preferred method for discharging treated water; however, the SEPTS retains capability for injection of treated water back into the perched zone. The irrigation system experienced mechanical failure in June 2017, and treated water from the SEPTS is currently reinjected.

The SEPTS removed 2,951 lbs of RDX and other HE contaminants and 464 lbs of Cr(VI) during the Second FYR period. Statistical concentration trends at Zone 12 source area wells are generally *decreasing* while concentrations directly east of the Plant along FM 2373 show *stable* trends, indicating control of plume migration. The SEPTS is the most effective remedy on-Site for removing and treating HE from groundwater.

Groundwater monitoring data over the past five years indicate a statistically *increasing* trend of HE in the southeast lobe of the plume outside the influence of the current SEPTS. Between 2016 and 2017, six additional groundwater investigation wells were installed in the southeast lobe of the perched unit. Data from these locations indicate that the HE plume has migrated south to Highway 60.

As noted in Chapter 5, six new EWs are anticipated to be connected to the SEPTS system in July 2018. These wells were installed in 2016 east of FM 2373 just south of the Pantex Plant property boundary in the vicinity of PTX06-1147. These wells are anticipated to improve control of plume migration to the southeast.

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 significantly reduced concentrations of groundwater COCs within the SEISB treatment zone (Attachment 7). In addition, groundwater COC concentrations are less than GWPS at three of the four downgradient wells, indicating that the SEISB has had a beneficial effect on downgradient groundwater quality (Attachment 7).

RDX, Cr(VI), and total Cr concentrations at the fourth downgradient groundwater quality well (PTX06-1153) have increased since the initial amendment injection in 2008. 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 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: upgradient wells PTX06-1103 and PTX06-1118; cross-gradient wells PTX06-1122 and PTX06-1119; and downgradient wells PTX06-1045 and PTX06-1124. PTX06-1118 has been dry over the past five years. These results indicate that the SEPTS is reducing saturation in the SEISB area, limiting the likelihood of plume mobilization in this area.

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 Chapter 4, and detailed evaluation information can be found in Attachment 7. The systems are operating as intended in the ROD within their area of influence and are expected to maintain their effectiveness.

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

- 90% operation time with no injection 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 limited below 250 gpm for the two systems; and
- 90% of system treatment or well field capacity, whichever is lower.

Approximately 87% (200 million gallons of the treated water produced from the SEPTS during the 2012 through 2016 period was discharged to the irrigation system. The operational goals for irrigation/beneficial reuse of water were achieved.

As described previously, performance goals with respect to operational run time were generally met except when change out of GAC or other treatment plant upgrades were conducted and when discharge was limited by irrigation system failure.

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 beneficial reuse system cannot accept treated discharge. This operational target was met in 12 of the 20 quarters during the 2012 to 2016 period at the SEPTS and in 7 of the 20 quarters at the P1PTS.

SEISB

O&M of the SEISB is described in Chapter 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 estimated to be once every 12 to 24 months at the SEISB. Four injection events were performed for the SEISB during this FYR period (May 2012, September 2013, April 2015, and October 2016). The intervals

between injections ranged from approximately 16 to 19 months at the SEISB. Treated water from the P&T systems is used to mix amendments for injection. Before each injection event, the injection wells are rehabilitated to address biofouling. The rehabilitation efforts appear to be effective based on the resulting sustained injection rates and performance monitoring data collected from downgradient wells.

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 is operation of the irrigation system for discharge of treated groundwater. The irrigation system was not specified as part of the Selected Remedy in the ROD, but is a component added to optimize remedial efficacy of the P&T systems.

Maintenance problems with the irrigation/beneficial reuse system limits the total amount of groundwater that can be treated and results in reinjection of treated water from the SEPTS and discharge of treated water from P1PTS to Playa 1. This challenges achievement of the remedial goal of reducing saturated thickness of the perched groundwater unit. Additional O&M protocols, such as freeze prevention, for the irrigation system may also be pursued.

A bulk water station was installed in 2016 to facilitate beneficial use in accordance with the Texas Land Application Permit (TLAP). Additional beneficial use opportunities should continue to be evaluated and incorporated into any optimization modeling that is performed.

Due to the size of the SEPTS, it affects several other groundwater areas and remedies. Optimization of pumping rates in the SEPTS as well as P1PTS may be considered to enhance several remedial objectives:

- The SEPTS appears to be moving the groundwater flow divide below Zone 11/Zone 12 to the west. As a result, the perchlorate plume below Zone 11 may potentially be drawn into the SEPTS capture zone. The COC 1,4-dioxane is also present in Zone 11 groundwater. As the SEPTS does not currently treat perchlorate or 1,4-dioxane, the problem needs to be evaluated to determine the best solution. The evaluation should consider modifying operation of the SEPTS (including addition of treatment for perchlorate and extension of ZN11ISB treatment along the eastern edge of the plume.

- Optimization of the SEPTS may enhance capture of the HE plume that is expanding in the southeast lobe. Extraction from newly installed wells east of FM 2373 may improve capture.
- The SEPTS has significantly reduced saturation in the SEISB area. Optimization of pumping near the SEISB may continue to reduce saturation in this sensitive area.
- Pumping in the P1PTS as well as changing groundwater elevations in the eastern perched unit may be limiting the extraction efficiency of the SEPTS. Going forward, formal or computational optimization of all pumping in the perched unit may be pursued to develop an extraction strategy that maximizes mass removal and plume control while reducing saturation.

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.

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 Chapter 8:

- Migration of the HE plume to the southeast lobe of the perched unit.
- Potential migration of the perchlorate plume into the capture zone of the SEPTS. The SEPTS does not have a perchlorate treatment unit.
- Incomplete treatment of COCs at SEISB performance monitoring well PTX06-1153.

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 may be required in the area of Highway 60, depending on results from the characterization of the plume migrating in the southeast lobe of the perched groundwater unit. This expansion of access controls may involve off-site property owners and stakeholders holding easements. 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 the southeast lobe of the perched groundwater unit. 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:

- ZN11ISB 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 ZN11ISB

The ZN11ISB system is functioning as designed and concentrations of COCs are decreasing in many locations, progressing toward cleanup goals. Overall, the ZN11ISB system has been effective at reducing contaminant mass and helping to control plume migration.

The primary groundwater COCs at the ZN11ISB are TCE and perchlorate. Although 1,4-dioxane is also present above remedial goals, it is not widespread and does not exceed remedial goals by the same magnitude as TCE and perchlorate.

Sampling results from 29 injection wells and monitoring wells were used to assess the performance of the ZN11ISB (Attachment 7, Section 4.3.3.1). The findings of this assessment showed the following:

- The eastern side of the Zone 11 ISB, where perchlorate is the dominant COC, appears to be functioning properly. COC concentrations in this area are less than the GWPS or have shown significant decreases since 2012. Although the perchlorate concentration in downgradient well PTX06-1148 exceeds the cleanup goal, the concentration of this COC has decreased by 72% since May 2012; this indicates that remediated groundwater is exerting a beneficial effect on groundwater quality several hundred feet downgradient of the treatment zone.
- The central portion of the ISB appears to have mixed results. The central portion of the ISB appears to be remediating perchlorate to below GWPS and several areas complete dechlorination of TCE and its degradation products. However, TCE is not reduced to its end products uniformly across the central ISB.

- The western portion of the ZN11ISB was expanded during the current FYR period. Establishment of the anaerobic zone is in the early stages of development and data collection efforts to date are not sufficient to demonstrate significant reductions in COC concentrations. Recent data suggest that TCE is beginning to reduce to cis-1,2-DCE at some locations, but cis-1,2-DCE is not being reduced.
- The analytical results for the western edge of the ZN11ISB indicate that the treatment zone does not span the entire plume. Groundwater contamination is likely flowing around the northwestern terminus of the ISB at PTX06-ISB098, where the TCE concentration was 210 µg/L in March 2015 and 190 µg/L in June 2015. The lateral extent of this contamination bypass is bounded by PTX06-1160 and PTX06-1181, where all results were less than the GWPS in 2016.

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 suggests that emulsified vegetable oil (EVO), the carbon substrate amendment, may not be adequately distributed throughout the treatment zone in some locations or, where the initial injection did achieve the necessary radius of influence, the application rate was too low to sustain anaerobic conditions.

7.2.1.2.2 System Operations/O&M

O&M procedures at the ZN11ISB, as implemented, are working in a manner that will ensure continued efficacy.

Carbon substrate amendment has been injected into the ZN11ISB five times during the current FYR period, with frequency ranging from 10 to 16 months. Treated water from the P&T systems is used to mix amendments for injection. Before each injection event, the injection wells undergo maintenance for biofouling. During the 2016 well maintenance program, 27 injection wells were chemically treated and redeveloped using airlift techniques, 10 wells were chemically and mechanically treated and redeveloped with jetting, and 14 wells were surged and bailed.

In total, 163,470 gallons of pure amendment diluted in 2,399,372 gallons of water followed by 296,069 gallons of chase water were injected into the ZN11ISB. At individual wells, injection volumes, including chase water, ranged from 44,499 gallons to 81,692 gallons.

7.2.1.2.3 Opportunities for Optimization

The following recommendations are provided to optimize performance of the ZN11ISB:

- Consider extending the Selected Remedy to the northwestern end of the ZN11ISB by installing more injection wells to span the entire extent of TCE contamination.

- Maintain current conditions in the eastern portion of the ZN11ISB.
- Increase the percentage of soluble, readily degraded carbon substrate (i.e., lactate or molasses) that is injected in the central and western portions of the ISB.
- Consider implementation of a groundwater recirculation system to improve distribution of the carbon substrate amendment in the treatment zone.
- Continue to test jetting for well maintenance to improve injection well transmissivity.
- Consider either expanding the ZN11ISB by adding more injection wells to the northeast to treat perchlorate migrating toward the SEPTS or optimizing pumping from wells in the SEPTS to prevent plume migration.

7.2.1.2.4 Early Indicators of Potential Issues

Two potential issues related to the Zone 11 groundwater plumes were identified in Section 7.2.1 and are discussed in detail in Chapter 8:

- The Zone 11 TCE plume extends west outside of the influence of the ZN11ISB treatment system.
- The perchlorate plume is potentially migrating from Zone 11 to the east under the influence of the SEPTS. The SEPTS does not currently have a treatment unit for perchlorate.

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 remedial goals to the same degree. Monitoring of 1,4-dioxane is recommended for the coming FYR period to confirm that the plume is not migrating and is controlled by current biogeochemical and hydrogeological conditions.

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.

The Zone 11 groundwater monitoring plan was reviewed (Attachment 11) and was found to be adequate to address monitoring objectives.

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. 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.

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 life-time health advisory (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 EPA has established an Interim 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 SDWA. The Texas Risk Reduction Program (TRRP) has established a residential groundwater PCL of 17 µg/L and a concentration of 51 µg/L for commercial/industrial property for Class 1 or 2 groundwater.

No changes are recommended for the GWPS values identified in the ROD at this time. However, changes in toxicity assessments and guidance will be considered as part of the process of issuing an ESD before the next FYR.

Several TBC analytes, referred to elsewhere in this document as COPCs not identified in the ROD, have been identified near or above EPA primary MCLs during the First and Second FYR periods. In addition, some COCs identified in the ROD have been found at concentrations higher than expected or in areas not previous identified during initial Site characterization. These TBC analytes are:

- Metals solubilized as a result of ISB treatment systems (arsenic, barium, and manganese)
- Cadmium beneath Zone 12 South (WMG 6/7)
- Cr(VI) near ZN11ISB
- 1,4-Dioxane near ZN11ISB
- Solvent degradation products cis-1,2-DCE and 1,1-DCE identified above MCLs

The additional TBC analytes are discussed in detail in Section 8 of this report. TBC analytes are recommended for addition to routine monitoring in both the perched and Ogallala Aquifer LTM programs.

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 lobe of the perched unit has the potential to exceed the boundaries of the current ICs. Plume migration may result in potentially complete exposure if groundwater is extracted and used as a water supply for human or agricultural consumption. If affected groundwater is identified outside of the current ICs, additional ICs will be implemented, and contingency measures enacted to prevent human and animal contact with affected media.

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. Three COCs have been detected in these wells:

- Cr(VI) was detected below the GWPS of 100 µg/L in 11 Ogallala Aquifer monitoring wells in 2016. The detections in all but two of the wells were below the laboratory practical quantitation limit (PQL) of 10 µg/L. It is likely that most of these sporadic detections are related to the recently lowered detection limits and the ability to quantify low-level background detections, as discussed in the *2016 Annual Progress Report: Remedial Action Progress in Support of Hazardous Waste Permit 50284 and Pantex Plant Interagency Agreement* (Pantex, 2017).
- 4-Amino-2,6-DNT (a breakdown product of the HE 2,4,6-trinitrotoluene) has been detected at PTX06-1056 since April 2014. It was detected in all four quarterly samples in 2016 at values less than or slightly above the PQL of 0.27 µg/L, but well below the GWPS of 1.2 µg/L.
- 1,2-Dichloroethane has been detected at PTX06-1056 since August 2015 and was detected in three of four quarterly samples in 2016. All detections were below the PQL (0.5 and 0.41 µg/L) and GWPS (5 µg/L).

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., indicated that the adjacent perched well was the most likely source of the contamination based on fate and transport modeling.

Pantex has fully implemented the sampling conditions specified in the *Pantex Plant Ogallala Aquifer and Perched Groundwater Contingency Plan* (B&W Pantex, 2009f) and will continue quarterly sampling for HE and VOCs and semiannual sampling for Cr(VI), total Cr, boron, and the soluble metals arsenic, barium, and manganese at PTX06-1056 to determine if further actions are necessary. If HE or VOC concentrations increase above GWPS, the actions in the contingency plan will address determination of the source and response actions.

7.2.2.3 Changes in Toxicity and other Contaminant Characteristics

Toxicity factors for COCs and TBCs have not changed over the FYR period in a way that could affect the protectiveness of the remedy.

No changes in radionuclide slope factors were found during the current review. No changes in MCLs for ROD-specified COCs were found. The GWPS used in the ROD were compared to current Texas PCLs based on the TRRP toxicity value tables (the regulatory program developed after the Texas RRR). No significant changes are identified for COCs included in the ROD. Details of the assessment are presented in Attachment 14.

This Second FYR examined changes for analytes that have been detected in groundwater but were not included in the ROD, to evaluate whether new COCs should be considered due to changes in risk or cleanup values. The new cleanup values for contaminants not specified in the ROD were compared to the maximum detected value for each analyte to identify those analytes for which risk might need to be calculated. Attachment 14 examined analytes with changed toxicity values, current PCLs, and compared maximum detected values to the current PCLs. The evaluation indicates that none of the detected analytes are of concern from a risk perspective.

There have been no changes to the barium MCL or arsenic background concentration. There have been no changes in toxicity values for manganese since the First FYR; therefore, the values calculated from that report are still applicable. The maximum detected concentrations of arsenic, barium, and manganese exceed current cleanup levels. Arsenic and barium concentration ranges and upper confidence limits (UCLs) were evaluated relative to their respective standards including the primary MCL for barium, the site-specific background for arsenic and the risk-based goal calculated in the First FYR for manganese.

There have been no changes in toxicity for 1,4-dioxane since the First FYR. 1,4-Dioxane was included in the ROD with a GWPS of 7.7 µg/L, which falls between the cleanup values calculated in the First FYR risk evaluation at the 1E-6 (0.85 µg/L) to 1E-4 (85 µg/L) risk range using the most recent toxicity values. Because the cleanup value included in the ROD remains within the risk range accepted by EPA, no change in the GWPS is recommended.

Overall, concentrations of 1,4-dioxane remain below a 1E-04 risk level. It is anticipated that combined anaerobic/aerobic treatment zone and natural attenuation mechanisms have been effective in controlling migration of 1,4-dioxane.

7.2.2.4 Changes in Risk Assessment Methods

Changes in EPA risk assessment methodologies and guidance have not changed in a way that would affect the protectiveness of the remedy.

EPA has revised many of the standard default residential exposure parameters to reflect changes in the United States population. The most significant of these changes is in the ingestion rate of drinking water for a child (previously 1.0 liters per day [L/day]; currently 0.78 L/day) and in the average adult body weight (previously 70 kilograms [kg]; currently 80 kg). The decrease in ingestion rate and increase in body weight will result in a decrease in estimated exposure and resulting risk and in an increase in recommended cleanup levels (Attachment 14). These changes indicate that the existing cleanup standards are conservative protective concentrations. Therefore, no changes in the GWPS or RA are recommended based on the change in risk assessment methods.

7.2.2.5 Expected Progress Toward Meeting RAOs

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

- ICs are effectively preventing exposure of human and animal receptors to affected groundwater.
- The P1PTS and SEPTS are reducing groundwater elevations in the perched unit.
- 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 and SEISB control plume migration in the southern part of the perched unit.
- The ZN11ISB 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 ZN11ISB system.
- LTM data indicate that the remedies are preventing impacts to the Ogallala Aquifer.

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

No. The groundwater remedy is currently protective and is expected to remain protective in the near future as the Pantex Plant progresses toward cleanup.

Enhancement and optimization of the Selected Remedy, by expansion of the pump and treat and ISB remedies is anticipated to address issues affecting long-term protectiveness. No conditions have been identified that would call into question the protectiveness of the Selected Remedy. Recommendations for ensuring long-term protectiveness of the Selected Remedy are presented in Chapter 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.

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

The Selected Remedy will continue to be implemented as designed during the next five years to allow for a more complete expression of its effects on the perched groundwater. Remedy operation and maintenance will continue while evaluations are conducted to develop and/or implement options for expanding/enhancing the existing systems, including:

- Six additional EWs have been installed to expand the SEPTS well field to actively remediate the portion of perched groundwater underlying the site east of FM 2373 that it is amenable to extraction. These wells will begin operation in mid-2018.
- Efforts are underway to install an additional ISB system to remediate perched groundwater underlying the site east of FM 2373 and south toward Highway 60 that is not amenable to extraction.
- Implementing additional ICs in areas where the groundwater plumes have migrated beyond the boundaries of the existing ICs.
- Options will be evaluated to determine the best way to enhance the ZN11ISB to address the contaminants that extend west of the existing injection well field and improve performance in the central part of the ISB.
- Evaluation of the CSM and performance monitoring data is underway to identify options to improve the effectiveness of the remedy in the west end of the SEISB and assess a path forward for cleanup.
- Remediating the perchlorate plume that is migrating from Zone 11 towards the SEPTS.
- 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. The areas outside the influence of the groundwater remedy, including expansion of HE plumes in perched groundwater east of FM 2373 and in the far southeast lobe, require continued collection of data to assess distribution of HEs and other risk driving COCs. Additional data are also needed to refine the CSM in the ZN11ISB and SEISB region to identify options to treat the entirety of the contaminant plumes in those areas. Evaluation of this data will provide a better understanding of the timing associated with the long-term goal of achieving restoration of the perched aquifer. Sampling plans will be updated to include additional COPCs identified during this FYR.

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8.0 ISSUES

Table 8-1 lists the issues identified during the Second 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, slope instability, animal burrows, and settling.	No	Yes
2	EPA guidance on protective dose-based ARARs for radionuclides changed from 15 to 12 mrem/yr	No	No
	Groundwater Remedies		
3	HE plumes are expanding in the southeast lobe of the perched unit toward Highway 60.	No	Yes
4	The Zone 11 TCE plume extends west outside of the influence of the ZN11ISB treatment system	No	Yes
5	Incomplete treatment of contaminants (HE and Cr[VI]) downgradient of the west end of the SEISB (PTX06-1153).	No	Yes
6	Additional groundwater analytes identified in the First and Second FYR requiring continued monitoring include: • Metals solubilized as a result of ISB treatment systems (arsenic, barium, and manganese) • Cadmium beneath Zone 12 South (WMG 6/7) • Cr(VI) near ZN11ISB • 1,4-Dioxane near ZN11ISB • Solvent degradation products cis-1,2-DCE and 1,1-DCE identified above MCLs	 No No No No No	 Yes No No Yes Yes
7	The perchlorate plume is migrating from Zone 11 to the east under the influence of the SEPTS. The SEPTS does not currently have a treatment unit for perchlorate	No	Yes
8	The GWPS for perchlorate is 26 µg/L. The current TRRP PCL for residential property is 17 µg/L and EPA has established an LHA of 15 µg/L.	No	No
9	Significant updates to the Selected Remedy are currently underway or being considered	No	Yes

8.1 DEFICIENCIES IN SOIL COVERS (ISSUE 1)

As noted in Section 4 and detailed in Attachment 8, some minor deficiencies in soil covers were identified during the 2017 Site and LiDAR inspections.

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 contract for repair and maintenance will be issued to address minor deficiencies in soil covers including erosion, settling, animal burrows and slope instability. This work will be completed by March 2019 to ensure that erosion of the protective covers does not occur, and long-term effectiveness of this remedy is maintained.

8.2 DOSE-BASED ARARS FOR RADIONUCLIDES (ISSUE 2)

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, ARAR for radionuclides from 15 to 12 mrem/yr. The new recommendation of 12 mrem/yr is based on using an updated risk assessment to achieve the same 3×10^{-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 1990's. 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 depleted uranium being the contaminant of concern that drove the risk. 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 are below 1.0E-06.

Because Pantex had used a screening process at FS-5 for the original ecological risk assessment, a full risk assessment process, as described in a site-wide ecological risk assessment planning document, was implemented during the First FYR. Risks were in acceptable ranges and no further action was recommended. However, due to the presence of a small depression at FS-5, the TCEQ requested evaluation of risk to aquatic receptors at the site. That risk assessment was included in this Second FYR. Risks were acceptable, and no further action is recommended.

Institutional controls have been implemented at both FS-5 and NWAR. To ensure continued protection of workers through a SWMU interference process, soil concentrations are reviewed when a work task is anticipated to disturb the soils. Soil concentrations are compared to updated protective factors for workers to determine

protective measures that must be taken when they work at the site. Those updated factors, including PRGs, have been recalculated periodically since the First FYR where it was recommended that this process be reviewed and updated for protection of workers. Pantex continues to review the updated worker protection values to determine whether use of personal protective equipment and institutional controls remain relevant or if other protective measures may be required.

Due to the magnitude and complexity of risk assessments and historical remedial actions, Pantex Site managers recommend that a meeting be held between EPA and Site project managers to discuss methods and results risk assessments. The discussion is anticipated to include any changes to radiological ARARs that have evolved since issuance of the ROD in 2008.

8.3 HE PLUMES EXPANDING EAST OF FM 2373 AND SOUTH TO HIGHWAY 60 (ISSUE 3)

Perched groundwater COC plumes continue to migrate in the far southeastern lobe of the perched aquifer. As stated in The *Remedial Action Effectiveness Report* (HGL, 2018) referenced in Attachment 7, portions of these areas are not under the long-term influence of the SEPTS due to limited saturated thickness and other hydrogeologic conditions.

Migration of perched unit plumes to the southeast are not a short-term threat to protectiveness as the perched groundwater is not used as a water supply in the area, and the property extending to Highway 60 is deed restricted to prevent drilling for purposes other than remedial action. Additional migration may present a threat to long-term protectiveness if the plume migrates beyond the current ICs or if perched groundwater affected by HE migrates to the Ogallala Aquifer.

Two primary responses are being implemented to address HE plume migration in the southeast perched unit. Six additional perched unit extraction wells were installed in 2016 east of FM 2373 and are anticipated to be connected to the SEPTS by mid-2018. The additional extraction wells are being implemented to control plume migration to the southeast.

Because the far southeast lobe of the perched unit has low saturated thickness (typically less than 15 ft), extraction wells are unlikely to be effective at remediating the plume. Therefore, an additional ISB system is being designed for the area along Highway 60 east of FM 2373. The ISB system is anticipated to control and remediate the HE plumes expanding to the southeast.

Ongoing characterization and installation of monitoring wells will delineate the plume in the southeast perched unit. Additional ICs will be enacted if contamination extends beyond the property currently covered by deed restrictions.

8.4 TCE PLUME NORTH AND WEST OF ZN11ISB (ISSUE 4)

Additional monitoring data acquired during the First FYR in the ZN11ISB area indicate that COC plumes extended farther to the west than expected. The western edge of the TCE plume is now delineated below GWPS by monitoring wells PTX06-1160 and PTX06-1181 (installed in 2012 and 2016, respectively; see Figure 4-4 for well location).

Five additional wells were installed north and west of the ZN11ISB treatment zone in September 2012 to acquire hydrogeologic information needed to evaluate the options for addressing the plumes west of the ZN11ISB. Two of these wells (PTX06-1161 and PTX06-1162) were installed approximately 50 and 100 feet southwest of PTX08-1005 and three wells (PTX06-1163, PTX06-1164, and PTX06-1165) were installed approximately 500 ft northwest of the ZN11ISB well field. Data were obtained via aquifer testing to evaluate the potential for P&T operations; however, the three wells installed nearer the ZN11ISB system (PTX06-1163, PTX06-1164, and PTX06-1165) were also constructed to allow for conversion to future ISB injection wells, if the evaluation supports ZN11ISB expansion as the preferred option to treat the plumes west of the ZN11ISB.

There is currently no threat to short-term protectiveness from the TCE plume west of the ZN11ISB as the property is covered by deed restrictions that prevent drilling into the perched unit for purposes other than remedial actions. Access to this area is also highly restricted. The presence of the TCE plume in this area does present a challenge to long-term protectiveness as contamination may migrate both laterally and vertically to the Ogallala Aquifer.

Even though the ISB system is operating as intended based on original design parameters, and is effectively treating the primary COCs, part of the plume is flowing past the west-end of the treatment zone. Options for addressing this issue are currently being evaluated. Options under evaluation are:

- Expansion of the current ZN11ISB well field
- Installation of a small P&T system north and west of the ZN11ISB system
- Installation of extraction wells north and west of the ZN11ISB system and construction of a conveyance line to the Southeast Pump and Treat building

8.5 INCOMPLETE TREATMENT AT SEISB WELL PTX06-1153 (ISSUE 5)

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.

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 remedial actions. Residual contamination at PTX06-1153 presents limited threats to long-term protectiveness. Saturated thickness in the area is very low and decreasing 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, 2017b).

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 aquifer and allowing untreated water to flow south of or around the dry spot toward PTX06-1153.
- Untreated water may be flowing around the treatment zone, in between the estimated perched aquifer extent and western edge of the well field, although areas to the west of PTX06-1153 appear to be unsaturated.
- Untreated water may be flowing through the well field, possibly through a preferential flow path of coarse-grained material.

An additional monitoring well was 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. 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.

8.6 ADDITIONAL CONTAMINANTS OF POTENTIAL CONCERN (ISSUE 6)

8.6.1 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 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 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. Site-wide, no exceedances of the GWPS for cadmium were recorded during the current FYR period.

Cadmium in perched groundwater does not present a short-term challenge to protectiveness because the area is highly restricted, covered by deed restrictions and is within the remedial response area for HE contamination. Cadmium is unlikely to pose a threat to long-term protectiveness as the affected area and total mass are limited.

Cadmium concentrations in perched groundwater relative to risk is discussed in the Attachment 14 Risk Evaluation. It is recommended that cadmium be included as an analyte at PTX06-1010 for the next FYR period to confirm concentrations below GWPS.

8.6.2 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 2016 for PTX08-1005 show a maximum detected concentration for Cr(VI) of 24.3 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 4 µg/L. Concentrations in this area are 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 ZN11ISB will effectively treat Cr(VI) if it is present. If concentrations of Cr(VI) are observed above the GWPS in the area, ZN11ISB 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.

8.6.3 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.

Arsenic, barium, and manganese concentrations in groundwater in the ISB areas during the Second FYR are discussed in detail in Attachment 14. The UCL on the median concentration was used as a reference point is assessing impact. Overall, the sampling results over the Second FYR period suggest that arsenic is the least likely to show UCL concentrations below the Site-specific background value of 12 μg/L in the long term, and the manganese UCL is already below the residential screening level of 1,700 μg/L at several wells. Table 8-2 provides a summary of the changes and trends observed in UCL median concentrations for arsenic, barium, and manganese.

The spatial and temporal response of the downgradient SEISB System is unclear because of the limited extent of the perched aquifer saturated thickness and how far the reducing zone will expand at the ISB system. Consequently, these metals will require continued monitoring in both the perched and Ogallala Aquifer to determine whether arsenic, barium, and manganese concentrations persist or if concentrations decline over time.

There is currently no threat to short-term protectiveness of the remedies, but longer-term issues may arise if elevated concentrations of metals persist or migrate laterally. Groundwater fate and transport modeling indicates that vertical migration of metals generated in the perched unit are unlikely to migrate to the Ogallala Aquifer. However, vertical migration of metals should be considered when evaluating the long-term threat to protectiveness in the Ogallala Aquifer.

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, monitoring for these metals is needed to confirm that concentrations eventually decrease as expected. Changes to the monitoring program will be included in the update to the Sampling and Analysis Plan in 2018 to ensure that data needed to evaluate the potential for impacts to the Ogallala Aquifer are collected.

Table 8-2. Summary of Arsenic, Barium, and Manganese UCL Median Concentration Trends

In Situ Bioremediation Area	Soluble Metal		
	Arsenic	Barium	Manganese
Zone 11	Increasing UCL in all downgradient wells but most treatment area wells showing similar or larger percentage decrease. Potential exists to reach background value thereby achieving long-term protectiveness.	Limited data (two wells) in downgradient area. One well showed increase in UCL while other decreased and was < background in both FYR periods. Four other wells (data not comparable between First and Second FYR) show UCL < background. The only well > background showed decrease in Second FYR.	Two of three downgradient wells show significant decrease in UCL and one is < Residential Screening Level. Nine of 10 treatment zone wells show decrease in UCL > 59% and 7 of 10 show UCL < Residential Screening Level. Potential exists to reach Residential Screening Level value over long term.
Southeast	UCL is increasing at all wells in both treatment and near-downgradient zones. Potential exists that UCL cannot meet background at limit of saturation. Ogallala Aquifer Monitoring needed to confirm long-term protectiveness.	Limited data (one well) in downgradient area and it showed 82% increase in UCL. Three other wells (data not comparable between First and Second FYR) sampled in Second FYR period for total of four. UCL > background in two wells and < background in two wells.	Two of four downgradient wells show significant decrease in UCL and the other two show significant increase. Only one well > Residential Screening Level in Second FYR period. All seven wells in treatment area show decrease in UCL of at least 30% and 3 show UCL < Residential Screening Level in Second FYR period. Potential exists to reach Residential Screening Level value over the long term in at least a portion of the downgradient zone.

Note: Unless otherwise noted, references to "wells" in table mean wells that were sampled for the given parameter in both the First and Second FYR periods.

8.6.4 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. Recent concentrations indicate that risk would now exceed 1.0E-06 in the perched groundwater. The effectiveness of ISB in treating 1,4-dioxane has not been demonstrated in the scientific literature. Fate and transport

modeling results indicate that 1,4-dioxane would still not present a risk to the underlying Ogallala Aquifer, as perched groundwater in the Zone 11 area would not reach a point-of-exposure in the underlying aquifer for more than 1,000 years.

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 remedial actions. Long-term threats to protectiveness are the same as those considered for other COPCs listed in Section 8.5.

The COC 1,4-dioxane will continue to be monitored and trends evaluated in the ZN11ISB 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 not treat 1,4-dioxane. 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, 2009f).

8.6.5 TCE Degradation Products

The products of TCE anaerobic degradation, including cis-1,2-DCE and vinyl chloride, may accumulate at concentrations above MCLs as degradation intermediates in the ZN11ISB 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.

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). This COPC is usually a degradation product of 1,1,1-trichloroethane but is also a 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 remedial actions. Long-term threats to protectiveness are the same as those considered for other COPCs listed in Section 8.5.

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 ZN11ISB to confirm that they are transient degradation intermediates and that the remedy is not generating a plume capable of downgradient migration.

8.7 MIGRATION OF THE PERCHLORATE PLUME TO THE EAST (ISSUE 7)

Perchlorate concentrations at perched monitoring well PTX08-1008 are statistically *increasing* (but also exhibit high variability). The well is located north and east of the ZN11ISB system. Groundwater flow directions indicate that groundwater is being drawn to the east by the SEPTS. Since initiation of the SEPTS the groundwater divide historically located south of Zone 12 has moved to the west, creating conditions whereby perchlorate may be drawn into the SEPTS capture zone. The current SEPTS does not include treatment for perchlorate.

Migration of the perchlorate plume does not present short-term challenges to protectiveness as the property is covered by deed and access restrictions that prevent extraction of perched groundwater for purposes other than remedial action. Long-term protectiveness may be threatened by migration of the plume above the GWPS of 26 µg/L to the SEPTS area of influence.

Recommendations to maintain protectiveness include monitoring of groundwater south of Zone 11 and 12 for perchlorate migration and in the SEPTS extraction wells to the southwest of the SEPTS treatment plant. Influent concentrations above the GWPS may trigger the need to add perchlorate treatment to the SEPTS treatment train, or other enhanced remedial response. Groundwater extraction from wells may be optimized to prevent movement of the groundwater divide and potential migration of the perchlorate plume, while still reducing saturation in the SEISB and southeast area of the perched unit.

8.8 PERCHLORATE GWPS (ISSUE 8)

The 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. TRRP has established a residential groundwater 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 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 were 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.

Several RAs have been implemented to prevent exposure and reduce concentrations of perchlorate on Site. ICs enacted at the Pantex Plant restrict property use to commercial/industrial development and prohibit residential property use. ICs prohibit utilization of groundwater in the perched aquifer below the Pantex Plant for drinking water supplies or for other agricultural, residential, or industrial use. Drilling into the perched unit is restricted to activities related to RAs. Industrial work that may result in contact with groundwater is strictly monitored.

Perchlorate detections at the Pantex Plant are limited to the perched groundwater emanating from two source areas, Zone 11 and the BG. Monitoring data collected at Pantex do not indicate migration of perchlorate from the perched groundwater to the Ogallala Aquifer, which is a regional water supply. Treatment of perchlorate is only necessary at Zone 11 and is currently accomplished by the ISB system through geochemical reduction. Data over the FYR period indicate the remedial system is effective at reducing concentrations of perchlorate below GWPS to non-detect levels.

Based on a review of the RAs, the ROD-specified GWPS is protective in the short term. Toxicity and risk factors for perchlorate were reviewed in the First FYR (2013, Attachment 14, Table 6) and no change in GWPS was determined to be necessary. No completed exposure pathways are present for affected groundwater at the Site, and the GWPS is below the TRRP PCL for commercial/industrial property and is relatively close to the PCL for residential property. A change in the GWPS would not require a change to the RA as the remedial action is achieving or is expected to achieve non-detect levels. Therefore, no change in GWPS is recommended for this FYR.

Pantex recognizes and agrees that protectiveness of the remedy with respect to perchlorate is important and should be re-evaluated periodically. So, the perchlorate remedial goal has been added as an issue and a recommended action in this FYR to evaluate changes to the perchlorate ARARs that have occurred since the ROD was issued in 2008. The outcome of the evaluation will be selection of an updated GWPS for perchlorate which will be documented in the ESD prepared to address significant changes in the remedy described in response to Issue 9. When EPA specifies an MCL for perchlorate, the long-term protectiveness of the perchlorate GWPS will be reviewed using the final toxicological data supporting the MCL.

8.9 SIGNIFICANT UPDATES TO SELECTED REMEDY (ISSUE 9)

The remedy selected in the ROD has not been modified by a ROD amendment or an ESD to date. RA technologies for groundwater selected in the ROD include groundwater extraction and treatment by conventional means (e.g. granular activated carbon, ion exchange) and ISB using carbon substrate. Selected remedies for soil include SVE, soil covers, and a ditch liner. ICs have been enacted for both soil and groundwater. No new technologies (e.g. thermal treatment, in situ soil stabilization) or change in status (e.g. technical impracticability waiver) are currently being considered at the Site. However, expansion of existing treatment technologies selected in the ROD, such as groundwater extraction and treatment and ISB, are underway.

EPA guidance on Post-ROD changes indicates that a remedy change is categorized by the lead agency based on scope, performance, and cost factors. A significant change is one that is more than minor and less than a fundamental departure from the ROD. A significant change generally involves a change to a component of a remedy that does not fundamentally alter the overall cleanup approach. Since 2009, several updates to the selected remedies have been implemented without revision of the ROD. All have been documented in annual progress reports, but the following would probably be categorized as significant.

- Seven new extraction wells were installed in the SEPTS in 2016 and are being connected to the treatment system in 2018. Another new extraction well was also installed in the P1PTS in 2016.
- In 2014, 18 new injection wells were added to the ZN11ISB and additional expansion to the northwest is likely as a future effort, as identified this FYR.
- In 2017, an extension of the Southeast ISB System was installed consisting of 25 new injection wells along the southern property boundary. Infrastructure needed to support routine injection of amendment that will stimulate in situ treatment of HE compounds present in the perched groundwater will be installed in 2018.

Presently, these changes are considered significant from the standpoint of both capital and O&M cost and future remedy performance. Other changes may be needed in the near future with respect to disposition of treated water produced from the SEPTS and P1PTS and further action to address the perched groundwater plume extending offsite to the southeast. The recommended action includes continued monitoring of the performance of the remedy updates and preparation of an ESD documenting updates to the Selected Remedy some time before the next FYR.

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 Chapter 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, slope instability, animal burrows and settling	Prepare and implement work plan to restore slopes and fill holes on soil cover surfaces.	Pantex	EPA/TCEQ	September 2020	No	Yes
New EPA protective dose calculations for radionuclides	Meet with EPA to discuss risk assessment process and data for radionuclides	Pantex	EPA/TCEQ	December 2019	No	No
Groundwater Remedies						
Plumes of high explosives (primarily RDX) are expanding in the southeast lobe of the perched groundwater unit in areas of low saturated thickness.	• Continue to characterize the conceptual site model for the southeast lobe of the perched unit, including the extent of contamination, saturated thickness, groundwater flow direction and topography of the FGZ. • Connect six new extraction wells east of FM 2373 to the SEPTS. • Design and implement an ISB system along Highway 60 southeast of the Pantex Plant. • Confirm deed restrictions encompass property affected by migration of the HE plume.	Pantex	EPA/TCEQ	Phased approach through 2020	No	Yes
The Zone 11 TCE plume extends west and outside of the Zone 11 ISB system.	• Continue evaluating alternatives for treatment of the TCE plume. Remedial systems to be considered include expanding/updating the ISB system or implementing a pump & treat system.	Pantex	EPA/TCEQ	September 2020	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)						
Incomplete treatment of HE and Cr [VI] downgradient of the west end of the SEISB at PTX06-1153. Other ISB performance wells show results below remedial goals.	Continue to collect and evaluate data from the SEISB area, 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 2019	No	Yes
Perchlorate plume potential migration to SEPTS	Continue monitoring the perchlorate plume south of Zone 11. Modify the SEPTS extraction to limit mobilization in the short-term as needed. Addition of a perchlorate treatment unit to the SEPTS would be warranted if perchlorate is detected in SEPTS influent at concentrations near the GWPS of 26 ppb.	Pantex	EPA/TCEQ	September 2019	No	Yes
GWPS for perchlorate is 26 µg/L, the TRRP PCL is 17 µg/L, and the EPA LHA is 15 µg/L.	Include perchlorate as part of the risk assessment meeting and discussion with EPA described under Issue 2 (Soil radionuclides risk assessment). Update GWPS as needed in potential ESD.	Pantex	EPA/TCEQ	September 2021	No	No
Significant updates to the selected remedy are currently underway or being considered	Issue an ESD before the 2023 FYR to document expansion and updates to the remedies selected in the ROD	EPA/Pantex	EPA/TCEQ	September 2021	No	No

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*
Additional Perched Groundwater COCs and COPCs						
Cadmium concentrations exceeded the MCL in 2011 beneath Zone 12 South (WMG 6/7) at PTX06-1010, recent data indicate concentrations below GWPS	Concentrations of cadmium should be monitored at PTX06-1010 and down-gradient well PTX06-1088 during the next five-year period to confirm concentrations below GWPS of 5 μg/L.	Pantex	EPA/TCEQ	Annually through Progress Reports	No	No
Detections of Cr (VI) in Zone 11 (PTX08-1005)	While Cr (VI) concentrations are still slightly below the GWPS, the area will need to be evaluated and concentrations trended in the future to determine if the Cr (VI) persists.	Pantex	EPA/TCEQ	Annually through Progress Reports	No	No
1.4-Dioxane in Zone 11 plumes	Continue monitoring for 1,4-dioxane in the Zone 11 plume and downgradient from the ZN11ISB system to evaluate potential expansion of the plume.	Pantex	EPA/TCEQ	Annually through Progress Reports	No	Yes

Table 9-2 Recommendations for Remedy Optimization and Monitoring

Recommendation	Follow-up Action	Party Responsible	Oversight Agency	Milestone Date
Soil Remedies				
Establish criteria for ceasing SVE system operations.	Develop a trial shutdown plan and monitoring program to evaluate potential rebound in concentrations during the shut-down period. Establish termination criteria.	Pantex	EPA/TCEQ	As needed after review of influence of recent upgrades to system
Groundwater Remedies				
Repair/enhance irrigation system and/or develop new options to reduce reliance on injection of treated water back into the perched zone.	Develop a work plan to optimize the irrigation system for disposing of treated groundwater and/or develop new options for beneficial reuse to increase extraction and treatment throughput volumes.	Pantex	EPA/TCEQ	July 2019
Consider optimization of the pumping network in the SEPTS.	Computational or qualitative optimization of extraction could improve: • Control of migration of perchlorate plume. • Continued reduction of saturation in the SEISB. • Control of the plume migrating in the southeast lobe of the perched unit.	Pantex	EPA/TCEQ	September 2020
Consider optimization of the SEISB injection effort may be reduced in areas where groundwater COC concentrations have dropped below GWPS.	• Consider amendment injections in wells around PTX06-1153 (even if they appear dry) to target one area where COC concentrations are not responding. • Schedule a reduced amendment injection frequency at the SEISB in areas where groundwater concentrations have dropped below GWPS. • Evaluate data annually and during the next FYR period to determine effects of the optimized strategy.	Pantex	EPA/TCEQ	September 2020

Table 9-2. Recommendations for Remedy Optimization and Monitoring (continued)

Recommendation	Follow-up Action	Party Responsible	Oversight Agency	Milestone Date
LTM Network				
Evaluate current conditions in Ogallala Aquifer monitoring wells to determine if changes are needed to implement improvement plan (2014).	Check current configuration of Ogallala Aquifer monitoring wells to decide if diverters need to be installed to improve early detection as recommended in the sampling improvement plan.	Pantex	EPA/TCEQ	September 2019
Update LTM Network design and SAP documents to capture changes and recommendations from the Second FYR, after regulatory approval.	LTM Network and SAP documents need to be updated to reflect recommendations from the 2017 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	September 2019
ICs				
Use data collected from the southeast lobe of the perched groundwater unit to determine if additional deed restrictions are required to restrict access to affected perched groundwater.	Implement additional deed restrictions as needed.	Pantex	EPA/TCEQ	Phased approach through 2020

Table 9-2. Recommendations for Remedy Optimization and Monitoring (continued)

Recommendation	Follow-up Action	Party Responsible	Oversight Agency	Milestone Date
Community Involvement				
Implement measures to better inform neighbors of the RA.	Update Community Involvement Plan, neighbor mailing lists, and distribute the annual newsletter and public meeting invitations accordingly to improve communication with Pantex neighbors/ local officials.	Pantex	EPA/TCEQ	December 2019
Improve communication of RA efforts with the Local Groundwater District	Provide copies of quarterly and annual progress reports to the Panhandle Ground Water District (PGWD) as part of distribution when submitted to TCEQ and EPA. This will ensure that RA progress and the new information on wells installed and water quality encountered is available to PGWD staff for use in protecting and conserving ground water resources critical to the future of the Panhandle region.	Pantex	EPA/TCEQ	Annually

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 pump and treat systems continue to reduce saturated thickness of the perched aquifer, thus reducing the potential for lateral and vertical movement of affected groundwater and protecting the underlying Ogallala Aquifer.
- 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 ZN11ISB 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.

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.
- Continue operation of the groundwater remedies to achieve cleanup standards in the perched aquifer and expand remedies in areas not currently addressed by active remedies.
- Continue to maintain and enforce the established ICs.
- Address the issues identified in Chapter 8 by implementing follow-up actions described in Table 9-1.

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11.0 NEXT REVIEW

The next FYR will be conducted in 2022 covering Site RAs conducted between 2017 and 2021. The final report will be completed in 2023, with concurrence by regulatory agencies no later than five years after concurrence with this report.

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Attachments 1 – 14

Please request attachments through the Pantex webmaster via
pantex_communications@cns.doe.gov