Pantex Plant

2020 Annual Progress Report

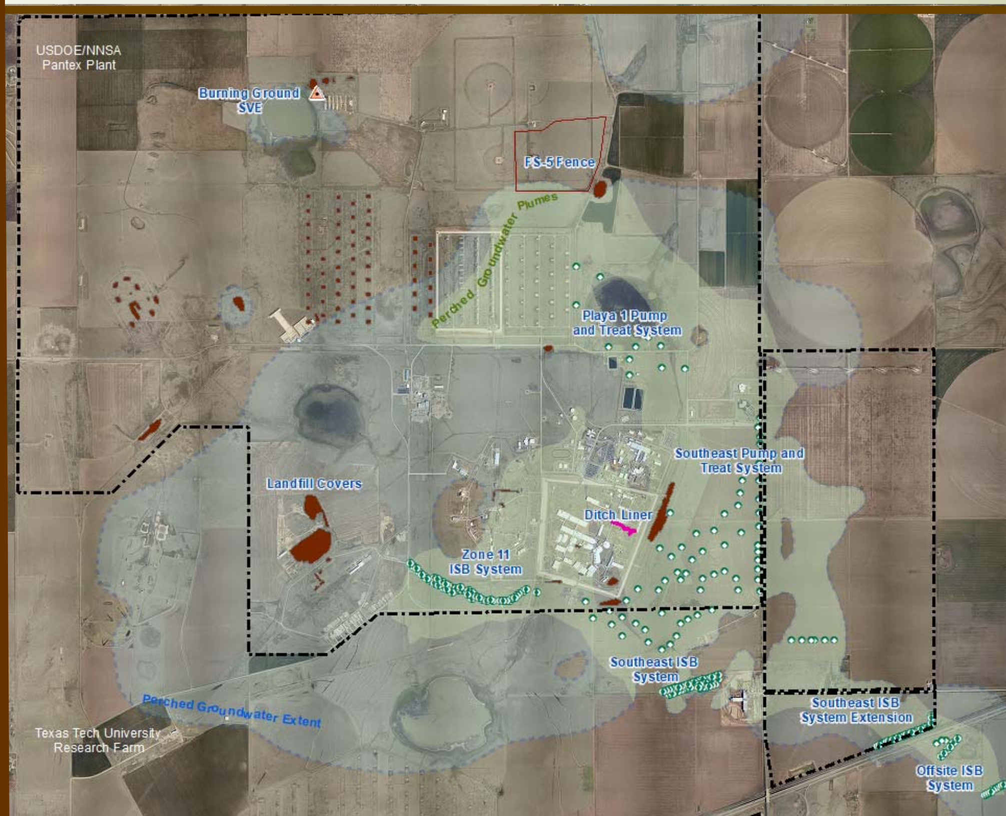
Remedial Action Progress

In Support of Hazardous Waste Permit 50284 and
Pantex Plant Interagency Agreement

June 2021

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

Pantex Plant Remedial Action Systems



CERTIFICATION STATEMENT

2020 Annual Progress Report
Remedial Action Progress
Pantex Plant, June 2021

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 fine and imprisonment for knowing violations.

6/24/21

Jimmy C. Rogers
Acting Senior Director
Pantex Environment, Safety and Health
Consolidated Nuclear Security, LLC

Date

2020 Annual Progress Report
Remedial Action Progress
in Support of Hazardous Waste Permit #50284
and Pantex Plant Interagency Agreement
for the Pantex Plant, Amarillo, Texas
June 2021

Prepared by:
Consolidated Nuclear Security, LLC
Management and Operating Contractor for the
Pantex Plant and Y-12 National Security Complex
under Contract No. DE-NA0001942
with the U.S. Department of Energy/
National Nuclear Security Administration

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.

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E.0 Executive Summary

> ***Annual Progress Report Outline***
>
> - Background Information
> - O&M of Remedial Actions
> - Groundwater Remedial Action Effectiveness
> - Soil Remedial Action Effectiveness
> - Recommendations and Conclusions

The Pantex Plant (Plant), located in the Texas Panhandle 17 miles northeast of Amarillo, is implementing a remedial action to remediate perched groundwater and soils. Two types of systems have been installed for the groundwater response action: pump and treat systems in two areas and in-situ bioremediation (ISB) systems in three areas. A soil vapor extraction (SVE) system has also been installed to remediate volatile organic compounds (VOCs) in soils at the Burning Ground area. Other soil remedies (i.e., fencing, soil covers, and ditch liners) and institutional controls are also maintained as part of the soil remedy for Pantex.

This annual report satisfies requirements in the Pantex Interagency Agreement (IAG) and Hazardous Waste Permit No. 50284 (HW-50284) to provide information on the remedial action system's performance and components. The focus of this report is the data and information collected for the soil and groundwater remedies during 2020. Data are evaluated according to criteria outlined in the *Update to the Long-Term Monitoring System Design Report* (Pantex, 2019a), HW-50284, the IAG, Land and Groundwater Use Control Implementation Plan, and various operation and maintenance (O&M) plans for the remediation systems.

E.1 Remedial Actions

Pantex has implemented soil and groundwater remedial actions, which are highlighted here:

Groundwater Remedial Actions

Two pump and treat systems:

- Reduce saturated thickness
- Reduce contaminant mass
- Plume stabilization

Four in-situ bioremediation systems:

- Reduce contaminant concentrations as groundwater migrates through the treatment zone

Institutional controls:

- Control perched groundwater

Soil Remedial Actions

Ditch liner and soil covers on landfills

- Protect future groundwater

Institutional controls:

- Protect workers
- Restrict areas to industrial use

Soil vapor extraction system:

- Clean up soil gas and residual NAPL in the soil at the Burning Ground

Fencing:

- Prevent traffic and control access

E.2 O&M of Remedial Actions

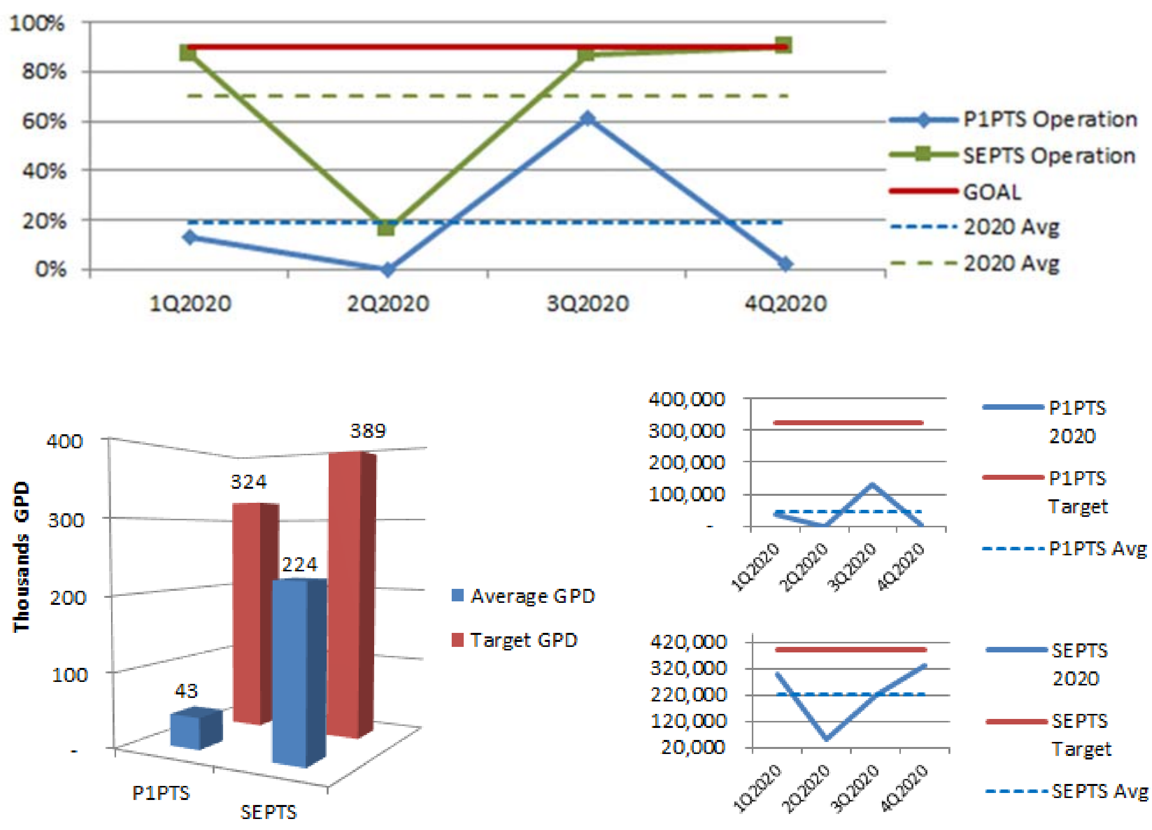
E.2.1 Pump and Treat Systems

Operational goals have been developed to promote mass removal and the continued removal of perched groundwater to reduce the perched aquifer's saturated thickness. The first goal of 90% system operation was not applicable at all times during 2020 due to maintenance shutdowns of the systems, shutdowns demanded by safety protocols against COVID-19, and in response to the break at the irrigation system's filter bank.

Additionally, the Playa 1 Pump and Treat System (P1PTS) only operated one week per quarter to allow the Southeast Pump and Treat System (SEPTS) to fully operate and improve water removal and the capture of the plume moving towards the southeast. The average operational rate across 2020 was 22% at the P1PTS and 70% at the SEPTS. The pump and treat systems' performance for 2020 is depicted in Figure E-1.

Treatment throughput has not been a primary goal after the break at the irrigation system's filter bank occurred in June 2017; however, the 90% goal is still depicted in the graphs, and throughput is evaluated. When the systems operated, daily treatment throughput varied due to reduced flow to the Wastewater Treatment Facility (WWTF) and irrigation system.

The P1PTS was heavily impacted by the irrigation system's shutdown after the filter bank break. Treated water from P1PTS can only be released to the WWTF, so flows are impacted when the WWTF cannot receive the water. Treated water from the WWTF is now routed to Playa 1 until repairs at the irrigation system are complete. Since release to Playa 1 is limited by permit, the P1PTS was shut down. SEPTS remained operational with higher flows throughout most of 2020 due to the operation of P1PTS one week per quarter. SEPTS's operation focused on removing water in high-priority well locations to control plume movement to the southeast.



2020 Average GPD by System

2020 Quarterly Average GPD by System

Figure E-1. Pump and Treat System Performance

To better manage treated water, Pantex contracted for the design of a center-pivot irrigation system east of FM 2373 in 2020. The design was completed in May 2021, and contracting has begun to construct the new irrigation system. Additionally, a project was initiated in 2018 to install new injection capabilities near Playa 2, away from the large plumes of contamination. This project is scheduled for completion in June 2021. Together, these two projects will provide a long-term solution to treated water management.

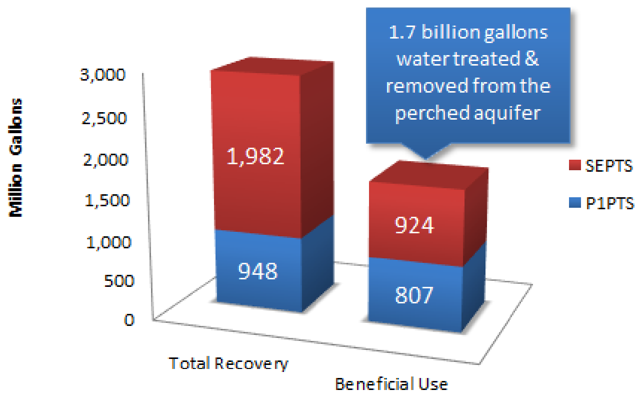


Figure E-2. Pump and Treat Recovery

Overall, the systems have operated efficiently to treat contamination and reduce saturated thickness. As depicted in Figure E-2, Pantex has treated over 2.9 billion gallons since the startup of the systems, with more than 1.7 billion gallons removed and beneficially used. Pantex continues to reduce reliance on the injection of treated water, where possible, and, as recommended in the first five-year review (FYR), Pantex has implemented new throughput goals to align operations with the goal of reducing saturated thickness. During 2020, only 4% of the treated water was beneficially used, 4% was injected back into the perched aquifer, and the rest was sent to Playa 1. Beneficial use of the treated water continues to be heavily impacted by the break at the irrigation system.

In addition to removing impacted water from the perched aquifer, the pump and treat systems remove contaminant mass from groundwater that is extracted from the aquifer. The P1PTS primarily removes the high explosive (HE) hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX), and the SEPTS primarily removes RDX and hexavalent chromium, shown as CR(VI) in Figure E-3. The figures below provide the mass removal for HEs and hexavalent chromium for 2020 as well as totals since the systems' startup.

The SEPTS has been operating longer than the P1PTS, and the greatest concentrations of HEs are found in the SEPTS's extraction well field, so mass removal is much higher at that system. During 2020, the SEPTS removed approximately 393 pounds (lbs) of contaminants, and the P1PTS removed approximately 5 lbs of contaminants.

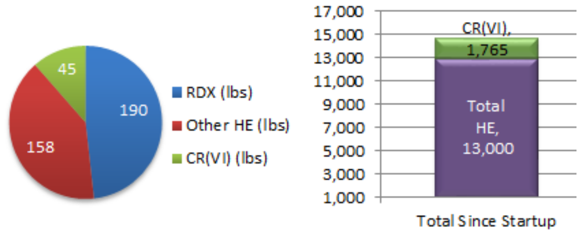


Figure E-3. SEPTS Mass Removal

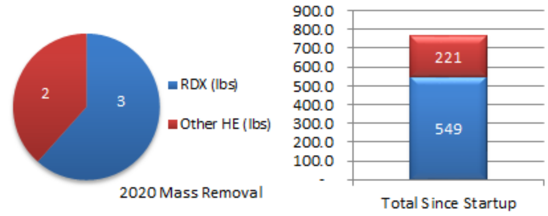


Figure E-4. P1PTS Mass Removal

E.2.2 In-Situ Bioremediation Systems

Pantex has four ISB systems installed: The Zone 11 ISB, Southeast ISB, Southeast ISB Extension, and Offsite ISB. Two systems, the Zone 11 ISB and Southeast ISB Extension, were maintained and injected during 2020.

The expansion area on the Zone 11 ISB system's northwest side was injected in 2020. Pantex continued the use of molasses injection, and results from the treatment zone indicate that conditions between the wells have improved. The use of molasses has decreased concentrations of trichloroethene (TCE) and perchlorate at the downgradient wells.

However, Pantex has experienced issues with injection at a portion of the wells; therefore, conditions between those wells have not improved, and response at the downgradient wells is hampered. Pantex is planning to infill wells in areas where injection is no longer possible. Additionally, in 2021, Pantex is drilling a second row of wells in areas of the Zone 11 ISB, where higher concentrations of TCE are moving, to improve treatment in those areas.

Pantex also injected the Southeast ISB Extension during 2020, with molasses used to improve distribution. Wells in the treatment zone indicate that HEs are treated, but downgradient wells have not yet had time to demonstrate treatment.

E.2.3 Soil Remedial Actions

In early 2012, a small-scale catalytic oxidation (CatOx) SVE system was installed at the Burning Ground to address the reduced soil gas plume at the Burning Ground. This small-scale system focuses on treating residual non-aqueous phase liquid (NAPL) and soil gas at soil gas well SVE-S-20.

The system was variably operated in 2020 due to occasional shutdowns for maintenance, repairs, extreme temperatures, and power outages, with an overall operation of approximately 49%. The system was shut down in December for the first planned pulsing period. Figure E-5 presents the mass removal calculated for the major VOCs contributing to the total VOC concentration in 2020 as well as the total mass removed since the SVE system was installed as an interim action in 2002. The system removed approximately 269 lbs of VOCs during 2020. This system demonstrated significant reductions in influent concentrations during 2020, indicating that the NAPL source may be depleting. Pantex will continue the planned pulsing as part of a path to closure of the system.

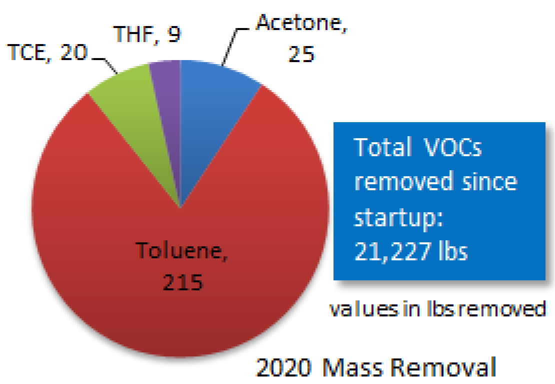


Figure E-5. Burning Ground SVE Mass Removal

In addition to the active soil remediation at the Burning Ground, Pantex maintains institutional controls in accordance with deed restrictions to protect workers and the environment. Pantex provides long-term control of any type of soil disturbance in the solid waste management units (SWMUs) to protect human health and prevent the spread of contaminated soils.

In 2020, SWMU interference was approved for five new projects that required work in a SWMU and four older projects were completed. Pantex also completed the control of burrowing animals in specific landfills and continues to regularly inspect and maintain all soil covers, fences, signs, postings, and ditch liners. In 2020, an inspection of a ditch liner indicated continuing issues with sedimentation and a tear in the liner. Pantex plans to contract for annual maintenance of the liner.

Pantex will continue to evaluate the landfills annually and report findings and plans that are developed to address holes, depressions, or bare areas. Any problems identified will be addressed annually through the landfill cover maintenance contract and larger issues, such as erosion, will be addressed through separate contracts, based on available funding. Pantex will also use onsite support maintenance personnel, when available.

E.3 Groundwater Remedial Action Effectiveness

E.3.1 Plume Stability

Plume stability was evaluated through examination of water level and concentration data. Water levels were used to generate hydrographs and trends for individual wells, maps of water elevations and contours, and water level trends. Concentration data were used to perform concentration trend analysis and were also combined with the water level data to generate plume maps for each contaminant of concern (COC). The maps and trends together formed the basis for an evaluation of overall plume stability. In addition, a comparison of observed versus expected conditions from the *Long-Term Monitoring System Design Report* (LTM Design Report) (Pantex, 2019a) was conducted as part of the evaluation process.

Overall, calculated concentration and groundwater level trends were consistent with expected conditions defined in the LTM Design Report. Figure E-6 depicts recent water level trends in the perched aquifer long-term monitoring (LTM) wells.

A total of 48 monitoring wells were expected to have decreasing water level trends, limited water, or dry conditions, as defined in the LTM Design Report. Of these 48 wells, 28 exhibited conditions inconsistent with expected conditions or trends, including 19 wells with recently increasing trends and 9 wells with recent “no trend” conditions. In addition, seven wells are exhibiting apparent long-term increasing trends. Most of these wells exhibited recently increasing trends in response to increased precipitation and resulting recharge through unlined ditches and playas along with decreased extraction of perched groundwater. The long-term water level trend is decreasing or not trending for 21 of these wells, and water levels are expected to continue declining.

Four of the remaining wells that have been historically dry or had limited water are now showing fluctuating water levels. The appearance of water in these wells is associated with recharge of stormwater runoff and does not represent the movement of impacted perched groundwater into these areas.

The remaining three wells are located near Playa 1 where reduced extraction of perched groundwater by P1PTS combined with the release of treated water to the playa and increased recharge through the playa from above-normal precipitation, have collectively resulted in short-term increasing trends in these wells.

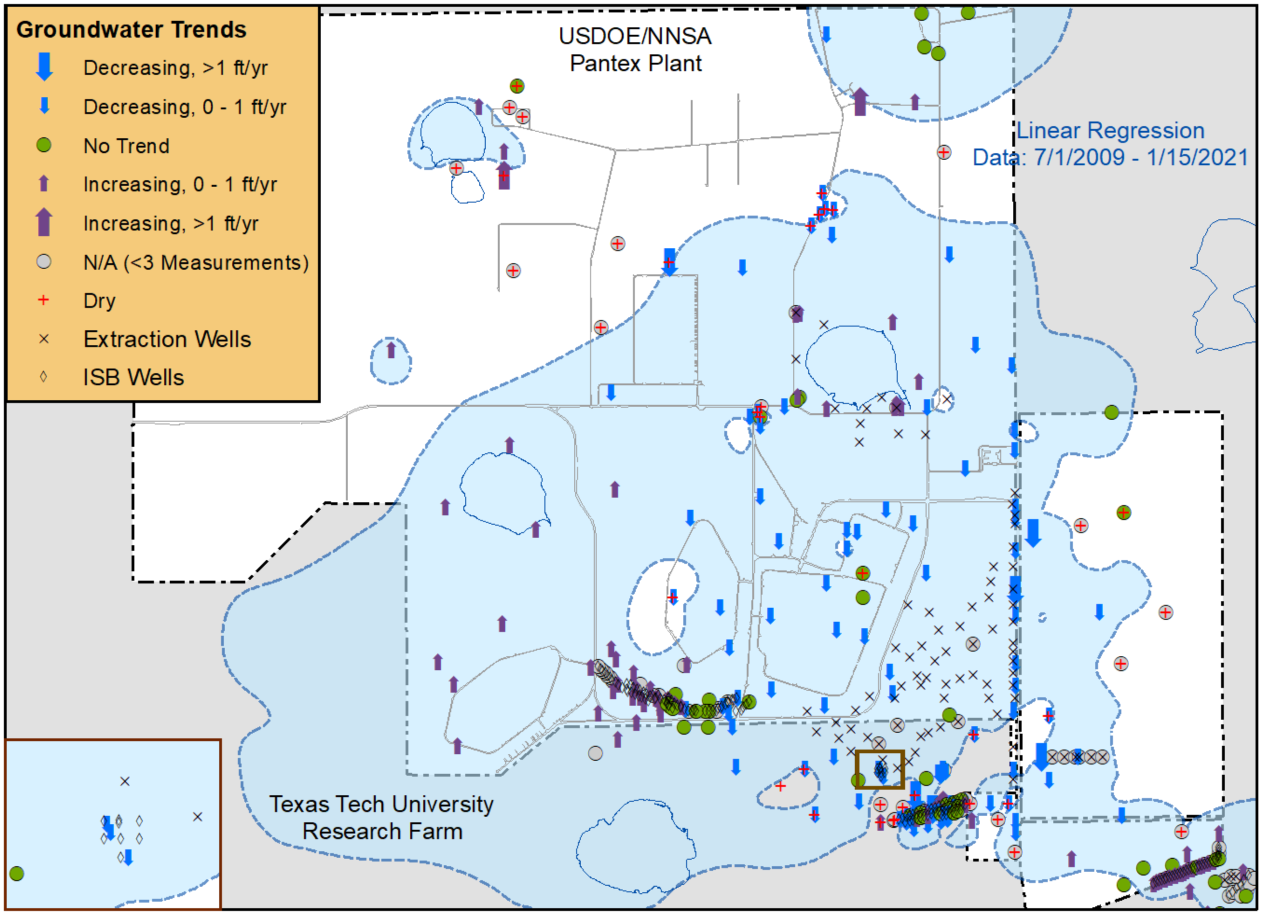


Figure E-6. Perched Aquifer Water Level Trends

Of the 116 monitoring wells with expected COC concentration conditions defined in the LTM Design Report, 34 wells did not exhibit trends consistent with expected conditions for the four major COCs (i.e., RDX, hexavalent chromium, TCE, and perchlorate). These trends are anticipated to meet expected conditions as corrective actions continue to operate in the perched aquifer. Figure E-7 depicts RDX trends since the start of the full remedial action in the perched aquifer LTM wells. Wells in the southeast lobe of the perched aquifer are not under the influence of remedial action.

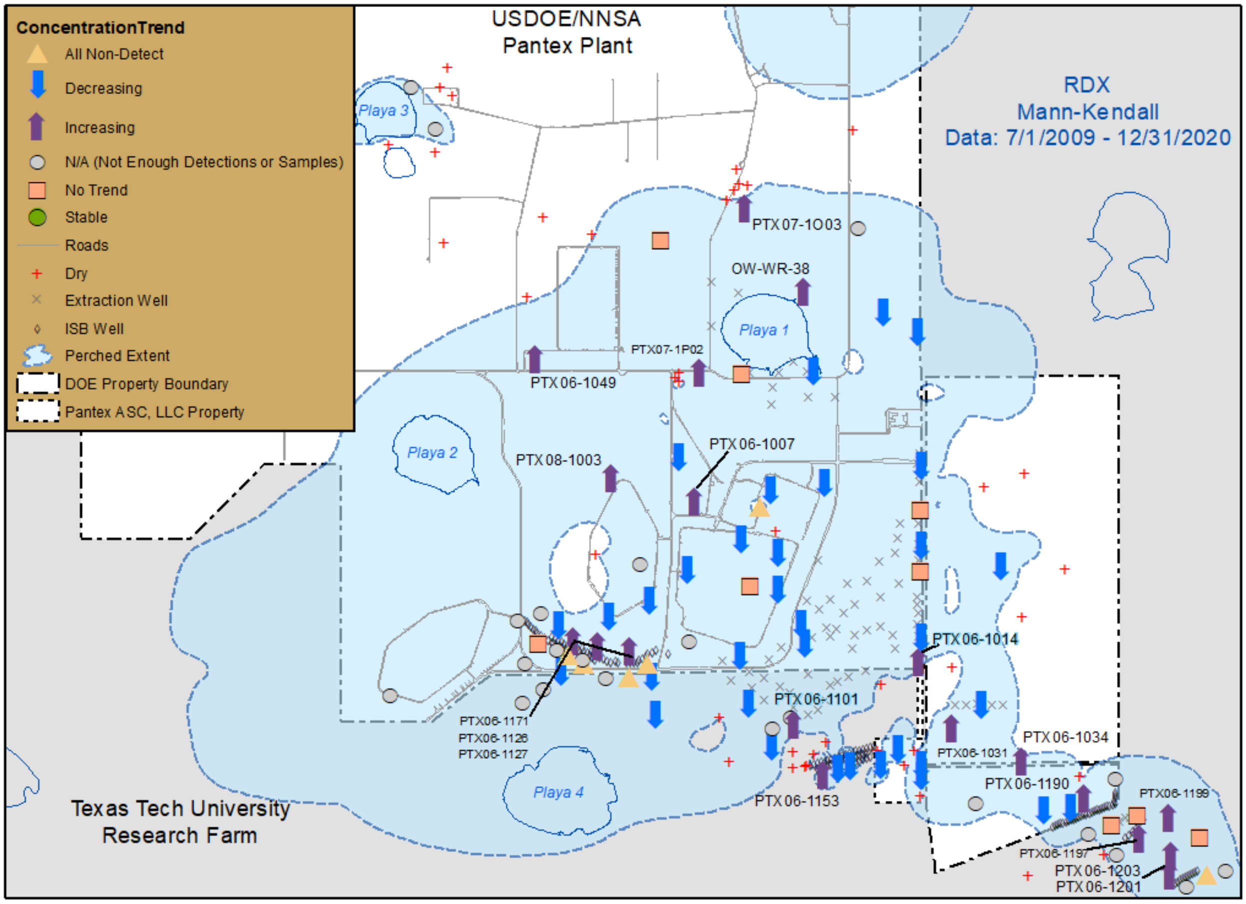


Figure E-7. RDX Trends in the Perched Aquifer

Generally, 2020's plume shapes are similar to 2009's COC plumes. The greatest differences between the shapes are due to changes in the extent of perched saturation in the perched groundwater's extreme southeast lobe and HE plumes in that area because of the new information collected from PTX06-1182 and other recently drilled wells. A shift in the hydraulic gradient eastward in the area between the southern parts of Zones 11 and 12 has allowed perchlorate to migrate east and southeast into the SEPTS well field; this portion of the perchlorate plume is being actively remediated by the SEPTS at this time. Other changes in plume size and shape were caused by general plume movement downgradient, slight changes in concentrations that define the boundaries of the plumes, newly installed wells, or effects of the pump and treat systems.

Major COC plumes of interest are depicted in Figure E-8.

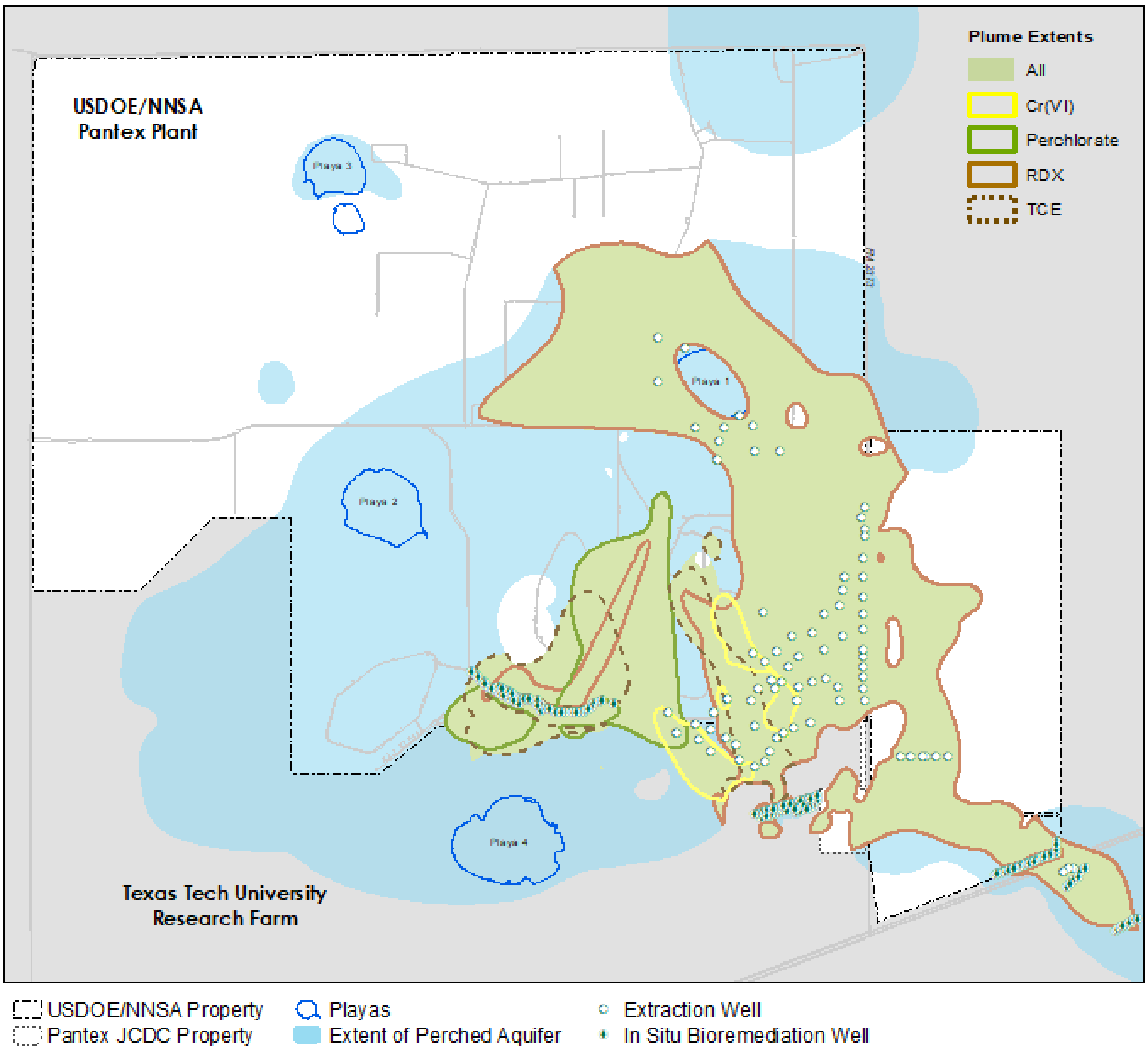


Figure E-8. Major COC Plumes in the Perched Aquifer

E.3.2 Remedial Action Effectiveness

One goal of the pump and treat systems is to affect plume movement; therefore, a plume stability evaluation can be used to determine the effectiveness of these systems.

The pump and treat systems have continued to be effective in 2020, although their operation was affected by a break at the irrigation system's filter bank. The SEPTS has altered the groundwater flow direction and gradient at localized areas near the extraction wells in the perched aquifer. The P1PTS appears to be influencing local water levels and hydraulic gradient in the area near Playa 1, although impacts from the irrigation system break have affected operations. When comparing the 2020 conditions to the LTM Design Report's expected conditions, the majority of expected conditions are being met. Most wells not yet meeting expected conditions are in locations that have not yet been affected by the systems.

The Southeast ISB system data collected in 2020 indicates that it is effectively meeting treatment objectives set in the *Remedial Design/Remedial Action Work Plan* (Pantex, 2009c). Based on geochemical conditions monitored at the treatment zone, the Southeast ISB system has established an adequate reducing zone for the contamination that is present. Three of the closest downgradient monitoring wells for the Southeast ISB (PTX06-1037, PTX06-1123, and PTX06-1154) demonstrate reductions in RDX, HE degradation products, and hexavalent chromium, resulting in concentrations below the groundwater protection standard (GWPS), with most not detected.

Although PTX06-1153 continues to exhibit RDX concentrations above the GWPS, this well demonstrated signs of partial treatment in 2020, with a sharp decline in RDX and the detection of RDX breakdown products at concentrations above the GWPS. Molasses was injected in the treatment zone in 2019 to better distribute amendment, in combination with low-rate extraction from PTX06-1153. This effort appears to have increased the level of treatment observed at PTX06-1153. As with other locations, water levels at this well continue to decline.

The Zone 11 ISB system's 2020 data indicate that the system has been effective in treating perchlorate and TCE at most downgradient areas. The system has a well-established treatment zone in the original portion of the system where injection has occurred since 2009. Deeper reducing conditions have been established at injection wells within the expansion area, which has now received four injections. Evaluation of data in the treatment zone wells indicates very mild to strong reducing conditions across the Zone 11 ISB. Deep reducing conditions have been more difficult to establish at treatment zone monitoring (TZM) wells located between the injection wells in the expansion area. The molasses injection has improved conditions between the injection wells across the western side of the Zone 11 ISB; however, some wells have limited ability to accept injection, and those areas will likely continue to demonstrate milder reducing conditions until the wells can be replaced.

Evaluation of data in the treatment zone wells indicates very mild to strong reducing conditions across the Zone 11 ISB. With the exception of PTX06-1175, all wells downgradient of the system have indicated arrival of treated water. Perchlorate was detected above the GWPS in two downgradient in-situ performance-monitoring (ISPM) wells in 2020 but was not detected or was detected below the GWPS in the other seven wells. TCE concentrations are below the GWPS in four of nine ISPM wells and two former injection wells. The only downgradient wells not demonstrating strong treatment are PTX06-1173 and PTX06-1175. Wells upgradient of PTX06-1173 were difficult to inject into during recent injection events, and PTX06-1175 is downgradient of a single row of injection wells.

The Southeast ISB Extension was first injected in 2019. Data collected at the injection wells indicate treatment is occurring. Downgradient wells are not expected to demonstrate treatment for at least two years following the first injection event.

The Offsite ISB was installed in 2020 and no injections have occurred. This system will be evaluated over time as data are collected following injection events.

E.3.3 Uncertainty Management and Early detection

The uncertainty management wells in the High Plains Aquifer (commonly and hereafter referred to as the Ogallala Aquifer) and perched aquifer have the following purposes:

- Confirm expected conditions identified in the Resource Conservation and Recovery Act's (RCRA) Facility Investigations and ensure there are no deviations.
- Fill in potential data gaps.
- Fulfill long-term monitoring requirements for soil units evaluated in a baseline risk assessment.

The purpose of early detection wells is to identify breakthrough of constituents to the Ogallala Aquifer from overlying perched groundwater, if present, or from potential source areas in the unsaturated zone before potential points of exposure are impacted. These wells were proposed in the LTM Design Report to evaluate the effectiveness of the soil and groundwater remedial actions.

Group 1 wells are located where contamination has not been detected or confirmed or in previous plume locations where concentrations have fallen below the GWPS, background, or practical quantitation limit (PQL). These wells were evaluated in the quarterly reports, and, in 2020, no Group 1 perched aquifer wells had unexpected conditions.

In 2020, detection of organic constituents or perchlorate above background occurred in four Ogallala wells, and boron was detected slightly above background in eight Ogallala wells. Because the boron concentrations are very close to background and observed boron concentrations tend to vary considerably, these concentrations appear to also represent background. Perchlorate was detected above background but below the GWPS in one well, and organics were detected in three wells with all detections less than the GWPS. The detections are summarized below.

Perchlorate was detected slightly above the background value of 0.96 micrograms per liter (ug/L) at a measured value of 1.03 ug/L in one well, PTX01-1012. This detection was below the GWPS of 26 ug/L and likely represents background variability.

One Ogallala Aquifer well, PTX06-1056, had continued detections of 4-amino-2,6-dinitrotoluene (DNT4A) and 1,2-dichloroethane above the laboratory PQL, but below the GWPS in 2020, indicating possible migration of perched groundwater to the Ogallala Aquifer. In response to these detections, Pantex has fully implemented conditions specified in the *Pantex Plant Ogallala Aquifer and Perched Groundwater Contingency Plan* (Pantex, 2009d) and has proactively evaluated potential sources for the contamination. An external independent review indicated that a nearby perched well, PTX06-1108, that was drilled deeply into the fine-grained zone (FGZ) was the most likely source of the contamination, based on fate and transport modeling. This well was plugged to address that potential source. A cement bond log was used to evaluate the competency of the concrete seal at the FGZ and indicated that the seal is competent. Therefore, PTX06-1056 is not likely acting as a preferential pathway for contamination to reach the Ogallala Aquifer.

DNT4A was detected at 0.09 ug/L below the PQL of 0.26 ug/L at PTX06-1076 in the second quarter of 2020; the detection was confirmed with a verification sample collected in August and a subsequent sample collected in October. Additionally, RDX was detected at 0.21 ug/L below the PQL of 0.256 ug/L at PTX07-1R01. Reanalysis of the sample indicated a similar low-level detection. Because these Ogallala detections were below the PQLs, sampling will continue as approved in the *Sampling and Analysis Plan* (SAP) (Pantex, 2019b) and in accordance with the *Pantex Plant Ogallala Aquifer and Perched Groundwater Contingency Plan* (Pantex, 2019c). Further actions will be determined based on the results of future sampling and the contingency plan.

Group 2 wells are perched wells near source areas and generally have contamination above the GWPS. The purpose of the Group 2 wells' annual evaluation is to determine if source strength is declining. The ditches and playas are expected to continue sourcing contaminants to the perched aquifer for 20 years or more but at much lower concentrations than in the past (Pantex 2006).

Ten of the Group 2 wells that have detections of COCs already meet expected conditions. Twelve wells are showing increasing trends since remedial actions began in 2009 when long-term decreasing trends are expected. Several of these wells are experiencing more recent decreasing trends. Some of those wells' decreasing trends could be due to changing gradients and/or plume movement away from the source. Pantex will continue to evaluate these trends over time. For many of these wells, concentrations are anticipated to stabilize, with an eventual long-term decreasing trend below the GWPS.

Several other Group 2 wells had metals detections above their site-specific backgrounds but below the GWPS. These detections are likely due to either well-screen corrosion or variation in background.

Other Unexpected Conditions

Pantex routinely evaluates laboratory data to determine if data are off-trend, are at an all-time high, or represent a new detection that may require further sampling or evaluation. Through the well-maintenance program, Pantex also inspects wells at least every five years to ensure they are not silting in and to evaluate whether the well remains in contact with the formation. No additional unexpected conditions were noted in 2020.

Natural Attenuation

Natural attenuation is the result of processes that naturally lower concentrations of contaminants over time. Data are collected at Pantex to help determine where and under what conditions natural attenuation is occurring and to estimate a rate of attenuation. This is an important process for RDX, the primary risk driver in perched groundwater, because it is widespread and extends beyond the reach of the groundwater remediation systems in some areas. Pantex has historically monitored for RDX, 2,4,6-trinitrotoluene (TNT), and TCE degradation products in key areas.

Although Pantex has monitored for breakdown products of TCE for many years, a strong indication of natural attenuation has not been observed in perched groundwater. Based on monitoring results for TNT and its breakdown products, TNT has naturally attenuated over time, with data indicating that the breakdown products are more widespread than TNT.

Perched groundwater sampling results for RDX and its breakdown products, hexahydro-1-nitroso-3,5-dinitro-1,3,5-triazine (MNX), hexahydro-1,3-dinitroso-5-nitro-1,3,5-triazine (DNX) and, hexahydro-1,3,5-trinitroso-1,3,5-triazine (TNX), indicate that the breakdown products are present throughout most of the RDX plume, with TNX being the most widespread. If complete biodegradation of RDX is occurring, RDX and all breakdown products would be expected to decrease over time.

A Strategic Environmental Research and Development Program (SERDP) study (2014) provided evidence that aerobic degradation is occurring in the Pantex RDX plume but was unable to quantify the rates of attenuation. This study provided new methods for evaluating RDX degradation including carbon and nitrogen fractionation (CSIA) approaches. These approaches, along with the ability to quantify 4-nitro-2,4-diazabutanal (NDAB), an aerobic degradation product, allows Pantex to better evaluate the degradation of RDX.

Pantex subsequently contracted with the SERDP study's leading researcher, Dr. Mark Fuller with APTIM Corporation, for a project to evaluate lines of evidence for natural attenuation of RDX at the Plant. The study included both aerobic and anaerobic degradation, with evidence of both occurring. The predominant attenuation process is aerobic biodegradation by bacterial strains. Biodegradation rates of 0.016 to 0.168 per year were calculated, translating to RDX half-lives of approximately 5 to 50 years.

The project found that the rates of RDX biodegradation are likely limited by the available labile organic carbon in the groundwater. The study found several lines of evidence for natural attenuation of RDX as well as the potential to enhance aerobic biodegradation of RDX by introducing low levels of labile organic carbon. Recommendations were presented for additional treatability studies, bioaugmentation, and additional proteomics analyses of degrading bacterial strains.

E.4 Soil Remedial Action Effectiveness

The small-scale SVE system at the Burning Ground is the only active soil remediation system at Pantex. The current CatOx/wet scrubber system continues to focus on treating residual NAPL and soil gas at well SVE-S-20. The system continues to be effective at removing residual soil NAPL.

Data collected at the system in 2020 indicated that the NAPL source may be depleting. Pantex plans to continue operating the system while evaluating removal rates and influent concentrations to determine when the system can no longer effectively remove VOCs using active remediation. Pantex also implemented a pulsing plan in late 2020 to enhance the removal and assessment of source depletion.

E.5 Recommendations and Conclusions

Pantex plans to continue currently approved remedial actions. The groundwater remedies are considered protective for the short term since untreated perched groundwater use is controlled to prevent human contact, and Ogallala Aquifer data continues to indicate COC concentrations either non-detect or below the GWPS. The systems are also proving to be effective in reaching long-term objectives for cleanup.

Soil remedies have also been effective at Pantex: Workers and the public are protected from exposure to contaminated soils, and data do not indicate that new contamination is migrating to the underlying groundwater from soil source areas. The SVE system is actively removing soil gas and residual NAPL in soils at the Burning Ground, thereby mitigating the vertical movement of VOCs to the Ogallala Aquifer.

Based on issues identified in the FYR and this report, several changes are recommended or have already been implemented to enhance the effectiveness of the remedies in some areas and to better monitor the actions' overall effectiveness. Those recommendations are provided in the following sections.

E.5.1 Recommended Changes to the Selected Remedies

Pantex plans to release an explanation of significant difference (ESD) describing changes to the southeast and Zone 11 remedies. The scheduled date for completion of this action, as provided in the second FYR, is September 2022.

E.5.2 Recommended changes to the Pump and Treat Systems

Pantex has implemented a previously recommended change to the operation of the SEPTS and P1PTS. The P1PTS is now only operated once each quarter to allow the SEPTS to fully operate and continue to more effectively capture perched groundwater and contaminant plumes moving to the southeast. Pantex expects to fully operate both systems once all repairs to the onsite irrigation system are complete or the new pivot irrigation system is complete. Impacts to the operation are expected until later in 2021 unless major repairs or upgrades are required to the communication system for the onsite subsurface irrigation system.

Pantex will complete the construction and tie-in of the new injection wells near Playa 2 in June 2021. Once SEPTS can utilize the injection wells, operations at P1PTS may be able to resume at a minimal level, while continuing to operate SEPTS. The key objective to control plumes and water movement to the southeast will require that SEPTS be operated in accordance with Pantex goals. P1PTS operation will be adjusted or shutdown to achieve that objective.

Pantex is currently evaluating methods to optimize the pump and treat systems to better capture plumes and remove water for the protection of the underlying Ogallala Aquifer. Optimizing the systems to control the perchlorate plume was identified as an issue in the second FYR and is scheduled to be complete by September 2022.

E.5.3 Recommended Changes to the ISB Systems

Pantex continues to evaluate the ISBs and make changes, as appropriate, to address incomplete treatment in certain areas.

E.5.3.1 Southeast ISB

Pantex has injected a more soluble carbon (i.e., molasses) to improve the distribution of amendment at the ISB, implemented pumping of PTX06-1153 during injection to induce flow to the well, and injected in dry upgradient wells. These changes will require evaluation over time to determine their full impact. Water levels will continue to be monitored since only one more injection is anticipated to be needed at this system.

E.5.3.2 Southeast ISB Extension

Pantex completed injections into this new ISB in 2020. Because data collected at the eastern fence line indicate that extra wells are needed to completely encompass the plume, two new injection wells are being installed in 2021 to address the treatment gap.

E.5.3.3 Zone 11 ISB

Pantex had previously recommended installing a recirculation system across the western side of the ISB where TCE plumes are present at high concentrations. Due to the SEPTS's continued removal of water, flow gradients in Zone 11 have changed, and the TCE plume in over half of the Zone 11 ISB is now moving to the southeast.

To address the higher TCE concentrations moving into the south-central portion of the system, Pantex has opted to install a second row of tightly spaced injection wells to ensure the complete treatment of TCE. Installation of the new injection wells will be complete by the end of 2021.

E.5.3.4 Offsite ISB

Due to available funding, the first two phases of the Offsite ISB were installed in 2020, which accelerated work planned for 2021. Injections will begin in 2021. Two more phases of installation are planned at this system in 2022 and 2023, subject to finalization of landowner agreements and funding availability.

E.5.4 Recommended Changes to the Monitoring Network

No changes are recommended at this time.

E.5.5 Recommended Changes to Soil Remedies

No changes to the landfill remedies are recommended.

Pantex is continuing to evaluate SVE data after modifying the system in May 2017. Further recommendations for a path to closure will be made once data obtained during system pulsing are evaluated.

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List of Acronyms

amsl	above mean sea level
ASC	Administrative Site Complex
AOC	Area of Concern
bgs	below ground surface
btoc	below top of casing
CatOx	Catalytic Oxidation
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
cis-1,2-DCE	cis-1,2-dichloroethene
CFR	Code of Federal Regulations
CMI	Corrective Measures Implementation
COC	contaminant of concern
CP-50284	Compliance Plan 50284
CR(VI)	hexavalent chromium
CSIA	compound specific isotope analysis
DCE	Dichloroethene
DHC	*Dehalococcoides sp.*
DNT	Dinitrotoluene
DNT4A	4-amino-2,6-dinitrotoluene
DNX	hexahydro-1,3-dinitroso-5-nitro-1,3,5-triazine
DO	dissolved oxygen
EPA	Environmental Protection Agency
ESD	explanation of significant differences
EVO	emulsified vegetable oil
FM	Farm-to-Market Road
FS	Firing Site
ft	feet
ft/ft	feet per foot
FGZ	fine-grained zone
FY	fiscal year
FYR	five-year review
GAC	granular activated carbon
gpm	gallons per minute
gpd	gallons per day
GPS	Global Positioning System
GWPS	groundwater protection standard
HE	high explosive

HMX	octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine
HW-50284	Hazardous Waste Permit No. 50284
in	Inches
IAG	Interagency Agreement
ICMs	Interim corrective measures
IRAR	Interim Remedial Action Report
IRPIM	Installation Restoration Program Information Management System
ISB	in-situ bioremediation
ISM	interim stabilization measure
ISPM	in-situ performance monitoring
lb	pounds
LTM	long-term monitoring
LTM Design Report	Long-Term Monitoring System Design Report
Mgal	million gallons
MAROS	Monitoring and Remediation Optimization System
MCL	Maximum Contaminant Limit
MNX	hexahydro-1-nitroso-3,5-dinitro-1,3,5-triazine
mV	millivolts
NAPL	non-aqueous phase liquid
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NDAB	4-nitro-2,4-diazabutanal
O&M	operation and maintenance
ORP	oxidation reduction potential
OSTP	Old Sewage Treatment Plant
PRB	permeable reactive barrier
P&A	plugging and abandonment
P1PTS	Playa 1 Pump and Treat System
PCA	1,1,2,2 – tetrachloroethane
PCE	Perchloroethene
PID	photoionization detector
PMZ	Plume Management Zone
POC	point of compliance
POE	point of exposure
ppm	parts per million
ppmv	parts per million by volume
PQL	practical quantitation limit
PVC	polyvinyl chloride
qPCR	quantitative polymerase chain reaction

RAP	Response Action Plan
RCRA	Resource Conservation and Recovery Act
RDX	hexahydro-1,3,5-trinitro-1,3,5-triazine
ROD	Record of Decision
SAP	Sampling and Analysis Plan
SCADA	supervisory control and data acquisition
scfm	standard cubic feet per minute
SEP/CBP	Solvent Evaporation Pit/Chemical Burn Pit
SEPTS	Southeast Pump and Treat System
SERDP	Strategic Environmental Research and Development Program
SMP	site management plan
SVE	soil vapor extraction
SWMU	Solid Waste Management Unit
TCE	Trichloroethene
TCEQ	Texas Commission on Environmental Quality
THF	tetrahydrofuran
TLAP	Texas Land Application Permit
TNB	Trinitrobenzene
TNX	hexahydro-1,3,5-trinitroso-1,3,5-triazine
TNT	trinitrotoluene
TOC	total organic carbon
TWDB	Texas Water Development Board
TTU	Texas Tech University
TZM	treatment zone monitoring
ug/L	micrograms per liter
USDOE/NNSA	United States Department of Energy/National Nuclear Security Administration
VFA	volatile fatty acid
VOC	volatile organic compound
WMG	waste management group
WWTF	Wastewater Treatment Facility

1.0 INTRODUCTION

The Pantex Plant (Plant), located in the Texas Panhandle approximately 17 miles northeast of Amarillo (see Figure 1-1), 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. Pantex continues with an active mission to support the nuclear weapons stockpile for the United States Department of Energy/National Nuclear Security Administration (USDOE/NNSA).

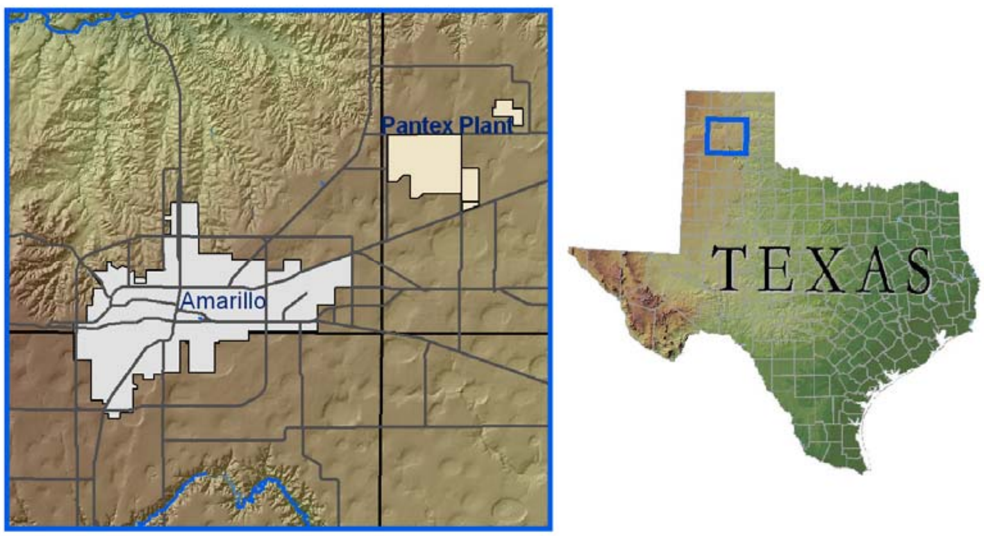

Figure 1-1. Location of Pantex Plant

The main Plant site encompasses approximately 9,100 acres. Approximately 2,000 acres of the USDOE/NNSA-owned property are used for industrial operations at Pantex, excluding the Burning Ground, Firing Sites, and other outlying areas. The Burning Ground and Firing Sites occupy approximately 489 acres. The remaining USDOE/NNSA-owned land serves safety and security purposes. In 2008, approximately 1,526 acres east of FM 2373 was purchased to provide better access and control of perched groundwater areas included in the Remedial Action. USDOE/NNSA also owns a detached piece of property called Pantex Lake, approximately 2.5 miles northeast of the main Plant. This property, encompassing 1,077 acres, includes the playa lake itself. No industrial operations are conducted at the Pantex Lake property.

Historical waste management practices at Pantex resulted in the release of contaminants through various waste streams. Treated and untreated industrial wastewater released to the ditches and playas resulted in the contamination of perched groundwater beneath Playa 1, portions of Zone 11, Zone 12, TTU property to the south, and property east of FM 2373. The extent of perched groundwater and major contaminant plumes are depicted in Figure 1-2.

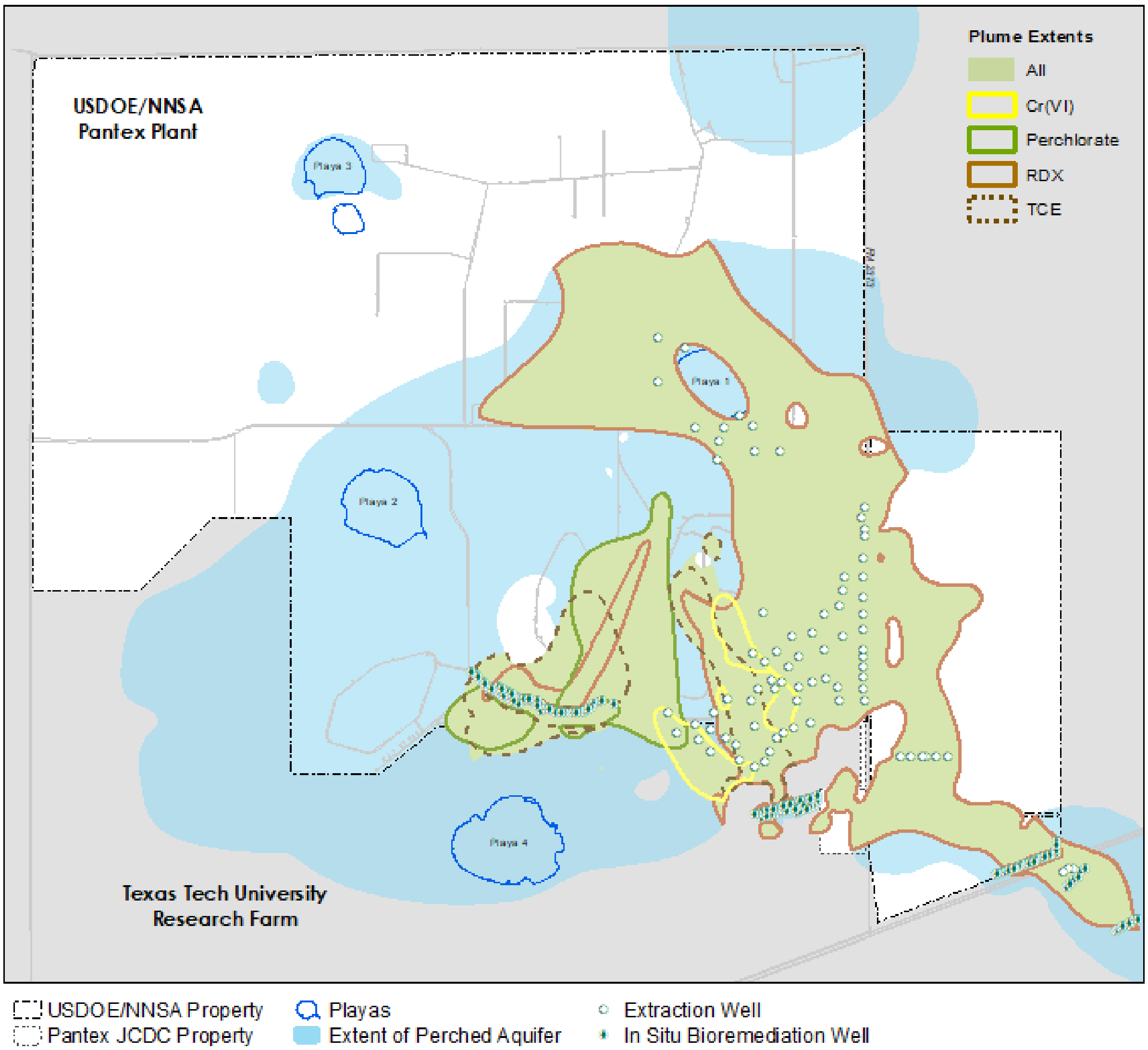

Figure 1-2. Extent of Perched Groundwater and Contaminant Plumes Exceeding GWPS

Impacted perched groundwater is not used for residential purposes; however, the perched aquifer overlies the Ogallala Aquifer, a drinking water source for the Texas Panhandle and Pantex. This aquifer system, which is dominated by the Ogallala Formation, includes the Dockum Formation in the vicinity of Pantex.

Historical waste management practices also resulted in the contamination of soil sites at Pantex. Landfills and specific soil sites require institutional controls to ensure continued use of the land for industrial purposes. In addition, some areas require soil covers and ditch liners to be maintained to prevent the infiltration of water and downward migration of contaminants to groundwater. Fencing and signs are also maintained to control worker use and traffic within the soil units.

Pantex has implemented remedial actions to mitigate perched groundwater contamination and prevent contamination of the deeper drinking water aquifer.

1.1 Regulatory Background

Pantex implemented its remedial actions in accordance with the *Compliance Plan for Industrial Solid Waste Management Sites* (Compliance Plan), originally issued on October 21, 2003, and subsequently updated with final remedial actions on September 16, 2010, under the provisions of the Texas Health and Safety Code, Chapter 361 and Chapter 26 of the Texas Water Code. The Compliance Plan is a Texas Commission on Environmental Quality (TCEQ) permit that stipulates the requirements for conduct of corrective actions and groundwater monitoring programs according to the Resource Conservation and Recovery Act (RCRA). The Plant's hazardous waste permit was renewed in 2014, and the Compliance Plan requirements were incorporated into the permit.

Pantex was listed on the National Priorities List in 1994, requiring investigation and clean up according to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), in addition to RCRA. Pantex meets the requirements of CERCLA through the Pantex Interagency Agreement (IAG), effective February 22, 2008. Table 1-1 lists the Compliance Plan (shown as CP), hazardous waste permit (shown as HW), and IAG with the date of issuance, modifications, and descriptions of each issue or modification.

Table 1-1. Regulatory Compliance Documents

Document	Date of Issue	Description
CP-50284	10/21/2003	Interim Stabilization Measure Compliance Plan issued to describe interim measures to stabilize groundwater plumes and monitor that action.
Interagency Agreement for the Pantex Superfund Site	2/22/2008	Established an agreement between the EPA, TCEQ, and USDOE for final remedial actions, the framework for responding to and implementing CERCLA requirements, and the framework for participation and exchange of information between parties.
CP-50284	9/16/2010	Modification issued to remove interim stabilization requirements and incorporate final corrective/remedial actions for Pantex and required monitoring and reporting of those actions.
HW-50284	5/30/2014	Hazardous waste permit renewal with inclusion of the Compliance Plan. Changes include corrective action observation well changes and minor edits. Compliance Plan requirements are included as Provision XI of HW-50284.

A Compliance Plan (CP-50284) was issued in 2003 that stipulated the requirements for conducting corrective actions and groundwater monitoring associated with defined interim stabilization measures (ISMs) and provided the operating requirements for ISMs that were in place for Pantex. The final corrective action/remedy has been approved through the *Pantex Site-Wide Record of Decision* (ROD) (Pantex and Sapere Consulting, 2008), and the final remedy was incorporated into CP-50284, effective September 16, 2010. The *Long-Term Monitoring System Design Report* (LTM Design Report) (Pantex, 2009a) and the *Sampling and Analysis Plan* (SAP) (Pantex, 2009b) were approved through the Compliance Plan as the basis for monitoring and reporting of the remedies. The 2009 documents were updated in January 2014 and again in 2019 (Pantex, 2019a and 2019b). The 2019 update was approved for use starting January 2020. The hazardous waste permit, HW-50284, was renewed in May 2014 and included the Compliance Plan requirements from the September 2010 CP-50284 with minor changes.

HW-50284 Provision XI (i.e., Compliance Plan) requires reporting of information pertaining to the effectiveness of the remedies, treatment of perched groundwater, contaminant data and plumes, and monitoring. Information on operation and maintenance (O&M) of the corrective action systems and components, new construction, the condition and status of the corrective actions/remedies, and recommendations for change is also required.

The IAG is a legally binding agreement among the USDOE, Environmental Protection Agency (EPA), and TCEQ to accomplish the cleanup of hazardous substances contamination at and from the Pantex Plant, pursuant to CERCLA, the National Oil and Hazardous Substances Pollution Contingency Plan (NCP), and Executive Order 12580, as amended by Executive Order 13016. The IAG has the following purposes:

1. Ensure that the environmental impacts associated with past and present activities at the Pantex Plant have been analyzed, tested, and thoroughly evaluated, and appropriate remedial action is taken as necessary to protect the public health, welfare, and the environment.
2. Establish a procedural framework and schedule for developing, implementing, and monitoring appropriate response actions in accordance with CERCLA, the NCP, Superfund policy, RCRA, RCRA policy, and applicable, relevant, and appropriate environmental laws.
3. Facilitate continued cooperation, exchange of information, and participation of USDOE, EPA, and TCEQ in such actions.

The IAG provides requirements for developing schedules, remedial design and remedial action implementation and reporting, record preservation, public participation, budget review, notification requirements, and periodic progress reports. Progress reports are required semi-annually and are combined with the Compliance Plan reports to fulfill the requirements of both RCRA and CERCLA.

Table 1-2 provides a detailed crosswalk of the Compliance Plan and IAG requirements to specific sections of the annual or quarterly report in which the requirements are fulfilled. The requirements are from CP Table VII and VIII of HW-50284. The specific Articles in the IAG that contain reporting requirements are also listed in the table. Although not included in the crosswalk, other requirements in the ROD and final documents supporting the design of the Remedial Actions were also considered when developing this report.

Table 1-2. Crosswalk of Regulatory Requirements to Quarterly and Annual Progress Reports

Item	Program	Reporting Frequency	Requirements	Location of Information in Progress Reports
Hazardous Waste Permit 50284 Requirements from CP Table VII:				
1.	All programs	Annual June 30	Each report shall be certified by a qualified engineer and/or geologist.	See certification page inside front cover of the quarterly and annual progress reports.
2.	Corrective Action	Annual June 30	A table of all modifications and amendments made to this Compliance Plan with their corresponding approval dates by the executive director or the Commission and a brief description of each action.;	Section 1.1, Table 1-1.
3.	Corrective Action	Annual June 30	A summary of any activity within an area subject to institutional control.	Section 2.3.2.
4.	Corrective Action	Annual June 30	Tabulation of well casing elevations in accordance with Attachment B;	Section 2.4.2.
5.	Corrective Action	Annual June 30	Certification and well installation diagram for any new well installation or replacement and certification for any well plugging and abandonment;	When applicable, certifications and diagrams are included as an appendix. See "List of Appendices."
6.	Corrective Action	Annual June 30	Recommendation for any changes to the program;	Chapter 5.0 of the annual report. "Recommendations and Conclusions" section of quarterly reports.
7.	Corrective Action	Annual June 30	Any other items requested by the executive director;	Crosswalk of requirements to information contained in report. Section 1.1. Information will be added as requested.

Item	Program	Reporting Frequency	Requirements	Location of Information in Progress Reports
8.	Corrective Action	Annual June 30	Water table maps shall be prepared from the groundwater data collected pursuant to Provision VII and shall be evaluated by the Permittee with regard to the following parameters: 8.1. Development and maintenance of a cone of depression during operation of the system; 8.2. Direction and gradient of groundwater flow; 8.3. Effectiveness of hydrodynamic control of the contaminated zone during operation; and, 8.4. Estimation of the rate and direction of groundwater contamination migration.	Sections 3.1.5, 3.1.7, and 3.2.
9.	Corrective Action	Annual June 30	The Permittee shall submit a report to each recipient listed in Provision X.C, which includes the information in items 3 through 26 determined since the previously submitted report, if those items are applicable. If both Corrective Action and Compliance Monitoring [Reserved] Programs are authorized, then the June 30th report shall contain information required for both programs.	Reports submitted as required. See items 3 through 26 of this table for location of report information.
10.	Corrective Action	Annual June 30	The Corrective Action System(s) authorized under Provision II in operation during the reporting period and a narrative summary of the evaluations made in accordance with Provisions XI.E, XI.F, and XI.G of this Compliance Plan for the preceding reporting period. The reporting periods shall be annual, January 1 through December 31, for Corrective Action Monitoring, unless an alternative schedule is approved by the Commission. The period for Compliance Monitoring [Reserved] shall be based on the calendar year;	Chapter 2.0 Chapter 3.0 Chapter 4.0 Appendices containing extraction well flow information, data tables, data evaluation tables, expected condition evaluation, COC trending, and hydrographs.

Item	Program	Reporting Frequency	Requirements	Location of Information in Progress Reports
11.	Corrective Action	Annual June 30	The method(s) utilized for management of recovered/purged groundwater shall be identified in accordance with Provision XIB.8. The Permittee shall maintain this list as part of the facility operating record and make it available for inspection upon request.	Section 2.5 and Appendix C
12.	Corrective Action	Annual June 30	An updated table and map of all monitoring and corrective action system wells. The wells to be sampled shall be those wells proposed in the Compliance Plan Application referenced in Provision XI.A.7. and any changes subsequently approved by the executive director pursuant to Provision XI.B.3. Provide in chronological order, a list of those wells which have been added to, or deleted from, the groundwater monitoring and remediation systems since original issuance of the Compliance Plan. Include the date of the Commission's approval for each entry;	Section 1.6.
13.	Corrective Action	Annual June 30	The results of the chemical analyses, submitted in a tabulated format acceptable to the executive director which clearly indicates each parameter that exceeds the GWPS. Copies of the original laboratory report for chemical analyses showing detection limits and quality control and quality assurance data shall be provided if requested by the executive director;	See "List of Appendices" for data evaluation tables and electronic data. A summary of the POC/POE well detections above GWPS is included in Section 3.5.
14.	Corrective Action	Annual June 30	Tabulation of all water level elevations required in Provision XI.F.3.d.1 depth to water measurements, and total depth of well measurements collected since the data that was submitted in the previous monitoring report;	Section 2.4 and Appendix C. Appendix containing electronic data tables.

Item	Program	Reporting Frequency	Requirements	Location of Information in Progress Reports
15.	Corrective Action	Annual June 30	Potentiometric surface maps showing the elevation of the water table at the time of sampling, delineation of the radius of influence of the Corrective Action System, and the direction of groundwater flow gradients outside any radius of influence;	Section 3.1.
16.	Corrective Action	Annual June 30	Tabulation of all data evaluation results pursuant to Provision XI.F.4 and status of each well with regard to compliance with the Corrective Action objectives and compliance with the GWPS;	These evaluations are summarized in Section 3.4 and 3.5. See "List of Appendices" for complete electronic data tables and expected conditions evaluation.
17.	Corrective Action	Annual June 30	An updated summary as required by CP Table VIII;	Chapters 1.0 through 4.0.
18.	Corrective Action	Annual June 30	Summary of any changes made to the monitoring/ corrective action program and a summary of well inspections, repairs, and any operational difficulties;	Chapters 2.0 and 5.0 and Appendix C.
19.	Corrective Action	Annual June 30	A notation of the presence or absence of NAPLs, both light and dense phases, in each well during each sampling event since the last event covered in the previous monitoring report and tabulation of depth and thickness of NAPLs, if detected;	Section 3.4.
20.	Corrective Action only	Annual June 30 Quarterly 90 days after end of quarter	Quarterly tabulations of quantities of recovered groundwater and NAPLs, and graphs of monthly recorded flow rates versus time for the Recovery Wells during each reporting period. A narrative summary describing and evaluating the NAPL recovery program shall also be submitted;	Annual Report: a. See Section 2.1 and "List of Appendices" for detailed extraction well flow information. b. See Section 2.3.1 for soil vapor extraction of residual NAPLs in soils at the Burning Ground. Quarterly Report: a. "Pump and Treat Systems" section and Appendix B.

Item	Program	Reporting Frequency	Requirements	Location of Information in Progress Reports
21.	Corrective Action only	Annual June 30 Quarterly 90 days after end of quarter	Tabulation of the total contaminant mass recovered from each recovery system for each reporting period.	Annual Report: a. Section 2.1. Quarterly Report: a. "Pump and Treat Systems" and "SVE System" sections.
22.	Corrective Action only	Annual June 30	Maps of the contaminated area where GWPSs are exceeded depicting concentrations of CP Table IIIA constituents and any newly detected CP Table III constituents as isopleth contours or discrete concentrations if isopleth contours cannot be inferred. Areas where concentrations of constituents exceed the GWPS should be clearly delineated. Depict the boundary of the plume management zone (PMZ), if applicable;	Section 3.1.6.
23.	Corrective Action only	Annual June 30	Maps and tables indicating the extent and thickness of the NAPLs both light and dense phases, if detected;	No detected NAPLs in groundwater.

Item	Program	Reporting Frequency	Requirements	Location of Information in Progress Reports
24.	Corrective Action only	Quarterly 90 days after end of quarter	Corrective Measures Implementation (CMI) Progress Report or Response Action Effectiveness Report or Response Action Completion Report to be submitted as a section of the Compliance Plan report in accordance with Provision XI.H.6, if necessary. The Permittee will include a narrative summary of the status of the approved final corrective measures conducted in accordance with the approved CMI Workplan or Response Action Plan (RAP), and that the requirements of Provision XI.H.7 are being met. The report shall include the following information: a. Information required for Item 20 of this table. b. Information required for Item 21 of this table. c. Trend charts of target COCs and degradation products at downgradient performance monitoring locations for the in-situ bioremediation systems. d. Summary of unexpected conditions, if found, at monitoring wells.	Annual Report: a. See Section 2.1 and "List of Appendices" for detailed extraction well flow information. See Section 2.3.1 for soil vapor extraction of residual NAPLs in soils at the Burning Ground. b. Section 2.1. c. See "List of Appendices" for COC concentration trends. Information is summarized in Section 3.2.3 of this report. d. Section 3.4. Quarterly Report: a. "Pump and Treat Systems" Section and Appendix B. b. "Pump and Treat Systems" and "SVE System" sections. c. See Appendix C. d. "Uncertainty Management and Early Detection" section.
25.	Corrective Action only	Annual June 30	The Permittee will include a narrative summary of the status of each Solid Waste Management Unit (SWMU) and/or Area of Concern (AOC) subject to the requirements of Provision XI.H and ICMs Program for a SWMU and/or AOC which documents that the objectives of Provision XI.H.8.b are being achieved. This summary shall be included as a section of the Compliance Plan annual report.	No units at Pantex are subject to the ICM requirements in Provision VIII.

Item	Program	Reporting Frequency	Requirements	Location of Information in Progress Reports
26.	Corrective Action only	5-Year Review	Conduct five-year review to be consistent with CERCLA §121(c) and the NCP (40 CFR Part 300.430(f)(4)(ii)). The five-year review will be conducted to evaluate the need to adjust corrective actions and associated monitoring.	The second five-year review was started in 2017. The final approved report was completed in September 2018.
Hazardous Waste Permit 50284 CP Table VIII				
A	Corrective Action	Annually	Submit to the Executive Director a schedule summarizing all activities required by the Compliance Plan in the annual progress report. The schedule shall list the starting dates of all routine activities. The permittee shall include an updated schedule in the annual groundwater monitoring report required by Provision XI.G.3. The schedule shall list the activity or report, the Compliance Plan Section which requires the activity or report and the calendar date the activity or report is to be completed or submitted (if this date can be determined).	Section 1.7 of the annual report contains a schedule of activities completed since the last annual report, work in progress, and upcoming activities that are scheduled for the next year. The quarterly report provides a listing of activities completed, in progress, or upcoming in the "Schedule Update" section.
IAG Progress Report Requirements:				
16.4.	Remedial Action	Quarterly Annual	All results of sampling or other monitoring results obtained during the previous quarter.	The "Uncertainty Management and Early Detection" section of the quarterly report summarizes the quarterly data. Annual Report: a. These data are summarized in Section 3.4 and 3.5. b. See "List of Appendices" for complete electronic data tables and expected conditions evaluation.
16.4	Remedial Action	Annual and Quarterly	Describe the actions which DOE has taken during the previous quarter to implement the requirements of this Agreement.	Section 1.5 provides a schedule of activities.

Item	Program	Reporting Frequency	Requirements	Location of Information in Progress Reports
16.4	Remedial Action	Annual	Include a detailed statement of how the requirements and time schedules set out in the attachments to this Agreement are being met, identify any anticipated delays in meeting time schedules, including the reason(s) for each delay and actions taken to prevent or mitigate the delay, and identify any potential problems that may result in a departure from the requirements and time schedules.	Section 1.7.

1.2 Remedial Action Background

Pantex has implemented soil and groundwater remedial actions to mitigate contamination that resulted from historical waste management practices. The remedial actions are described in detail in the ROD, which can be found here: http://pantex.energy.gov/mission/environment/environmental-cleanup-documents. Soil and groundwater remedial actions are detailed in the following sections.

1.3 Soil Remedial Actions

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 solid waste management units (SWMUs) and associated groundwater were submitted to the TCEQ and EPA in the form of RCRA Facility Investigation Reports. Those investigation reports closed many units through interim remedial actions; therefore, no further controls other than deed recordation are necessary for those units. Other units were evaluated in human health and ecological risk assessments to identify units that required further remedial actions to protect human health and the environment. Figure 1-3 depicts the location and status of the 254 units.

The 15 units still in active use will be closed in accordance with CERCLA and RCRA permit provisions when they become inactive and are determined to be of no further use as well as when funding is identified for investigation and cleanup of the site. One active facility has been changed to inactive, and Pantex has requested funding to address the site. A detailed summary of actions for the 254 units can be found in the ROD (Pantex and Sapere Consulting, 2008).

Units requiring further remedial actions were then assessed in a corrective measures study to identify and recommend final remedial actions. The final remedial actions that were approved are detailed in the ROD. A detailed status table of the SWMUs is included in Appendix A of this report.

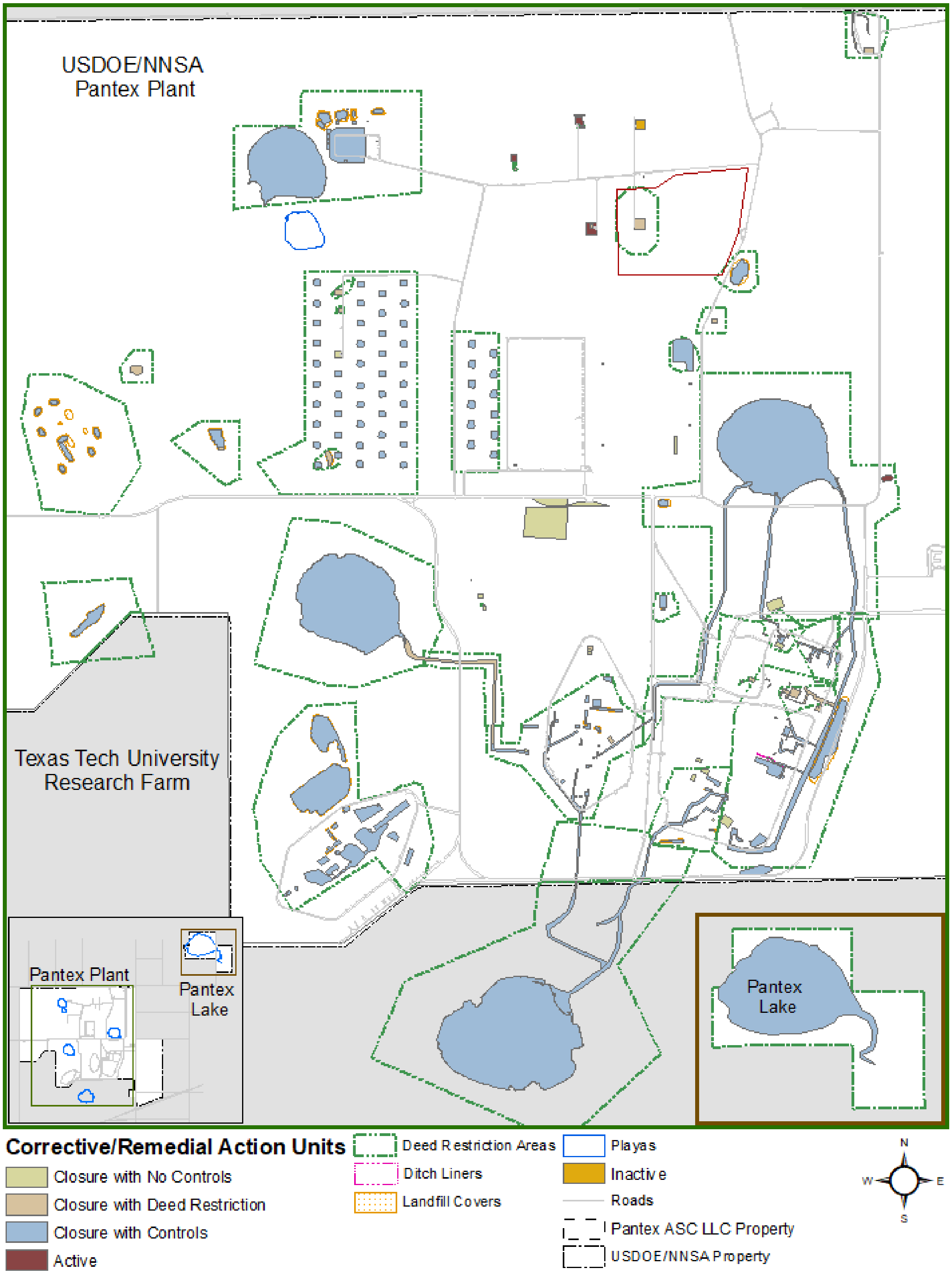

Figure 1-3. Status of Corrective/Remedial Action Units

Soil remedial actions focus on:

- Cleanup of soil gas and non-aqueous phase liquids (NAPL) in soil at the Burning Ground for future protection of groundwater resources.
- Institutional controls to protect workers.
- Fencing to prevent traffic and control access to Firing Site 5 (FS-5).
- Maintenance of soil remedies (i.e., ditch liners and soil covers) for future protection of groundwater resources.

Soil Remedial Actions

- Ditch Liner
- Soil Covers on Landfills
- Institutional Controls
- Soil Vapor Extraction System
- Fencing

In addition to the remedial actions, Pantex has deed recorded all soil units where contamination was identified. Those areas are restricted to industrial use to ensure future use of the area is in agreement with cleanup assumptions.

1.3.1 BURNING GROUND SVE SYSTEM

The Burning Ground Soil Vapor Extraction (SVE) system was installed in February 2002 as an interim remedial action and became the final remedial action with the issuance of the ROD and HW-50284. The SVE system was installed to remediate volatile organic compounds (VOCs) present in the shallow- and intermediate-depth vadose zone at the Burning Ground, specifically SWMUs 47 and 38.

The system was designed to remediate soil gas in areas beneath the solvent evaporation pit/chemical burn pit (SEP/CBP) and the landfills north of the SEP/CBP. The RCRA Facility Investigations noted that original VOC concentrations at the Burning Ground were as high as 962 parts per million by volume (ppmv) in the shallow zone (i.e., 20 to 90 feet [ft] below ground surface [bgs]), based on wells in place at that time. However, higher concentrations were found in well SVE-S-20 when the SVE system was installed in 2001. Concentrations in the intermediate zone (i.e., 95 to 275 ft bgs) were as high as 1845 ppmv (Stoller, 2002).

The remedial goal was to significantly reduce the mass of VOC contaminants in soil gas, thus mitigating impacts to the underlying groundwater. That goal was achieved in all but a single extraction well, SVE-S-20. Rebound testing conducted in October 2005 indicated that all wells, except SVE-S-20, yielded field-measured VOC concentrations less than 100 ppmv.

A small-scale SVE was installed at the Burning Ground in late 2006 after the large-scale catalytic oxidation (CatOx) and scrubber system became inefficient at continued removal of soil gas and residual NAPL within the soil pore space once the larger area had been remediated. The small-scale system focused on treating residual NAPL and soil gas at a SVE-S-20, where soil gas concentrations continued to remain above 100 ppm. The system consisted of a series of activated carbon drums and a smaller blower motor for extraction. The activated carbon system was shut down at the end of January 2012 to install a small-scale CatOx system that continues to focus on remediating SVE-S-20.

The new system is more cost efficient and will effectively treat all detected contaminants of concern (COCs) at the Burning Ground. System construction and installation began in February 2012. System startup and testing began on April 5, 2012, with normal operations commencing on April 19, 2012.

The system was modified in May 2017 to increase air flow through the area surrounding SVE-S-20 and promote increased volatilization and bioremediation of the remaining soil NAPL. Six wells surrounding SVE-S-20 were modified to include aboveground piping that would allow airflow through the wells while the system is operating and pulling air from SVE-S-20 (see Figure 1-4). Pantex increased influent flow to the SVE by 40% from 32 standard cubic ft per minute (scfm) to approximately 45 scfm, close to the maximum design flow of 50 scfm. To gain baseline information, Pantex also increased monitoring and evaluation of influent air to the SVE system and of the individual wells that were modified. The evaluations, presented in Section 4, will be used to help provide a path to closure of the Burning Ground SVE.

Figure 1-4. Burning Ground SVE System Wells and Modifications

1.3.2 Protective Covers

The remedial action for landfills included installing and maintaining protective covers for the Former Burning Ground Ash Disposal Trench and SWMUs 14 through 24, the former operational area of FS-5, and 27 landfill units depicted in Figure 1-3. These protective covers were either placed after landfilling operations ceased or were installed as interim corrective measures (ICMs) under State RCRA Authority to prevent worker contact and the infiltration of water through landfill materials that could lead to migration of contaminants to the underlying aquifer without mitigation.

Construction of all protective covers was completed and approved in 2009. All but two covers are constructed of soil, with the two landfills, Landfill 1 and 2, having Closure Turf installed over the soil cover. Closure Turf was installed at Landfill 1 in 2013 and at Landfill 2 during 2017. Refer to the respective annual reports for the closure turf installation information.

1.3.3 Ditch Liners

A total of five ditch sections representing SWMUs 2 and 5-05, with a total length of approximately 832 ft, were lined as an ICM in 2004 to prevent migration of vadose zone soil contamination to the perched groundwater. The ditch liner is depicted in Figure 1-3.

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 1-ft deep to control erosion and 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. The river rock ballast was replaced by Platipus® anchors in 2011.

Between December 2016 and March 2017, a new 45-millimeter Hypalon liner was installed over the existing SWMUs 2 and 5-05's ditch liner. Before installing the new liner, sediment, debris, and water were removed from the ditch areas. An anchor trench was excavated around nearly all sides of the liner emplacement and used to secure the new liner around the outer edge of the ditch. A total of 163 Platipus® anchors were installed at approximately 5-ft intervals, typically located at the bottom of the ditch, to further secure the liner in place.

The Platipus® device consists of a flat metal anchor attached to a wire driven 2 ft vertically into the ground with a pivot set horizontally and a plastic plate tightened to the surface of the liner. At the anchor location, the surface of the liner is then patched to create a water-tight seal. Ten anchors were not installed as planned due to potential interferences 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.

1.4 Groundwater Remedial Actions

In accordance with the IAG and HW-50284, Pantex has implemented actions to remediate the contaminated perched groundwater. Two types of active remediation systems (see Figure 1-5) were installed to address the contamination: Pump and treat systems and

Groundwater Remedial Actions

Pump & Treat Systems

- Playa 1 Pump and Treat
- Southeast Pump and Treat

In-Situ Bioremediation Systems

- Zone 11 ISB
- Southeast ISB
- Southeast ISB Extension
- Offsite ISB

Institutional Controls

in-situ bioremediation (ISB) systems. Institutional controls are also part of the final remedy for groundwater.

Groundwater remedial actions focus on the following tasks:

- Cleanup of perched aquifer to the groundwater protection standard (GWPS).
- Reduce perched water levels to protect the underlying drinking water aquifer (i.e., Ogallala Aquifer) and prevent growth of plumes.
- Implement institutional controls to restrict perched groundwater use without treatment and control drilling into and through the perched aquifer to prevent cross-contamination.

Pump and treat systems were installed to address contamination in areas with generally greater than 15 ft of saturation in the perched aquifer. These systems are designed to remove and treat perched groundwater to reduce contaminant mass and the perched aquifer's saturated thickness. Reduction in saturated thickness should significantly reduce the migration of contaminants both vertically and horizontally so that natural breakdown processes can occur over time.

Pantex has installed ISBs to reduce the concentration of contaminants as they migrate through the remediation zone in targeted areas of the groundwater plumes.

Each of the remediation systems is detailed in the following sections.

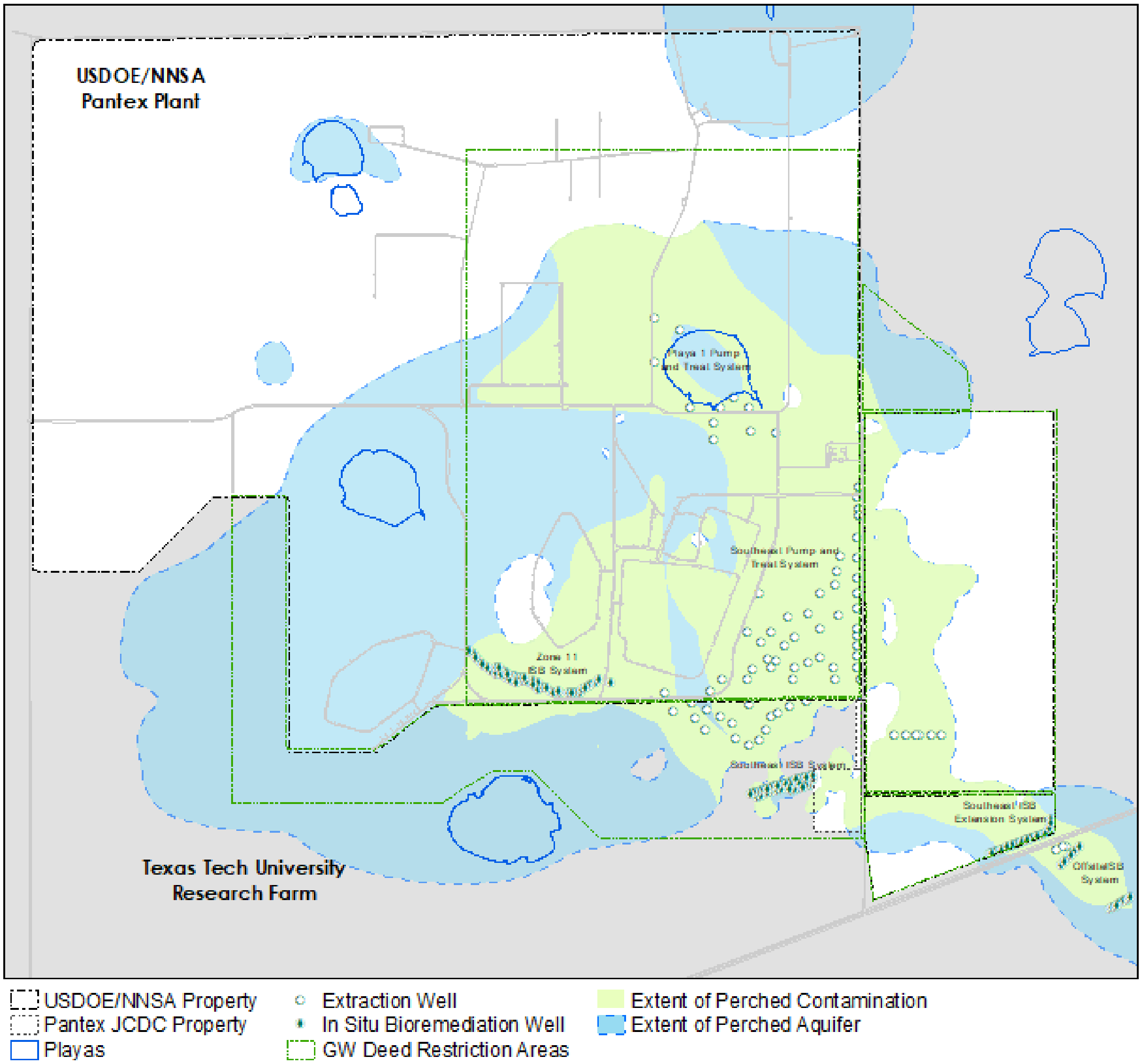

Figure 1-5. Groundwater Remedial Actions

1.4.1 Pump and Treat Systems

As part of the Remedial Action, Pantex installed two pump and treat systems, the Southeast Pump and Treat System (SEPTS) and the Playa 1 Pump and Treat System (P1PTS), with 1 injection well and 76 operating extraction wells that currently treat up to a total of 550 gallons per minute (gpm) of contaminated perched groundwater. The systems address contamination in areas that generally had greater than 15 ft of saturation in the perched aquifer at the time of system installation. These systems were designed to remove and treat groundwater to achieve contaminant mass reduction as well as reductions in the saturated thickness of the perched aquifer. Reduction in saturated thickness will significantly reduce the migration of contaminants both vertically and horizontally so that natural attenuation processes can occur over time.

PTS Operational Goals

1. 90% operation time with no injection when the WWTF and irrigation system can receive all treated water.
2. When the WWTF and irrigation system limits flow, no injection at the SEPTS, with minimum flow rates (i.e., 125 gpm) maintained at both systems. Injection is used at the SEPTS to maintain minimum flow if flow is limited below 250 gpm for the two systems.
3. 90% of system treatment or well field capacity, whichever is lower.

To achieve mass reduction and reduction in saturated thickness, pump and treat systems treat extracted water and remove contaminants before the effluent is sent to the wastewater treatment facility (WWTF) and irrigation system for beneficial use. Pantex also uses the water beneficially for ISB injection and has been approved to use the treated water for various purposes, including dust suppression, firefighting, washing, and make-up water. Pantex installed a bulk water station at the SEPTS that began operating in 2016 to allow beneficial use in accordance with the Texas Land Application Permit (TLAP). While the primary use option is irrigation, the SEPTS retains the capability to inject back into the perched zone as necessary.

The P1PTS began start-up operations in late 2008, and the system became fully operational in January 2009. The SEPTS has been operating since 1995 when it started as a treatability study. It has since been expanded with additional extraction wells and the capacity to treat boron and hexavalent chromium to become part of the final Remedial Action for southeastern portion of the groundwater plumes. A list of the extraction and injection wells and their status is included in Section 1.6.

1.4.1.1 Playa 1 Pump and Treat System

The P1PTS extracts water from 11 wells near Playa 1 and treats it through a series of granular activated carbon (GAC) beds to reduce high explosives (HEs) below the GWPS established in the ROD and HW-50284. 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.

This system treats small amounts of HEs and volatile organics such as trichloroethene (TCE). Boron is treated using an ion exchange vessel to concentrations below 500 micrograms per liter (ug/L) when the water will be used for irrigation purposes. Since the primary focus of this system is to remove water, only small amounts of COCs are removed during the treatment process since concentrations have greatly declined in groundwater beneath Playa 1. Figure 1-12 depicts the P1PTS wells and conveyance.

P1PTS beneficially uses all treated water by sending it through the WWTF to the irrigation system. Because this system cannot inject the treated water back into the perched aquifer, the treatment throughput must be temporarily adjusted or discontinued based on the demands of the WWTF or irrigation system. In 2017, a break occurred at the irrigation system, so all irrigation usage was discontinued.

Operating under a permit issued by the State of Texas, Pantex can release treated wastewater to Playa 1. Pantex continues to release to Playa 1 while engineering studies, designs, and repairs are completed on the onsite irrigation system. Pantex is also designing a second center-pivot irrigation system east of FM2373 to allow beneficial use of water from both pump and treat systems. The new center-pivot system is expected to be completed in 2022.

Figure 1-6. P1PTS Wells and Conveyance Lines

1.4.1.2 Southeast Pump and Treat System

The SEPTS was originally installed at Pantex in 1995 as part of a treatability study. Since then, the pump and treat system has been expanded to meet the objectives of the environmental restoration project and final remedy established in the ROD and HW-50284.

The SEPTS currently consists of a treatment building, 64 active extraction wells, and 1 injection well (see Figure 1-7). Six new extraction wells were drilled east of FM 2373 to provide additional control of plume movement to the southeast. The wells were tied-in to the SEPTS and started operating by May 2019.

This system treats the recovered perched groundwater through a series of GAC vessels and ion exchange resin beds to reduce concentrations below the GWPS established in the ROD and HW-50284. Primary contaminants treated by this system includes HEs and hexavalent chromium. There are other minor plumes in the area, including TCE, that are treated by the SEPTS. Boron is treated below 500 ug/L when the water will be used for irrigation purposes.

The objective of the SEPTS is to remove and treat contaminated perched groundwater for industrial and/or irrigation use. While this system can inject treated water back into the perched zone, the intent is to permanently remove perched groundwater to gradually reduce the saturated thickness in this zone. This effort will achieve the following two important objectives:

1. Gradual reduction of the volume of perched groundwater and contamination moving downgradient toward the extent of the perched aquifer.
2. A reduction in the head (i.e., driving force) for vertical migration of perched groundwater into the fine-grained zone (FGZ) and to the drinking water aquifer.

To meet these objectives, operational goals were established for this system, as presented in the highlight box in Section 1.4.1. Goals are prioritized for system operation and will be met as conditions allow.

Figure 1-7. SEPTS Wells and Conveyance Lines

1.4.2 In-Situ Bioremediation Systems

Pantex has installed and operates three ISB systems as part of the final Remedial Action for groundwater. A fourth system was installed in 2020, but injection will not occur until late spring 2021. One operating system is on the southeast side of the Plant on TTU property, another along the southeast property boundary east of FM 2373, and the final one south of Zone 11. The new system was installed to the southeast of Pantex-owned property, south of Highway 60.

In 2020, the operating ISB systems consisted of 121 active treatment zone injection wells, 5 treatment zone monitoring (TZM) wells, and 17 in-situ performance-monitoring (ISPM) wells. Four new wells were installed along the eastern side of the Southeast ISB Extension in 2020 but will not be injected until early spring 2021. The new Offsite ISB currently consists of 16 treatment zone injection wells and 11 ISB extraction wells. This new system will continue to be expanded through 2023, based on current designs and funding requests.

The objective of the ISB systems is to establish an anaerobic biodegradation treatment zone capable of reducing COC concentrations to the GWPS by injecting the necessary amendments and nutrients to stimulate resident bacteria. The bacteria first consume oxygen and then, in turn, consume other electron acceptors, creating reducing geochemical conditions. Under reducing conditions, biotic and abiotic treatment mechanisms are carried out to remove contaminant mass from groundwater. Regular injections of amendment are essential to maintaining the health of the treatment zone.

1.4.2.1 Zone 11 ISB

The Zone 11 ISB system is on Pantex property, south of Zone 11 (see Figure 1-8). The system, as operated in 2020, consists of 58 active and inactive injection wells, 5 TZM wells, and 9 downgradient ISPM wells installed in a zone of saturated thickness of approximately 15 to 20 ft.

The system, originally consisting of 23 wells and 3 downgradient performance monitoring 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 ISB. One of the original wells, PTX06-ISB082, was removed from active injection in 2013, and three other wells on the eastern side, PTX06-ISB079 through PTX06-ISB081, were also removed from active injection by 2015.

Pantex expanded the system in late 2014 to include an additional 20 injection wells (i.e., 18 new injection wells and 2 previously installed pump test wells), 3 new downgradient ISPM wells, and 3 TZM wells that will not receive injection. One TZM well was previously installed as a pump test well, and two additional TZM wells were also installed in the original system on the TCE (i.e., western) side. The two additional TZM wells have replaced monitoring of a portion of the injection wells on that side of the system.

To evaluate the movement of treated water to the south of the system, Pantex also designated three established downgradient monitoring wells as ISPM wells to evaluate the movement of treated water to the south of the system. In late 2019, Pantex extended the system again with six new injection wells to the northwest. The expansion wells were installed to fully encompass the TCE and perchlorate plume that extended northwest of the original system.

Pantex has contracted to expand the Zone 11 ISB in 2021 to include a double row of wells on the south side of the system. A total of 28 wells have been planned for installation by the end of the 2021 fiscal year (FY). Wells will be closely spaced at 50 ft to allow injection with Newman Zone® amendment and greater gaps in injection timeframes since this vegetable oil amendment has been proven to have greater longevity.

These wells are being added in response to data indicating a change in the hydraulic gradient, which has been affected by the pump and treat systems' removal of water. Groundwater flow in much of the Zone 11 ISB is now to the southeast, causing the TCE plume to change direction and move into the south and east side of the ISB. The additional wells will provide a longer plume residence time in the treatment zone, allowing TCE to be fully treated. Two additional TZM wells will also be installed in the new line of wells to help monitor the health of the treatment zone.

Installed injection wells were drilled in a line perpendicular to the hydraulic gradient so water flowing through this zone will be treated before it reaches the area beneath TTU property near Playa 4. This system treats primarily TCE and perchlorate, although minor plumes of HEs are also present. Based on the rate of perched groundwater flow and estimated amendment longevity of the Newman Zone® soybean oil, injections were estimated to be necessary approximately every 12 to 24 months. Pantex has been scheduling rehabilitation and injection activities every 24 months based on data collected in the original treatment zone.

To improve amendment distribution, Pantex recently moved to use of a more soluble amendment, molasses, for injection to improve distribution between wells. However, molasses will require more frequent injection and, thus, has been scheduled for reinjection every nine months following the 2019 injection.

Ten injection events have been completed for this system. Table 1-3 provides the list of injection events and dates of completion.

Table 1-3. Zone 11 ISB Injection Events

Injection Event	Completion Date
1	June 2009 (original 23 wells) November 2009 (9 new wells)
2	September 2010
3	October 2011
4	September 2012
5	July 2013 (31 wells)
6	July 2014 (31 wells + 2 converted pump test wells)
7	November 2015 (51 wells)
8	August 2016
9	October 2018 (20 wells)
10	January 2020
11	January 2021 (26 wells)

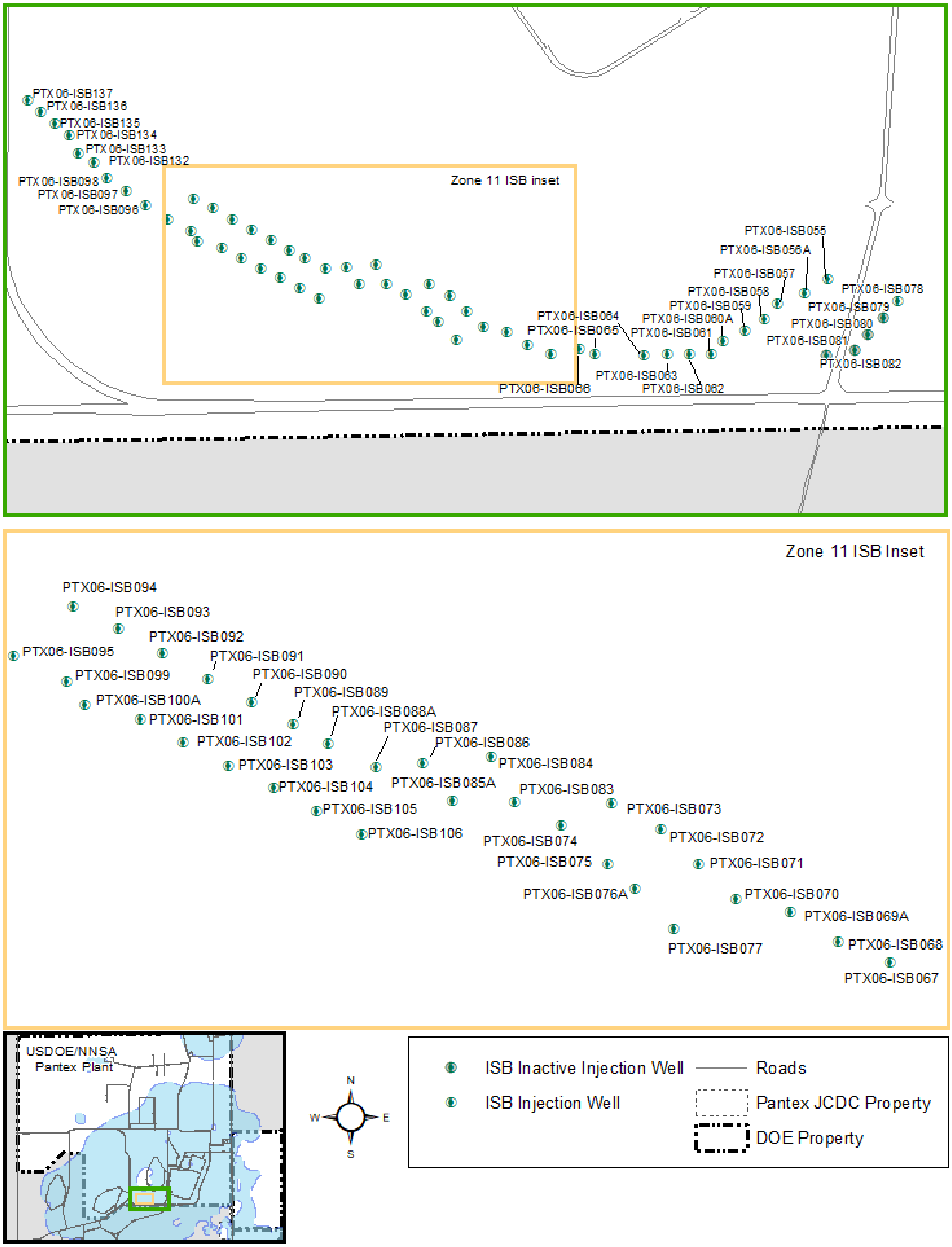

Figure 1-8. Zone 11 ISB Treatment Zone and Performance Monitoring Wells

The *In Situ Bioremediation Corrective Measures Construction Zone 11 South Implementation Report* (Aquifer Solutions, 2009a) documents the implementation of the Zone 11 ISB system. That report was included with the *Final Pantex Interim Remedial Action Report* (IRAR) (Pantex, 2010a). The installation of the nine new wells is documented in the *Well Installation Implementation Report Perched Aquifer Injection Wells for the In Situ Bioremediation System* (Stoller, 2009) included in the *2009 Annual Progress Report* (Pantex, 2010b).

Pantex expanded the Zone 11 ISB in 2014, and the design report for the equipment pad, road, and water supply was included in the *2014 Annual Progress Report* (Pantex, 2015). The well design followed the original design document for the Zone 11 ISB (Aquifer Solutions, 2008). Well installations are documented in the *Well Drilling Implementation Report* (Trihydro, 2014), which is also included in the *2014 Annual Progress Report*. The *Bioaugmentation Implementation Plan* (Trihydro, 2015) provides the detailed plan for injection of *Dehalococcoides sp*.

The 2019 well installations follow the design of the original well installation. An implementation report was developed in late 2020 and is included in this report. Well construction details are provided in Appendix G of this document.

1.4.2.2 Southeast ISB

Installed in 2007 as an early action, the Southeast ISB System is on TTU property south of Pantexand consists of 42 injection wells within the treatment zone and 5 ISPM wells (see Figure 1-9). The injection wells were drilled in a line perpendicular to the hydraulic gradient so the water flowing through the treatment zone will be treated before reaching the area beneath TTU property where the FGZ becomes less resistant to vertical migration. The system is designed to treat HEs and hexavalent chromium.

Based on the rate of perched groundwater flow and estimated longevity of the Newman Zone® soybean oil, injections were estimated to be necessary about every 12 to 24 months. Pantex has reduced the frequency of injection to three years based on a review of the pilot study ISB's amendment longevity and performance.

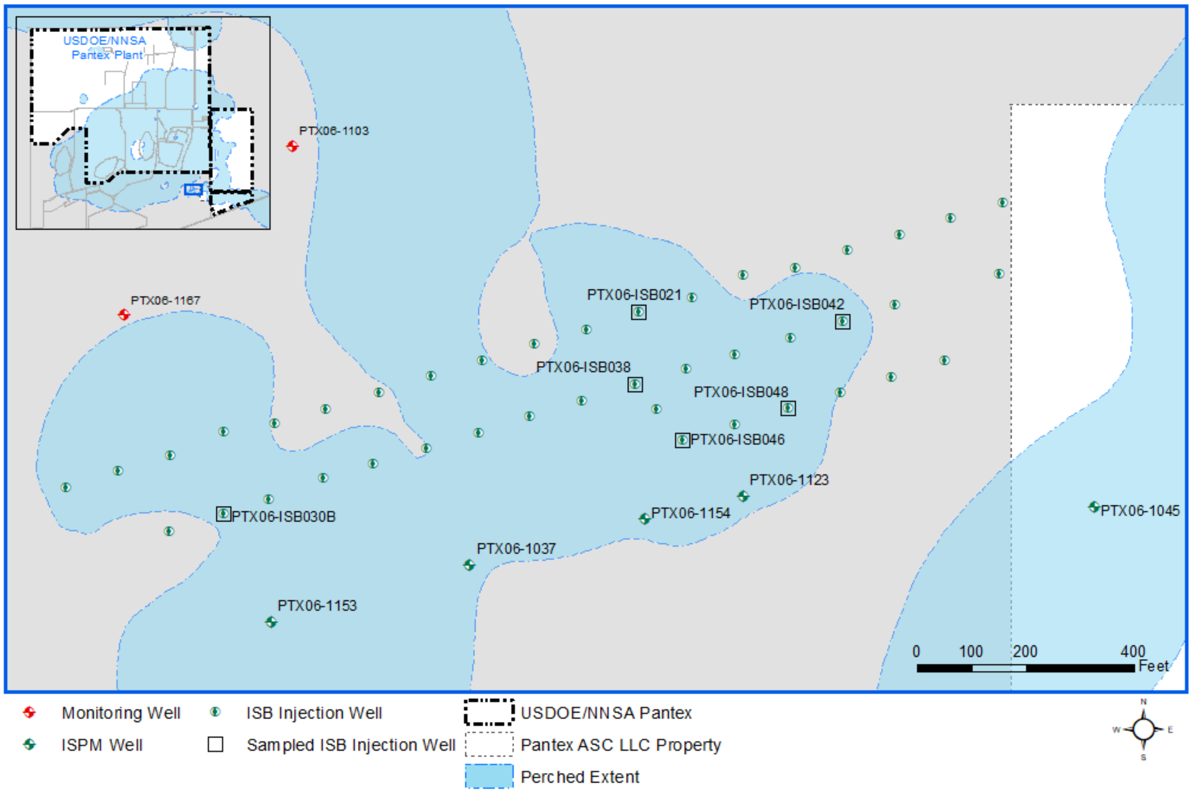

Figure 1-9. Southeast ISB Treatment Zone and Performance Monitoring Wells

In 2019, Pantex moved to injection of molasses in this system; with the change in substrate, another injection is planned in late 2021. However, due to continued water level decline, injections are expected to cease in upcoming years. Current injections are limited to approximately 50% of the system due to increased dry areas within in the system. Seven injection events have been completed for the Southeast ISB, as shown in Table 1-4.

Table 1-4. Southeast ISB Injection Events

Injection Event	Completion Date
1	March 2008
2	April 2010
3	May 2012
4	September 2013
5	April 2015
6	October 2016
7	January 2020

The *Revised Implementation Report, Southeast Plume In Situ Bioremediation Corrective Measures Design and Construction* (Aquifer Solutions, 2009b) documents the design and construction of the Southeast ISB. That report was included in the IRAR (Pantex, 2010a).

1.4.2.3 Southeast ISB Extension

Pantex installed a new system in 2017 to address another area of contamination in the southeast perched groundwater. The new system is an extension of the original ISB remedy for the southeast perched groundwater plume, as provided in the ROD.

The system consists of 29 injection wells and 3 downgradient monitoring wells. The new line of wells, including 24 new wells completed in 2017 and 1 monitoring well that was converted for use as an injection well, was positioned to treat HE contaminants in the southeast plume moving to offsite, landowner property. Four additional wells were added in late 2019 to encompass the plume to the east but will not be injected until early 2021. The system will arrest the continued migration of the HE plume to offsite property, particularly hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX). Due to the new extraction wells' upgradient removal of water, water levels are anticipated to decline in this system over time, and future injections will be unnecessary. Figure 1-10 depicts the Southeast ISB Extension.

Based on the rate of perched groundwater flow and estimated amendment longevity of molasses, injections are estimated to be necessary every six to nine months. As depicted in Table 1-5, two injection events have been completed at this system.

This system was installed using a similar design to the Southeast ISB. Wells were more closely spaced at 75 ft to ensure better distribution of amendment. The implementation of this system was documented in the *2018 Annual Progress Report* (Pantex, 2019d) as part of the implementation report for drilling. Two more injection wells will be drilled in 2021 at this system to fully encompass the plume to the east.

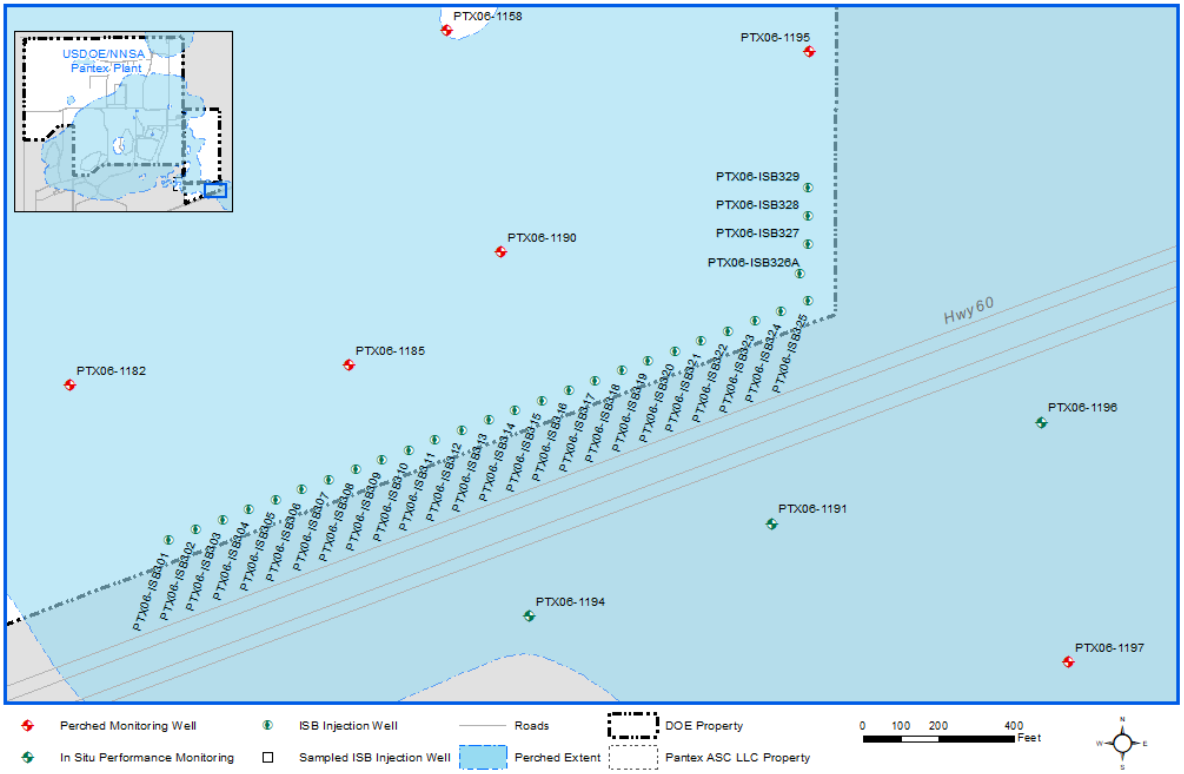

Figure 1-10. Southeast ISB Extension Treatment Zone and In-Situ Performance Monitoring Wells

Table 1-5. Southeast ISB Extension Injection Events

Injection Event	Completion Date
1	February 2019
2	September 2019
3	August 2020

1.4.2.4 Offsite ISB

To address HE contamination that moved onto a neighboring property, Pantex began installing an offsite ISB system in 2020. This ISB is located to the southeast of Pantex-owned property, south of Highway 60, and currently consists of 16 ISB injection wells and 11 extraction wells, as depicted in Figure 1-11. The first phase of its installation focused on beginning treatment at the leading edge and in the heart of the plume near the property’s northern boundary. Two more expansions of the system are planned in 2022 and 2023 and will include ISB injection and extraction and downgradient ISPM wells.

All water used in the injection process must be withdrawn from the neighboring property, so downgradient ISB extraction wells were installed. Downgradient removal also assists in pulling the amendment towards the removal wells, providing a longer zone for COC treatment.

Based on the use of molasses, injections are planned every six months at differing parts of the system. Injection plans will follow the schedule that was designed using fate and transport modeling and optimization modeling. No injections occurred in 2020 and early 2021 due to required planning, setting up of new contracts, and development of necessary infrastructure for injection. However, the injections are planned to begin in June 2021.

Designed to complete clean-up within 25 years at the offsite property, the system was developed using the updated perched groundwater fate and transport model (HGL, 2019). The final placement of wells was driven by the data collected as each new system well was installed in 2020, with modeling used to determine optimum placement for achieving clean-up.

Based on final analytical and aquifer data collected at the newly installed system wells, the system's final update and optimization will occur in 2021. That final modeling effort will guide the final placement of system wells in 2022 and 2023 as well as the final injection timing and placement. Based on the system's original optimization modeling, all or portions of the injection wells are currently injected twice per year.

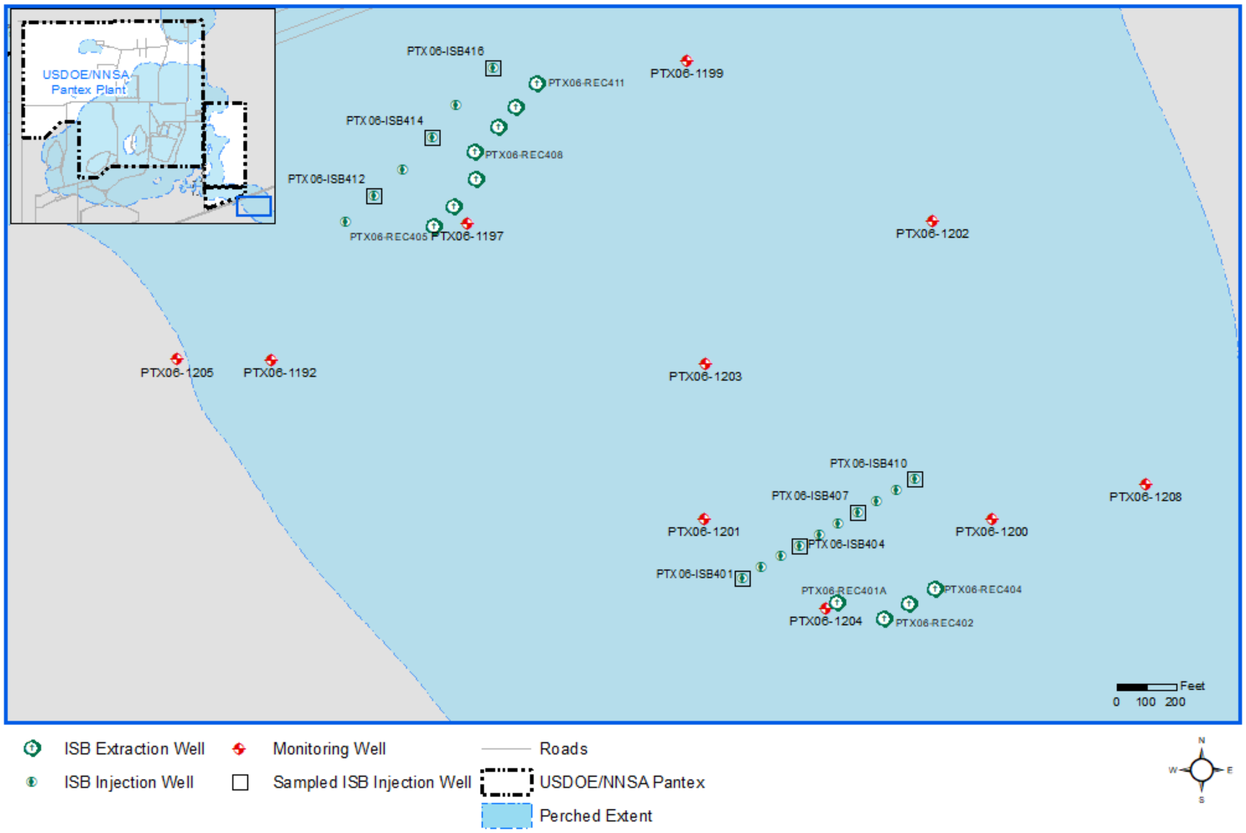

Figure 1-11. Offsite Treatment Zone and Monitoring Wells

1.5 Report Purpose and Objectives

This report satisfies requirements in the IAG and HW-50284 to provide information on the remedial system performance and components. The focus of this report is on the data and information collected for the soil and groundwater remedies during the previous year, and the objective is to provide a more detailed account of the remedies than the quarterly reports.

The only active soil remedy is the Burning Ground SVE system, and this report provides information on its operation, mass removal, and effluent readings during 2019. This report also provides information on the inspection and maintenance of the ditch liner, soil covers, and fencing that are part of the remedial action. In addition, information on site control in accordance with institutional controls and deed restrictions is provided.

This progress report also provides information on the O&M of groundwater remediation systems and components. Data are evaluated according to criteria outlined in the *Update*

> ***Groundwater Remedial Action Evaluation Criteria***
>
> - Plume Stability
> - Remedial Action Effectiveness
> - Uncertainty Management
> - Early Detection
> - Natural Attenuation of COCs

to the Long-Term Monitoring System Design Report (Pantex, 2014a). Those criteria are included in the highlight box and are detailed in the appropriate sections of this report.

This report is organized to present detailed information in a summary form in the main report along with appropriate supporting detail to provide an understanding of the conclusions. The appendices include detailed information such as statistical trending of concentrations and water levels at each well, electronic analytical and field-collected data, pump and treat flow data, well maintenance activities, SWMU status, contractor operational reports for the ISB, and implementation reports, and well-drilling reports, as applicable.

1.6 Long-Term Monitoring of Remedial Actions

Pantex has developed a long-term monitoring (LTM) network to evaluate the effectiveness of the remedial actions, ensure that objectives from the ROD are achieved, and confirm expected future conditions within the perched and Ogallala aquifers. The LTM design and evaluation criteria are provided in the *Update to the Long-Term Monitoring System Design Report* (Pantex, 2019a). The final system design was incorporated into the Compliance Plan portion of the hazardous waste permit when it was issued. The design was further detailed in the Compliance Plan to include point of exposure (POE) and point of compliance (POC) wells where the GWPS is required to be met.

1.6.1 Perched Aquifer Long-Term Monitoring Network

The final perched aquifer LTM network is divided into four areas defined by indicator COC monitoring lists for wells in each area. At the end of 2020, the network consisted of the following assets:

- 132 perched wells, of which 27 are monitored for continued dry or limited water conditions; 86 are sampled for indicator COCs and other applicable analytes including natural attenuation products, corrosion indicators, and general water quality indicators; and 19 are monitored as ISPM wells for the ISB systems and previous pilot study system. The ISPM wells are monitored for COCs, degradation products, and ISB treatment zone parameters. All 132 perched LTM wells and 38 additional wells not included in the LTM network have water levels measured semi-annually.

- 37 wells are sampled semi-annually, 58 wells annually, and 10 wells are sampled every five years.
- 34 of the sampled wells, including 24 of the annually and semi-annually sampled wells, are sampled every 5 years using a modified groundwater list in 40 Code of Federal Regulations (CFR), Part 264, Appendix IX, to satisfy uncertainty management requirements. The next five-year sampling is scheduled for 2021 (see Figure 1-12).
- 4 indicator areas were defined for the perched groundwater. COCs to be monitored are defined for each of those areas.
- Wells were added to the perched LTM table shown in Table 1-6 due to their inclusion in the LTM Design. The wells were already drilled at Pantex and have been monitored in the past but are now officially added as LTM wells. The wells included in the LTM network include PTX06-1171 and PTX06-1180 in the Zone 11 indicator area.

Table 1-6 lists all wells in the perched LTM network and HW-50284, their LTM objective, indicator monitoring area, Compliance Plan objective (POE and POC wells), date of inclusion or removal from HW-50284, and coordinates. The wells are listed in chronological order according to the date of inclusion in HW-50284, in accordance with HW-50284’s CP Table VII requirements. Figure 1-12 depicts the current active LTM wells listed in Table 1-6.

Table 1-6. Perched LTM Network and ISM Compliance Plan Wells

Well ID	Indicator Area	ISM Well[1]	LTM Well[2]	CP Approval Date	CP Removal Date	Well Status	LTM Objectives	POC/ POE	Northing	Easting
PTX-BEG3		Y	N	6/9/2003	9/16/2010	P&A			3773380.09	643702.32
PTX01-1008	Burning Ground	Y	Y	6/9/2003		Active	UM	POC	3770782.89	629942.97
PTX01-1001	Burning Ground	Y	Y	6/9/2003		Active	UM	POC	3769641.90	630592.95
PTX01-1002	Burning Ground	Y	Y	6/9/2003	1/4/2017	P&A			3769596.99	628496.92
PTX06-1012	ISPM Zone 11	Y	Y	6/9/2003		Active	PS, RA		3755068.80	634640.91
PTX04-1002	Miscellaneous	Y	Y	6/9/2003		Active	UM		3772165.27	641818.01
PTX06-1080	Miscellaneous	Y	Y	6/9/2003	2/11/2020	Active			3772643.95	638901.00
PTX06-1081	Miscellaneous	Y	Y	6/9/2003	2/11/2020	Active			3770912.33	641222.41
PTX08-1010	Miscellaneous	Y	Y	6/9/2003		Active	UM		3773206.74	641401.47
PTX06-1048A	North	Y	Y	6/9/2003		Active	PS, RA		3766957.63	642103.43
PTX06-1015	Southeast	Y	Y	6/9/2003		Active	RA		3753617.00	643765.00
PTX06-1023	Southeast	Y	Y	6/9/2003		Active	RA	POC	3764603.10	642773.84
PTX06-1030	Southeast	Y	Y	6/9/2003		Active	RA		3755008.03	644670.42
PTX06-1034	Southeast	Y	Y	6/9/2003		Active	RA	POC	3752434.98	646555.62
PTX06-1036	Southeast	Y	Y	6/9/2003		Dry	PS		3752455.56	638615.43
PTX06-1038	Southeast	Y	Y	6/9/2003		Active	RA		3760426.35	643802.04
PTX06-1040	Southeast	Y	Y	6/9/2003		Active	RA		3758262.93	643811.23
PTX06-1042	Southeast	Y	Y	6/9/2003		Active	RA	POC	3755779.88	643812.20
PTX06-1046	Southeast	Y	Y	6/9/2003		Active	RA	POC	3752292.55	643802.63
PTX06-1052	Southeast	Y	Y	6/9/2003		Active	RA	POC	3753957.66	639100.91
PTX06-1069	Southeast	Y	Y	6/9/2003		Active	PS		3762879.60	646317.00
PTX06-1053	Southeast, Zone 11	Y	Y	6/9/2003		Active	PS, UM		3753672.06	636576.74
PTX08-1008	Southeast, Zone 11	Y	Y	6/9/2003		Active	UM, RA		3755695.51	637485.10
PTX06-1035	Zone 11	Y	Y	6/9/2003		Active	PS		3755092.64	633027.45
PTX10-1014	Southeast, Zone 11	N	Y	8/26/2010		Active	UM		3759769.72	639701.73
PTX01-1004	Burning Ground	N	Y	9/16/2010		Dry	PS		3770768.71	630729.82

Well ID	Indicator Area	ISM Well[1]	LTM Well[2]	CP Approval Date	CP Removal Date	Well Status	LTM Objectives	POC/ POE	Northing	Easting
PTX01-1009	Burning Ground	N	Y	9/16/2010		Dry	PS		3769018.50	630594.67
PTX06-1037	ISPM Southeast	N	Y	9/16/2010		Active	RA		3752194.06	641549.25
PTX06-1045	ISPM Southeast	N	Y	9/16/2010		Dry	RA	POC	3752300.00	642697.65
PTX06-1118	ISPM Southeast	N	Y	9/16/2010	2/11/2020	Dry			3752736.07	641644.92
PTX06-1123	ISPM Southeast	N	Y	9/16/2010		Active	RA		3752319.94	642051.96
PTX06-1153	ISPM Southeast	N	Y	9/16/2010		Active	RA	POC	3752089.44	641184.13
PTX06-1154	ISPM Southeast	N	Y	9/16/2010		Active	RA	POC	3752278.90	641870.52
PTX06-1155	ISPM Zone 11	N	Y	9/16/2010		Active	RA	POC	3755215.62	634603.74
PTX06-1156	ISPM Zone 11	N	Y	9/16/2010		Active	RA	POC	3755076.47	636378.92
PTX04-1001	Miscellaneous	N	Y	9/16/2010	2/11/2020	Active			3772334.66	641458.10
PTX06-1049	Miscellaneous	N	Y	9/16/2010		Active	PS		3763376.96	633343.53
PTX06-1055	Miscellaneous	N	Y	9/16/2010	2/11/2020	Dry			3767254.87	633521.90
PTX06-1071	Miscellaneous	N	Y	9/16/2010		Active	UM		3773219.43	642601.46
PTX06-1082	Miscellaneous	N	Y	9/16/2010		Active	UM		3780321.59	653856.27
PTX06-1083	Miscellaneous	N	Y	9/16/2010		Active	UM		3779777.76	658643.46
PTX06-1085	Miscellaneous	N	Y	9/16/2010		Active	UM		3760418.31	629059.82
PTX06-1086	Miscellaneous	N	Y	9/16/2010		Active	UM		3759843.32	631411.81
PTX06-1096A	Miscellaneous	N	Y	9/16/2010	2/11/2020	Dry			3766548.35	630823.57
PTX06-1097	Miscellaneous	N	Y	9/16/2010		Dry	PS		3765068.63	633104.35
PTX06-1131	Miscellaneous	N	Y	9/16/2010		Active	UM		3754232.91	629371.68
PTX07-1Q01	Miscellaneous	N	Y	9/16/2010		Active	UM		3755836.12	629274.83
PTX07-1Q02	Miscellaneous	N	Y	9/16/2010		Active	UM		3756408.66	628876.97
PTX07-1Q03	Miscellaneous	N	Y	9/16/2010	2/11/2020	Active			3757408.87	630542.61
PTX07-1R03	Miscellaneous	N	Y	9/16/2010		Active	UM		3764501.80	627664.39
OW-WR-38	North	N	Y	9/16/2010		Active	UM, RA		3765214.16	640649.01
PTX06-1050	North	N	Y	9/16/2010		Active	UM, RA	POC	3766622.06	636746.04
PTX06-1136	North	N	Y	9/16/2010		Dry	PS		3766771.76	634860.83
PTX07-1O01	North	N	Y	9/16/2010		Dry	PS, UM, RA		3767695.22	638532.53

Well ID	Indicator Area	ISM Well[1]	LTM Well[2]	CP Approval Date	CP Removal Date	Well Status	LTM Objectives	POC/ POE	Northing	Easting
PTX07-1O02	North	N	Y	9/16/2010		Active	PS, UM, RA	POC	3768117.46	639106.56
PTX07-1O03	North	N	Y	9/16/2010		Active	PS, UM, RA		3767462.56	639046.64
PTX07-1O06	North	N	Y	9/16/2010	2/11/2020	Active			3768536.81	638814.40
PTX06-1002A	Southeast	N	Y	9/16/2010		Active	UM, RA		3759984.00	641161.56
PTX06-1003	Southeast	N	Y	9/16/2010	2/11/2020	Active			3758711.05	641498.93
PTX06-1005	Southeast	N	Y	9/16/2010		Active	UM, RA		3756139.87	640545.44
PTX06-1010	Southeast	N	Y	9/16/2010		Active	UM		3758067.00	639886.62
PTX06-1013	Southeast	N	Y	9/16/2010		Active	RA		3764075.09	643710.38
PTX06-1014	Southeast	Y	Y	9/16/2010		Active	RA		3755125.71	643758.88
PTX06-1031	Southeast	Y	Y	9/16/2010		Active	RA		3753348.03	644674.92
PTX06-1039A	Southeast	N	Y	9/16/2010		Active	RA		3759272.56	643807.47
PTX06-1041	Southeast	N	Y	9/16/2010		Active	RA		3757622.78	643803.61
PTX06-1047A	Southeast	N	Y	9/16/2010		Active	RA		3752004.39	643817.46
PTX06-1051	Southeast	N	Y	9/16/2010		Dry	PS		3752279.10	640332.91
PTX06-1088	Southeast	N	Y	9/16/2010		Active	UM, RA		3757059.42	639902.10
PTX06-1089	Southeast	N	Y	9/16/2010		Dry	PS		3760258.95	646637.32
PTX06-1090	Southeast	N	Y	9/16/2010		Dry	PS		3757684.39	647727.51
PTX06-1091	Southeast	N	Y	9/16/2010		Dry	PS		3756363.40	646554.01
PTX06-1093	Southeast	N	Y	9/16/2010		Dry	PS		3759922.32	645529.01
PTX06-1094	Southeast	N	Y	9/16/2010	2/11/2020	Dry			3751494.55	643813.77
PTX06-1095A	Southeast	N	Y	9/16/2010		Active	UM, RA		3755598.65	640634.87
PTX06-1098	Southeast	N	Y	9/16/2010		Active	RA		3753628.43	640266.14
PTX06-1100	Southeast	N	Y	9/16/2010	2/11/2020	Active			3753579.52	640285.97
PTX06-1101	Southeast	N	Y	9/16/2010		Active	RA		3753437.09	640383.57
PTX06-1102	Southeast	N	Y	9/16/2010		Dry	RA		3754532.94	642751.09
PTX06-1103	Southeast	N	Y	9/16/2010		Dry	RA	POC	3752963.37	641222.64
PTX06-1119	Southeast	N	Y	9/16/2010	2/11/2020	Dry			3752739.01	642646.10
PTX06-1120	Southeast	N	Y	9/16/2010		Active	PS		3752735.03	643152.43

Well ID	Indicator Area	ISM Well[1]	LTM Well[2]	CP Approval Date	CP Removal Date	Well Status	LTM Objectives	POC/ POE	Northing	Easting
PTX06-1121	Southeast	N	Y	9/16/2010		Dry	PS		3752750.09	643645.57
PTX06-1122	Southeast	N	Y	9/16/2010		Dry	PS		3752308.74	640677.35
PTX06-1124	Southeast	N	Y	9/16/2010	2/11/2020	Dry			3752327.45	642877.91
PTX06-1125	Southeast	N	Y	9/16/2010		Dry	PS		3752331.14	643377.53
PTX06-1130	Southeast	N	Y	9/16/2010		Active	RA	POC	3759745.02	644270.36
PTX06-1133A	Southeast	N	Y	9/16/2010		Active	PS		3751315.73	645287.37
PTX06-1135	Southeast	N	Y	9/16/2010		Dry	PS		3753631.93	638343.76
PTX06-1146	Southeast	N	Y	9/16/2010		Active	PS	POC	3757691.87	645978.91
PTX06-1147	Southeast	N	Y	9/16/2010		Active	PS		3753953.21	645431.85
PTX08-1002	Southeast	N	Y	9/16/2010		Active	UM, RA		3763003.22	640859.00
PTX08-1009	Southeast	N	Y	9/16/2010		Active	UM, RA		3755275.01	638866.95
PTX06-1008	Southeast, Zone 11	N	Y	9/16/2010		Active	UM		3759325.25	639441.93
PTX06-1011	Southeast, Zone 11	N	Y	9/16/2010		Active	UM		3757219.75	639178.93
PTX08-1007	Southeast, Zone 11	N	Y	9/16/2010		Active	UM		3758440.46	638900.04
1114-MW4	Zone 11	N	Y	9/16/2010		Active	UM		3757809.40	636151.93
PTX06-1006	Zone 11	N	Y	9/16/2010		Active	PS		3757599.75	637450.19
PTX06-1007	Zone 11	N	Y	9/16/2010		Active	UM		3759513.00	637679.37
PTX06-1073A	Zone 11	N	Y	9/16/2010		Dry	PS		3758072.00	634963.34
PTX06-1077A	Zone 11	N	Y	9/16/2010		Active	UM		3760689.50	637201.80
PTX06-1126	Zone 11	N	Y	9/16/2010		Active	PS	POC	3755562.85	635034.72
PTX06-1127	Zone 11	N	Y	9/16/2010		Active	PS	POC	3755432.03	635901.90
PTX06-1134	Zone 11	N	Y	9/16/2010		Active	PS		3754409.17	633520.06
PTX06-1148	Zone 11	N	Y	9/16/2010		Active	PS, RA		3754719.67	636467.02
PTX06-1149	Zone 11	N	Y	9/16/2010		Active	PS		3754717.64	635864.13
PTX06-1150	Zone 11	N	Y	9/16/2010		Active	PS, RA		3754718.24	635233.98
PTX06-1151	Zone 11	N	Y	9/16/2010		Active	PS		3756123.62	633935.95
PTX07-1P02	Zone 11	N	Y	9/16/2010		Active	UM	POC	3763019.08	637817.70
PTX07-1P05	Zone 11	N	Y	9/16/2010		Dry	UM		3762886.83	637136.13

Well ID	Indicator Area	ISM Well[1]	LTM Well[2]	CP Approval Date	CP Removal Date	Well Status	LTM Objectives	POC/ POE	Northing	Easting
PTX08-1001	Zone 11	N	Y	9/16/2010		Active	UM, RA		3762976.26	638941.45
PTX08-1003	Zone 11	N	Y	9/16/2010		Active	PS		3760136.56	635385.36
PTX08-1005	Zone 11	N	Y	9/16/2010		Active	UM		3756346.19	635316.66
PTX08-1006	Zone 11	N	Y	9/16/2010		Active	UM		3756761.86	636400.41
PTX06-1167[3]	Southeast	N	Y	7/28/2013		Dry	RA		3752653.00	640913.72
PTX06-1158	Zone 11	N	Y	5/30/2014		Active	PS		3752025.93	648137.99
PTX06-1159	Zone 11	N	Y	5/30/2014		Active	PS, RA		3754843.46	634015.04
PTX06-1160	Zone 11	N	Y	5/30/2014		Active	PS		3756274.13	632835.73
PTX06-1166	Southeast	N	Y	5/30/2014		Active	PS		3752799.74	639750.35
PTX06-1173[4]	Zone 11	N	Y	11/17/2015		Active	RA		3755312.40	634197.62
PTX06-1174[4]	Zone 11	N	Y	11/17/2015		Active	RA		3755489.15	633904.63
PTX06-1175[4]	Zone 11	N	Y	11/17/2015		Active	RA		3755651.06	633416.97
PTX06-1182[5]	Southeast	N	Y	7/11/2016		Active	PS		3751088.49	647140.17
PTX06-1183[5]	Southeast	N	Y	7/11/2016		Active	PS		3753350.43	639765.77
PTX06-1184	Southeast	N	Y	5/4/2017		Active	PS		3750638.25	646625.06
PTX06-1185	Southeast	N	Y	5/6/2017		Active	PS		3751139.83	647878.41
PTX06-1188	Southeast	N	Y	5/22/2017		Dry	PS		3752340.04	640691.28
PTX06-1189	Southeast	N	Y	5/19/2017		Dry	PS		3752711.44	640322.51
PTX06-1190	Southeast	N	Y	11/20/2017		Active	PS		3751439.52	648281.31
PTX06-1191	Southeast	N	Y	1/22/2018		Active	RA		3750720.88	648996.85
PTX06-1192	Southeast	N	Y	1/19/2018		Active	PS		3749893.14	649119.32
PTX06-1193	Southeast	N	Y	1/24/2018		Active	PS		3749346.75	646719.13
PTX06-1194	Southeast	N	Y	1/27/2018		Active	RA		3750477.77	648355.41
PTX06-1195	Southeast	N	Y	1/30/2018		Active	PS		3751968.74	649096.79
PTX06-1196	Southeast	N	Y	7/20/2018		Active	RA		3750989.94	649710.26
PTX06-1197	Southeast	N	Y	7/17/2018		Active	PS		3750355.29	649782.14
PTX06-1199	Southeast	N	Y	7/11/2018		Active	PS		3750905.45	650525.52
PX06-1200	Southeast	N	Y	01/07/19		Active	PS		3749356.32	651557.89

Well ID	Indicator Area	ISM Well[1]	LTM Well[2]	CP Approval Date	CP Removal Date	Well Status	LTM Objectives	POC/ POE	Northing	Easting
PX06-1201	Southeast	N	Y	01/10/19		Active	PS		3749355.48	650585.15
PX06-1202	Southeast	N	Y	01/12/19		Active	PS		3750361.84	651358.99
PX06-1203	Southeast	N	Y	01/25/19		Active	PS		3749879.41	650588.31
PX06-1204	Southeast	N	Y	01/29/19		Active	PS		3749051.98	650997.75
PX06-1205	Southeast	N	Y	01/23/19		Dry	PS		3749894.03	648801.56
PX06-1207	Zone 11	N	Y	1/21/2020		Active	PS		3754046.00	632911.00
PTX06-1171	Zone 11	N	Y	2/11/2020		Active	PS		3755715.08	634373.95
PTX06-1180	Zone 11	N	Y	2/11/2020		Active	PS		3756487.93	633474.07

POC – point of compliance POE – point of exposure
PS – plume stability RA – Remedial Action effectiveness UM – uncertainty management

Wells with no designation in the POC/POE column are considered observation wells. These wells are not listed in HW-50284 Table V, so the corresponding date of HW-50284 approval or removal date corresponds to either the date of inclusion in a Compliance Plan modification, approval letter date for the corresponding progress report where the recommendation was made to include the well in the monitoring network, or the date the well was drilled.

[1]ISM – interim stabilization monitoring (from CP-50284 issued 10/21/2003) – most of these wells were retained in the corrective action Compliance Plan issued in 2010.

[2]LTM –long-term monitoring from CP-50284 issued 9/16/2010, which included the final corrective actions and long-term monitoring for the actions. CP-50284 is now included as Provision XI in HW-50284.

[3]Well was recommended for inclusion in the network in the *2012 Annual Progress Report* (Pantex, June 2013).

[4]These wells were recommended for inclusion in the network in the *2014 Annual Progress Report* (Pantex, 2015). Report approval letter from TCEQ was dated November 17, 2015.

[5]These wells were recommended for inclusion in the *2015 Annual Progress Report* (Pantex, 2016). Report approval letter from TCEQ was dated July 11, 2016.

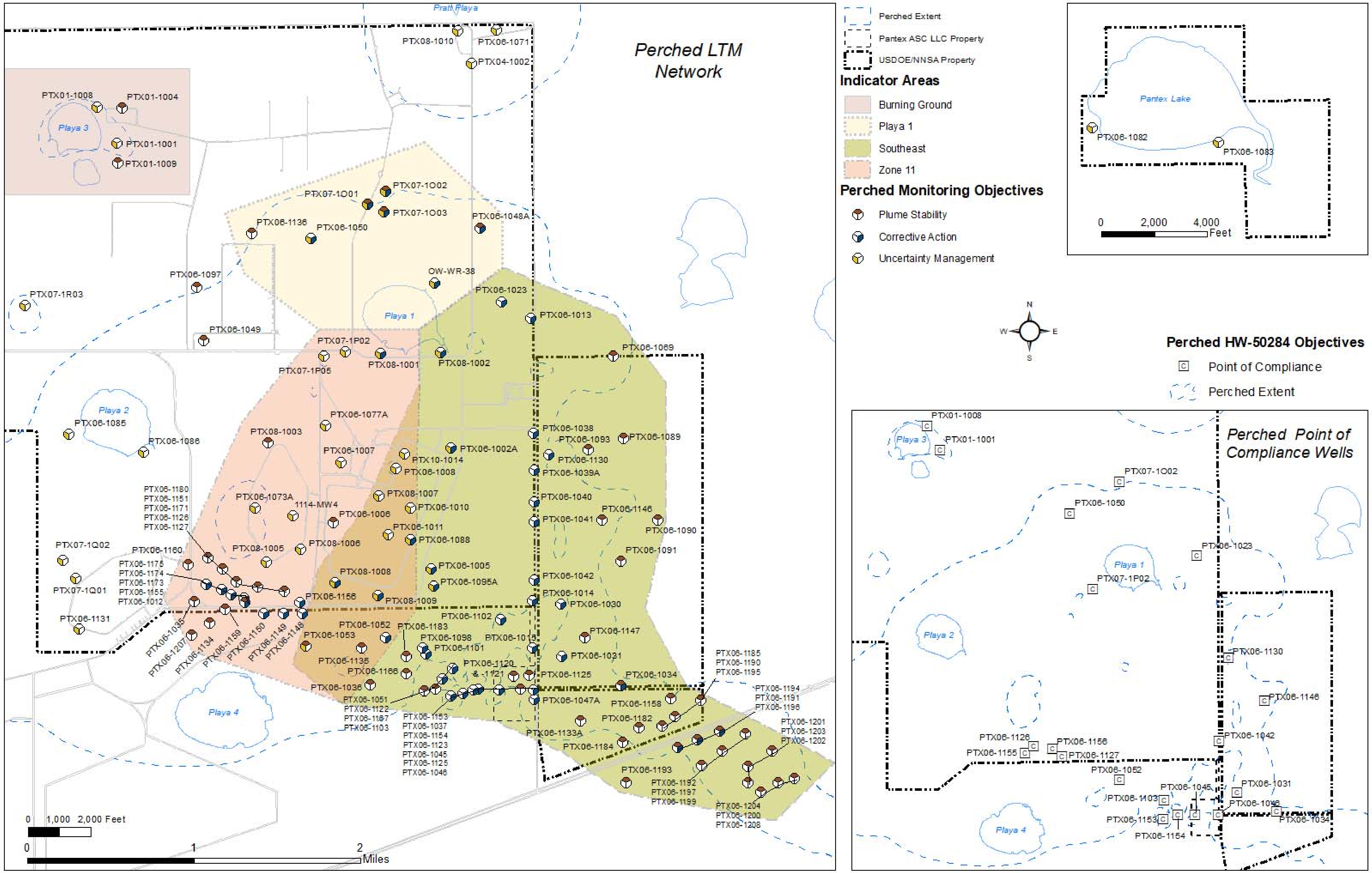

Figure 1-12. Perched LTM Network and Compliance Plan Wells

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1.6.2 Ogallala Aquifer Long-Term Monitoring Network

The final Ogallala Aquifer LTM network consists of the following assets:

- 24 LTM wells are monitored for indicator COCs and water levels. An additional well is used for monitoring water levels in the Ogallala Aquifer.
- 16 wells are sampled semi-annually and 8 are sampled annually.
- 6 wells are sampled at multiple levels every five years. The baseline multi-level sampling was conducted after the wells were installed. All other multi-level sampling events are conducted for five-year reviews (FYRs). The next sampling event for the five-year sampling will be conducted in 2021. Two wells, PTX06-1137A and PTX06-1139, were installed with two sampling intervals; however, water levels dropped below the first interval so they are now only sampled at the deepest sampling interval.
- 7 wells are sampled every five years using a modified groundwater list in 40 CFR, Part 264, Appendix IX, to satisfy uncertainty management requirements. That sampling will be conducted again in 2021.
- 2 indicator areas were defined for the Ogallala wells, and indicator COC monitoring lists were developed for each of those areas.
- 4 additional monitoring wells along the southern and western boundaries are monitored annually to evaluate the quality of groundwater upgradient of the Plant.

Table 1-7 lists all wells in the LTM network and HW-50284, with the corresponding LTM objective, indicator monitoring area, Compliance Plan objectives (POC/POE well), date of inclusion or removal from HW-50284, and coordinates. Figure 1-13 depicts currently active monitoring wells listed in Table 1-7 as well as the additional four wells monitored along the southern and western boundaries. The wells are listed in chronological order according to their date of inclusion in HW-50284, in accordance with CP Table VII requirements.

Table 1-7. Ogallala Aquifer LTM and Compliance Plan Wells

Well ID	Indicator Area	ISM Well[1]	LTM Well[2]	CP Approval Date	CP Removal Date[3]	Current Status	LTM Objectives	POC/ POE	Multi-Level Well	Easting	Northing
PTX01-1010	Northwest	Y	Y	6/9/2003		Active	ED, UM	POC		630576.88	3771397.26
PTX01-1011	Northwest	Y	Y	6/9/2003		Active	ED, UM			629986.45	3771397.29
PTX01-1012	Northwest	Y	Y	6/9/2003		Active	ED, UM	POE		632664.21	3773264.13
PTX01-1013	Northwest	Y	Y	6/9/2003		Active	UM	POE		628976.89	3773218.25
PTX06-1033	Southeast/Northwest	Y	Y	6/9/2003	11/15/2017	P&A	ED, UM			642614.48	3759581.41
PTX06-1044	Southeast/Northwest	Y	Y	6/9/2003		Active	ED, UM			642706.18	3764538.54
PTX06-1054		N	N	6/9/2003	8/11/2004	P&A					
PTX06-1056	Southeast	Y	Y	6/9/2003		Active	ED, UM	POC		643767.03	3754642.87
PTX06-1057A	Northwest	Y	Y	6/9/2003		Active	UM			629630.04	3768142.23
PTX06-1058	Northwest	Y	Y	6/9/2003		Active	UM			624894.00	3759747.11
PTX06-1059[4]		Y	N	6/9/2003	9/16/2010	Active				628129.98	3760459.31
PTX06-1061	Northwest	Y	Y	6/9/2003		Active	UM			625651.61	3773186.59
PTX06-1062A	Northwest	Y	Y	6/9/2003		Active	ED, UM			633017.18	3771685.22
PTX06-1063A[5]		Y	N	6/9/2003	9/16/2010	Unknown				639265.11	3775502.62
PTX06-1064	Northwest	Y	Y	6/9/2003		Active	UM	POE		635900.45	3773557.90
PTX06-1065		Y	N	6/9/2003	9/16/2010	P&A				633197.45	3775896.50
PTX06-1066		Y	N	6/9/2003	9/16/2010	P&A				632838.71	3773430.45
PTX06-1067		Y	N	6/9/2003	9/16/2010	P&A				622714.85	3773696.89
PTX06-1068	Northwest	Y	Y	6/9/2003		Active	ED, UM	POE		643403.70	3773360.30
PTX06-1074[4]		Y	N	6/9/2003	9/16/2010	Active				620994.02	3765626.52
PTX06-1075[4]		Y	N	6/9/2003	9/16/2010	Active				630512.54	3753624.01
PTX06-1076	Southeast/Northwest	Y	Y	6/9/2003		Active	ED, UM			637327.32	3752978.41
PTX-BEG2	Northwest	Y	Y	6/9/2003	1/31/2018	P&A	UM			632652.49	3756906.56
PTX06-1157	Southeast	N	Y	2/10/2010		Active	ED, UM		Y	647100.00	3753700.00
PTX06-1043	Southeast/Northwest	N	Y	9/16/2010		Active	ED, UM			640711.00	3765225.21
PTX06-1072	Northwest	N	Y	9/16/2010		Active	ED, UM			635047.45	3758434.63

Well ID	Indicator Area	ISM Well[1]	LTM Well[2]	CP Approval Date	CP Removal Date[3]	Current Status	LTM Objectives	POC/ POE	Multi-Level Well	Easting	Northing
PTX06-1137A	Southeast	N	Y	9/16/2010		Active	ED, UM			647900.89	3758635.67
PTX06-1138	Southeast	N	Y	9/16/2010		Active	ED, UM	POE	Y	646285.31	3760503.82
PTX06-1139	Southeast	N	Y	9/16/2010		Active	ED, UM	POE	Y	646768.73	3756376.08
PTX06-1140	Southeast	N	Y	9/16/2010		Active	ED, UM		Y	646959.38	3762807.67
PTX06-1141	Northwest	N	Y	9/16/2010		Active	UM		Y	633445.44	3766872.94
PTX06-1143	Northwest	N	Y	9/16/2010		Active	ED, UM	POE	Y	639244.72	3770496.78
PTX06-1144	Northwest	N	Y	9/16/2010		Active	ED, UM	POE	Y	640252.98	3773320.45
PTX07-1R01	Northwest	N	Y	9/16/2010		Active	ED, UM			627914.28	3764159.91
PTX06-1032	Southeast	N	Y		2/10/2010	P&A	ED, UM			646004.29	3752640.94
PTX06-1060[4]		N	N			Active				620969.93	3758599.72

POC – point of compliance POE – point of exposure

ED – early detection RA – Remedial Action effectiveness UM – uncertainty management

[1]ISM – interim stabilization monitoring (from CP-50284 issued 10/21/2003) – most of these wells were retained in the Corrective Action Compliance Plan issued in 2010.

[2]LTM –long-term monitoring from CP-50284 issued 9/16/2010, which included the final corrective actions and long-term monitoring for the actions. CP-50284 is now included as Provision XI in HW-50284.

[3]The CP removal date corresponds to the date of a Compliance Plan/hazardous waste permit change or an approval letter date.

[4]These wells are retained for monitoring water upgradient to Pantex Plant but are not considered as LTM wells.

[5]This well was located on offsite property. Well ownership has been transferred to the landowner.

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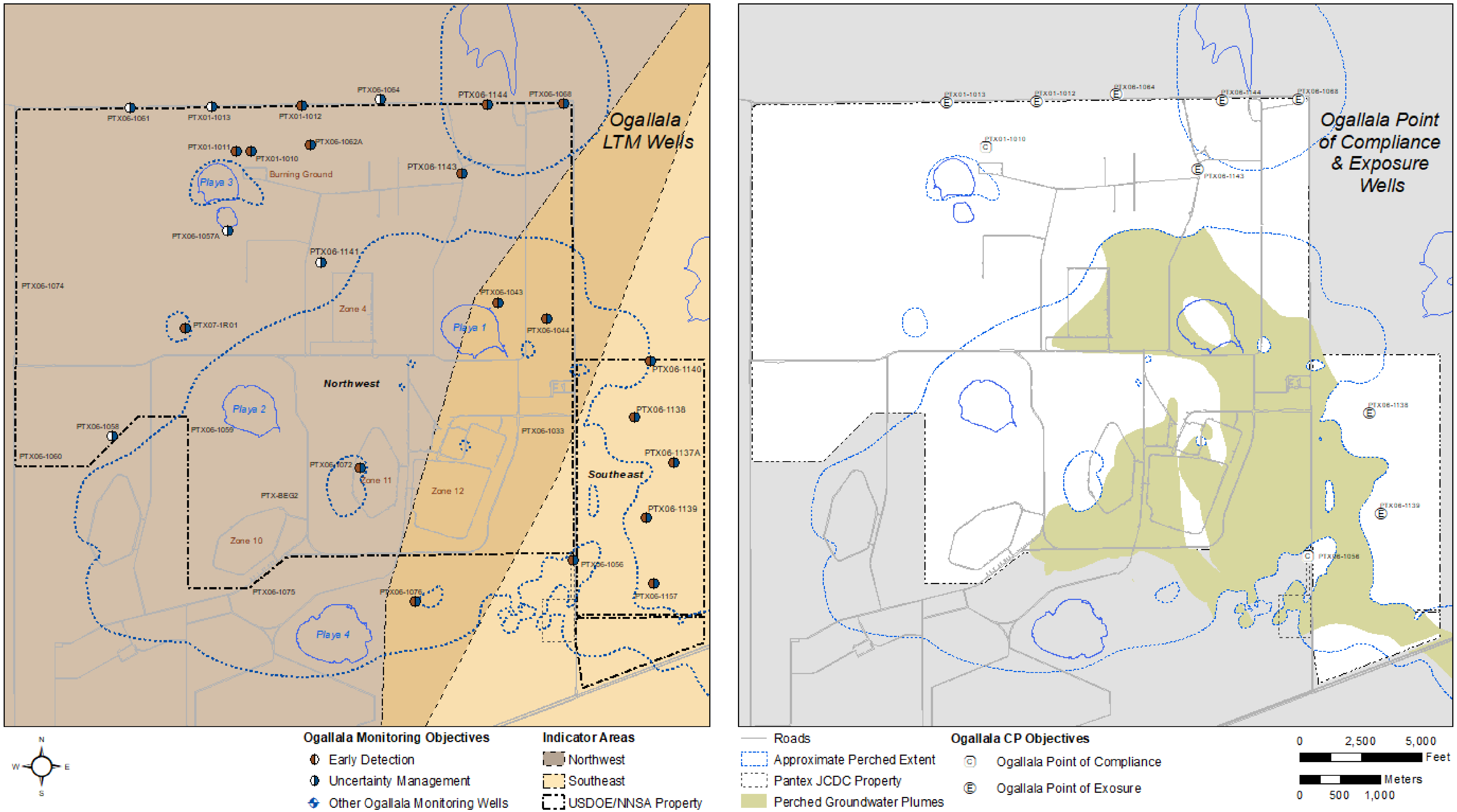

Figure 1-13. Ogallala Aquifer LTM and Compliance Plan Wells

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1.6.3 Remedial Action Wells

Two groundwater remedial actions and one soil remedial action are being performed at Pantex. Wells have been installed for two pump and treat systems, four ISB systems, and an SVE system.

Table 1-8 and Table 1-9 detail all installed wells for the pump and treat systems and for the ISB systems, respectively, as well as their current status, date of plugging and abandonment, and coordinates. Table 1-10 details all installed wells for the SVE system, their current status, plugging and abandonment dates, well depths, and coordinates. Figures depicting the active well systems follow each table.

The network is used for remediation, but some wells are also sampled to provide information for the remedial action.

- 19 active ISB wells are used to monitor treatment zone conditions in the three established ISB systems. The fourth system will be monitored in 2021 after injection occurs.
- 1 inactive ISB well is monitored on the eastern side of the Zone 11 ISB. This monitoring evaluates the system's continued effectiveness using only one row of injection on the eastern side of the ISB.
- All available extraction wells (i.e., pumping at time of sampling) are generally monitored during June and July of each year. These data are used to support the plume mapping.
- 5 wells in the SEPTS are monitored semi-annually to evaluate the movement of perchlorate into those wells.
- The SVE system is monitored to evaluate remedial action effectiveness and path to closure and to provide information for the air quality monitoring report for the TCEQ.

The following changes to the remedial action systems occurred during 2020:

- 6 new ISB injection wells were added to the Zone 11 ISB.
- 4 new ISB injection wells were added to the Southeast ISB Extension.
- A new ISB system was installed on an offsite property. 16 new ISB injection wells and 11 new ISB extraction wells were drilled in 2020.

- 3 new pump and treat extraction wells were drilled on the offsite property. A mobile pump and treat unit will be constructed to be used at the property during warm months, with the water being used for amendment injections or injection at downgradient wells that will be installed during Phase 3. The wells will be used for ISB injection until the mobile pump and treat unit is constructed and the downgradient injection wells are installed.

Table 1-8. Pump and Treat System Wells

Well ID	Completion/ Replacement Date	Current Status	P&A Date	Easting	Northing
Southeast Pump and Treat System					
PTX06-EW-01	9/13/1995	Active		641278.87	3756038.24
PTX06-EW-02	8/30/1995	Active		641528.4	3756005.28
PTX06-EW-03	9/8/1995	Active		641366.55	3755801.72
PTX06-EW-04	8/23/1996	Active		643755.08	3756426.14
PTX06-EW-05	8/23/1996	P&A	12/30/2011	643358.11	3755061.32
PTX06-EW-06[1]	9/15/1996	Converted to PTX06-1206		641510.19	3753404.52
PTX06-EW-07	8/26/1996	Active		643751.83	3756882.87
PTX06-EW-08A[1]	10/2/1996	Converted to PTX06-1102		642751.09	3754532.94
PTX06-EW-09	9/28/1996	Active		639170.49	3754843.18
PTX06-EW-10	8/17/1996	Active		638430.01	3755126.91
PTX06-EW-11	9/18/1996	P&A	12/28/2011	643761.85	3754217.08
PTX06-EW-12	8/26/1996	Active		643756.48	3755796.66
PTX06-EW-13[1]	9/13/1996	Converted to PTX06-1108	11/19/2014	643764.04	3754617.19
PTX06-EW-14	9/24/1996	P&A	12/28/2011	643767.08	3753367.23
PTX06-EW-15	8/19/1996	Active		639694.26	3755163.6
PTX06-EW-16	9/8/1998	Active		643801.7	3759993.02
PTX06-EW-17	9/11/1998	Active		643801.02	3760200.19
PTX06-EW-18	9/14/1998	Active		643731.32	3760496.47
PTX06-EW-19	9/18/1998	Active		643797.5	3760790.28
PTX06-EW-20	2/23/2000	Active		641025.56	3757877.46
PTX06-EW-21	8/1/1999	Inactive		641586.01	3757701.14
PTX06-EW-22A	8/26/1999	Active		641838.18	3757228.36
PTX06-EW-23A	9/26/1999	Active		643234.37	3757243.67
PTX06-EW-24	9/12/1999	Active		640724.28	3756777.19
PTX06-EW-25	8/9/1999	Active		641383.9	3756817.82
PTX06-EW-26	9/24/1999	Active		642723.35	3756878.53
PTX06-EW-27	8/13/1999	Active		643750.35	3756680.87
PTX06-EW-28	6/20/1999	Active		640036.65	3755513.98
PTX06-EW-29	7/28/1999	Active		640696.41	3755476.57
PTX06-EW-30	9/1/1999	Active		641973.98	3755476.99
PTX06-EW-31	8/30/1999	Active		642024.65	3755827.25
PTX06-EW-32	8/28/1999	Active		642374.99	3755975.61
PTX06-EW-33	8/25/1999	Active		642726.52	3756075.79

Well ID	Completion/ Replacement Date	Current Status	P&A Date	Easting	Northing
PTX06-EW-34	8/18/1999	Active		643080.1	3755826.59
PTX06-EW-35	8/14/1999	Active		643750.86	3756128.69
PTX06-EW-36	9/24/1999	Active		640775.89	3754778.09
PTX06-EW-37	1/25/2000	Active		639573.03	3754667.07
PTX06-EW-38C	4/6/2000	Active		639987.21	3754454.74
PTX06-EW-39	9/29/1999	Active		640275.11	3754278.61
PTX06-EW-40	3/28/2000	Active		640372.77	3753865.67
PTX06-EW-41	3/15/2000	Active		640775.16	3753666.41
PTX06-EW-42A	3/10/2000	Active		641052.06	3753818.72
PTX06-EW-43	9/15/1999	Active		641223.53	3754077.05
PTX06-EW-44	3/9/2000	Active		641376.89	3754474.61
PTX06-EW-45	9/23/1999	Active		641575.19	3754577.81
PTX06-EW-46	3/12/2000	Active		641876.25	3754724.89
PTX06-EW-47[1]	9/11/1999	Converted to PTX06-1168		642128.78	3755035.31
PTX06-EW-48	9/12/1999	Active		643124.45	3755475.11
PTX06-EW-49	2/28/2000	Active		642325.53	3754868.53
PTX06-EW-50	9/1/2005	Active		643762.45	3759386.42
PTX06-EW-51	9/9/2005	Active		638670.18	3754606.95
PTX06-EW-52[1]	9/15/2005	Converted to PTX06-1103	10/28/2010	641248.7	3752987.68
PTX06-EW-53	5/14/2001	Active		643813.98	3755471.87
PTX06-EW-54	2/21/2007	Active		643766.44	3758870.74
PTX06-EW-55	2/22/2007	Active		643763.99	3758298.96
PTX06-EW-56	2/24/2007	Active		643763.8	3757875.83
PTX06-EW-57	2/25/2007	Active		643766.32	3757453.43
PTX06-EW-58	2/12/2007	Active		643262.82	3758881.53
PTX06-EW-59	2/8/2007	Active		643197.17	3758490.03
PTX06-EW-60	2/1/2007	Active		643131.98	3758083.47
PTX06-EW-61	1/30/2007	Active		642700.95	3757847.08
PTX06-EW-62	1/28/2007	Active		642379.35	3757323.3
PTX06-EW-63	1/27/2007	Active		642028.64	3756678.15
PTX06-EW-64	1/25/2007	Active		641727.44	3756431.79
PTX06-EW-65	1/17/2007	Active		641081.67	3756535.05
PTX06-EW-66	1/11/2007	Active		640868.51	3755784.1
PTX06-EW-67	3/6/2007	Active		639249.6	3754428.77
PTX06-EW-68	3/6/2007	Active		639566.17	3754095.17
PTX06-EW-82	07/26/2016	Active		644481.36	3753953.55
PTX06-EW-83	07/24/2016	Active		644782.02	3753953.69
PTX06-EW-84	07/21/2016	Active		645082.73	3753954.16
PTX06-EW-85	09/14/2015	Active		645382.52	3753959.20
PTX06-EW-86	09/13/2015	Active		645482.05	3753946.07
PTX06-EW-87	08/03/2016	Active		645782.09	3753953.71
PTX06-EW-88	09/12/2016	Active		646083.18	3753954.30
PTX06-INJ-1	1/12/1993	P&A	9/24/2004	641043	3757545
PTX06-INJ-2	9/8/1996	P&A	11/23/2011	641155.36	3758791.57
PTX06-INJ-3	2/10/2000	P&A	10/25/2004	643226.15	3756469.63
PTX06-INJ-4	2/26/2000	P&A	3/26/2008	640126.87	3755016.27

Well ID	Completion/ Replacement Date	Current Status	P&A Date	Easting	Northing
PTX06-INJ-5	2/10/2000	P&A	10/25/2004	641482	3755164.77
PTX06-INJ-6	2/26/2000	P&A	10/26/2004	642521.57	3755369.02
PTX06-INJ-7	3/7/2000	P&A	10/27/2004	640774.75	3754319.02
PTX06-INJ-8	2/27/2000	P&A	3/25/2008	640419.84	3756164.91
PTX06-INJ-9	2/17/2000	P&A	10/26/2004	642024.8	3756518.86
PTX06-INJ-10	9/12/2004	Inactive		641005.96	3757505.73
PTX06-INJ-11	8/28/2004	Active		641752.09	3758137.05
PTX06-INJ-12A	1/24/2008	P&A	5/24/2017	640737.15	3756104.67
Playa 1 Pump and Treat System					
PTX06-EW-69	7/22/2007	Active		638869.86	3765146.41
PTX06-EW-70	8/11/2006	Active		638141.28	3765454.51
PTX06-EW-71	7/24/2007	Active		638139.57	3764250.42
PTX06-EW-72	8/20/2007	Active		639152.16	3762973.95
PTX06-EW-73	8/10/2007	Active		639962.23	3762980.08
PTX06-EW-74	8/18/2007	Active		640354.99	3763274.66
PTX06-EW-75	8/19/2006	Active		640751.11	3763004.67
PTX06-EW-76[1]	7/13/2007	Converted to PTX06-1128		641330.75	3763667.42
PTX06-EW-77[1]	8/6/2007	Converted to PTX06-1129		641330.75	3763667.42
PTX06-EW-78A	8/23/2007	Active		639800.79	3762590.92
PTX06-EW-79	8/18/2007	Active		640784.57	3762323.44
PTX06-EW-80	8/14/2007	Active		641490.31	3762305.03
PTX06-EW-81A[2]	9/21/2013	Active		639773.41	3762095.77
Offsite Mobile Pump and Treat System					
PTX06-MEW401	8/10/2020	Inactive		649249.28	3750765.90
PTX06-MEW402	9/13/2020	Inactive		649411.98	3750861.97
PTX06-MEW403	9/17/2020	Inactive		649523.62	3750870.15

P&A = plugging and abandonment

[1]Due to low well yield and need for monitoring data, the extraction well was converted to a monitoring well rather than being plugged and abandoned.

[2]Pantex completed connection to the system in June 2016, with the well becoming operational by November 2016.

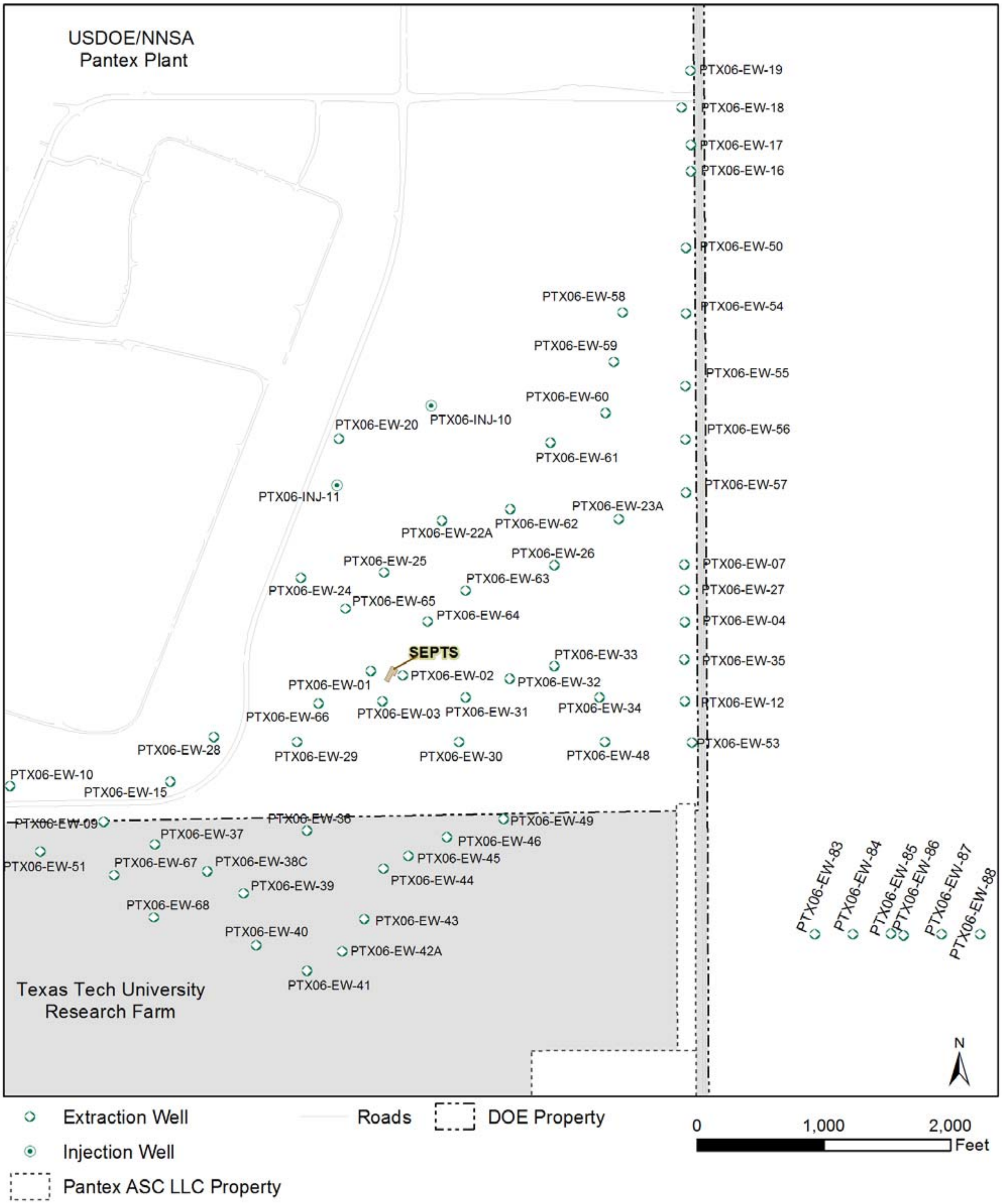

Figure 1-14. SEPTS Wells

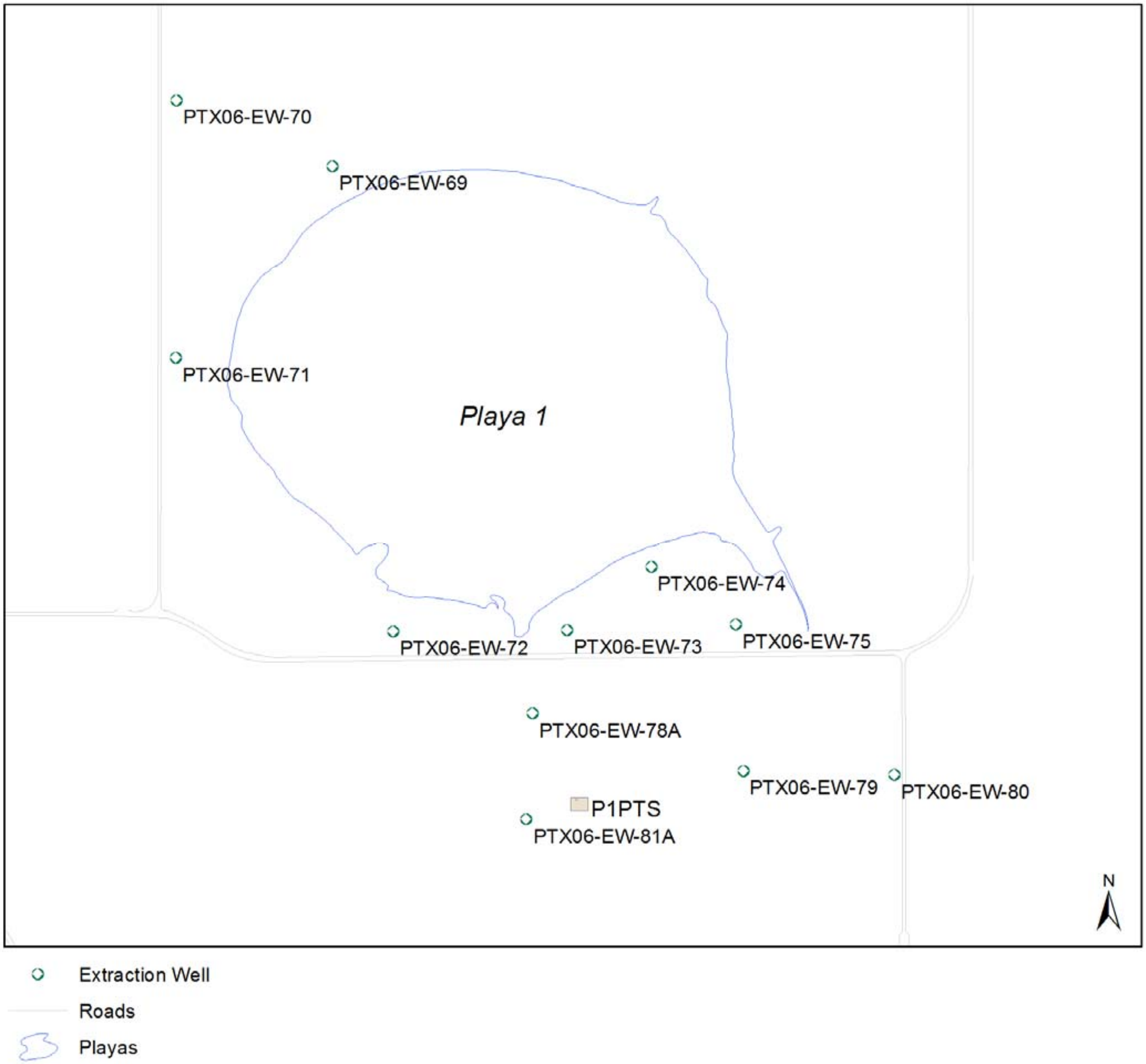

Figure 1-15. P1PTS Wells

Table 1-9. ISB System Wells

Well ID	Completion Date	Current Status	Replacement Date	P&A Date	Easting	Northing
Southeast ISB System						
PTX06-ISB010	10/4/2007	Active			640805.43	3752335.36
PTX06-ISB011	8/6/2007	Active			640901.34	3752364.37
PTX06-ISB012	10/3/2007	Active			640997.33	3752392.85
PTX06-ISB013	10/2/2007	Active	6/17/2011		641094.48	3752437.36
PTX06-ISB014	10/1/2007	Active			641188.34	3752451.45
PTX06-ISB015	10/1/2007	Active			641282.85	3752478.49
PTX06-ISB016	8/4/2007	Active			641379.46	3752509.22
PTX06-ISB017	10/4/2007	Active			641476.26	3752538.73
PTX06-ISB018	9/18/2007	Active			641570.69	3752567.95
PTX06-ISB019	9/19/2007	Active			641666.28	3752597.62
PTX06-ISB020	9/24/2007	Active			641762.34	3752625.80
PTX06-ISB021	9/24/2007	Active			641857.77	3752657.45
PTX06-ISB022	10/1/2007	Active			641955.44	3752684.48
PTX06-ISB023A	10/22/2007	Active			642048.63	3752724.53
PTX06-ISB024	7/18/2007	Active			642144.65	3752737.70
PTX06-ISB025	9/14/2007	Active			642241.84	3752770.49
PTX06-ISB026	9/13/2007	Active			642336.93	3752798.27
PTX06-ISB027	8/22/2007	Active			642431.36	3752828.68
PTX06-ISB028	8/20/2007	Active			642527.37	3752858.27
PTX06-ISB029A	9/27/2007	Active			640994.88	3752253.46
PTX06-ISB030B	9/17/2007	Active			641094.72	3752286.25
PTX06-ISB031	7/11/2007	Active			641176.52	3752313.22
PTX06-ISB032	8/15/2007	Active			641277.51	3752351.41
PTX06-ISB033	8/16/2007	Active			641370.09	3752378.35
PTX06-ISB034	9/9/2007	Active			641467.88	3752407.71
PTX06-ISB035	9/7/2007	Active			641563.65	3752435.15
PTX06-ISB036	9/6/2007	Active			641657.73	3752465.76
PTX06-ISB037	9/11/2007	Active			641753.03	3752494.63
PTX06-ISB038	8/14/2007	Active			641850.23	3752524.17
PTX06-ISB039	9/26/2007	Active			641945.73	3752552.70
PTX06-ISB040	8/31/2007	Active			642035.47	3752578.67
PTX06-ISB041	8/29/2007	Active			642136.52	3752608.90
PTX06-ISB042	8/25/2007	Active			642233.39	3752640.96
PTX06-ISB043	10/24/2007	Active			642329.34	3752670.29
PTX06-ISB044	8/3/2007	P&A		7/27/2011	642425.15	3752698.59
PTX06-ISB044A	6/12/2011	Active			641891.24	3752479.24
PTX06-ISB045	8/24/2007	Active			642521.05	3752726.81
PTX06-ISB046	10/24/2007	Active			641939.34	3752422.69
PTX06-ISB047	10/10/2007	Active			642035.50	3752450.45
PTX06-ISB048	10/24/2007	Active			642131.84	3752479.89
PTX06-ISB049	10/24/2007	Active			642227.63	3752509.10
PTX06-ISB050	10/24/2007	Active			642323.05	3752537.46
PTX06-ISB051	10/19/2007	Active			642419.78	3752567.70

Well ID	Completion Date	Current Status	Replacement Date	P&A Date	Easting	Northing
Zone 11 ISB System						
PTX06-ISB055	3/4/2009	Active			636606.08	3755477.40
PTX06-ISB056A	3/3/2009	Active			636503.22	3755414.42
PTX06-ISB057	2/27/2009	Active	6/15/2011		636381.76	3755371.18
PTX06-ISB058	2/26/2009	Active			636320.75	3755299.58
PTX06-ISB059	2/25/2009	Active			636234.22	3755246.12
PTX06-ISB060A	2/24/2009	Active			636136.74	3755200.44
PTX06-ISB061	2/23/2009	Active			636085.48	3755140.80
PTX06-ISB062	2/20/2009	Active			635986.17	3755141.57
PTX06-ISB063	2/19/2009	Active			635886.33	3755141.05
PTX06-ISB064	2/18/2009	Active			635785.77	3755140.34
PTX06-ISB065	2/17/2009	Active			635563.31	3755140.57
PTX06-ISB066	2/17/2009	Active	9/21/2012		635495.33	3755164.83
PTX06-ISB067	2/13/2009	Active			635364.80	3755140.76
PTX06-ISB068	2/12/2009	Active			635263.93	3755181.61
PTX06-ISB069A	2/11/2009	Active			635170.02	3755241.04
PTX06-ISB070	2/10/2009	Active			635064.71	3755266.05
PTX06-ISB071	11/25/2008	Active			634991.20	3755334.12
PTX06-ISB072	11/20/2008	Active			634917.45	3755401.42
PTX06-ISB073	11/19/2008	Active	9/29/2011		634821.31	3755453.71
PTX06-ISB074	11/18/2008	Active			634722.57	3755411.00
PTX06-ISB075	11/17/2008	Active	9/28/2012		634813.17	3755333.92
PTX06-ISB076A	11/26/2008	Active			634867.07	3755287.08
PTX06-ISB077	11/13/2008	Active			634942.76	3755207.57
PTX06-ISB078	9/18/2009	Active			636919.77	3755377.85
PTX06-ISB079	9/18/2009	Inactive			636854.05	3755302.76
PTX06-ISB080	9/18/2009	Inactive			636787.42	3755227.38
PTX06-ISB081	8/26/2009	Inactive			636729.13	3755162.74
PTX06-ISB082	8/26/2009	Inactive			636597.92	3755139.36
PTX06-ISB083	9/8/2009	Active			634632.29	3755455.37
PTX06-ISB084	9/8/2009	Active			634585.86	3755544.14
PTX06-ISB085A	9/17/2009	Active			634511.57	3755458.25
PTX06-ISB086	9/8/2009	Active			634452.91	3755531.59
PTX06-ISB087	07/24/2014	Active			634360.64	3755523.08
PTX06-ISB088A	09/23/2014	Active			634266.60	3755570.13
PTX06-ISB089	07/12/2014	Active			634200.34	3755606.47
PTX06-ISB090	07/10/2014	Active			634117.26	3755650.38
PTX06-ISB091	09/09/2012	Active			634032.91	3755697.13
PTX06-ISB092	09/11/2012	Active			633944.35	3755745.69
PTX06-ISB093	07/16/2014	Active			633857.23	3755794.35
PTX06-ISB094	07/07/2014	Active			633769.25	3755838.98
PTX06-ISB095	07/24/2014	Active			633652.63	3755742.68
PTX06-ISB096	06/22/2014	Active			633559.57	3755807.06
PTX06-ISB097	08/27/2014	Active			633470.54	3755870.31
PTX06-ISB098	08/19/2014	Active			633384.06	3755929.79
PTX06-ISB099	08/11/2014	Active			633757.56	3755690.13
PTX06-ISB100A	09/16/2014	Active			633791.28	3755646.03
PTX06-ISB101	08/07/2014	Active			633899.71	3755616.85
PTX06-ISB102	07/31/2014	Active			633985.55	3755572.69

Well ID	Completion Date	Current Status	Replacement Date	P&A Date	Easting	Northing
PTX06-ISB103	09/02/2014	Active			634073.50	3755527.39
PTX06-ISB104	08/19/2014	Active			634160.38	3755482.36
PTX06-ISB105	08/06/2014	Active			634245.60	3755438.20
PTX06-ISB106	07/29/2014	Active			634332.49	3755393.36
PTX06-ISB132	12/15/2019	Active			633327.01	3755997.20
PTX06-ISB133	12/18/2019	Active			633258.03	3756042.56
PTX06-ISB134	12/21/2019	Active			633217.07	3756119.70
PTX06-ISB135	1/11/2020	Active			633150.44	3756170.97
PTX06-ISB136	1/8/2020	Active			633089.99	3756225.42
PTX06-ISB137	12/14/2019	Active			633029.65	3756277.60
Southeast ISB Extension[1]						
PTX06-ISB301	04/22/2017	Active			647400.94	3750677.17
PTX06-ISB302	12/13/2017	Active			647471.65	3750705.36
PTX06-ISB303	12/04/2017	Active			647541.96	3750731.23
PTX06-ISB304	12/02/2017	Active			647612.02	3750757.59
PTX06-ISB305	12/15/2017	Active			647682.57	3750783.88
PTX06-ISB306	12/13/2017	Active			647753.08	3750810.07
PTX06-ISB307	11/03/2017	Active			647823.09	3750836.66
PTX06-ISB308	11/07/2017	Active			647894.07	3750862.53
PTX06-ISB309	11/03/2017	Active			647964.07	3750888.51
PTX06-ISB310	11/05/2017	Active			648034.69	3750914.87
PTX06-ISB311	11/14/2017	Active			648105.30	3750940.93
PTX06-ISB312	11/15/2017	Active			648175.64	3750967.12
PTX06-ISB313	11/17/2017	Active			648245.97	3750993.50
PTX06-ISB314	11/30/2017	Active			648316.24	3751019.54
PTX06-ISB315	11/08/2017	Active			648386.52	3751045.71
PTX06-ISB316	11/06/2017	Active			648457.75	3751072.09
PTX06-ISB317	11/04/2017	Active			648527.50	3751098.16
PTX06-ISB318	12/03/2017	Active			648597.96	3751124.55
PTX06-ISB319	12/01/2017	Active			648668.62	3751150.76
PTX06-ISB320	11/17/2017	Active			648738.78	3751176.87
PTX06-ISB321	11/29/2017	Active			648809.07	3751203.15
PTX06-ISB322	10/24/2017	Active			648879.71	3751229.17
PTX06-ISB323	11/15/2017	Active			648950.08	3751255.41
PTX06-ISB324	11/14/2017	Active			649020.47	3751282.05
PTX06-ISB325	11/01/2017	Active			649090.64	3751308.18
PTX06-ISB326A	10/7/2020	Active			649069.98	3751382.33
PTX06-ISB327	10/15/2020	Active			649090.60	3751459.62
PTX06-ISB328	10/18/2020	Active			649090.73	3751534.22
PTX06-ISB329	10/20/2020	Active			649091.36	3751609.51
Offsite ISB						
PTX06-ISB401	6/11/2020	Active			650711.91	3749151.58
PTX06-ISB401	6/15/2020	Active			650776.49	3749189.00
PTX06-ISB402	5/28/2020	Active			650841.82	3749226.42
PTX06-ISB403	5/18/2020	Active			650906.57	3749264.00
PTX06-ISB404	6/2/2020	Active			650972.52	3749300.97
PTX06-ISB405	5/13/2020	Active			651036.29	3749338.63
PTX06-ISB406	5/19/2020	Active			651101.78	3749376.17
PTX06-ISB407	5/14/2020	Active			651167.09	3749413.87

Well ID	Completion Date	Current Status	Replacement Date	P&A Date	Easting	Northing
PTX06-ISB408	6/3/2020	Active			651231.74	3749451.28
PTX06-ISB409	5/16/2020	Active			651296.89	3749487.69
PTX06-ISB410	8/21/2020	Active			649369.83	3750358.61
PTX06-ISB411	8/23/2020	Active			649464.65	3750447.35
PTX06-ISB412	6/17/2020	Active			649562.18	3750534.62
PTX06-ISB413	6/26/2020	Active			649662.66	3750642.84
PTX06-ISB414	8/25/2020	Active			649740.82	3750753.45
PTX06-ISB415	8/27/2020	Active			649866.95	3750879.41
PTX06-ISB416	6/11/2020	Active			650711.91	3749151.58
PTX06-REC401A	5/2/2020	Active			651032.665	3749068.08
PTX06-REC402	6/15/2020	Active			651188.55	3749013.99
PTX06-REC403	5/31/2020	Active			651274.87	3749064.42
PTX06-REC404	6/13/2020	Active			651363.17	3749115.24
PTX06-REC405	9/10/2020	Active			649666.01	3750342.12
PTX06-REC406	8/31/2020	Active			649732.34	3750408.10
PTX06-REC407	7/25/2020	Active			649808.08	3750498.69
PTX06-REC408	7/28/2020	Active			649805.35	3750592.25
PTX06-REC409	8/6/2020	Active			649883.64	3750677.72
PTX06-REC410	8/8/2020	Active			649942.73	3750742.93
PTX06-REC411	8/10/2020	Active			650016.35	3750822.87

[1]Pantex renumbered the wells in this system in 2020 for ease of system identification.

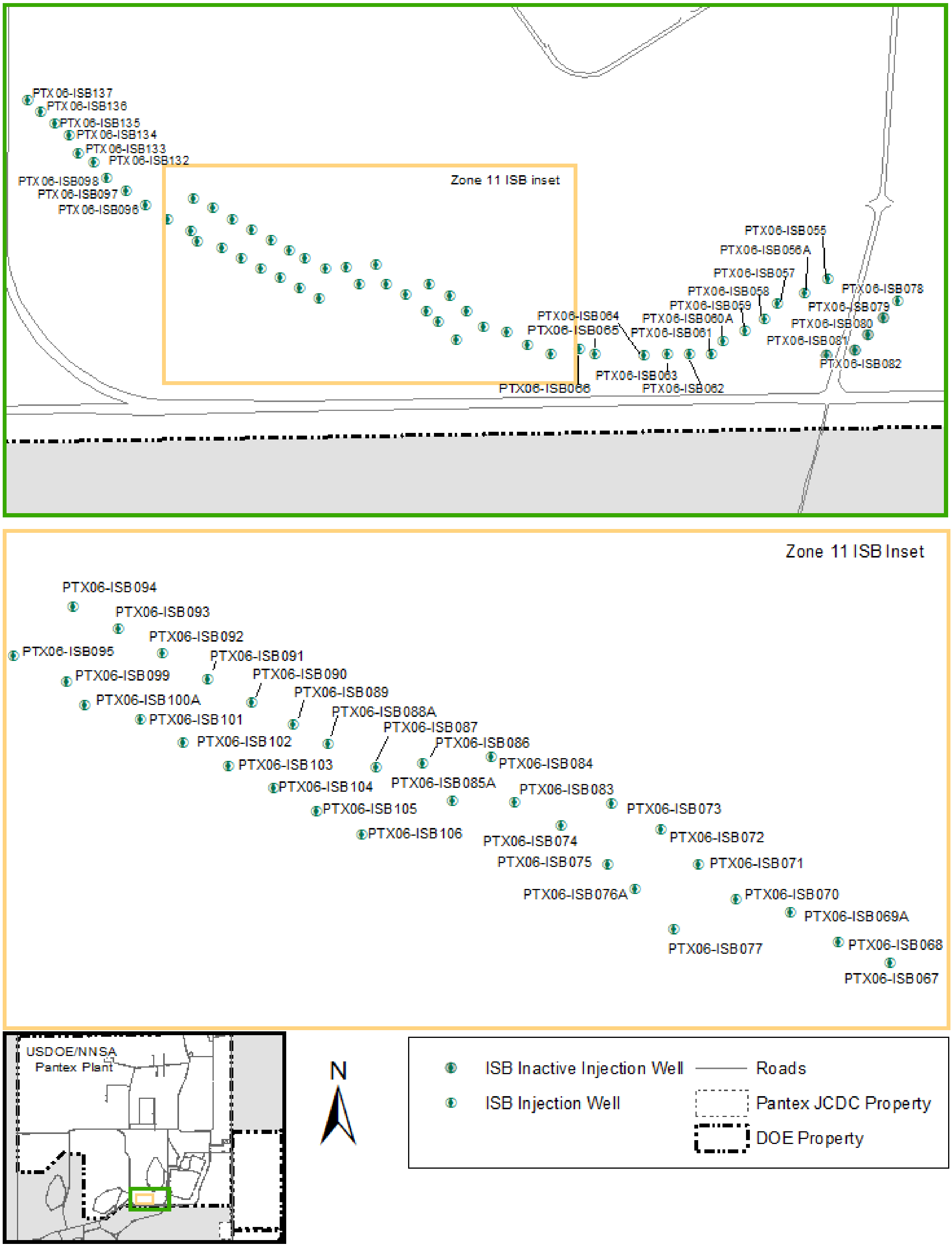

Figure 1-16. Zone 11 ISB System Wells

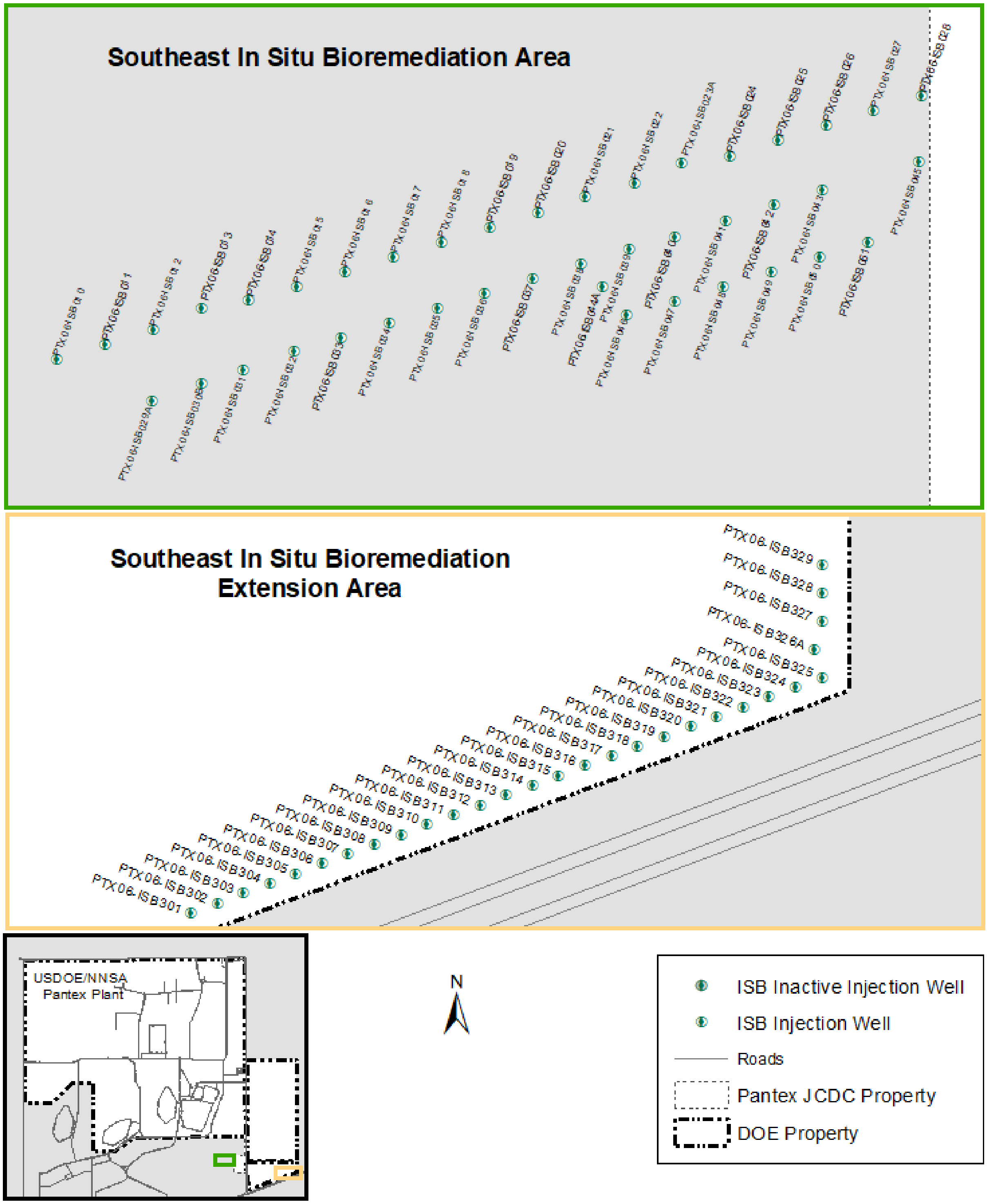

Figure 1-17. Southeast ISB System Wells

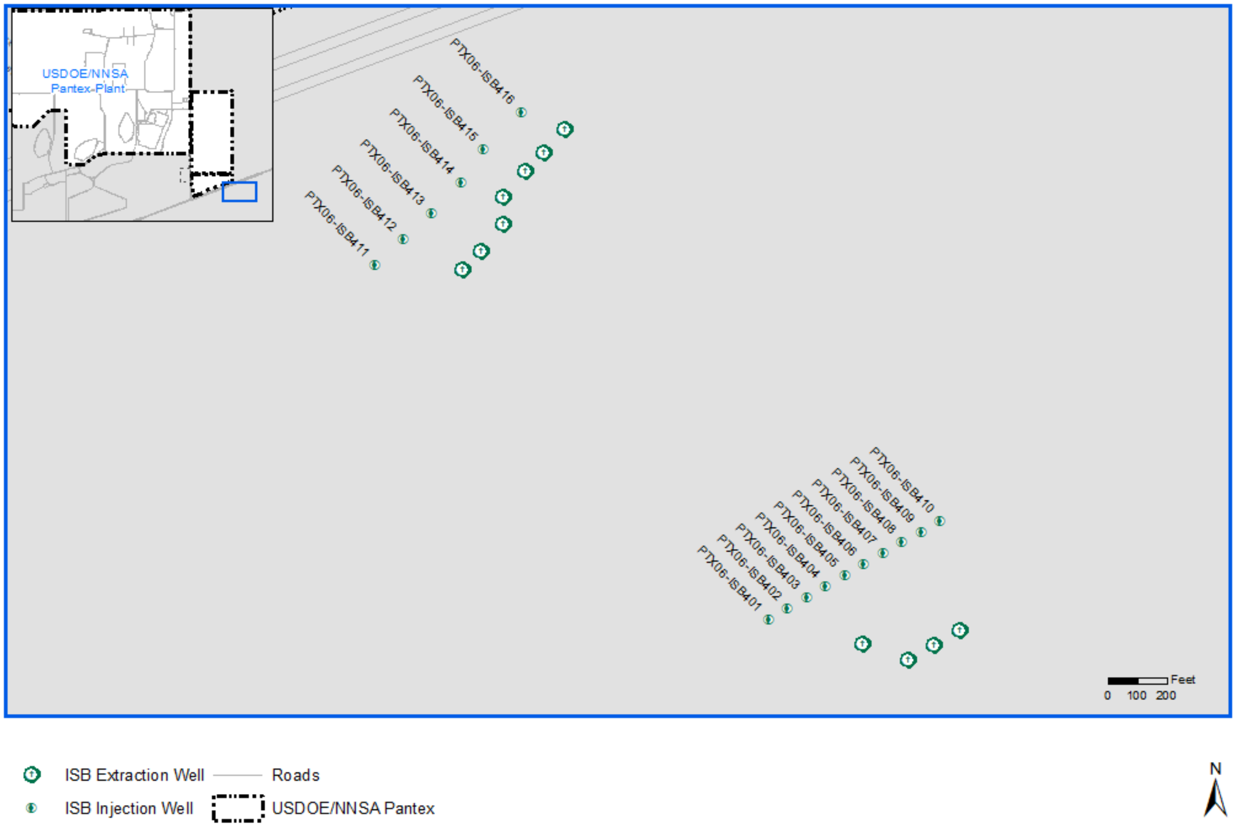

Figure 1-18. Offsite ISB System Wells

Table 1-10. Burning Ground SVE System Wells

Name	Well Depth[1]	Completion Date	Current Status	Easting	Northing
SVE-I-06	Intermediate	12/1/2001	Inactive	630006.43	3771358.79
SVE-I-11	Intermediate	12/24/2001	Inactive	630140.42	3771223.11
SVE-I-13	Intermediate	11/10/2001	Inactive	630024.96	3770909.40
SVE-I-16	Intermediate	12/10/2001	Inactive	630264.66	3770916.85
SVE-I-21	Intermediate	12/10/2001	Inactive	630142.72	3770795.37
SVE-I-26	Intermediate	11/17/2001	Inactive	630022.91	3770678.74
SVE-I-29	Intermediate	11/13/2001	Inactive	630245.81	3770680.38
SVE-S-05	Shallow	11/20/2001	Inactive	629996.81	3771361.24
SVE-S-07	Shallow	11/20/2001	Inactive	630130.43	3771359.23
SVE-S-08	Shallow	11/20/2001	Inactive	630070.51	3771300.84
SVE-S-09	Shallow	11/19/2001	Inactive	630005.69	3771220.82
SVE-S-10	Shallow	11/21/2001	Inactive	630131.84	3771220.90
SVE-S-12	Shallow	11/12/2001	Inactive	630016.08	3770920.93
SVE-S-13	Shallow	11/10/2001	Inactive	630024.96	3770909.40
SVE-S-14	Shallow	11/12/2001	Inactive	630133.76	3770915.03
SVE-S-15	Shallow	11/9/2001	Inactive	630254.26	3770915.75
SVE-S-17	Shallow	11/12/2001	Inactive	630074.42	3770855.43
SVE-S-18	Shallow	11/9/2001	Inactive	630194.14	3770855.08
SVE-S-19	Shallow	11/11/2001	Inactive	630012.77	3770795.38
SVE-S-20	Shallow	11/9/2001	Active	630133.75	3770795.37
SVE-S-22	Shallow	11/10/2001	Inactive	630254.47	3770794.59
SVE-S-23	Shallow	11/11/2001	Inactive	630074.68	3770735.48
SVE-S-24	Shallow	11/10/2001	Inactive	630194.80	3770735.89
SVE-S-25	Shallow	11/11/2001	Inactive	630015.03	3770678.85
SVE-S-27	Shallow	11/12/2001	Inactive	630134.13	3770679.10
SVE-S-28	Shallow	11/19/2001	Inactive	630238.26	3770681.91
SVE-S-30	Shallow	11/20/2001	Inactive	630077.40	3771163.35
SVE-S-31	Shallow	11/19/2001	Inactive	630005.18	3771080.74
SVE-S-32	Shallow	11/21/2001	P&A	630147.02	3771079.12
SVE-S-32A	Shallow	11/26/2001	Inactive	630153.88	3771082.13

[1]The shallow depth wells are screened from 20 to 45 ft and 50 to 90 ft bgs. The intermediate depth wells are screened from 95 to 180 ft and 190 to 275 ft bgs.

This well list represents the final configuration for the full-scale SVE system. SVE pilot test wells that were not appropriate for use in the final system were not included in this list.

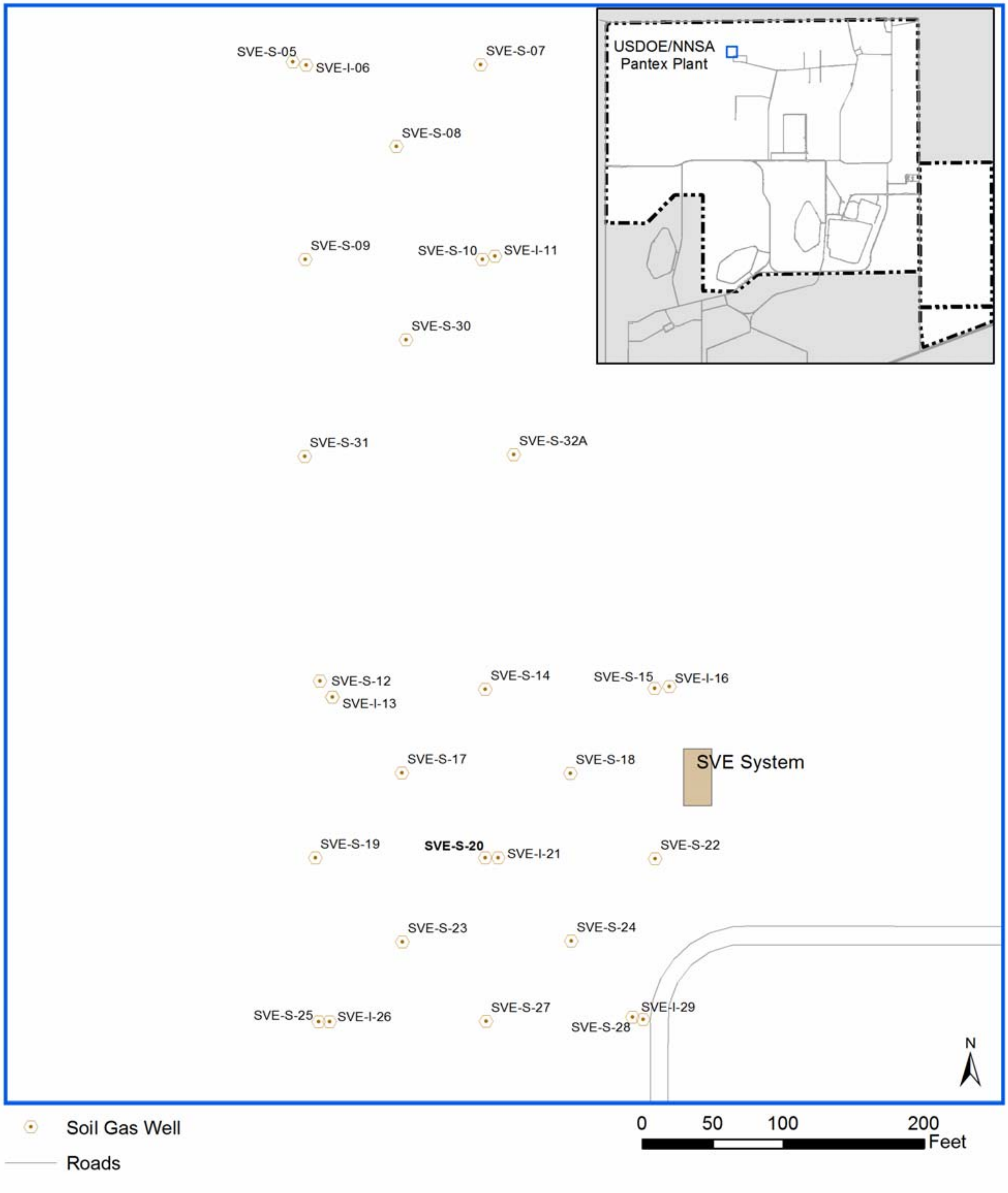

Figure 1-19. Burning Ground SVE Wells

1.6.4 Schedule of Activities

As detailed in HW-50284 and the IAG, Pantex must meet requirements under CERCLA and RCRA. In accordance with the IAG, Pantex has submitted a Site Management Plan (SMP) that provides a list of required activities and planned dates of completion.

Table 1-11 summarizes activities completed in 2020 since the date of the last annual report, activities completed in 2021 prior to the publication of this report, and activities that have projected starts or completions between July 2021 to June 2022. The schedule of activities included in the 2019 Annual Progress Report was the basis for this table, which also includes revisions made to that schedule.

Pantex completed 2020 activities related to recommendations from previous reports while completing normally scheduled monitoring and operations of the remedial actions. In response to COVID-19, some projects were delayed due to a Pantex-wide shutdown that was phased beginning the first of April 2020, with the treatment systems being shut down on April 9, 2020. Normal operations resumed beginning June 24, 2020, after plans were prepared to address worker safety.

The shutdown affected the operation of the groundwater pump and treat systems and SVE system, delayed ISB injections, and delayed completion of a portion of the groundwater sampling during the first half of the year. Some inspections were also put on hold while attempting to restart other work. No contracted annual landfill maintenance was performed, although onsite resources completed some work at the SVS7b landfills.

Some contractor projects were also paused for a time to ensure plans were put in place for worker safety. Work resumed on drilling as soon as possible to continue installing the offsite remediation system. Other projects were slower to restart due to the limited availability of resources at Pantex.

Pantex completed an FYR in 2013 and 2018. Most of the recommendations and issues to be addressed from the first FYR were completed before the second FYR. Some of the continuing evaluations, such as the expansion of plumes to the southeast, will continue to be addressed through issues and recommendations from the second FYR, from which a table of action items has been developed. Those actions are included in Section 6 of this report and will be tracked to completion.

The significant actions completed in 2020 and early 2021 in relation to the second FYR include:

Pantex committed to evaluating the expanding plumes of HEs east of FM 2373 in the first and second FYRs. To address the plume expansion, Pantex continues to evaluate and implement new actions to fully address the contamination.

Pantex completed the following tasks in 2020:

- 16 ISB injection wells, 11 ISB extraction wells, and 3 pump and treat extraction wells were installed on offsite property in 2020. Injection was planned to start in May 2021, but excessive rain required the schedule to be moved to June.
- Pantex contracted Hydrogeologic (HGL) to complete modeling evaluations while drilling two wells to determine the best placement of the other wells. This effort resulted in moving the wells to the leading edge of the plume to ensure full treatment of the plume.
- Pantex contracted for the installation of infrastructure for all phases of well drilling. Design of the infrastructure started in September 2020, and installation began in early 2021. Injection was delayed to construct the injection pad and install well components to extract water at the offsite property.
- Pantex continues to work with two landowners to implement deed restrictions on one property and obtain a long-term lease on the other property so that remediation work can continue. Currently, Pantex is installing the remediation system in limited areas based on a Right of Entry Agreement with the landowner. Deed restrictions are anticipated to be in place during 2021 and the landowner lease to be complete before the cessation of the Right of Entry in early 2022.
- Four additional wells were drilled on the eastern side of the Southeast ISB Extension to encompass the plume moving to the east. Two more wells have been planned for installation in 2021 to completely encompass the plume on the eastern boundary of the Pantex property.
- Pantex contracted the optimization of the pump and treat systems in 2020, which included another update to the conceptual site model and numerical model for the perched groundwater. This work will be completed and sent to the EPA and TCEQ by the end of September 2021, in accordance with recommendations in the second FYR.

Pantex has also implemented actions for the following recommendations made in the 2018 and 2019 Progress Reports:

- Pantex contracted for the design of a new center-pivot irrigation system east of FM 2373. Design started in October 2020 and was completed in May 2021. Contracting for construction began in May 2021.
- Installation and tie-in of new injection wells near Playa 2 are expected to be completed by the end of June 2021. The wells will allow up to 150 gpm of treated water to be injected when other beneficial use options are not available.

In-progress and upcoming activities continue to focus on the O&M and monitoring of the remedial actions; O&M of soil actions; progress on the second FYR's issues and recommendations; and implementation of recommendations made to treat the offsite plume. Some of the reporting and plans will require regulatory review and approval and are provided in bold in Table 1-11.

Table 1-11. Complete, In-Progress and Upcoming Activities

Activity	Start Date	Scheduled Complete Date	Actual Completion	CP Provision or Requirement	Origin of Recommended Action
Completed Work					
Landowner Right of Entry for limited installation and treatment of the plume	Dec 2019	Mar 2020	Mar 2020	HW-50284 Provision XI.E.1	
1st Semi-Annual 2020 Groundwater and ISB Sampling	Jan 2020	Jun 2020	Jul 2020	HW-50284 Provision XI.F	
Southeast ISB Extension Injection	Jun 2020*	Jul 2020	Aug 2020	IAG Article 8 HW-50284 Provision XI.E.1	
FY20 Drilling – Offsite Remediation System wells – Phase 1	Apr 2020	Sep 2020	Oct 2020	HW-50284 XI.B.1 and XI.B.2	2Q2019
Well Drilling – 2021 Offsite Remediation System Wells – Phase 2	Dec 2020	Jun 2021	Oct 2020	HW-50284 XI.B.1 and XI.B.2	2Q2019
Zone 11 ISB Rehabilitation and Injection	Feb 2020	Oct 2020*	Nov 2020	IAG Article 8 HW-50284 Provision XI.E.1	
2nd Semi-Annual 2020 Groundwater and ISB Sampling	Jul 2020	Dec 2020	Dec 2020	HW-50284 Provision XI.F	
Design Irrigation System East of FM 2373	Jan 2021	Jul 2021	May 2021	HW-50284 XI.B.1 and XI.B.2	4Q2018
Southeast ISB Extension Injection	Mar 2021	*Apr 2021	May 2021	IAG Article 8 HW-50284 Provision XI.E.1	
2nd Quarter 2020 Progress Report	Aug 2020	Sep 2020	Sep 2020	HW-50284 Provision XI.G.3 and IAG Article 16.4	
3rd Quarter 2020 Progress Report	Nov 2020	Dec 2020	Dec 2020	HW-50284 Provision XI.G.3 and IAG Article 16.4	
4th Quarter 2020 Progress Report	Feb 2021	Mar 2021	Mar 2021	HW-50284 Provision XI.G.3 and IAG Article 16.4	
1st Quarter 2021 Progress Report	Apr 2021	Jun 2021	Jun 2021	HW-50284 Provision XI.G.3 and IAG Article 16.4	
2020 Annual Progress Report	Mar 2021	Jun 2021	Jun 2021	HW-50284 Provision XI.G.3 and IAG Article 16.4	

Activity	Start Date	Scheduled Complete Date	Actual Completion	CP Provision or Requirement	Origin of Recommended Action
Work In-Progress					
Landowner Agreement for Deed Recordation	Apr 2020	*Dec 2021		HW-50284 Provision XI.E.1	
Landowner Lease Agreement for Remediation	Apr 2020	*Feb 2022		HW-50284 Provision XI.E.1	
Offsite ISB Injection	*June 2021	*July 2021		IAG Article 8 HW-50284 Provision XI.E.1	
Playa 2 injection wells – Design and construction of wells and infrastructure	Nov 2019	*June 2021		HW-50284 Provision XI.E.1	2Q2018
Design/Construct Offsite Infrastructure – Phase 1	Jun 2020	Sep 2020		HW-50284 XI.B.1 and XI.B.2	2Q2019
Design/Construct Offsite Infrastructure – Phase 2	Jan 2021	Sep 2021		HW-50284 XI.B.1 and XI.B.2	2Q2019
1st Semi-Annual 2021 Groundwater and ISB Sampling	Jan 2021	Jun 2021		HW-50284 Provision XI.F	
Optimization Evaluation of Pump and Treat Systems	Jan 2021	*Sep 2021		HW-50284 XI.B.1 and XI.B.2	2018 FYR
Annual Landfill Cover Maintenance – 2021	Jun 2021	Aug 2021		IAG Article 8.9 HW-50284 Provision XI.E	4Q2015, 2015A
Well Drilling – 2021 Drilling (replaces Zone 11 recirculation project and enhances Zone 11 ISB, SE ISB Ext, and Offsite ISB)	May 2021	Oct 2021		HW-50284 XI.B.1 and XI.B.2	2Q2019
Construct Irrigation System East of FM 2373	Jun 2021	Sep 2022		HW-50284 XI.B.1 and XI.B.2	4Q2018
Zone 11 ISB Rehabilitation and Injection	Jun 2021	Oct 2021		IAG Article 8 HW-50284 Provision XI.E.1	
Upcoming Work					
Southeast ISB Extension Injection	Sep 2021 Mar 2022	Oct 2021 Apr 2022		IAG Article 8 HW-50284 Provision XI.E.1	

Activity	Start Date	Scheduled Complete Date	Actual Completion	CP Provision or Requirement	Origin of Recommended Action
Southeast ISB Rehabilitation and Injection	Oct 2021	Jan 2022		IAG Article 8 HW-50284 Provision XI.E.1	
Offsite ISB Rehabilitation and Injection	Oct 2021 Apr 2022	Oct 2021 Apr 2022		IAG Article 8 HW-50284 Provision XI.E.1	
Design/Construct Offsite Infrastructure – Phase 3	Sep 2021	Sep 2022		HW-50284 XI.B.1 and XI.B.2	2Q2019
Design/Construct Perchlorate Pre-Treatment at SEPTS	Jul 2021	Jun 2022		HW-50284 XI.B.1 and XI.B.2	2019A
Design/Construct Mobile Pump and Treat System	Aug 2021	Apr 2022		HW-50284 XI.B.1 and XI.B.2	2Q2019
Well Drilling – 2022 Offsite Remediation System Wells – Phase 3	Jan 2022	Sep 2022		HW-50284 XI.B.1 and XI.B.2	2Q2019
Five Year Review Reporting – Contracting, Evaluation, and Reporting	Mar 2022	Jul 2023		HW-50284 CP Table VII, Item 26 and IAG Article 21	
LiDAR Study of Pantex Landfills to support Five Year Review	Mar 2022	Aug 2022		HW-50284 CP Table VII, Item 26 and IAG Article 21	
Explanation of Significant Difference	Mar 2022	Sep 2022		HW-50284 CP Table VII, Item 26 and IAG Article 21	
Annual Landfill Cover Maintenance – 2022	Mar 2022	Jul 2022		IAG Article 8.9 HW-50284 Provision XI.E	4Q2015, 2015A
Zone 11 ISB Rehabilitation and Injection	Jun 2022	Oct 2022		IAG Article 8 HW-50284 Provision XI.E.1	
2nd Quarter 2021 Progress Report	Aug 2021	Sep 2021		HW-50284 Provision XI.G.3 and IAG Article 16.4	
3rd Quarter 2021 Progress Report	Nov 2021	Dec 2021		HW-50284 Provision XI.G.3 and IAG Article 16.4	

Activity	Start Date	Scheduled Complete Date	Actual Completion	CP Provision or Requirement	Origin of Recommended Action
4th Quarter 2021 Progress Report	**Feb 2022**	**Mar 2022**		HW-50284 Provision XI.G.3 and IAG Article 16.4	
1st Quarter 2022 Progress Report	**Apr 2022**	**Jun 2022**		HW-50284 Provision XI.G.3 and IAG Article 16.4	
2021 Annual Progress Report	**Mar 2022**	**Jun 2022**		HW-50284 Provision XI.G.3 and IAG Article 16.4	
1st Semi-Annual 2021 Groundwater and ISB Sampling	Jan 2022	Jun 2022		HW-50284 Provision XI.F	
2nd Semi-Annual 2021 Groundwater and ISB Sampling	Jul 2021	Dec 2021		HW-50284 Provision XI.F	

*Revised activity or date.

"Origin of Recommended Actions" refers to the report that first presented the recommendation to complete the project. Year plus "A" refers to the specific yearly annual progress report while the quarter and year refers to the specific quarterly progress report that presented the recommendation.

FYR - Five-Year Review

Activities in bold require regulatory interaction and/or review and approval

2.0 Operation and Maintenance of Remedial Actions

Operation of the remedial actions is critical to meeting the remedial action objectives established in the ROD. Maintenance activities, both routine and unscheduled, ensure that the systems continue to operate optimally. This section summarizes the remedial action systems' O&M efforts to provide an understanding of the remedy's effectiveness.

2.1 Pump and Treat Systems

The pump and treat systems were described in Section 1.4. In 2020, these systems continued to reduce saturated thickness and contaminant mass in the southeast perched groundwater, although they were impacted by reduced flow and shutdowns resulting from the subsurface irrigation breakdown. These data demonstrate that the systems are effective in removing mass and water from the perched aquifer, and system operation continues to move towards meeting Pantex's remedial action objectives.

Appendix B contains the monthly flow calculations for each active well and detailed O&M information.

Pump and Treat Systems Milestones

2020	Since Startup
• 99 million gallons treated	• 2.9 billion gallons treated
• 4% of treated water beneficially used	• 1.7 billion gallons beneficially used
• 398 lbs of contaminants removed	• 15,535 lbs contaminants removed

2.1.1 Playa 1 Pump and Treat System

A description of the P1PTS is provided in Section 1.4.2. The operational goals for the systems were realigned in 2014 and are depicted in the highlight box in Section 1.4.1. These goals are prioritized and will be met as conditions allow.

The P1PTS was designed with a treatment capacity of 250 gpm or 360,000 gallons per day (gpd) and could potentially treat up to 131 million gallons (Mgal) of water per year running at design capacity and 100% operation. P1PTS releases all water through the WWTF, so operation is affected when water cannot be released to the WWTF. Operation of P1PTS has been impacted by a break at the irrigation system that occurred in late June 2017 and required an engineering evaluation and complex repairs. Once the break was repaired, the system had to be tested and repaired for leaks and communication issues. Troubleshooting and repairs continue for the communication failure.

While the irrigation system remains down, the WWTF's treated water is being routed to Playa 1. Flow to Playa 1 is restricted by permit; therefore, Pantex has also reduced the P1PTS's operation to allow higher recovery at the SEPTS, which provides better control of the RDX plume's movement to the southeast. This reduction in operation is reflected in the reduced number of operational days and throughput for the system.

During 2020, P1PTS was operated one week per quarter to maintain function and operability, with the exception of a shutdown executed as a COVID-19 response or when SEPTS could not be fully operated. When both systems are operated, flow must be reduced at both systems due to permit restrictions that limit its release to Playa 1.

The following figures depict the P1PTS's system operation, throughput, and well operation, providing the percentage of design capacity or operation achieved as well as goals for the system. While operation and throughput were reduced in 2020 to allow better capture of the RDX plume through the SEPTS's increased operation, the 90% goals are still depicted in the graphs and used to identify potential issues with system or well operation.

The P1PTS operated 78 days during 2020 with an average annual operational rate of 22%, based on total hours operated versus total possible operation time. The actual percentage of monthly system operational time versus the target percentage is depicted in Figure 2-1.

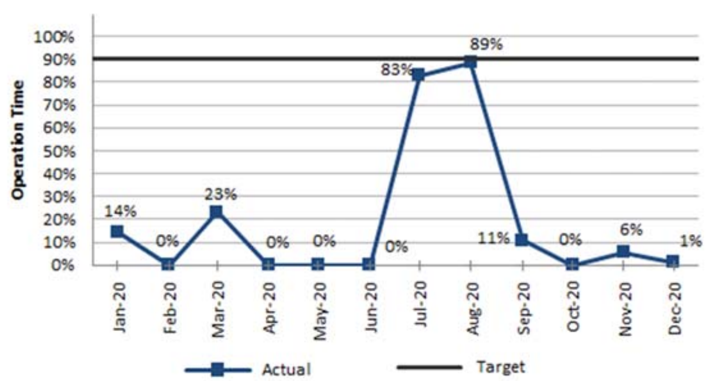

Figure 2-1. P1PTS Operation Time vs Target

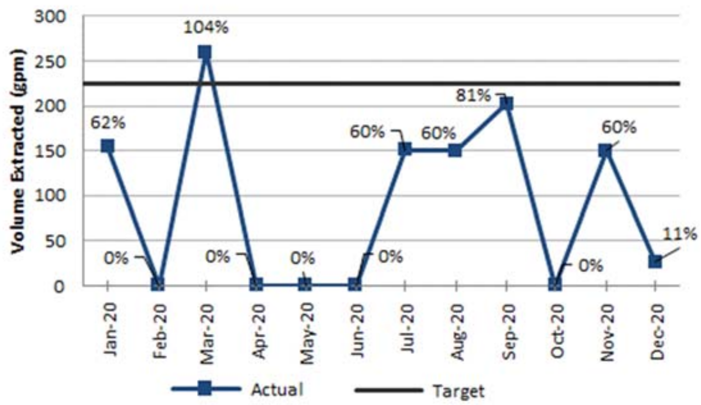

Figure 2-2. P1PTS Average GPM and % Capacity

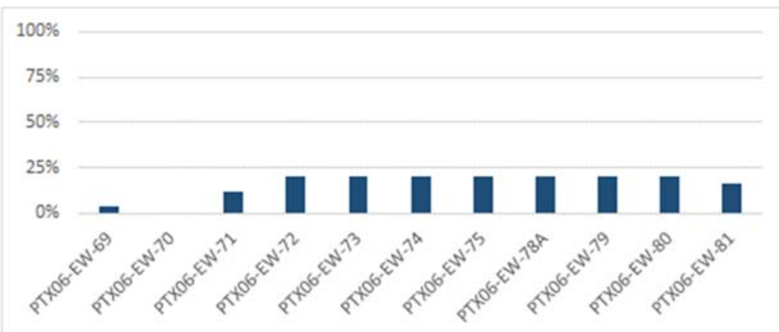

Figure 2-3. P1PTS Well Operation Time

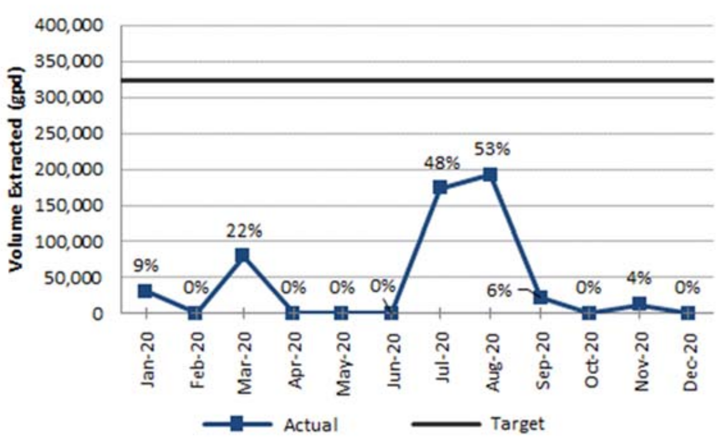

Figure 2-4. P1PTS Average GPD and % Capacity

Figure 2-2 depicts the average gpm extracted from all wells by month. The P1PTS system extracted an average of 156 gpm (about 62% of design throughput) from the well field while operating in 2020. The calculated gpm accounts for water extracted from the well field when the system operated and is affected by each well's yield, downtime, or reduced flow required by the WWTF/irrigation system.

Figure 2-3 reflects the operation time by well. Two wells were down last year and in need of repair. Those wells are included in a contract to address the electrical and pump issues. All other wells were running when the system was periodically operated.

Figure 2-4 reflects the P1PTS's overall system efficiency considering system and well operation. The system treated an average of about 42,600 gpd during 2020, which is approximately 12% of design capacity. The gpd is affected by system operational time, ability to extract water from the wells, and reduced flow to the WWTF and irrigation system. The system treated approximately 16.3 Mgals during 2020, with an average treatment volume of about 2.3 Mgals per month when operating.

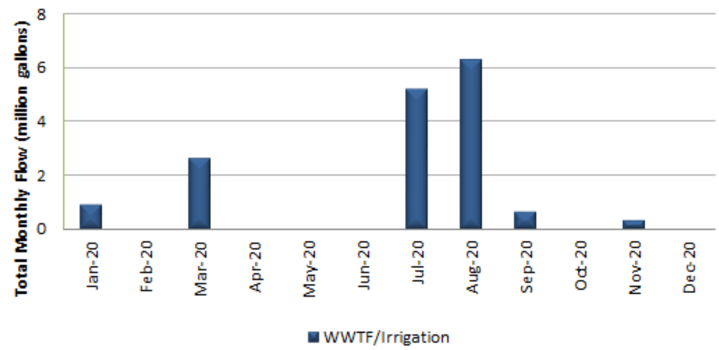

Figure 2-5. P1PTS System Monthly Total Flow

The monthly treatment flow volumes and treated water usage are depicted in Figure 2-5.

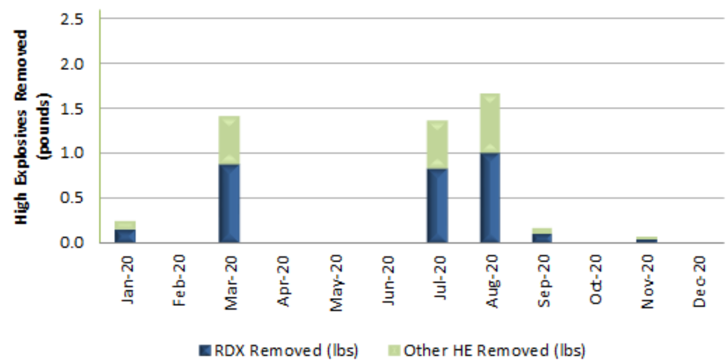

Figure 2-6. P1PTS Mass Removal by Month

During 2020, the system removed approximately 3 pounds (lbs) of RDX and 2 lbs of all other HEs (see Figure 2-6). The average removal rate of HEs was approximately 0.3 lbs per million gallons (lbs/Mgal) of treated water. Since startup in September 2008, the system has removed a total of 549 lbs of RDX and 221 lbs of all other HEs.

HE mass removal is dependent on the wells operated within the system, which affects influent concentrations and throughput. Source concentrations from Playa 1 are rapidly declining, with a small area directly beneath the Playa now demonstrating full treatment (see the plume maps in Section 3). Therefore, most wells are no longer in the higher-concentration HE plume; thus, mass removal is low at P1PTS. Two of the wells that continue to capture higher concentrations were down last year, causing slightly suppressed influent concentrations. However, even with the operation of those two wells, influent concentrations have greatly decreased at the P1PTS.

The average influent concentration of RDX was 148 ug/L in 2009 while the average influent concentration in 2020 was 18.3 ug/L. The maximum influent RDX concentration in 2009 was 200 ug/L and 19.4 ug/L in 2020. This system primarily reduces saturated thickness and head on the southeast perched groundwater, although mass removal is also achieved.

Evaluation of effluent data indicates that the system treated the recovered groundwater to concentrations below the GWPS. The complete set of effluent data collected during 2020 is included in Appendix D's electronic data tables.

Pantex also evaluates extraction wells near SWMU 5-12's ditch for evidence of contamination that could affect the P1PTS. In the past, wells in that area indicated the presence of perchlorate and 1,4-dioxane, which are not treatable by GAC. The plumes have shrunk back toward the source areas and are no longer expected to reach the P1PTS.

Pantex re-evaluated goals for the pump and treat systems to emphasize beneficial use of treated water while continuing to meet remedial action goals. These goals first emphasize meeting the 90% operational goal; however, when flow is restricted to the WWTF system, the P1PTS is shut down or flow is restricted at both systems to avoid injection, if possible. During 2020, the filter bank break at the irrigation system heavily impacted the P1PTS's throughput, goals to remove water from Playa 1, and minimizing of injecting treated water into the contaminated portion of the perched aquifer.

Pantex has evaluated other methods to manage treated water and, in 2018, recommended extending the line going to the Zone 11 ISB to an area east of Playa 2 and injecting treated water there. That project started in late 2019 and will be complete in June 2021. Pantex also completed the design of a new center-pivot irrigation system east of FM 2373 in May 2021. Contracting for construction will be complete by July 2021, with project completion expected by summer 2022.

In 2020, the P1PTS was in its twelfth year of operation. Operational performance was low for most of the year. Performance was affected by the break at the irrigation system filter bank, which required reduced operations to allow higher operation of the SEPTS. However, paging system issues and carbon/resin change-out also contributed to reduced operations. In particular, paging system issues impact the ability to operate the system overnight or on weekends. The aging supervisory control and data acquisition (SCADA) system can no longer use the existing paging system to send warnings and alerts to pump and treat personnel; therefore, the system must be shut down overnight and on weekends to avoid potential issues with the unplanned release of water from the system.

Pantex is working to update the paging system but must work within security requirements for Pantex and gain approval for new paging system call-outs. The existing paging system call-outs are expected to be updated and operational by summer 2021. Additionally, Pantex has requested funding in 2022 and 2023 to design and install a complete new SCADA system at both pump and treat systems to ensure continued reliability of the systems operation. Pantex is preparing to contract for the new SCADA system's design and construction by August 2021. Construction is expected to begin by summer 2022.

2.1.2 Southeast Pump and Treat System

The SEPTS is designed to treat up to 300 gpm or 432,000 gpd and has the capability to treat 158 Mgal, annually, if operated at 100%.

During 2020, the SEPTS operated all or part of 264 days with an average operational rate of 70%, based on total hours operated versus total possible operation time. The percent operation time (i.e., hours per day) versus the target operation time is depicted in Figure 2-7.

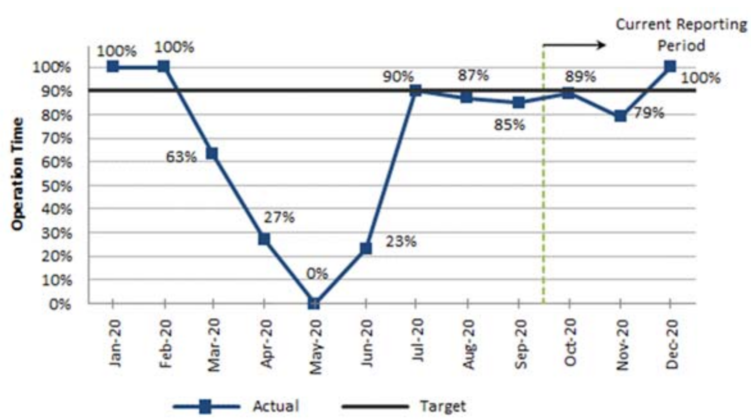

Figure 2-7. SEPTS Operation Time vs Target

System operation was affected by a shutdown for COVID-19, power outages, paging issues, computer failure, building maintenance, and carbon/resin change-out. Other than during the COVID-19 shutdown, operation was consistent at the SEPTS due to shutdown of P1PTS. When P1PTS is operating, flow is reduced at the SEPTS to meet discharge permit limits to Playa 1 and minimize injection into the perched aquifer.

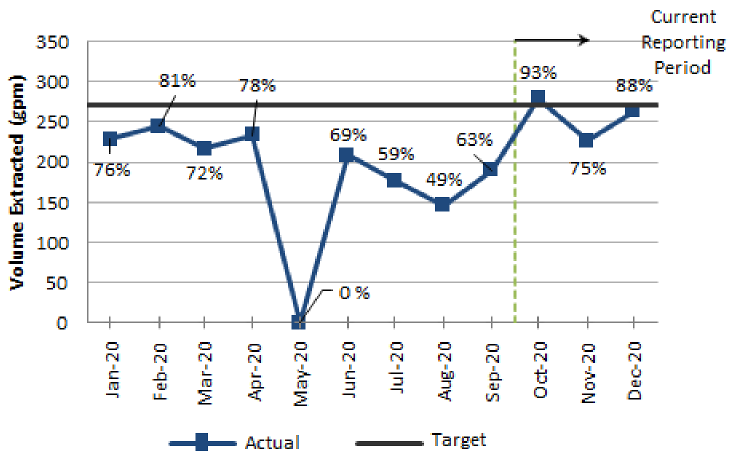

Figure 2-8. SEPTS Average GPM and % Capacity

As a measure of well operation efficiency, Figure 2-8 depicts the average gpm extracted from all wells by month, the percentage of design capacity achieved, and system goals. Unless flow is affected by the WWTF or other issues, the system's operational rate has been the prioritized goal after June 2014. Even though the 90% throughput goal was not applicable during portions of 2020, it is still depicted in the graphs, and well throughput is evaluated to identify potential issues.

The system extracted an annual average of 224 gpm (about 67% of design capacity) from the well field while operating. The calculated gpm accounts for water extracted from the well field during the time the system operated and is affected by each well's yield, downtime, or reduced flow required by the WWTF/irrigation system. Because the WWTF/irrigation system was unable to receive full flow from the pump and treat systems, flow was sent to Playa 1 in accordance with permit limits, and injection into the perched aquifer was minimized. The SEPTS operated fully, when possible, with shutdown of P1PTS used to increase flow and treatment through the SEPTS.

Well operation was reduced when the P1PTS was operated at the first of each quarter. Flow was limited to Playa 1 when both systems were operating to reduce injection into the perched groundwater. Well operation and throughput were also affected by the number of extraction wells that were down in 2020 as well as by the ability to only operate one pump and treat injection well. Well repairs require the use of an electrical contractor, and contracting was set up after return from COVID-19 shutdown; however, well repairs were delayed due to restrictions on the number of lockout/tagouts allowed for each round of repairs. When 90% flow could not be achieved at SEPTS in July, August, and early September, P1PTS was operated in addition to SEPTS.

Because the SEPTS has 65 operating wells, it is currently capable of extracting more water than its maximum treatment capacity. For this reason, not all wells are pumping within the SEPTS on a daily basis. Estimated flow volumes for each well in the SEPTS are included in Appendix B.

Six new extraction wells, PTX06- EW-83 through EW-88, were installed in 2016 to control the movement of HE plumes to the southeast. Those wells were connected to SEPTS and began consistent operation in May 2019. However, those wells were impacted in May 2020 by farming equipment that cut the overhead electrical line to the wells. Due to the complexity of the repair, electricity was not available to the wells until April 2021.

Although perched groundwater levels are declining, the extraction rates from the well field currently exceed the treatment system's capacity. Pantex extracts from the well field according to set priorities that best meet long-term objectives. The seven well-extraction priorities for operating wells are as follows and depicted in Figure 2-9:

- Priority 1 wells: Wells along the eastern edge of the well field (i.e., along the eastern fence line of the main plan) and a line of wells east of FM 2373 that are used to control the continued movement of water and contamination to thinner saturated zones at the margin of the perched aquifer where pump and treat technology is ineffective. The new wells, PTX06-EW-83 through PTX06-EW-88, are included in this group.
- Priority 2 wells: Wells along the southern edge of the system that were installed to capture the highest concentrations of hexavalent chromium and prevent the plume's migration to thinner saturated zones or into areas where the FGZ is more permeable.
- Priority 3 wells: Wells along the southeastern edge of the system that capture the highest concentrations of RDX and prevent the plume's migration to thinner saturated zones or into areas where the FGZ is more permeable.
- Priority 4 wells: Wells along the northern edge of the hexavalent chromium plume from the Zone 12 South area.
- Priority 5 wells: Wells close to the highest concentrations of RDX. These wells will continue to capture the RDX plume movement when the Priority 3 wells are not pumping.

- **Priority 6 wells:** Wells that capture the center of the hexavalent chromium plume from the former cooling tower on the eastern side of Zone 12.
- **Priority 7 wells:** All other wells in the SEPTS. With the exception of EW-49, these wells help reduce saturated thickness in the perched aquifer and remove head that pushes the groundwater horizontally and vertically but will not be as effective at controlling plume movement. EW-49 is in a low-transmissivity zone and, thus, is a very low-producing well. For this reason, it was not placed in a high priority for pumping.

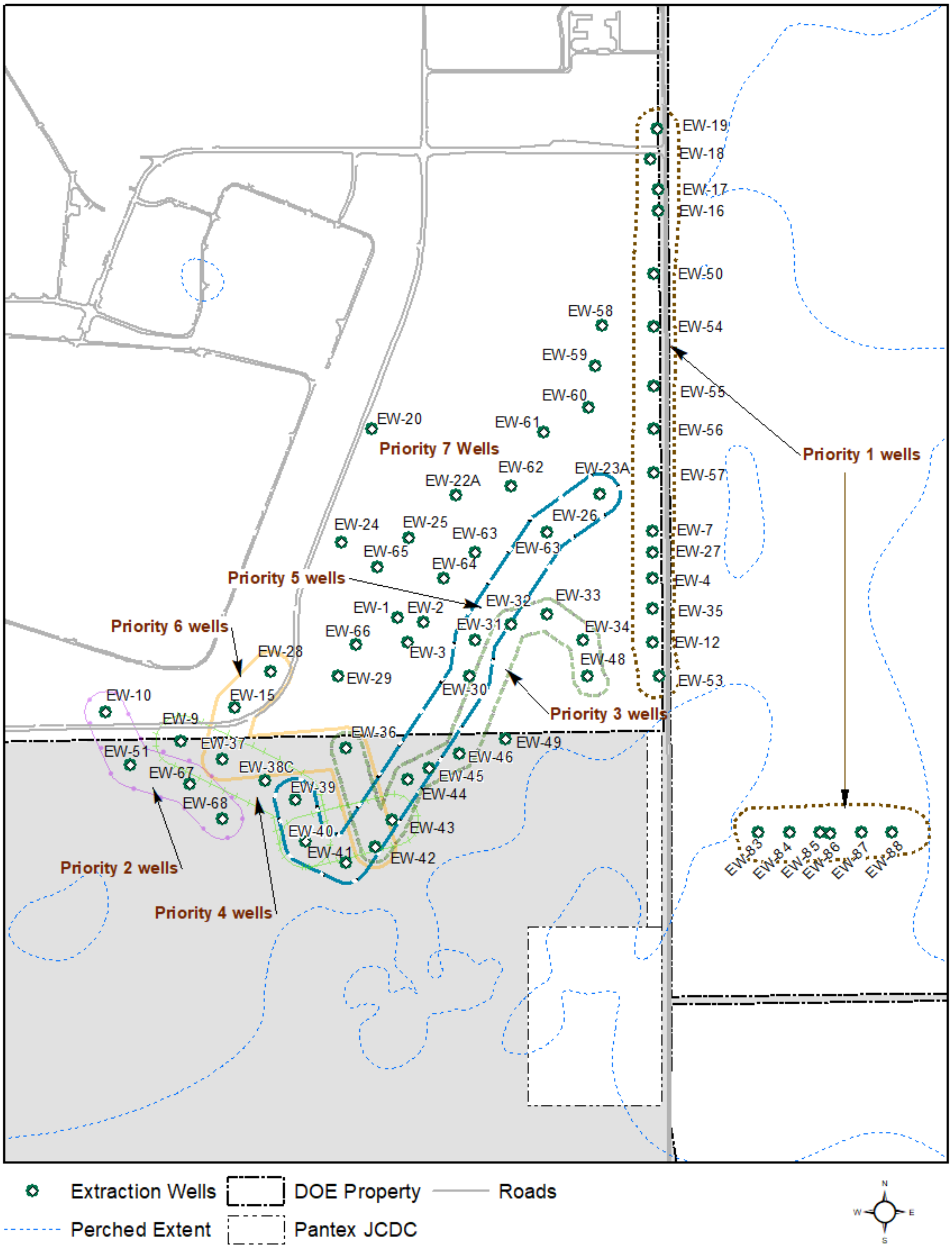

Figure 2-9. Extraction Well Prioritization

During 2020, the highest-priority wells were operated to meet extraction rates, unless issues with maintenance or low water levels occurred at the wells. Lower-priority wells were only operated to make up additional flow that was needed. Due to the number of wells that were down after return from the COVID-19 shutdown, all available wells were operated.

This prioritization scheme was implemented in 2009 after the system was expanded. Figure 2-10 provides the percentage of days on which the wells were operated in the SEPTS. Priority 1-5 wells were operated at higher frequencies with the exception of wells that had repair issues, were locked out due to repair issues with wells on the same line, or had low water levels that prevent them from operating properly. Two wells, PTX06-EW-10 and PTX06-EW-51, in the perchlorate plume were shut down while contracting for the design and installation of perchlorate pre-treatment.

Some of the high-priority wells are in areas that have rapidly declining water levels and/or are in low-yield portions of the formation. Those wells are operated intermittently due pumps cycling on and off. As the system continues to remove water from the perched aquifer, this effect is becoming more prominent in wells in thin, saturated portions of the perched aquifer. In particular, many wells along the eastern fence line and to the south on TTU property are frequently cycling off due to the limited saturation in some areas.

Several wells have gone dry and have been removed from the pumping network. As noted in the *4th Quarter 2017 Progress Report*, a well video at PTX06-EW-58 indicated multiple stress fractures in the casing. In late 2020, this well was lined with a smaller casing and screen. The well will be operated until it fails and then replaced, if needed. Priority 6 and 7 extraction wells were operated as needed to ensure that wells remain operational or to make up flow.

The prioritization of the well pumping is expected to change based on results of optimization that will be completed in 2021 or be discontinued in the future as the pump and treat system’s capacity exceeds extraction rates. Pantex has contracted for support and is currently repairing the wells with the goal of having all repairs complete by summer 2021.

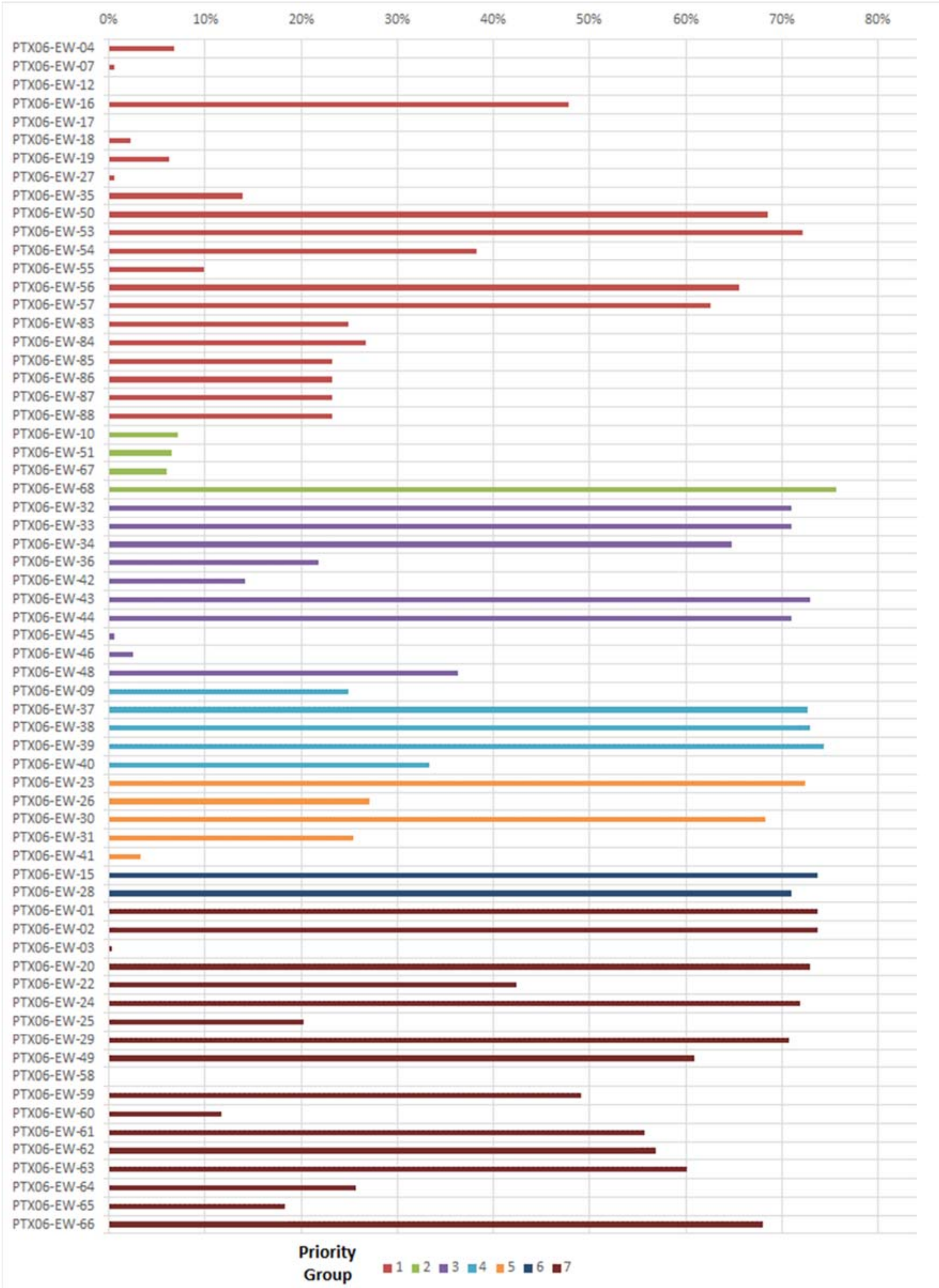

Figure 2-10. 2020 SEPTS Well % Operation

Figure 2-11. SEPTS Average GPD and % Capacity

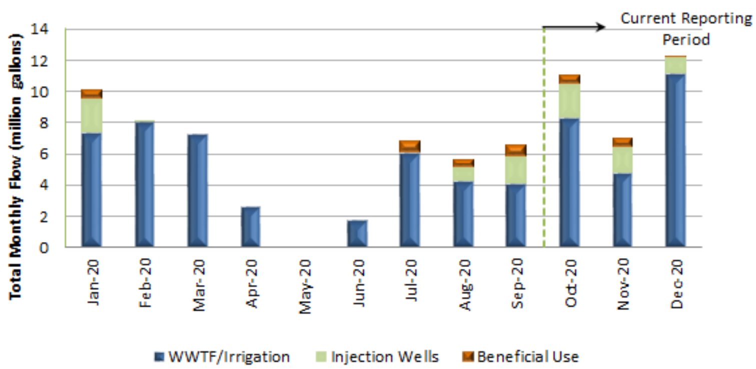

Figure 2-12. SEPTS Total Flow Volume and Disposition of Effluent

Figure 2-11 reflects the SEPTS's overall efficiency considering system and well operation. The figure depicts the average daily treatment rate in gpd by month, the target, and the percentage of total capacity achieved at the SEPTS. In 2020, the SEPTS treated an annual average of approximately 224,318 gpd (about 52% of design capacity), based on total possible hours of operation and total inflow from the well field.

The gpd is affected by system operational time, the ability to extract water from the wells, and reduced flow to the WWTF and irrigation system. As discussed above, the system was primarily affected by the loss of wells that required repair and reduced throughput to the WWTF/irrigation system due to the break at the irrigation filter bank. Throughput is reduced when both systems are operating, and operational time was primarily affected by the COVID-19 shutdown. Operation was also impacted by carbon change-out, building maintenance, computer failure, power outages, and paging system issues.

The system treated approximately 82.8 Mgals of extracted water during 2020. The total volume treated by month and the final disposition of the treated water are depicted in Figure 2-12. Approximately 12% of the treated water was injected into the perched aquifer, 5% was used beneficially for ISB injection, and the remainder was released to Playa 1 via the WWTF.

The SEPTS primarily removes RDX and hexavalent chromium from the perched groundwater. The system removed approximately 45 lbs of hexavalent chromium, 187 lbs of RDX, and 156 lbs of all other HEs during 2020. The total mass removed for hexavalent chromium and HEs, by month, is depicted in Figure 2-13 and Figure 2-14. The average removal rate of hexavalent chromium was 0.5 lbs/Mgal of water, and the average removal rate for HEs was 3.8 lbs/Mgal of water.

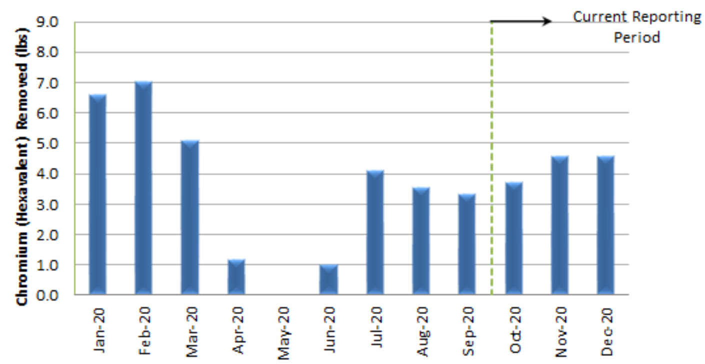

Figure 2-13. SEPTS Chromium Mass Removed by Month

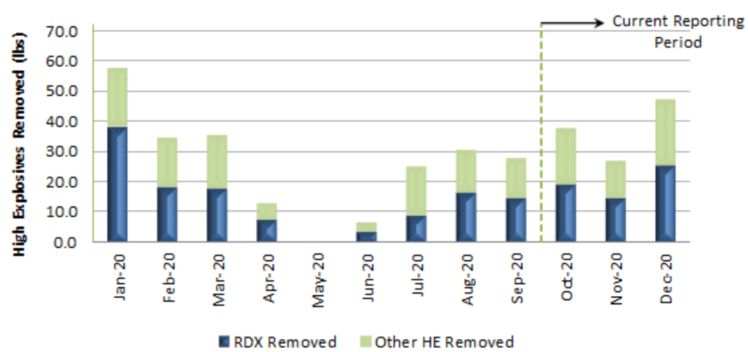

Figure 2-14. SEPTS High Explosive Mass Removed by Month

Hexavalent chromium mass removal is declining because concentrations in PTX06-EW-51 and nearby extraction wells continue to decline. PTX06-EW-51 was located in the heart of the hexavalent chromium plume south of Zone 12 and contributed heavily to the hexavalent chromium influent concentrations at the SEPTS. The plume has moved downgradient, and other extraction wells now capture portions of it even though concentrations are much lower at these wells. HE mass removal is affected by wells that operate in higher-concentration portions of the RDX plume. Overall, average concentrations of RDX in the SEPTS influent have declined with average concentrations about 570 ug/L in 2009, the first year of the full remedial action, to about 230 ug/L in 2020. Average influent concentrations of hexavalent chromium were approximately 214 ug/L in 2009 and approximately 73 ug/L in 2020.

This system has treated approximately 13,000 lbs of HEs and 1,765 lbs of hexavalent chromium since it started operating. Evaluation of effluent data indicates the system treated the recovered groundwater to concentrations below GWPS.

A summary of COC effluent detections at the SEPTS is included in Table 2-1, with the exception of boron, which is detected in all samples and continues to remain below the GWPS. The complete set of effluent data collected during 2020 is included in Appendix D.

Table 2-1. Summary of Effluent COC Detections at SEPTS

Sample Date	Analyte	Measured Value (ug/L)	Bkgd (ug/L)	> Bkgd?	PQL (ug/L)	> PQL?	GWPS (ug/L)	> GWPS?
1/8/2020	Perchlorate	4.2	0.96	Y	10	N	26	N
1/20/2020	Perchlorate	5.1	0.96	Y	10	N	26	N
2/4/2020	Perchlorate	5.3	0.96	Y	20	N	26	N
2/18/2020	Perchlorate	4.8	0.96	Y	20	N	26	N
2/18/2020	Perchlorate	5.11	0.96	Y	5	Y	26	N
3/4/2020	RDX	0.115	NA	NA	0.256	N	2	N
3/4/2020	Chromium, Total	5.1	32	N	10	N	100	N
3/4/2020	Perchlorate	6.1	0.96	Y	20	N	26	N
4/7/2020	Perchlorate	0.8	0.96	N	2	N	26	N
7/21/2020	Perchlorate	1.7	0.96	Y	5	N	26	N
8/6/2020	Perchlorate	4.1	0.96	Y	10	N	26	N
8/17/2020	Perchlorate	6.2	0.96	Y	10	N	26	N
9/2/2020	Perchlorate	8	0.96	Y	20	N	26	N
9/21/2020	Perchlorate	0.4	0.96	N	1	N	26	N
10/7/2020	Perchlorate	6.9	0.96	Y	20	N	26	N
10/21/2020	Perchlorate	4.8	0.96	Y	10	N	26	N
11/18/2020	Chromium, Total	4.7	32	N	10	N	100	N
11/18/2020	Perchlorate	3.4	0.96	Y	10	N	26	N
12/2/2020	Chromium, Total	8.1	32	N	10	N	100	N
12/2/2020	Perchlorate	4.9	0.96	Y	10	N	26	N

J = Estimated value representing a concentration detected less than the practical quantitation limit and equal to or greater than the method detection limit (MDL).

In accordance with the *Pantex Plant Ogallala Aquifer and Perched Groundwater Contingency Plan* (Pantex, 2019c), Pantex also evaluated five extraction wells (PTX06-EW-9, -EW-10, -EW-51, -EW-67, and -EW-68) for evidence of perchlorate. Due to removal of perched water, flow directions are changing along the eastern side of Zone 11; therefore, perchlorate, which is not treatable by GAC, has moved into the southwestern portion of the SEPTS's extraction well field. Perchlorate was detected in the two closest downgradient extraction wells starting in 2017, with concentrations increasing since then.

Pantex has evaluated options to treat perchlorate through the SEPTS since it is expected to move through the same area as the hexavalent chromium plume. Pantex continued to operate one of the extraction wells during early 2020. The maximum SEPTS influent concentration of perchlorate was 10 ug/L during the year. Pantex continued to operate one of the perchlorate-impacted wells since the current hexavalent chromium resin treatment can remove a limited amount of perchlorate. As concentrations increased at the individual wells, both were shut down until a perchlorate pre-treatment could be added to the system.

Overall, the SEPTS continues to remove and treat water from the well field. The system was primarily affected by a COVID-19 shutdown, a break at the irrigation system filter bank, and permit restrictions that limit release to Playa 1. Pantex has evaluated options to better manage the treated water. As discussed in the *2nd Quarter 2018 Progress Report*, Pantex is currently completing construction of a line that extends from the current Zone 11 ISB system to an area east of Playa 2 for the injection of the treated water when the ISB system is not using it for injection. The project is currently underway and is expected to be complete in June 2021 to help increase flow until the pivot irrigation system is constructed.

Since the injection line will only allow 150 to 180 gpm, Pantex is also planning to design and construct up to five small center-pivot irrigation systems in fields east of FM 2373. This project is currently planned to receive treated water from the pump and treat systems and will provide a consistent, long-term, high-volume option to manage treated water. A future option to tie-in the WWTF effluent is included in the design. Currently, the design is underway with the 100% design planned for completion by June 2021. Contracting for construction will begin in June 2021.

2.2 ISB Systems

Pantex has installed and operates three ISB systems as part of the final Remedial Action for groundwater. One system is southeast of the Plant on TTU property, one is south of Zone 11, and one is southeast of the main Plant (i.e., east of FM 2373) at the extreme southeast boundary of USDOE/NNSA-owned property. System information and maps are provided in Section 1.4.2. In 2020, the ISB systems consisted of 125 treatment zone injection wells, 5 treatment zone monitoring wells, and 18 ISPM wells. Some of the wells are now dry or inactive due to changing conditions at the ISBs.

In the past, the systems were injected with Newman Zone®, an emulsified soybean oil. Based on indications that the amendment was not distributing well, Pantex conducted studies at the Zone 11 ISB to determine an approach that could impact monitoring wells located between the injection points. Based on the study, Pantex has moved to the sole use of a more soluble carbon source, such as molasses, in the systems. This change has also required more frequent injection of amendment to ensure continued treatment of COCs. With the exception of the Offsite ISB, each system's frequency of injection is determined by the amount of saturated thickness and water movement through the system.

Injection volumes and amendment concentrations are planned based on the Zone 11 ISB study, which indicated that a higher volume of amended water was needed to affect areas between the wells. A dose response study was conducted early in the 2018 injection event to determine if a solution of molasses mixed with Newman Zone® would reach the areas between the wells at an appreciable concentration. Pantex also studied three TZM wells between the injected wells, allowing for a robust study on the effectiveness of injection.

For the study, fluorescein dye was injected into five injection wells (PTX06-ISB091, PTX06-ISB092, PTX06-ISB096, PTX06-ISB103, and PTX06-ISB104), and three monitoring wells (PTX06-1164, PTX06-1176, and PTX06-1177) were monitored to evaluate the distribution of the injection solution. Samples were collected for visual comparison to a pre-mixed fluorescein standard and for laboratory analysis for total organic carbon (TOC). Because TOC data analysis and reporting would be delayed, the fluorescein dye was used as a tracer to determine when injection should be discontinued. Dye arrival was not observed at the monitoring locations when the target volume was reached; therefore, injections were continued until dye arrival was confirmed or a volume equivalent to 20% mobile porosity was reached.

The study indicated that only the more soluble carbon (i.e., molasses) reached the monitoring points between the injection wells. Calculations using dye and TOC concentration results indicate that injection volumes must be increased. Information from this study is now used at all ISBs to determine injection volumes.

Based on the dose response study, future operation of all ISBs will focus on the use of a more soluble carbon (e.g., molasses) to achieve the distribution needed at the ISB Systems. This is important since the Zone 11 ISB and Southeast ISB systems are configured with 100-ft spacing between injection wells. The Southeast ISB Extension was configured with 75-ft spacing to overcome known problems with distribution. This approach will be evaluated through continued monitoring, and results and recommendations will be provided in future reporting.

2.2.1 Zone 11 ISB

2.2.1.1 History of Zone 11 ISB

The Zone 11 ISB system is on Pantex property, south of Zone 11. The system, as operated in 2020, consists of 58 injection wells, 5 TZM wells, and 9 downgradient ISPM wells installed in a zone of a saturated thickness of approximately 15 to 20 ft. The system is detailed in Section 1.4.2.

Based on recommendations made in the *2016 Annual Progress Report*, injections have been lengthened to approximately two years in the original portion of the ISB where reducing conditions are established. This is based on evaluation of two factors: PTX06-ISB082 and pilot study data.

In the past, Pantex had decreased injection at a second row well, PTX06-ISB082, to determine if pausing injection would be effective in reducing biomass and provide more effective sampling. This well had a viscous white mass in the well when injection was discontinued, and rehabilitation was performed at the well for two years following the last injection to remove this mass. Within two years the well had improved.

Data at the monitoring wells installed for the pilot study indicated that complete treatment of HEs and hexavalent chromium occurred in less than two years at most downgradient wells. Where monitoring was continued at the downgradient wells, results indicated that the ISB is continuing to treat RDX and hexavalent chromium into 2020 at all but one well, with no further injections in the Pilot Study wells, even though the system was only injected in 2005 and 2006. These results indicate that treatment has continued for at least

10 years after the final injection. While conditions at the Pilot Study differ from those of the Zone 11 ISB, it does indicate that longer wait times for injection are appropriate when an emulsified vegetable oil, such as Newman Zone®, is used.

Pantex has moved to the use of a more soluble carbon source throughout the Zone 11 ISB and modified injection frequencies to nine to twelve months in portions of the system where Newman Zone® has not been used.

Based on a previous recommendation in the *4th Quarter 2015 Progress Report*, Pantex discontinued injection into the second row of wells on the perchlorate side in 2016. This decision was based on information collected at PTX06-ISB082 and PTX06-1156.

To evaluate the need for continued injection into the second-row wells, Pantex discontinued injection into PTX06-ISB082 after the fifth injection event in 2013. Data collected since 2014 indicate that PTX06-ISB082 maintains deep reducing conditions and has ample food source for the continued degradation of perchlorate. PTX06-ISB079 has also been monitored since all treatment was discontinued in the second row of wells on the ISB's eastern side, and data through 2020 indicate that treatment is continuing and that ample food source remains to continue treatment. The current downgradient ISPM well, PTX06-1156, continues to indicate that perchlorate is treated, even though it is downgradient of a single row of injection wells.

Pantex will continue to watch these wells as TCE moves towards the southeast in portions of the Zone 11 ISB due to the change in flow direction caused by the removal of water by the SEPTS.

2.2.1.2 Operation of Zone 11 ISB

During 2020, injection occurred in the northwest area of the Zone 11 ISB, with 20 wells rehabilitated and 26 injected. The rehabilitation and post-injection reports are included in Appendix H.

Previously injected wells were first maintained to improve injection performance and mitigate the effects of biofouling so that the wells were suitable for amendment injection. Maintenance consisted of mechanical and chemical rehabilitation and was performed from July to August 2020. Maintenance was performed in the following three steps:

1. An initial round of mechanical rehabilitation was conducted to remove gross deposits from the well and enhance the effectiveness of subsequent chemical

rehabilitation. Mechanical rehabilitation consisted of an initial evaluation of the well followed by brushing, surging, and bailing to loosen and remove deposits from the well screen and filter pack.

2. Chemical rehabilitation involved the application of Cotey Chemical Corporation's Welgicide Cleaner (Welgicide) or Scrud Remover®. The purpose of chemical rehabilitation was to dissolve and remove mineral scale and/or biomass on the well screen and in the filter pack. To determine the best treatment method, two wells were treated with Scrud Remover as a comparison to Welgicide. After the Welgicide solution was allowed to react in the well for 24 hours, the solution was purged from the well. Meanwhile, Scrud Remover was allowed to react in the well and then was left there for final mechanical rehabilitation.
3. A second round of mechanical rehabilitation was conducted using a combination of jetting, surging, bailing, and airlifting. Development was considered complete when extracted water was clear and free of suspended solids. Consistent readings for indicator parameters (i.e., pH, specific conductivity, and temperature) in grab samples were used as an additional line of evidence that effective communication between the well and the surrounding formation had been restored.

After well maintenance, constant-rate injection tests were performed to calculate transmissivity and specific capacity values for each well. The objective of hydraulic testing was to evaluate present well performance compared to what is documented in historical testing results. Well maintenance effectively increased performance to what was observed prior to the implementation of injection operations; however, based on results of injection testing and actual injection rates achieved, overall transmissivity has decreased across the well field. Flow rates also decreased with continued injection into the wells.

Injection occurred from August 17 through November 25, 2020, with the wells in the northwest expansion area injected.

For injection, Pantex used 70 or 80% strength of 79.5 BRIX molasses to enhance the distribution of amendment across the treatment zone. The 70% strength molasses was used during colder months to decrease the viscosity. The injected solution was approximately 3% pure molasses by volume, higher than the 2% solution injected previously.

Injection activities consisted of injecting makeup water mixed with amendment followed by a clean water flush. Approximately 2,680,000 gallons of solution were injected into 26 injection wells during the 2020 injection event. Target volumes were amended at 19 wells due to decreased injection performance. Packers were installed and injection was completed under pressure at most of the wells. The wells that did not receive packers consisted of newly installed wells, PTX06-ISB132 to PTX06-ISB136, and wells PTX06-ISB091, PTX06-ISB092, PTX06-ISB093, and PTX06-ISB098. A packer was installed in PTX06-ISB136 for the final two weeks of operation; however, injection of approximately 160,000 gallons over the first month of operation was achieved prior to packer installation. Revisions were made to injection volumes at wells PTX06-ISB087 through PTX06-ISB092, PTX06-ISB094 through PTX06-ISB097, PTX06-ISB099 through PTX06-ISB102, PTX06-ISB104, PTX06-ISB105, PTX06-ISB106, PTX06-ISB132, and PTX06-ISB136. The average flow rate at these locations was 2.2 gpm. The average flow rate at the other seven locations was 4.1 gpm.

Target dosing of 3% pure molasses was achieved in 100% of the wells. The wells were flushed with approximately 1,000 gallons of water following the amendment injection.

2.2.2 Southeast ISB

2.2.2.1 History of Southeast ISB

The Southeast ISB system is on TTU property, southeast of the main Plant. The system consists of 42 injection wells and 5 downgradient ISPM wells installed in a zone of saturated thickness of less than 4 ft throughout most of the system. The system is detailed in Section 1.4.2.

Due to upgradient pump and treat operations, areas within and surrounding the Southeast ISB continue to demonstrate declining water conditions. An upgradient monitoring well, PTX06-1118, has not been sampled since 2010. Three of the five downgradient ISPM wells south of the system went dry in 2009, 2015, and 2018, although water came back into PTX06-1045 in 2018 because of water retention ponds installed at the administrative complex. PTX06-1167, which was installed to the north of the system in July 2013 to evaluate the water and COCs entering the western side of the system, remains dry. Several areas inside the treatment zone are dry, and injection does not typically occur in those wells.

Across all data, water level trends indicate that water is declining. While recent trends indicate increasing water likely due to reduced treatment flow at the SEPTS, water level trends are expected to reverse as the irrigation systems and the Playa 2 injection wells become available. The system has very little saturated thickness (i.e., <10 ft of water), as shown in Figure 2-15. Only a small number of wells inside the treatment zone demonstrate greater than 5 ft of water, with all downgradient wells having less than 5 ft of water.

Evaluation of water level trends indicates that water levels have decreased since the start of remedial action, with some wells now dry. The 2020 water-level mapping indicates that a small portion of upgradient perched water has reconnected to the central portion of the ISB. Where disconnected from the upgradient perched water source, any water remaining in the system will continue to move through it and be treated. Once the new Playa 2 injection wells and pivot irrigation system is installed, this trend is expected to reverse, and the ISB is expected to dry up over time and no longer require injections. The planned installation of the pivot system is included in the schedule in Section 1.6.4.

Note that downgradient well PTX06-1045, which was previously dry, has demonstrated some recovery in water levels during 2018. This is believed to be related to the construction of the Administrative Site Complex (ASC), south of the main Pantex property. Management of drainage required the installation of retention ponds at the northwest and southwest corners of the property. The northwest retention pond is near PTX06-1045 and believed to be a contributor to the increased water levels in that well, which has been sampled since 2019.

Pantex recommended in the *2016 Annual Progress Report* that injection at the Southeast ISB be repeated in 2019 (i.e., three years after the last injection event) and be re-evaluated thereafter. Pantex has planned for injections every two years at this system, based on the change to molasses. Due to declines in water levels, it is possible that much of this system will no longer require injection after the next injection event planned in late 2021. However, monitoring data will be used to inform the timing and need for injection.

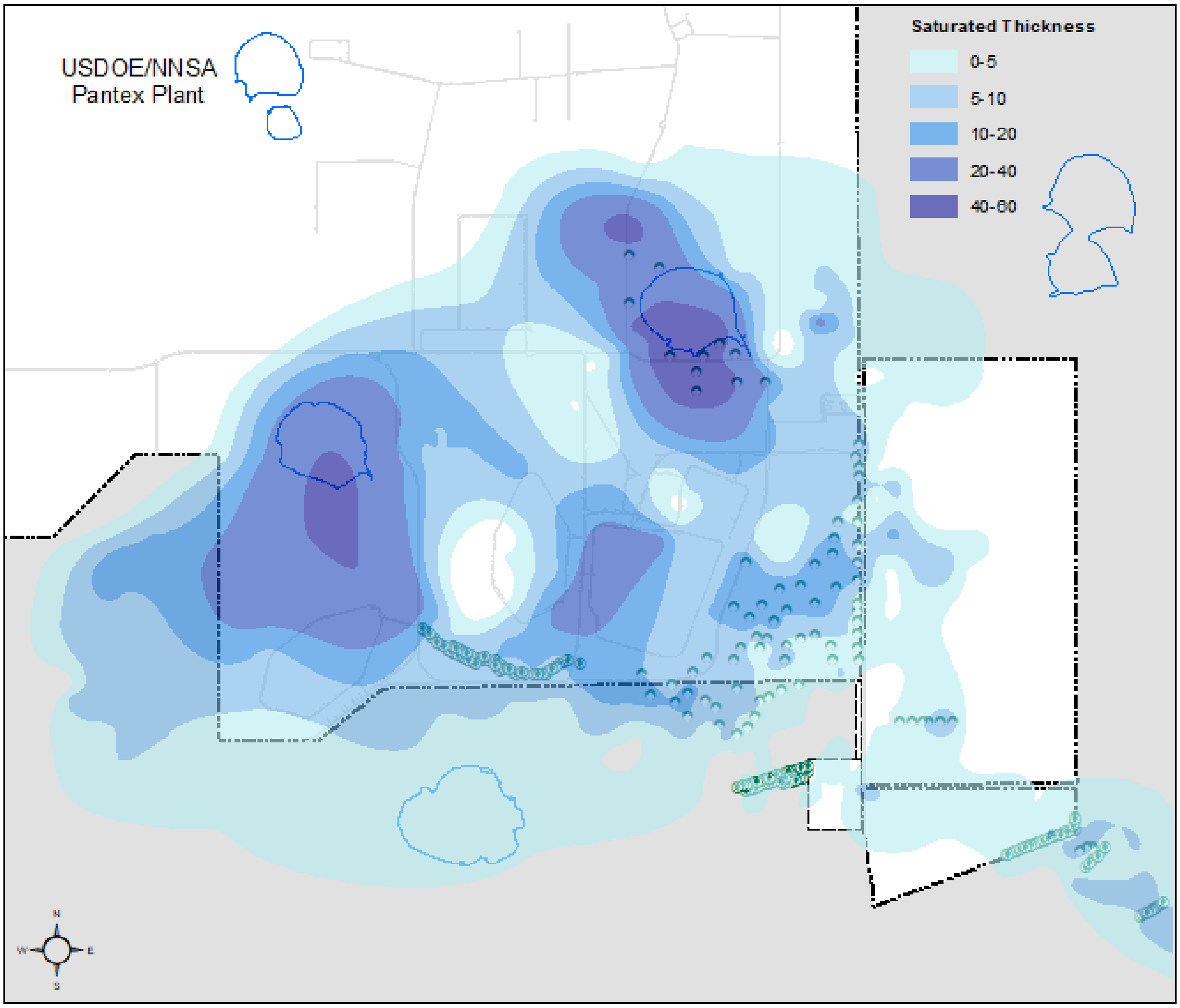

Figure 2-15. Perched Aquifer Saturated Thickness, 2020

2.2.2.2 Operation of the Southeast ISB

No injection or rehabilitation occurred at the Southeast ISB during 2020. The next injection event is scheduled for late 2021.

2.2.3 Southeast ISB Extension

2.2.3.1 History of the Southeast ISB Extension

The Southeast ISB Extension system is on USDOE/NNSA property, southeast of the main Plant, along the southeast fence line east of FM 2373. The system consists of 29 injection wells and 3 downgradient ISPM wells installed in a zone of saturated thickness of less than 12 ft throughout the system. The system is detailed in Section 1.4.2.

Similar to the Southeast ISB, this ISB extension will also be affected by the upgradient removal of water from the SEPTS. Water levels are anticipated to decline in this system over time, and future injections will be unnecessary. Currently, injections are budgeted semi-annually since this system has only been injected with a more soluble carbon source (i.e., molasses). Data are currently being collected to determine if a nine-month injection frequency is appropriate.

2.2.3.2 Operation of the Southeast ISB Extension

Injection and rehabilitation occurred at the Southeast ISB Extension once in 2020, during which the originally installed 25 wells were inspected and injected. Since molasses is solely used at this ISB extension, well are inspected first and only maintained, if necessary.

During well inspection, a grab sample was collected from each well using a bailer. Visual and olfactory observations of water and any deposits were recorded. Consistency between past and current measurements of total well depth indicated that material had not accumulated in the bottom of the wells, providing a line of evidence that the wells were not significantly fouled. No sludge was observed or removed, and no oils, sludge, or viscous residue of molasses was noted in extracted water. These observations indicate that the wells have not significantly fouled; therefore, no well rehabilitation was performed. Additionally, no injection tests were performed prior to injection.

Injection occurred from July 14 to August 4, 2020, with 25 wells injected. For injection, Pantex used 70% strength of 79.5 BRIX molasses to enhance the distribution of amendment across the treatment zone. Injection activities consisted of the injection of makeup water mixed with amendment, followed by a clean water flush. The final amendment injection consisted of 3% pure molasses by volume, and a total of 866,000 gallons of amendment solution was injected into 25 injection wells during the first injection event. Approximately 1000 gallons of flush water were then injected into each well.

Target injection volumes and dosing were met or exceeded at all wells. Four wells in higher flow areas were injected with excess amendment to deplete the remaining molasses.

2.3 Soil Remedial Actions

Soil remedial actions at Pantex include the Burning Ground SVE system, landfill covers, ditch liners, and institutional controls (see Section 1.3). The O&M of the soil remedies is discussed in these sections.

2.3.1 Burning Ground SVE

A description of the Burning Ground SVE is included in Section 1.3.1.

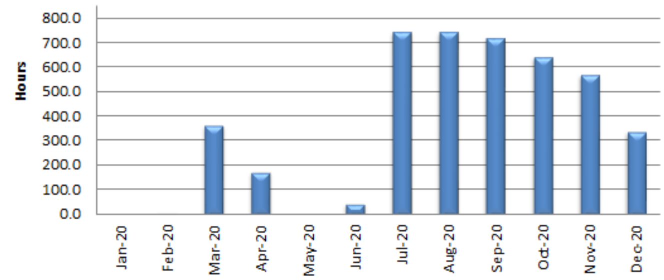

Figure 2-16. SVE System Operation

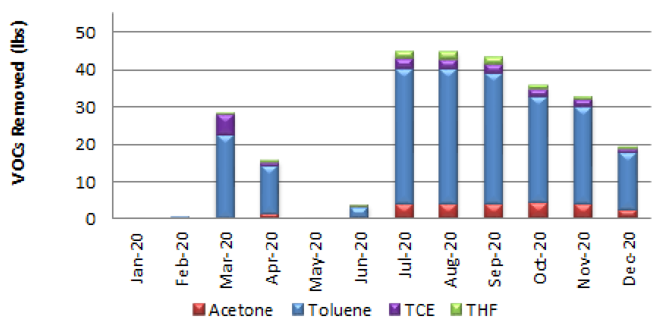

Figure 2-17. Burning Ground SVE Mass Removal

Figure 2-16 depicts the SVE system's operation for 2020. The system was down from January to March and from April to June due to major repairs that required replacement parts to be ordered first. Power failures also impacted the system during other months. The system was shut down in early December for the beginning of the first planned pulsing period. Overall, the system operated approximately 49% of the year.

Calculated mass removal for 2020 is presented in Figure 2-17. Mass removal was estimated based on concentrations reported from analytical sampling, system operation time, and system flow rates. VOC constituents contributing the majority of the total VOC concentration were included in the calculation. The system removed approximately 269 lbs of VOCs during 2020, and, since its inception, the SVE system has removed over 21,297 lbs of VOCs. Trends of removal rates, concentrations, and general effectiveness of the SVE are provided in Section 4.

Since system modifications were completed in May 2017, the influent flow rate was increased from 32 scfm to approximately 44 scfm before the end of 2017. The 44 scfm flow rate was maintained through most of 2020. Flow of approximately 41 scfm occurred for a short time. Flow rates increased from 13% to 24% from 2017's first quarter baseline, causing a rise in mass removal as well. However, data collected from 2018 to 2020 indicate that, although flow rate remained steady, mass removal rates declined due to lower influent concentrations.

As documented in the monthly air quality monitoring reports to the regional TCEQ office, all 2020 effluent photoionization detector (PID) readings for the system indicate that destruction efficiency was greater than 92%.

2.3.2 Engineered and Institutional Controls

The soil remedial actions at Pantex are discussed in Chapter 1.

The SVE system and containment of landfills and ditch soils are the only active soil remedies at this time; however, other soil remedies require long-term stewardship to maintain controls. Pantex drafted all deed restrictions required as part of the final remedy during 2009 and submitted them to TCEQ and EPA as part of the draft final IRAR. Those deed restrictions were filed in 2010 in conjunction with the approval of the final IRAR (Pantex, 2010a). All remedial action units at Pantex are restricted to industrial use. To support the deed restrictions, Pantex maintains long-term control of any type of soil disturbance in the SWMUs to protect human health and prevent spread of contaminated soils.

Pantex also regularly inspects and maintains soil covers on landfills to prevent infiltration of water into the landfills' contents and the migration of impacted water to groundwater. In 2020, Pantex conducted landfill inspections in accordance with the updated *Maintenance Plan for Landfill Covers* (Pantex, 2017a), although many inspections were delayed into early 2021 due to impacts of the COVID-19 shutdown. Pantex installed, inspects, and maintains a fence around FS-5 to control access and use of an area that is impacted by depleted uranium.

Additionally, Pantex installed a synthetic liner along a ditch system in Zone 12 where investigations indicate that the ditches continue to act as a source to perched groundwater. Installation of the ditch liner will minimize migration of contaminants because it prevents rainwater from infiltrating into soils. Inspections for the ditch liners were conducted in accordance with the recently updated *Maintenance Plan for SWMUs 2 and 5-05 Ditch Liner* (Pantex, 2017b). Inspections were also conducted for SWMU signs and postings at various times during 2020 and early 2021.

Maintenance is either contracted, as necessary, or work orders are placed with the onsite maintenance department. Findings from the inspections of landfills and ditch liners are provided below.

2.3.2.1 Landfill Inspection and Maintenance

Many of the findings at the landfills are related to wildlife activities that disturb soils in the landfill covers. It is expected that Pantex will have ongoing activities at many of the landfills due to holes/voids from wildlife. Additionally, the landfills can be affected by heavy rainfall and drought conditions that frequently occur in the Texas Panhandle. Areas that become eroded from heavy rainfall can be impacted by loss of vegetation that can be worsened by drought conditions.

In the past, these smaller issues were addressed using Pantex maintenance personnel and equipment. However, to ensure consistent comprehensive support with the landfill covers, Pantex has contracted for long-term maintenance of the landfills. The landfills will be inspected each year and then maintenance will be contracted based on the evaluation. Larger issues are planned, budgeted, and contracted separately for design and construction. Each contracting effort is followed up with inspections to evaluate the effectiveness of the actions.

Key findings and maintenance actions completed from past soil inspections, including those completed in 2020, are included in Table 2-2. The results of the landfills' site inspection from the *Second Five-Year Review* (HGL and Pantex, 2018) are also included if corrective action was not completed at the landfill.

Table 2-2. Key Findings and Corrective Actions for Landfill SWMUs

Findings	Corrective Actions
Previous Findings	
SWMU 56, Landfill 5 depressions and re-seeding. Also identified in 2nd FYR.	This is a low-priority landfill. Have requested help from onsite maintenance group, with completion planned by the end of 2022.
SWMU 43 and 44, Burning Ground Landfills have animal burrows in the middle of the cover.	Work was completed in 2020.
SVS 7a/b, Igloo Demolition Debris Landfills have burrowing animal holes and voids.	Identified during the second FYR. These are low-priority landfills and will be addressed as funding and/or onsite maintenance allows. Work started in 2020 and is planned for completion by the end of 2022 through onsite and contract resources.
SVS 8, Zone 10 Abandoned Landfill has minor holes and depressions.	This landfill will be addressed through onsite waste operations department.

Findings	Corrective Actions
SWMU 63, Landfill 12, small depressions and animal burrowing holes observed. Erosion was noted on the south end of the landfill.	Prairie dog control occurred at this landfill and nearby SVS 7a and 7b landfills. Request for onsite maintenance group to fill depressions is expected to be completed in 2021. The latest inspection notes that the south end of the landfill has been revegetated from the last seeding efforts.
SWMU 68d settling and small holes.	This landfill will be addressed through onsite waste operations department.
SWMU 68c, Landfill 2 prairie dog encroachment on perimeter of anchor trench, holes/subsidence near anchor trench, SWMU signs need repair.	This will be addressed through an onsite contract to control prairie dogs and onsite maintenance to fill subsidence where needed. Onsite contractors will repair or replace signs.
SWMU 70, FS-5 needs SWMU signs posted on the fence.	This will be completed by onsite contracted labor as budget and time allow.
SWMU 64, Landfill 13 requires signs to be posted.	This will be completed by onsite contracted labor as budget and time allow.
New 2020 Findings	
SWMU 66, Landfill 15 large holes.	This is a low-priority landfill that will be filled by onsite maintenance group as time and resources allow.

Based on the second FYR's findings and previous findings, Pantex will have to continue to prioritize landfill cover maintenance based on available funding. Some of the older construction debris landfills are given lower priorities than other landfills that had new additional cover placed at the end of the investigations, given their content. Pantex will always prioritize the following landfills for maintenance of the cover:

- Landfill 1 (SWMU 68b).
- Landfill 2 (SWMU 68c).
- Landfill 3 (SWMU 54).
- Landfill 12 (SWMU 63).
- Landfill 13 (SWMU 64).
- Burning Ground Landfills (SWMUs 37-44).
- Burning Ground Ash Disposal Trench.
- FS-5 facility cover located inside the berm (SWMU 70).

Other landfills will be addressed over time by a combination of available contract funding and onsite maintenance. Due to the settling caused by burrowing animal activity at some of these landfills resulting from, such as SVS 7a/b, it will take multiple years to completely restore all of the covers on multiple landfills identified in the second FYR. Pantex has requested an increase in budget in future years and has planned to address the 2nd FYR findings by the end of 2022, while continuing to prioritize other landfill cover maintenance.

Pantex will continue to evaluate the landfills annually and report findings and plans developed to address holes, depressions, or bare areas. Problems identified will be addressed through the landfill cover maintenance contracts or limited onsite maintenance. The active landfill area at Pantex is continually maintained by the waste operations department, and old landfills (i.e., SVS 8 and SWMU 68d) in that area continue to be addressed by onsite waste operations personnel.

Ditch Liner Inspection

Pantex installed a new liner over the old one, with construction complete in March 2017. As discussed above, a new maintenance plan was developed for the new liner.

An inspection conducted in 2020 indicated tears were present in the liner, and sedimentation and erosion of the anchor trench continue to be an issue. Contracting is currently planned to address the liner repairs, anchor trench erosion, and sedimentation on an ongoing basis.

2.3.2.2 Review of Soil Disturbance

Pantex also conducts reviews of projects (referred to as SWMU interference) that will disturb SWMU soils. Project plans or work requests for repairs were reviewed to ensure that workers used necessary protective equipment and that soils were managed appropriately during the execution of work. Older listed projects from the completed project areas were verified after the completion of work to ensure that all soils were returned to the excavation or kept within the contamination extent. Long-term projects are reviewed periodically to ensure that contractors are adhering to SWMU interference permit requirements.

Table 2-3 provides information on projects that were not complete by the last annual report as well as new SWMU interference projects from 2020. Five new permits were issued in 2020 for projects that are still active. Four older projects were completed in 2020.

Table 2-3. SWMU Interference Log

SIN#	State Approval Date	SWMU #	Explanation of Work
Previous SWMU Interference Notifications (SINs)			
SIN17-003	03.27.17	1 5/5 5/7 5/6 5/12a	Installation of outdoor floodlighting system. Installation will include new floodlights and poles, duct bank, and concrete pole casings. Hydro-excavation will be used as well as ditching equipment, auger, backhoes, directional bore, and skid loader. Excavation depth is set at 30 ft, and the width will be 15 ft. Status: Active.
SIN18-001	2/27/2018	SWMU 5-09; 148	Lightning-protection system testing and upgrades at 11-17, 11-17A, 11-25. Status: Active.
SIN18-003	2/27/2018	WMG 6/7; SWMU 1	Lightning-protection system testing and upgrades at 12-62 and 12-62 Berm (Berm in 12/18). Status: Active.
SIN18-008	10/29/2018	SWMU 75 No WMG	Electrical mechanical upgrades at Firing Site 22. Status: Complete. Soil returned to SWMU.
SIN18-009	11/8/2018	WMG 12, SWMU 143 a & b	Electrical upgrades at Building 10-09. Status: Complete. Soil returned to SWMU.
SIN18-010	12/19/2018	WMG 10 SWMU 5-01 a & b	Water leak repair at Building 09-146. Status: Complete. Soil returned to SWMU.
SIN19-001	4/2/2019	WMG 13	Burning Ground lightning-protection system upgrades Status: Active.
SiIN19-002	4/2/2019	5/5	12-21 chiller upgrades. Status: Complete. Soil returned to SWMU.
SIN19-003	6/20/2019	SVS 7b	Clearing ditches around 16-24 Range Complex. Status: Active.
SIN19-004	8/6/2019	Extents	Demolition of 12-101. Status: Active.
SIN19-005	10/22/2019	WMG 5/ SWMU 68a	Zone 12 South paving - South of 12-R-79. Status: Active.
2020 SWMU Interference Notifications			
SIN20-001	1/22/2020	Zone 10 Extents	Zone 10 Lot 3 Electrical equipment installation. Status: Active.
SIN20-002	2/26/2020	SWMU 97 & Extents	Building 12-34 SS demolition. Status: Active.
SIN20-003	6/30/2020	WMG 4, SWMU 87	Building 11-20 SS demolition. Status: Active.
SIN20-004	7/27/2020	WMG 6/7 extents	Building 12-26E chiller replacement. Status: Active.
SIN20-005	11/30/2020	WMG 6/7, SWMU 122b	Building 12-024E, 12-024S, 12-030 demolition. Status: Active.

2.4 Long-Term Monitoring Well Network

2.4.1 Well Maintenance

As recommended in the *First Five-Year Review* (Pantex, 2013d), the *Well Maintenance Plan* (Pantex, 2013b) was completed in October 2013 and implemented in January 2014. This plan formalized the well-surveillance and -inspection process already in place and incorporated analytical and empirical data collected over time to develop a well-maintenance schedule. The plan is updated yearly to add or remove wells and underwent a larger update in 2020 (Pantex, 2020) to change the frequency of maintenance where needed.

The plan completes the following significant tasks:

- Assigns an inspection and maintenance frequency of three years to all active Ogallala Aquifer monitoring wells, as recommended in the *Ogallala Aquifer Sampling Improvement Plan* (Pantex, 2013a).
- Assigns a maintenance frequency of three years for all wells with stainless-steel screens that have documented well corrosion and elevated chromium concentrations.
- Assigns a default inspection frequency of five years for all perched aquifer LTM wells to comply with requirements for total depth measurement in the Compliance Plan.

Additional program activities, such as redevelopment, down-hole videos, pump and tubing bundle replacements, vegetation control, and other associated tasks, are completed when requested by the groundwater media scientist or identified by field technicians. Water levels are measured at each sampling event and twice annually while total well depths are only measured when dedicated equipment is not present in the well.

The 2020 maintenance log for groundwater wells is included in Appendix C, which contains all entries for well inspections, redevelopment of wells, changes in sample intake depths, and Bennett pump servicing at the wells. The log also contains the water depths and total well depths measured at wells when equipment was removed as well as the disposition of the purge water from well activities.

Through well videos, Pantex has identified evidence of bacteria in many of the stainless-steel wells. This condition is common in monitoring wells, especially those with lower groundwater flux. This is occurring in both newly installed wells and older wells in both the perched aquifer and Ogallala Aquifer, although the perched wells experience greater problems. The bacteria may be the source of stainless steel corrosion indicators (i.e., chromium, manganese, molybdenum, and nickel) that become elevated in wells; well videos recorded during routine well inspections indicate that a large percentage of stainless steel wells have some biofouling.

Pantex continues to evaluate rehabilitation methods for biofouling and, in 2018, developed plans to evaluate a chemical rehabilitation program that addresses growth that has completely blocked portions of the screens in certain wells. A study was completed in 2020 on two parked wells to evaluate the biofouling's impacts on water quality as well as the ability to effectively manage it. Data will be evaluated in 2021. New perched wells are now installed with polyvinyl chloride (PVC) materials, rather than stainless steel, to avoid corrosion issues associated with the well materials; however, pumps still consist of stainless steel that is subject to corrosion.

When screens were found to be impacted by biofouling, calcium deposits, or sedimentation or when elevated chromium levels were observed, Pantex redeveloped the wells by brushing, bailing, and pumping, as necessary. Based on well videos and total depth measurements, some wells were observed to have sediment in the sump, with a few having sediment built up into the bottom of the screen. However, no LTM wells had more than 20% of the saturated screen silted in, so Pantex will continue to monitor and sample the wells.

Pantex performed the following well-maintenance activities in 2020:

- 68 well videos to evaluate the wells' installation or condition and determine if re-development or other maintenance was required. The effectiveness of rehabilitation was also confirmed.
- Pump service (i.e., removal and installation of the pump and tubing bundles) at 15 locations to prepare for well videos, re-development, special sampling, change-outs of pump and tubing bundle, lengthening of sampling depths, and/or the replacement of pumps.
- Miscellaneous maintenance including moving diverters, replacing power cables, and collection of total depth, as requested.

Due to the increase in wells and related inspections and maintenance, Pantex has requested extra resources in 2021 and beyond to provide continued well maintenance as planned.

2.4.2 Well Casing Elevations

In accordance with HW-50284, Pantex periodically surveys the top of casing elevations at the monitoring wells. This work must be performed every 10 years, at a minimum, for wells included in the monitoring network. To evaluate water levels, Pantex also maintains wells not included in the monitoring network, which are surveyed to ensure that the water table maps developed from water level readings are correct.

Pantex re-surveyed all LTM wells and wells used for water-table mapping in 2020 using their real-time kinetic Global Positioning System (GPS) system that is calibrated to the National Geodetic Survey. This system will be consistently used to re-survey wells in the future. The next survey is due in 2030.

The surveyed elevations for new wells and re-surveyed wells are included in Table 2-4. A review of differences observed in the data stored for the water-table mapping indicates that most re-surveyed TOC elevations are similar. Since the data were similar and there was no clear trend indicating settling of the wells or other problems, no adjustments were made to the original TOC elevations. Two wells indicated a greater difference in TOC elevations. After comparing water levels using new elevations to surrounding data points, the new water level elevations were in line with nearby wells; therefore, the top of casing elevations for PTX06-1098 and PTX06-PRB14 were updated to the new elevations. In 2020, Pantex installed two monitoring wells at the offsite location.

Table 2-4. Well Elevations Collected in 2020

Well	Easting	Northing	Ground Surface Elevation (amsl)	TOC Elevation (amsl)
Wells Installed in 2020				
PTX06-1207	632958.06	3754044.99	3524.07	3526.19
PTX06-1208	652081.58	3749472.60	3508.04	3510.11
Re-surveyed Wells				
1114-MW4				3550.65
OW-WR-38				3522.055
OW-WR-45				3547.273

Well	Easting	Northing	Ground Surface Elevation (amsl)	TOC Elevation (amsl)
PTX01-1001				3569.398
PTX01-1004				3575.673
PTX01-1006				3574.648
PTX01-1007				3576.843
PTX01-1008				3571.081
PTX01-1009				3569.417
PTX01-1010				3576.506
PTX01-1011				3575.492
PTX01-1012				3574.675
PTX01-1013				3584.352
PTX01-1014A				3565.257
PTX04-1001				3527.745
PTX04-1002				3531.141
PTX06-1002A				3541.642
PTX06-1003				3540.017
PTX06-1005				3538.198
PTX06-1006				3545.146
PTX06-1007				3546.685
PTX06-1008				3549.432
PTX06-1009				3546.672
PTX06-1010				3546.383
PTX06-1011				3545.701
PTX06-1012				3540.912
PTX06-1013				3544.288
PTX06-1014				3533.413
PTX06-1015				3530.159
PTX06-1017				3533.674
PTX06-1023				3544.539
PTX06-1030				3532.751
PTX06-1031				3529.184
PTX06-1034				3525.21
PTX06-1035				3541.948
PTX06-1036				3534.661
PTX06-1037				3528.452
PTX06-1038				3542.627
PTX06-1039A				3541.041
PTX06-1040				3539.881
PTX06-1041				3538.946
PTX06-1042				3535.605
PTX06-1043				3524.616
PTX06-1044				3544.486
PTX06-1045				3527.965

Well	Easting	Northing	Ground Surface Elevation (amsl)	TOC Elevation (amsl)
PTX06-1046				3527.316
PTX06-1047A				3526.292
PTX06-1048A				3540.447
PTX06-1049				3556.784
PTX06-1050				3554.396
PTX06-1050				3554.602
PTX06-1051				3532.245
PTX06-1052				3536.844
PTX06-1053				3519.757
PTX06-1055				3562.994
PTX06-1056				3533.036
PTX06-1057A				3567.353
PTX06-1058				3568.882
PTX06-1059				3548.273
PTX06-1060				3572.596
PTX06-1061				3591.776
PTX06-1062A				3574.013
PTX06-1064				3565.115
PTX06-1068				3538.724
PTX06-1069				3532.78
PTX06-1071				3531.241
PTX06-1072				3551.737
PTX06-1073A				3550.673
PTX06-1074				3578.384
PTX06-1075				3548.768
PTX06-1076				3530.42
PTX06-1077A				3549.448
PTX06-1078				3540.773
PTX06-1079				3542.913
PTX06-1080				3536.166
PTX06-1081				3533.342
PTX06-1082				3468.705
PTX06-1083				3468.044
PTX06-1084				3479.481
PTX06-1085				3533.963
PTX06-1086				3526.103
PTX06-1087				3534.221
PTX06-1088				3544.058
PTX06-1089				3535.568
PTX06-1090				3530.131
PTX06-1091				3532.466
PTX06-1093				3537.963

Well	Easting	Northing	Ground Surface Elevation (amsl)	TOC Elevation (amsl)
PTX06-1094				3523.922
PTX06-1095A				3536.003
PTX06-1096A				3568.375
PTX06-1097				3561.484
PTX06-1098				3533.57
PTX06-1100				3534.474
PTX06-1101				3533.366
PTX06-1102				3534.434
PTX06-1103				3530.815
PTX06-1104				3532.595
PTX06-1106				3532.408
PTX06-1107				3532.554
PTX06-1109				3519.093
PTX06-1110				3521.272
PTX06-1112				3543.326
PTX06-1113				3545.282
PTX06-1115				3529.013
PTX06-1116				3530.079
PTX06-1118				3529.231
PTX06-1119				3528.235
PTX06-1120				3527.661
PTX06-1121				3526.491
PTX06-1122				3531.345
PTX06-1122				3531.318
PTX06-1123				3528.603
PTX06-1125				3527.044
PTX06-1126				3542.666
PTX06-1127				3538.781
PTX06-1128				3521.887
PTX06-1129				3522.225
PTX06-1130				3539.927
PTX06-1131				3549.591
PTX06-1133A				3520.826
PTX06-1134				3538.192
PTX06-1135				3535.72
PTX06-1136				3559.574
PTX06-1137A				3529.694
PTX06-1138				3536.543
PTX06-1139				3531.658
PTX06-1140				3529.209
PTX06-1141				3562.936
PTX06-1143				3547.965

Well	Easting	Northing	Ground Surface Elevation (amsl)	TOC Elevation (amsl)
PTX06-1144				3528.506
PTX06-1146				3535.993
PTX06-1147				3529.715
PTX06-1148				3526.126
PTX06-1149				3531.404
PTX06-1150				3533.958
PTX06-1151				3546.647
PTX06-1153				3529.266
PTX06-1154				3528.154
PTX06-1155				3541.764
PTX06-1156				3529.229
PTX06-1157				3525.964
PTX06-1158				3519.885
PTX06-1159				3541.933
PTX06-1160				3546.721
PTX06-1164				3545.499
PTX06-1166				3533.625
PTX06-1167				3529.763
PTX06-1168				3533.886
PTX06-1170				3543.105
PTX06-1171				3544.97
PTX06-1173				3543.344
PTX06-1174				3544.53
PTX06-1175				3545.634
PTX06-1176				3544.477
PTX06-1177				3545.175
PTX06-1180				3547.543
PTX06-1181				3547.477
PTX06-1182				3517.493
PTX06-1183				3534.404
PTX06-1184				3516.242
PTX06-1185				3517.56
PTX06-1188				3531.362
PTX06-1189				3531.896
PTX06-1190				3518.505
PTX06-1191				3515.349
PTX06-1192				3512.338
PTX06-1193				3510.273
PTX06-1194				3514.84
PTX06-1195				3518.994
PTX06-1196				3514.88
PTX06-1197				3512.985

Well	Easting	Northing	Ground Surface Elevation (amsl)	TOC Elevation (amsl)
PTX06-1198				3530.539
PTX06-1199				3513.941
PTX06-ISB010				3531.359
PTX06-ISB011				3530.796
PTX06-ISB012				3531.297
PTX06-ISB013				3530.63
PTX06-ISB014				3530.693
PTX06-ISB015				3530.448
PTX06-ISB016				3530.186
PTX06-ISB017				3529.878
PTX06-ISB018				3529.453
PTX06-ISB019				3529.278
PTX06-ISB020				3528.517
PTX06-ISB021				3529.46
PTX06-ISB022				3528.883
PTX06-ISB023A				3529.256
PTX06-ISB024				3528.97
PTX06-ISB025				3528.962
PTX06-ISB026				3528.785
PTX06-ISB027				3528.596
PTX06-ISB028				3528.763
PTX06-ISB029A				3530.753
PTX06-ISB030B				3530.975
PTX06-ISB031				3529.88
PTX06-ISB032				3530.405
PTX06-ISB033				3530.061
PTX06-ISB034				3529.722
PTX06-ISB035				3529.326
PTX06-ISB036				3528.939
PTX06-ISB037				3528.835
PTX06-ISB038				3528.783
PTX06-ISB039				3529.061
PTX06-ISB040				3528.79
PTX06-ISB041				3528.88
PTX06-ISB042				3528.819
PTX06-ISB044A				3529.161
PTX06-ISB045				3528.443
PTX06-ISB046				3528.596
PTX06-ISB047				3528.672
PTX06-ISB048				3528.609
PTX06-ISB049				3528.528
PTX06-ISB050				3528.278

Well	Easting	Northing	Ground Surface Elevation (amsl)	TOC Elevation (amsl)
PTX06-ISB051				3528.177
PTX06-ISB055				3534.021
PTX06-ISB059				3533.927
PTX06-ISB063				3536.033
PTX06-ISB069A				3538.415
PTX06-ISB071				3540.915
PTX06-ISB073				3542.309
PTX06-ISB075				3541.961
PTX06-ISB077				3540.135
PTX06-ISB079				3531.707
PTX06-ISB082				3530.549
PTX06-ISB302				3516.214
PTX06-ISB307				3516.563
PTX06-ISB312				3516.753
PTX06-ISB317				3517.183
PTX06-ISB321				3517.055
PTX06-ISB324				3517.194
PTX06-ISB325				3517.13
PTX06-PRB14				3532.79
PTX06-PZ01				3542.026
PTX06-PZ02				3542.141
PTX06-PZ03				3542.457
PTX06-PZ05				3541.93
PTX06-PZ06				3537.25
PTX07-1O01				3552.426
PTX07-1O02				3551.388
PTX07-1O03				3550.378
PTX07-1O04				3552.778
PTX07-1O05				3552.184
PTX07-1O06				3551.736
PTX07-1P01				3543.873
PTX07-1P02				3534.805
PTX07-1P03				3546.73
PTX07-1P04				3542.748
PTX07-1P05				3545.529
PTX07-1P06				3545.459
PTX07-1Q01				3547.726
PTX07-1Q02				3552.223
PTX07-1Q03				3537.352
PTX07-1R01				3572.05
PTX07-1R03				3573.655
PTX08-1001				3518.859

Well	Easting	Northing	Ground Surface Elevation (amsl)	TOC Elevation (amsl)
PTX08-1002				3517.033
PTX08-1003				3553.365
PTX08-1005				3546.655
PTX08-1006				3545.797
PTX08-1007				3549.133
PTX08-1008				3538.724
PTX08-1009				3539.407
PTX08-1010				3524.636
PTX08-1011A				3576.733
PTX10-1008				3544.135
PTX10-1014				3544.201

Northings and Eastings are Texas State Plane

amsl – above mean sea level TOC - top of casing

2.4.3 Water Level Elevations and Total Depths

In accordance with requirements in Provision XI.F.3.d and CP Table VII of the HW-50284, Pantex must measure water level elevations at each well during each sampling event and total well depths when dedicated pumps are removed or when the well is sampled if no dedicated pump is installed. Pantex also measures water levels at all wells twice per year to provide consistent measurements to map the water table. Water level measurements are also taken during any well-maintenance activities. The measurements and corresponding water elevations and total depth elevations are included in Appendix C.

2.5 Management of Recovered/Purged Groundwater

In 2020, all purged, contaminated groundwater found to exceed the GWPS during sampling events and maintenance activities was containerized. Then, the volume of water was logged and treated through the SEPTS in accordance with Provision XI.B.8 of the HW-50284, with a few exceptions. Purge water from all ISB system wells was containerized and disposed of by the Plant’s waste operations department since the water was characteristically hazardous or contained contaminants that were not treatable by the pump and treat systems. Additionally, a chemical rehabilitation study was ongoing in 2020, and water from the study was also containerized and managed as Class 1 waste.

Most Ogallala Aquifer wells are unaffected and not required to be managed or their volumes tabulated, so the water is released to nearby ditches. Because Ogallala well PTX06-1056 had low-level detections of HEs below the GWPS in 2020, Pantex containerized the purge water from sampling events and then logged and treated it through the SEPTS.

In accordance with Provision XI.B.8 of HW-50284, all recovered perched groundwater from the extraction wells is treated through the P1PTS or SEPTS. All treated water from the P1PTS and the majority of the SEPTS's treated water is sent through subsurface lines to the WWTF's storage lagoon. Lagoon water is then sent through the WWTF's filter building and subsequently released to the Plant's subsurface irrigation system, when operating.

The Pantex Plant has been authorized by permit (TLAP #04397, issued April 2012) to release treated wastewater for the irrigation of crops. Provisions were added in the latest permit renewal, which allows treated water obtained directly from the SEPTS or P1PTS to be used in other ways, such as for construction projects, so long as the treated water meets the GWPS and criteria specified by the State of Texas. Pantex constructed a bulk water station at the SEPTS to deliver treated water for beneficial use at Pantex. Pantex set up procedures and record-keeping for this station, which became operational in July 2016.

A break at the irrigation system's filter bank caused all of the water from the WWTF to be routed to Playa 1 via Outfall 001 after June 2017, in accordance with TCEQ Permit #WQ00002296000. All treated water from the SEPTS was either injected back into the perched groundwater, released to Playa 1 via the WWTF, or beneficially used for ISB injection or well drilling. All of the P1PTS's water was released to Playa 1 via the WWTF.

As authorized by the Underground Injection Control, Authorization No. 5X2600215, Pantex injects treated water into select wells. Portions of the SEPTS's treated water are injected through injection well PTX06-INJ-10 when needed. Some of the SEPTS's treated water is also used for ISB amendment injections. Treated water is mixed with the amendment and injected into the treatment zone. The volumes of treated water injected, sent to the WWTF, or sent to the ISB system are provided in Section 2.1.

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3.0 Groundwater Remedial Action Effectiveness

In this section, the groundwater remedial action is evaluated for overall effectiveness during 2020 operations. This evaluation focuses on the following four aspects of monitoring associated with the remedy for perched groundwater:

1. Plume stability.
2. Remedial action effectiveness.
3. Uncertainty management and early detection.
4. Natural attenuation.

In addition, POC and POE wells are evaluated against the GWPS to determine compliance with HW-50284.

3.1 Plume Stability

Plume stability is evaluated through the examination of water level and concentration data. Water levels are used to generate hydrographs and trends for individual wells and contour maps of water elevations. Data from dry wells (e.g., continuing dry conditions or influx of water) support this analysis.

Concentration data are used to perform concentration trend analyses. Concentration trend data are mapped for the four major COCs to identify trends in their spatial distributions. The concentration data are used to generate plume maps for each COC. The maps and trends, together, form the basis for an evaluation of overall plume stability.

To satisfy the objectives of the LTM design, expected conditions and trends were developed for each LTM network well in the *Update to the Long-Term Monitoring System Design Report* (Pantex, 2019a). Therefore, a comparison of observed versus expected conditions was conducted as part of the evaluation process. Appendix E includes the LTM expected conditions and current conditions based on 2020 analytical and water level data.

3.1.1 Water Level Mapping

Groundwater beneath the Plant and vicinity occurs in two stratigraphic horizons within the Ogallala Formation. The most significant quantities of groundwater in the vicinity of the

Plant are found in the Ogallala Aquifer system. Considerably less water occurs in the upper Ogallala Formation since perched groundwater overlies an FGZ.

Presented in this section are water table maps of the Ogallala Aquifer and the primary perched aquifer underlying the Plant. Water level measurements used to create these maps were collected primarily during December 2020 from Pantex Ogallala and perched aquifer monitor wells. These data were supplemented with recent water level measurements in the Ogallala Aquifer, collected by the Panhandle Groundwater Conservation District.

Figure 3-1 presents the Ogallala Aquifer water levels while Figure 3-2, Figure 3-3, and Figure 3-4 presents perched aquifer water levels.

3.1.1.1 Ogallala Aquifer

As shown in Figure 3-1, flow in the Ogallala Aquifer underlying the Plant is to the northeast. The northeast hydraulic gradient results from agricultural pumping as well as from the City of Amarillo's well field to the north and from the Pantex water supply wells in the northeastern part of the USDOE/NNSA property. The Amarillo well field produces approximately 12.7 Mgals per day from the Ogallala Aquifer, based on the City of Amarillo's 2018 data. The hydraulic gradient in the Ogallala Aquifer underlying the northern part of the Plant is approximately 0.006 foot per foot (ft/ft).

3.1.1.2 Perched Aquifer

As shown in Figure 3-2, Figure 3-3, and Figure 3-4, perched groundwater occurs as a number of separate flow systems beneath the Plant. Each of these flow systems is associated with an area of focused recharge, usually a playa lake.

The main perched aquifer is associated with natural recharge from Playas 1, 2, and 4; past treated wastewater discharge to Playa 1; and historical wastewater releases to the ditches draining Zones 11 and 12. Small areas of perched groundwater occur in the vicinity of Playa 3, the Old Sewage Treatment Plant (OSTP) area, and Zone 6. Because of the limited extent and saturated thickness of these separate areas, water table contours for these areas are omitted from the perched aquifer contour map. The extents of saturation for the main perched aquifer and perched groundwater beneath the OSTP area show that these two bodies of groundwater are separated by only a short distance. However, observed water levels in both areas indicate that hydraulic interaction between these two areas is limited, even if the extents of saturation overlap. Perched groundwater has also been observed beneath the southern side of Pantex Lake, located approximately 2.5 miles northeast of the USDOE/NNSA property boundary, but this body of groundwater is not hydraulically connected to the perched aquifer underlying the Pantex Plant.

Historically, groundwater in the perched aquifer tended to flow radially away from Playa 1, but extraction of perched groundwater beneath Playa 1 by the P1PTS has shifted the highest elevations of perched groundwater northeast of the playa. Flow to the north and directly east of Playa 1 is limited by the structure of the FGZ. Flow to the south and southwest has extended several miles from Playa 1 and has been enhanced by recharge through Playas 2 and 4. Additionally, the large area of contaminated groundwater in the southeast corner of the USDOE/NNSA property occurred as a result of historical discharges of treated and untreated process waters from Zone 12. Two perched groundwater pump and treatment systems are currently removing water and contaminants from the perched aquifer, thus limiting the further migration of contaminated groundwater to the east and south.

The horizontal hydraulic gradient of the perched aquifer varies spatially across the Plant. The hydraulic gradient is 0.0058 ft/ft near Playa 1, 0.0017 ft/ft near Playa 2, 0.0048 ft/ft downgradient of Zone 12, and 0.0015 ft/ft south of Zone 11.

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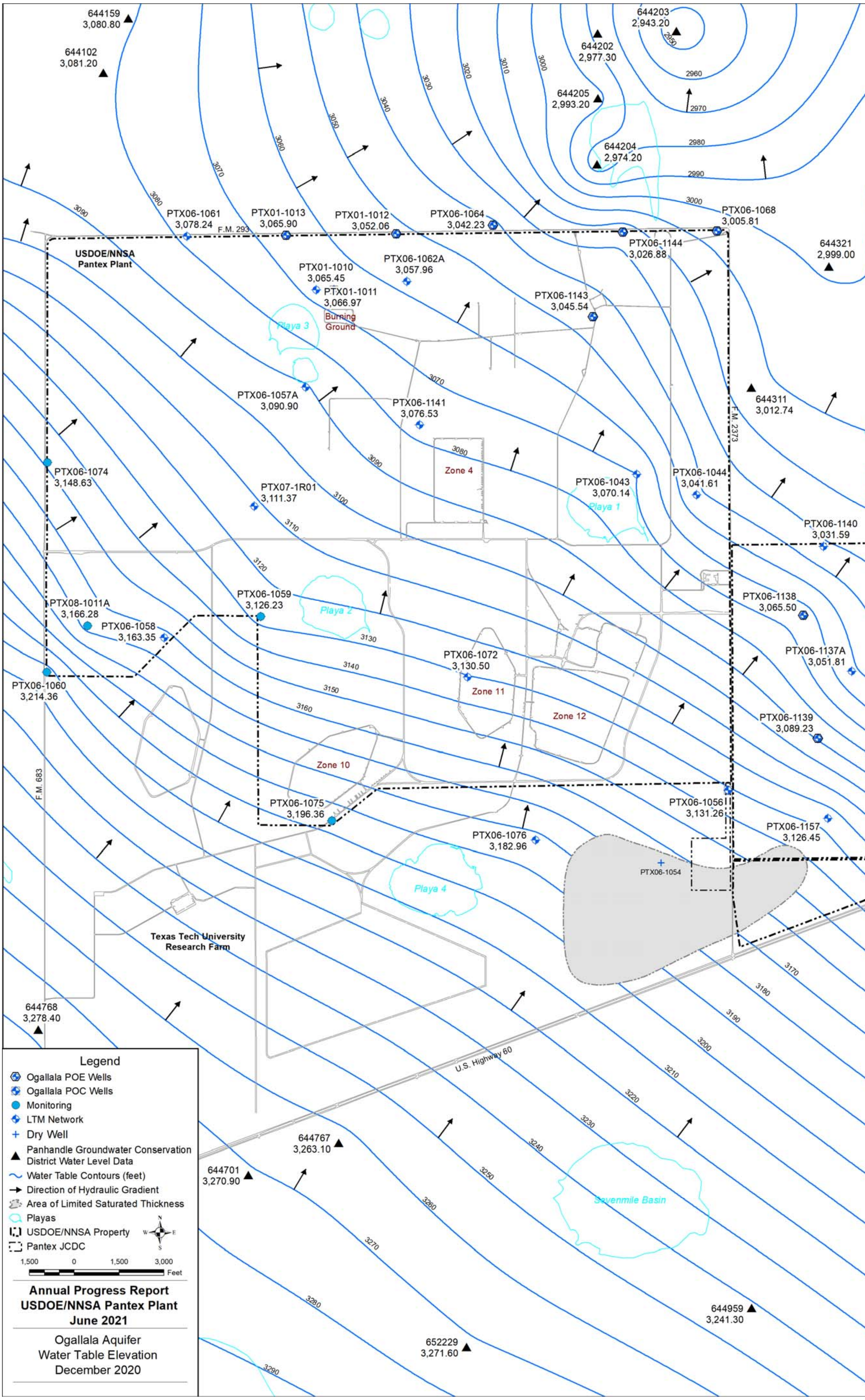

Figure 3-1. Ogallala Aquifer Water Levels

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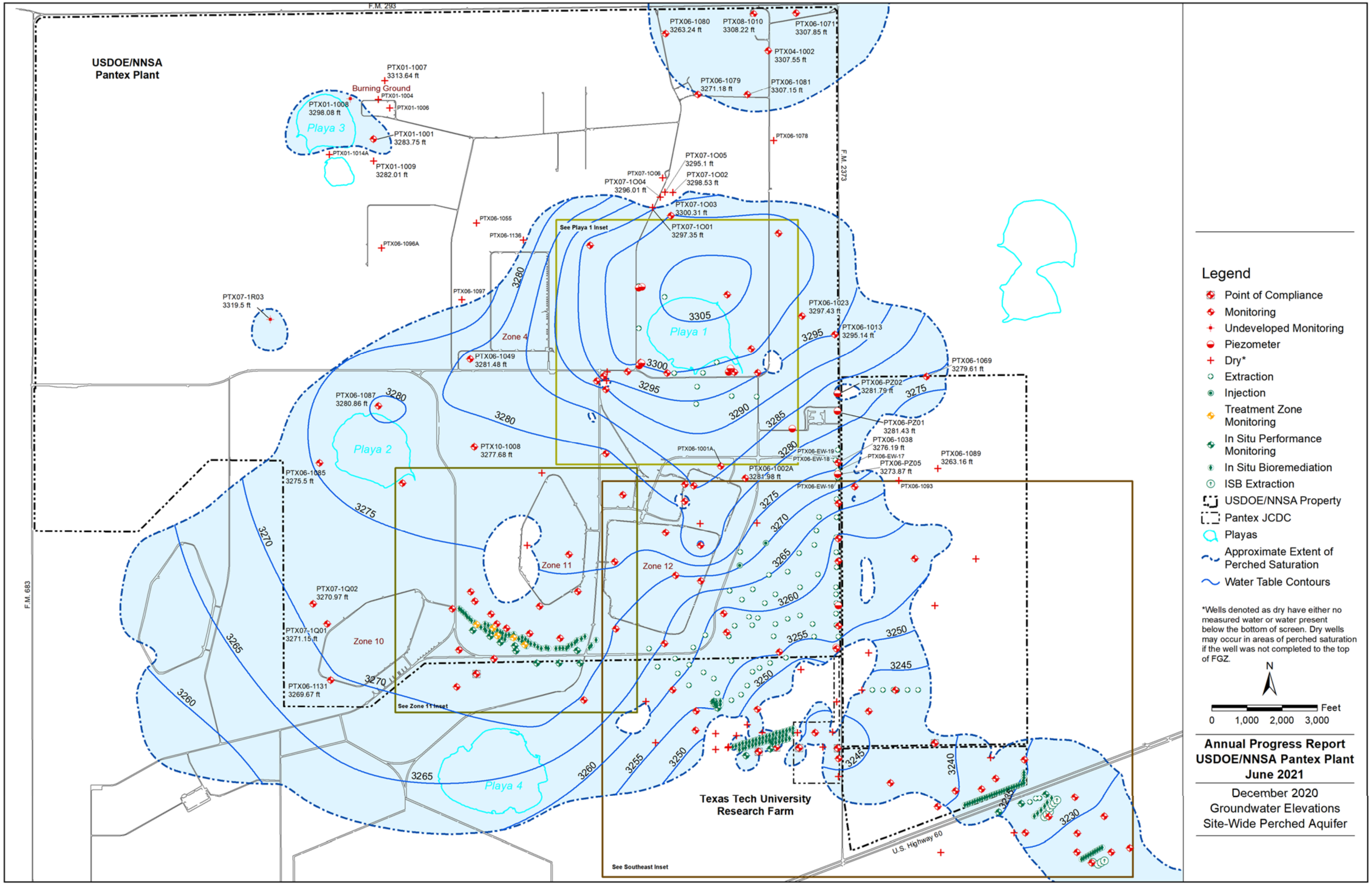

Figure 3-2. Perched Aquifer Water Levels

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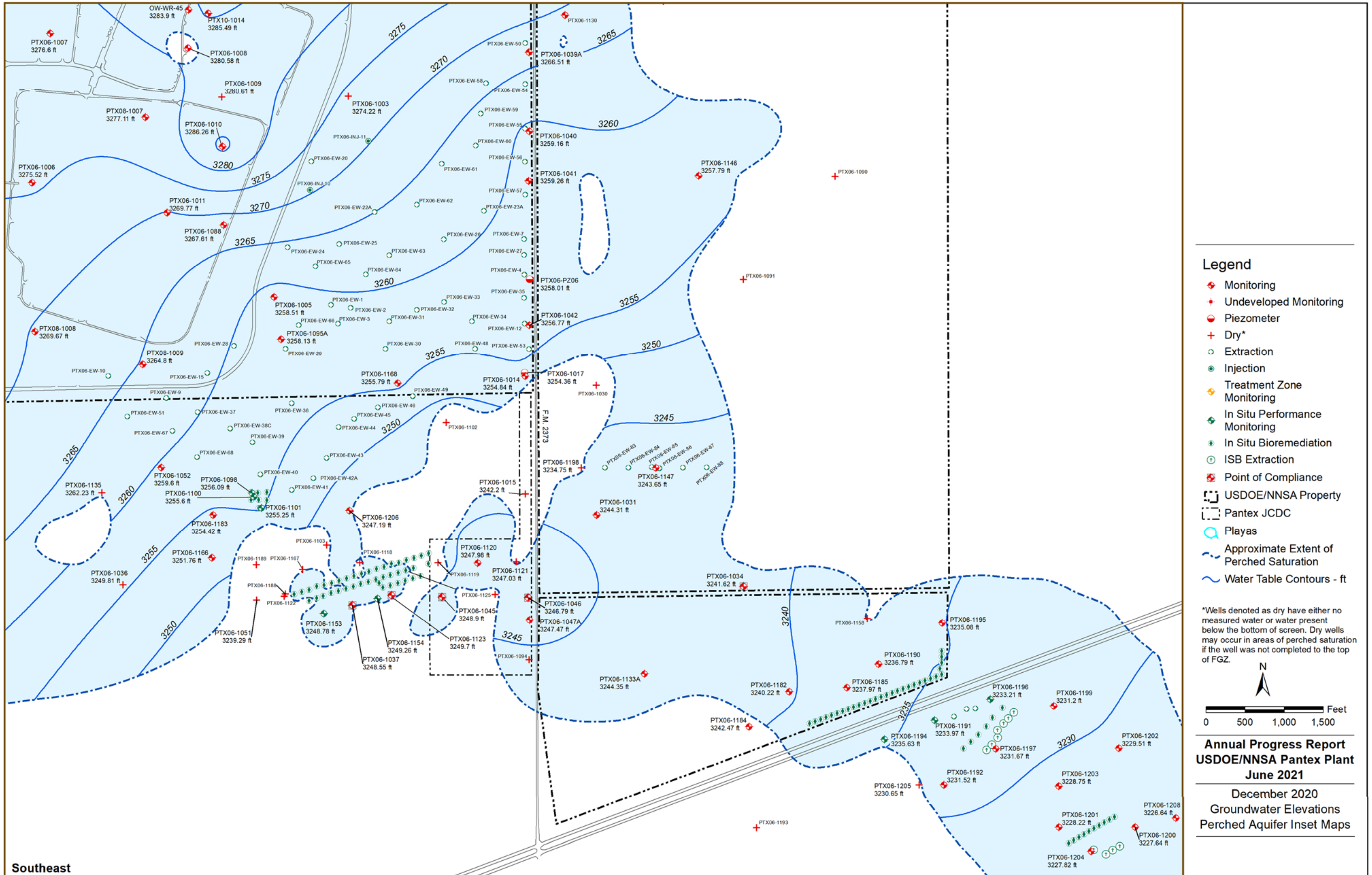

Figure 3-3. Perched Aquifer Water Levels, Southeast Inset Map

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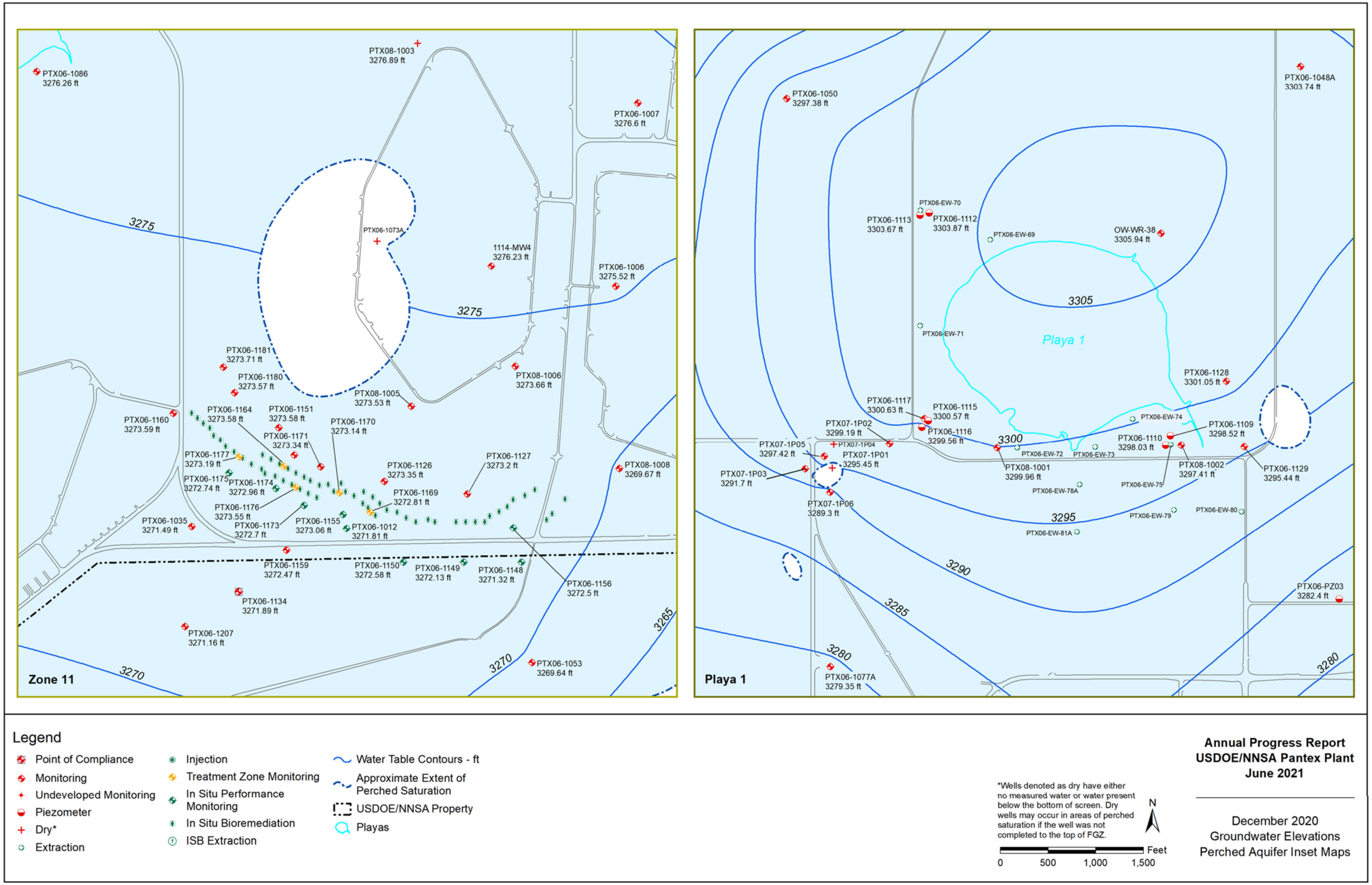

Figure 3-4. Perched Aquifer Water Levels, Zone 11 and Playa 1 Inset Maps

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3.1.2 Water Level Trending

The Monitoring and Remediation Optimization System (MAROS) software linear regression methodology (AFCEE, 2007) outlined in the LTM Design Report was used to trend water levels at each well. Trends were calculated for the dataset of water levels collected since the start of remedial actions in 2009, in addition to the most recent two years of data at each well. The recent trends are expected to give more accurate measurements of the effectiveness of the two pump and treat systems since the P1PTS began operating in late 2008 and the SEPTS was operating near full capacity by April 2009.

Figure 3-5 depicts the water level trends in all LTM perched aquifer wells. Well hydrographs are included in Appendix F.

Trending results show positive effects of the remedial actions given that almost all wells currently recognized to be under the influence of the SEPTS and P1PTS have exhibited decreasing water level trends in recent years. Above normal precipitation during the spring and summer of 2016 and, again, in the summers of 2017, 2018, and 2019 filled the playas, and a resulting increase in water levels was observed in several wells near Playa 1 and some ditches. The apparent recharge through the playa was much greater than the volume extracted by the P1PTS, causing short-term increasing trends in these wells.

In addition, SEPTS and P1PTS operation and throughput continued to be impacted in 2020 by a filter bank break at the irrigation system that occurred in late June 2017. Because of the severity of the break, engineering evaluation, contracting, and major repairs are required to restore the irrigation system. Meanwhile, Pantex continues to release all WWTF water to Playa 1. The flow to Playa 1 is restricted by permit, so flow from the remediation systems must also be restricted until the irrigation system is repaired.

Current and future operations will be impaired by the restricted flow to the WWTF. The SEPTS has the capability to reinject, so the system has operated at a lower capacity, with the treated water being injected into the one available injection well for the system and/or released to the WWTF and Playa 1. Reduced extraction of perched groundwater by the SEPTS and P1PTS, combined with injection or release of treated water to Playa 1, limits the ability of the remedial actions to influence water levels. A discussion of the remedial action effectiveness is included in Section 3.2.

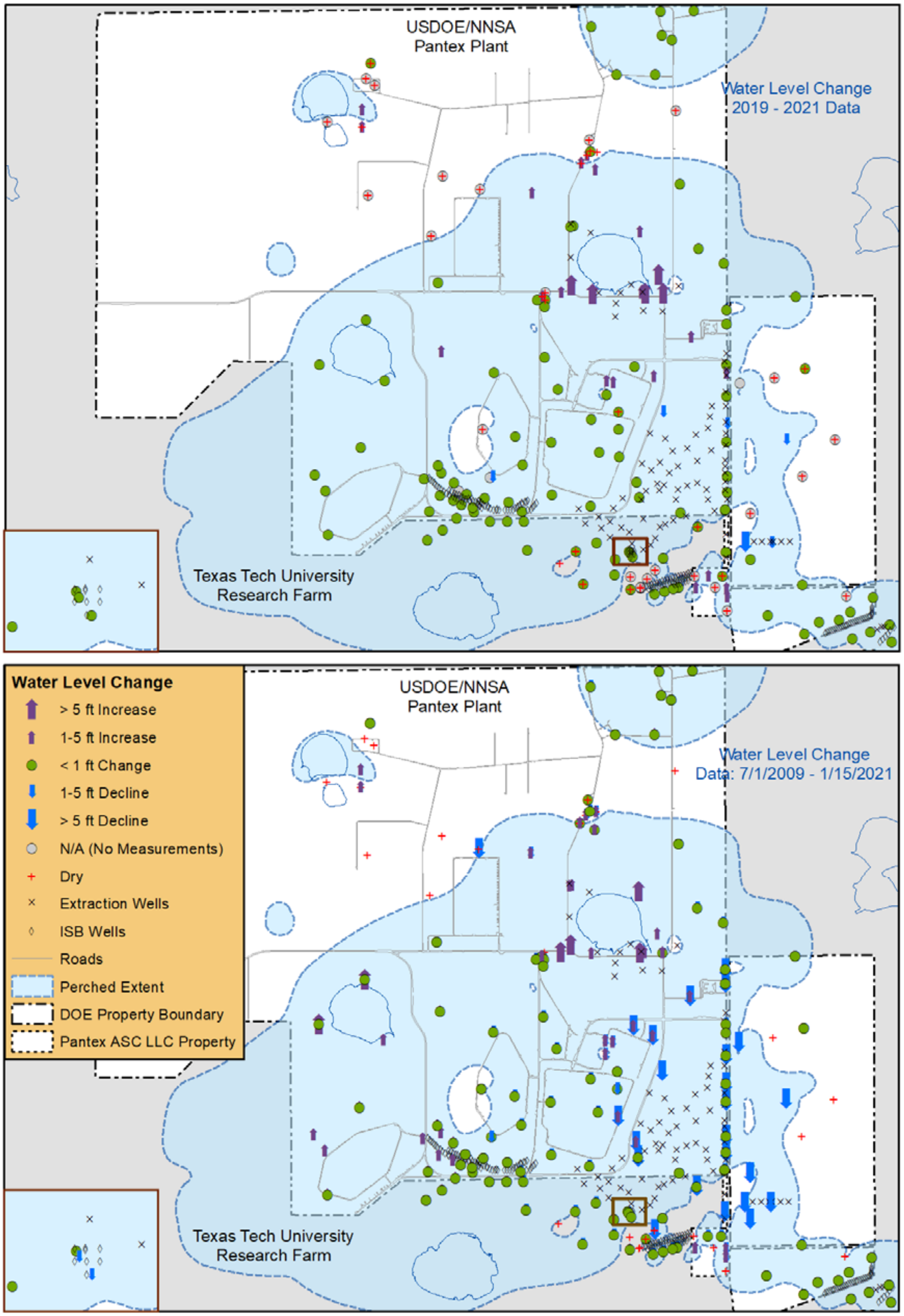

Figure 3-5. Water Level Trends in the Perched Aquifer

3.1.3 Water Level Trends Compared To Expected Conditions

Overall, calculated groundwater level trends are consistent with expected conditions defined in the LTM Design Report, which is summarized in Appendix E. Of the 48 monitoring wells with expected decreasing water level trends, limited water, or dry conditions defined in the *Update to the Long Term Monitoring System Design Report* (Pantex, 2019a), the 28 wells depicted in Figure 3-6 exhibited conditions inconsistent with current expected conditions or trends. These include 19 wells with recent increasing trends and 9 wells with recent "No Trend" conditions. In addition, seven wells are exhibiting apparent long-term increasing trends.

A recent increasing trend was observed at four wells near Playa 1 (OW-WR-38, PTX06-1050, PTX08-1001, and PTX08-1002), and recent "No Trend" conditions were observed at PTX06-1013 and PTX06-1023 located east of Playa 1. These trends are associated with a combination of increased recharge through the playa resulting from the discharge of treated wastewater effluent and reclaimed perched groundwater to the playa along with decreased extraction of perched groundwater from the P1PTS. The long-term water level trend is decreasing for all of these wells except OW-WR-38, PTX08-1001, and PTX08-1002, which are increasing but remain below historically observed high levels.

A recent increasing trend was observed in several wells in the southeast area (PTX06-1002A, PTX06-1052, PTX06-1095A, PTX08-1008 and PTX08-1009), and recent "No Trend" conditions were observed at PTX06-1003, PTX06-1005, PTX06-1039A, PTX06-1041, PTX06-1088, and PTX06-1102. Most of these wells exhibited a marked increase in 2017 water levels, a response to above-normal precipitation, followed by more gentle increasing trends or declines through 2020. The hydrographs for all of these wells show that water levels have fluctuated in recent data and the long-term water level trend is decreasing. The observed fluctuations may be associated with recharge to the ditches and areas that pond in Zone 12 as well as reduced extraction of perched groundwater from the SEPTS.

A recent "No Trend" condition or increasing trend was observed in four wells in the southeast area along FM 2373 (PTX06-1014, PTX06-1038, PTX06-1041, and PTX06-1042). The long-term water level trend is decreasing for all of these wells. Similarly, a recent "No Trend" condition was observed at PTX06-1089, a historically dry well beyond the extent of perched saturation east of FM 2373. Water has intermittently been detected in the sump of this well since 2010 but has not been measured in the screen. Observation of water in the well sump does not indicate the presence of perched groundwater at this location.

Increasing trends have been observed at four wells (PTX06-1045, PTX06-1046, PTX06-1047A, and PTX06-1120) located southeast of the Southeast ISB system near the Pantex ASC south of the main Pantex property. Management of drainage required the installation of retention ponds at the northwest and southwest corners of the property along with new drainage ditches to the north and south. The increasing water levels in these wells is believed to be related to the recharge of stormwater runoff from this facility.

An apparent long-term increasing trend was identified for PTX06-1051, although recent data indicate no trend. Historically, this well has been dry, with no water measured; however, the current well is a replacement well completed in October 2015. Water was measured in the sump starting in June 2016 and, again, in December 2016; then, a maximum of 0.15 ft of water was measured above the bottom of the well screen in 2017 and has since fallen below the bottom of the screen. The water level indicated by these measurements is approximately 10 ft below the elevation where perched water would be expected if it occurred in this area.

Pantex completed a well video survey in July 2018 to evaluate the condition of the well and potential sources of this water. The video showed seepage of water into the well screen at and just above the level of standing water in the well but did not identify any structural issues with the well. This well will continue to be monitored for changes in water level.

Water levels in PTX06-1133A increased sharply in 2016 after declining in 2011 and 2012 and then holding constant below the bottom of the well screen from 2013 through 2015. Inspection of the hydrograph shows that water levels peaked in May 2018 then subsequently declined by approximately 2 ft through December 2019, then peaked again in June 2020, and have since declined. This well is located near the southern extent of perched groundwater; the cyclical fluctuations in this well’s water levels may be associated with above-normal precipitation during recent years and increased recharge through a large borrow pit to the south.

An apparent increasing trend was observed at PTX06-1184, located in the far southeast area just north of Highway 60. However, the screen of this well was set below the top of the FGZ, and the observed water levels are at or below the elevation of the top of the FGZ. Therefore, observation of water in this well does not indicate the presence of perched groundwater at this location; as such, this well is meeting the expected dry condition.

Increasing water levels have been observed at PTX01-1009 near Playa 3. This well has historically been dry, but water was first measured in the screen in June 2019. The subsequent December water level measurement was dry, but water has been observed in the screen in both measurements in 2020. These recent increased water levels may be associated with above-normal precipitation and increased recharge through the playa.

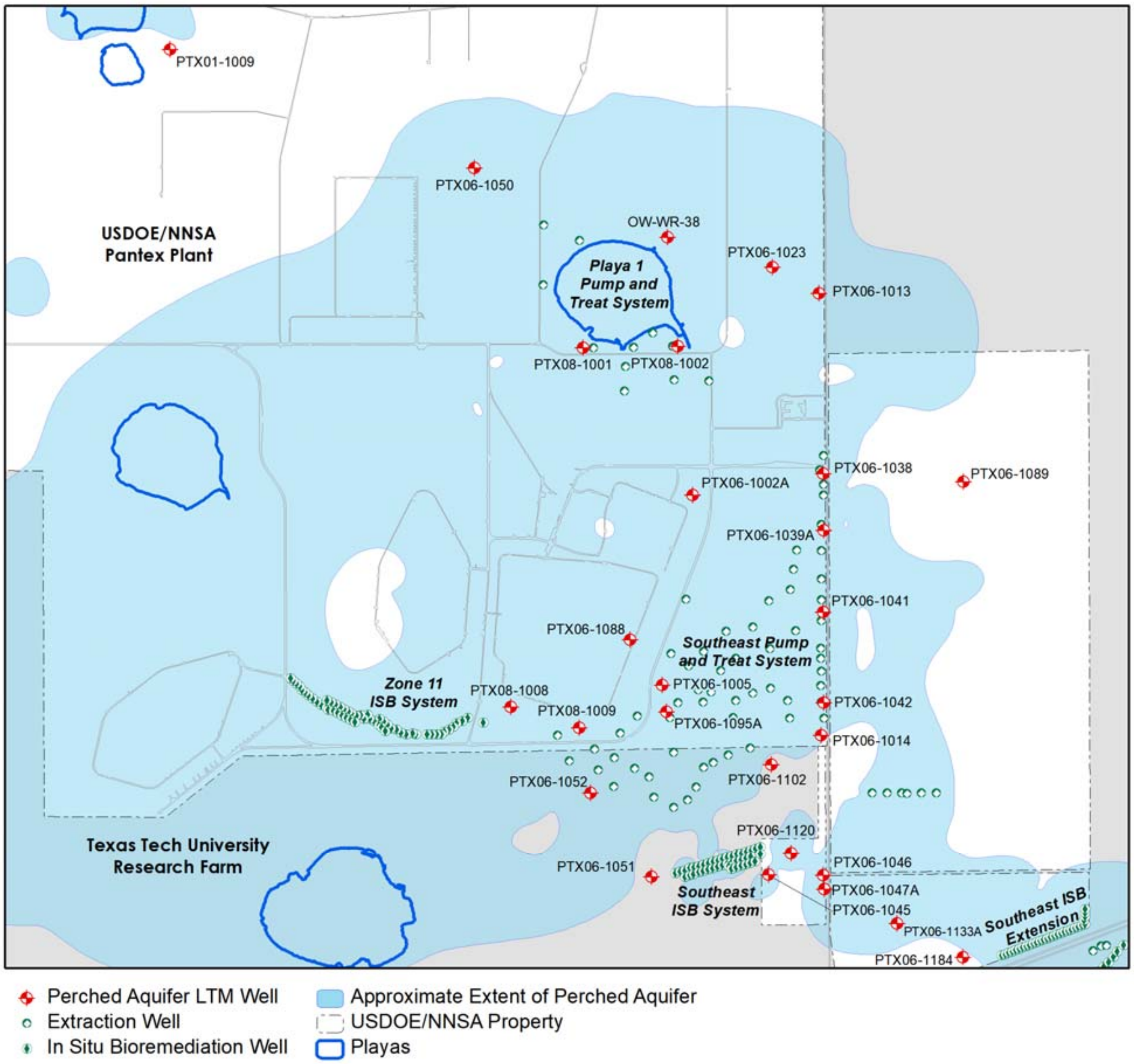

Figure 3-6. Perched Wells with Unexpected Water Level Trends

3.1.4 COC Concentration Trending

COC concentration trends were calculated using both the non-parametric Mann-Kendall and parametric linear regression statistical methods adapted from the MAROS software (AFCEE, 2007). Trends were calculated for the entire dataset for each LTM network well (i.e., long term), data from the four most recent sampling events (i.e., short term), and data collected since the start of remedial actions in 2009. The results of these analyses can be found on the concentration trend graphs located in Appendix E. In addition, the Mann-Kendall trending results since the start of remedial actions for RDX, hexavalent chromium, perchlorate, and TCE are depicted in Figure 3-7, Figure 3-8, Figure 3-9, and Figure 3-10, respectively, to illustrate the effectiveness of the groundwater remedial actions.

Linear regression is a parametric statistical procedure that is typically used for analyzing trends in data over time. However, with the usual approach of interpreting the log slope of the regression line, concentration trends may often be obscured by data scatter arising from non-ideal hydrogeologic or sampling and analysis conditions. The Mann-Kendall test is a non-parametric statistical procedure that is well suited for analyzing trends in data over time (Gilbert, 1987). The Mann-Kendall test can be viewed as a nonparametric test for zero slope of the first-order regression of time-ordered concentration data versus time. The Mann-Kendall test does not require any assumptions as to the statistical distribution of the data (e.g., normal, lognormal) and can be used with data sets that include irregular sampling intervals and missing data (i.e., non-detects). More information on these statistical methods can be found in the *Update to the Long Term Monitoring System Design Report* (Pantex, 2019a).

3.1.4.1 RDX Trends

Evaluation of concentration trends indicates that RDX is decreasing or does not demonstrate a trend at all monitoring points near the ditch along the eastern side of Zone 12. This condition is expected, given that the source areas are predicted to continue contributing to the perched aquifer for up to 20 years but at much lower concentrations than in the past (Pantex, 2006).

Some wells near Playa 1 are exhibiting increasing trends because of system operations at the P1PTS, which have dramatically affected water levels and gradients in this region of perched groundwater. The SEPTS has had some effect on the plume since the majority of COC concentrations are declining or exhibit no trend within the boundaries of the well field. The Southeast ISB has had some effect on wells to the south on TTU property, exemplified by stable or declining concentrations in downgradient wells, including the trend of recent data at PTX06-1153, being. This is a key area for declining concentrations because portions of that area are potentially more sensitive to vertical migration to the deeper drinking water aquifer. The trends are depicted in Figure 3-7.

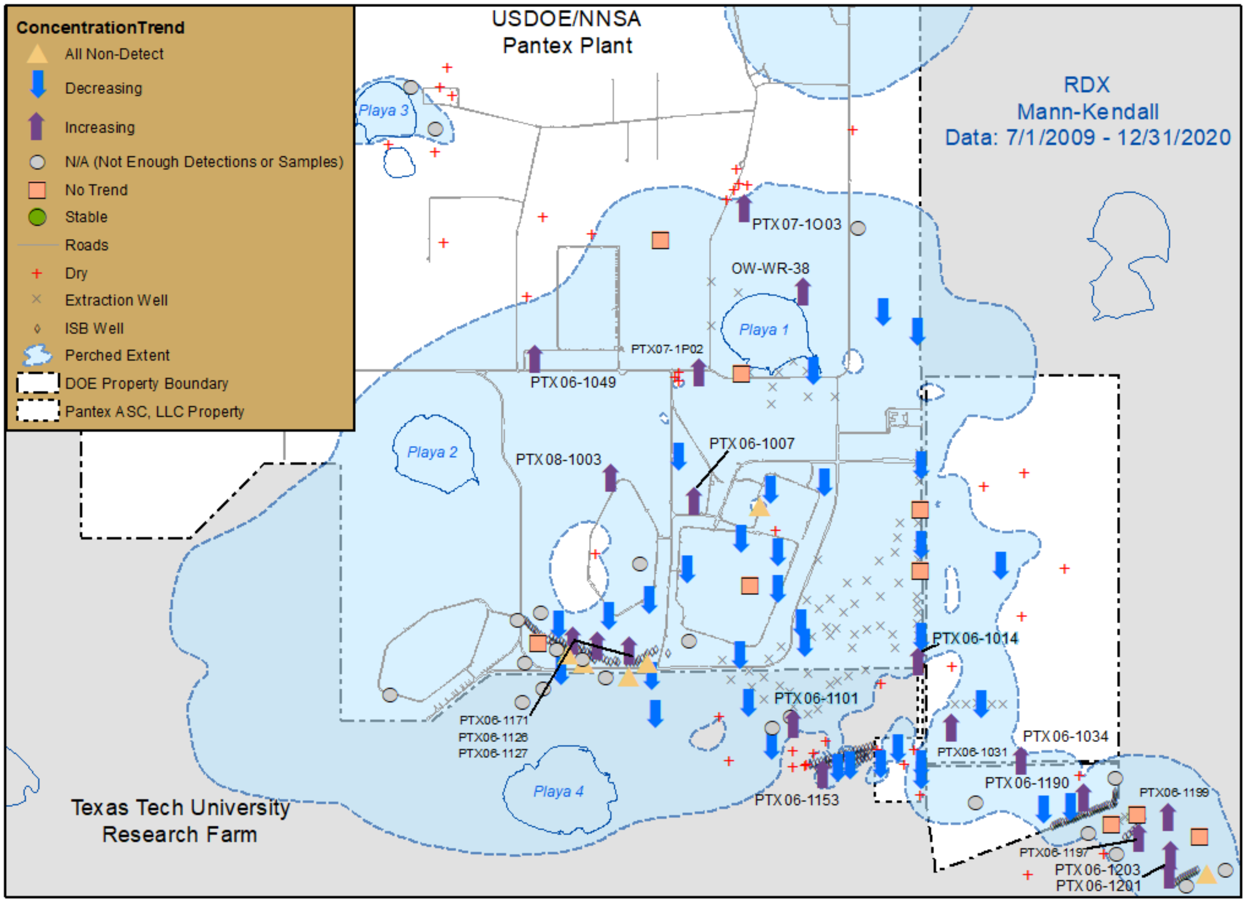

Figure 3-7. RDX Trends in the Perched Aquifer

According to data collected since the start of remedial actions, the following 19 monitoring wells exhibited increasing trends in RDX, as depicted in Figure 3-7:

- OW-WR-38, located north of Playa 1, is exhibiting an increasing trend in RDX. RDX concentrations have been fluctuating near the GWPS since 2009 but increased to near 50 ug/L in the most recent sample collected in 2020. Although elevated RDX has not been previously observed at this well, other wells north of Playa 1 (e.g., PTX06-1050 and PTX07-1O03) have exhibited higher concentrations of RDX in the past. The trend may be due to the P1PTS's effect or recent changes in the discharge of treated water to Playa 1, which have dramatically affected water levels and gradients in this region of perched groundwater.

- PTX06-1007, located between and north of Zones 11 and 12, is exhibiting a probably increasing trend in RDX. Since 2002, RDX has been detected at levels near the practical quantitation limit (PQL) in this well with only one detection of 5 ug/L above the GWPS in 2017. However, in 2020, RDX increased from near the PQL to 27 ug/L. This increase could be caused by changes in flow gradients and plume movement from the SWMU 5-13C ditch.

- PTX06-1014 is exhibiting an increasing trend, although data for the last two years shows no trend. This well is within the influence of the SEPTS well field. Recently observed concentrations are similar to levels observed since 2009 and remain below this well's historical maximums.

- Two wells located in the far southeast lobe of perched groundwater (PTX06-1031 and PTX06-1034) are exhibiting increasing trends in RDX, likely due to plume movement into these wells. However, recent data indicate decreasing and "No Trend" conditions, respectively.

- RDX was first observed at low concentrations in PTX06-1049 in 2011 and has since fluctuated at levels near the GWPS. This well is located on the far western side of the perched aquifer, which is outside the influence of remedial action. These trends are likely due to groundwater flow from the Playa 1 vicinity.

- PTX06-1101 is located immediately downgradient of the Southeast ISB pilot study well field. RDX had been non-detect in this well since its installation in 2007 until 2014 and has been increasing since then. The increasing trend results from loss of treatment effectiveness in the ISB pilot area and concentrations returning to baseline conditions.

- PX06-1126, PX06-1127, and PTX06-1171, located south of Zone 11 and outside the effects of remedial action, are exhibiting long-term increasing RDX trends. However, recent data indicate decreasing trends in PX06-1126 and PX06-1127 and no trend in PTX06-1171. These wells are located upgradient of the Zone 11 ISB system and, based on the data collected in the Southeast ISB system, RDX will be effectively treated by the system.

- PTX06-1153, a downgradient ISPM well for the Southeast ISB system, is exhibiting an increasing but highly variable trend in RDX since the start of remedial actions. However, the recent trend is decreasing. This well is detailed in Section 3.2.3.2.
- PTX06-1190, PTX06-1197, PTX06-1199, PTX06-1201, and PTX06-1203, located in the southeastern lobe of perched groundwater, are exhibiting increasing RDX trends. These five wells are part of the 14 monitoring wells installed in 2018 and 2019 to define the extent of the plume to the southeast. The extent of contamination to the southeast has been defined, with HE not being detected in two of the offsite wells. The increasing trends are expected because these wells are monitoring the leading edge of the RDX plume in this area. Pantex has installed a combination ISB/pump and treat system to control the plume and prevent further movement downgradient. Increasing concentrations in these wells are expected for several years as the treatment system is installed and expanded.
- PTX07-1O03, located north of Playa 1, is exhibiting an apparent increasing trend in RDX. However, this well exhibited higher historical RDX concentrations and, considering all data, a decreasing trend; the trend has been stable for the last two years. The increasing trend may be due to effects of the P1PTS because system operations have dramatically affected water levels and gradients in this region of perched groundwater.
- PTX07-1P02, located southwest of Playa 1, is exhibiting an increasing but variable trend just above the GWPS, but fluctuating concentrations remain far below historical levels for this well. The apparent increasing trend may be due to the effects of the P1PTS effects because system operations have dramatically affected water levels and gradients in this region of perched groundwater.
- PTX08-1003, is exhibiting a probably increasing trend, but all values are near the PQL and well below the GWPS. Data for the last four samples indicate a decreasing trend.

A comparison of current trends to expected conditions for specific wells in the LTM network is included in Section 3.1.5.

3.1.4.2 Hexavalent Chromium Trends

As depicted in Figure 3-8, the following eight perched aquifer wells are exhibiting increasing trends in hexavalent chromium below the GWPS since remedial actions began:

- An increasing trend was identified for PTX06-1011. This well is located within Zone 12, southwest of one of the hexavalent chromium source areas, at the former cooling tower. Historical concentrations in this well have fluctuated from slightly above the GWPS in the mid-1990s to less than the PQL. Concentrations in this well likely decreased after the SEPTS came online and, as flow conditions changed with the decline in saturated thickness in the perched groundwater, concentrations have fluctuated. The long-term trend for this well is decreasing, and recent concentrations remain below the GWPS. The identified increasing trend is partially the result of low-level detections and the use of one-half the detection limit in the trending but may also reflect the variable influence of the remedial actions and general plume movement in this area. Data for the last four samples indicate a decreasing trend.

- A probably increasing trend was identified for PTX06-1031, but concentrations remain far below the GWPS. Concentrations of total chromium, molybdenum, and nickel in this well have also fluctuated over the past several years; therefore, observed fluctuations in hexavalent chromium may be due to corrosion of the well's stainless-steel screen.

- PTX06-1095A is within the influence of the SEPTS well field but is also located less than 50 ft downgradient of the permeable reactive barrier (PRB) pilot study wells PTX06-PRB01A and PTX06-PRB02. Since 2013, detections have been highly variable. The increasing trend is likely due to the PRB losing treatment effectiveness and concentrations returning to baseline conditions. A decreasing trend was exhibited in the last four samples.

- An apparent increasing trend was identified for PTX06-1146; however, no trend was identified for the last four samples. Concentrations of total chromium in this well have also fluctuated over the past several years; therefore, observed fluctuations in hexavalent chromium may be due to corrosion of the stainless-steel screen of the well.

- An increasing trend was identified for PTX06-1166, and concentrations exceeded the GWPS for the first time in 2020. This well is located along the southern edge of the hexavalent chromium plume, so the observed increase is related to the movement of the plume to the southeast.

- An apparent increasing trend was identified for PTX06-1190; however, no trend was identified for the last four samples. All concentrations remain far below the GWPS.
- A probably increasing trend was identified for PTX06-1192; however, no trend was identified for the last four samples. All concentrations remain far below the GWPS.
- An apparent increasing trend was identified for PTX06-1199; however, no trend was identified for the last four samples. All concentrations remain far below the GWPS.

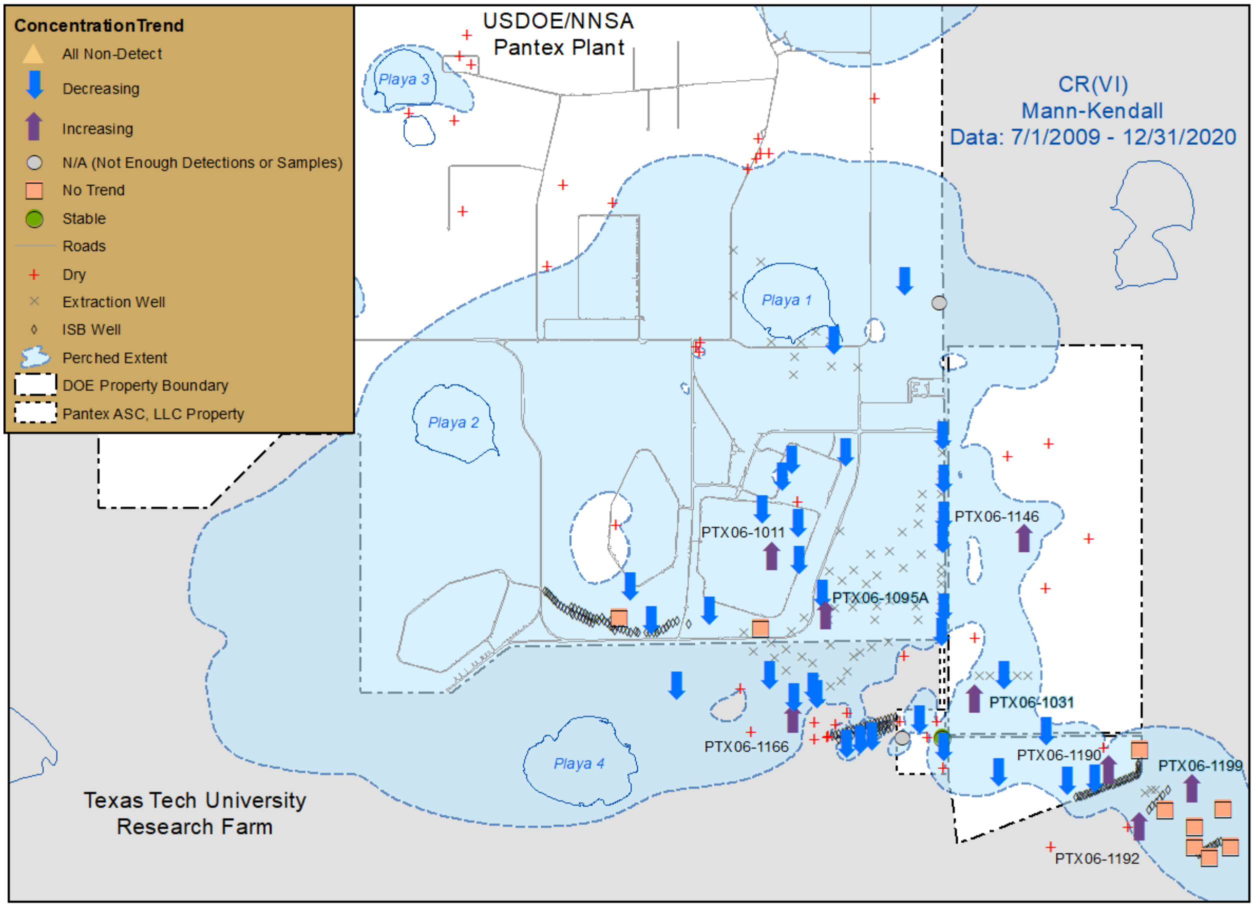

Figure 3-8. Hexavalent Chromium Trends in the Perched Aquifer

3.1.4.3 Perchlorate Trends

As depicted in Figure 3-9, seven monitoring wells are exhibiting increasing trends in perchlorate concentration:

- 1114-MW4 is exhibiting an increasing trend in perchlorate concentrations since the start of remedial actions in 2009. This well had concentrations in the range of 300 ug/L when installed in 2002, which steadily declined until 2010 then exhibited a slowly increasing trend. Observed concentrations have been generally declining since 2018 with a slight increase observed in 2020. These shifting trends could be due to changes in gradients or general plume movement downgradient. Regardless, 1114-MW4 is installed upgradient of the Zone 11 ISB system and the SEPTS; the perchlorate will be treated as it flows through the ISB system or is captured by the SEPTS.

- PTX06-1006 was exhibiting a decreasing trend in perchlorate from the time it was first detected in the well until 2014; the Mann-Kendall analysis indicates an increasing trend based on data collected since the start of remedial actions in 2009. However, concentrations have remained relatively constant since 2014, and a decreasing trend is indicated for the last four samples. These fluctuations could be caused by changes in gradients and plume movement from the SWMU 5-13A ditch. Another possible cause of these shifting trends could be caused by historical injection and the resulting return to unaffected perchlorate concentrations after injection ceased. As discussed in several prior annual progress reports, historical injection from 1996 to 2006 at the SEPTS injection well PTX06-INJ-02 affected COC concentrations and trends in wells installed east of PTX06-1006.

- PTX06-1035, PTX06-1134, and PTX06-1159, which are located southwest of the Zone 11 ISB system, are demonstrating increasing trends in perchlorate concentrations likely due to general plume movement downgradient. These wells are located downgradient of the Zone 11 ISB system, and treated water was not expected to reach these wells for many years following the establishment of reducing conditions in the treatment zone. Concentrations in all three wells had been increasing for several years, but the most recent samples collected exhibit a significant decline in concentrations. These declines may indicate that treated groundwater may be entering the wells.

- PTX08-1007 is exhibiting an increasing trend in perchlorate. Perchlorate has been detected below the PQL since 2014, and recent data do not indicate a trend.

- Perchlorate increased in PTX08-1008 from 2014 into 2017; however, perchlorate has been decreasing in this well since 2017. The variation in perchlorate in this well may be due to general plume movement to the southeast in this area, which may also be influenced by the SEPTS's operations.

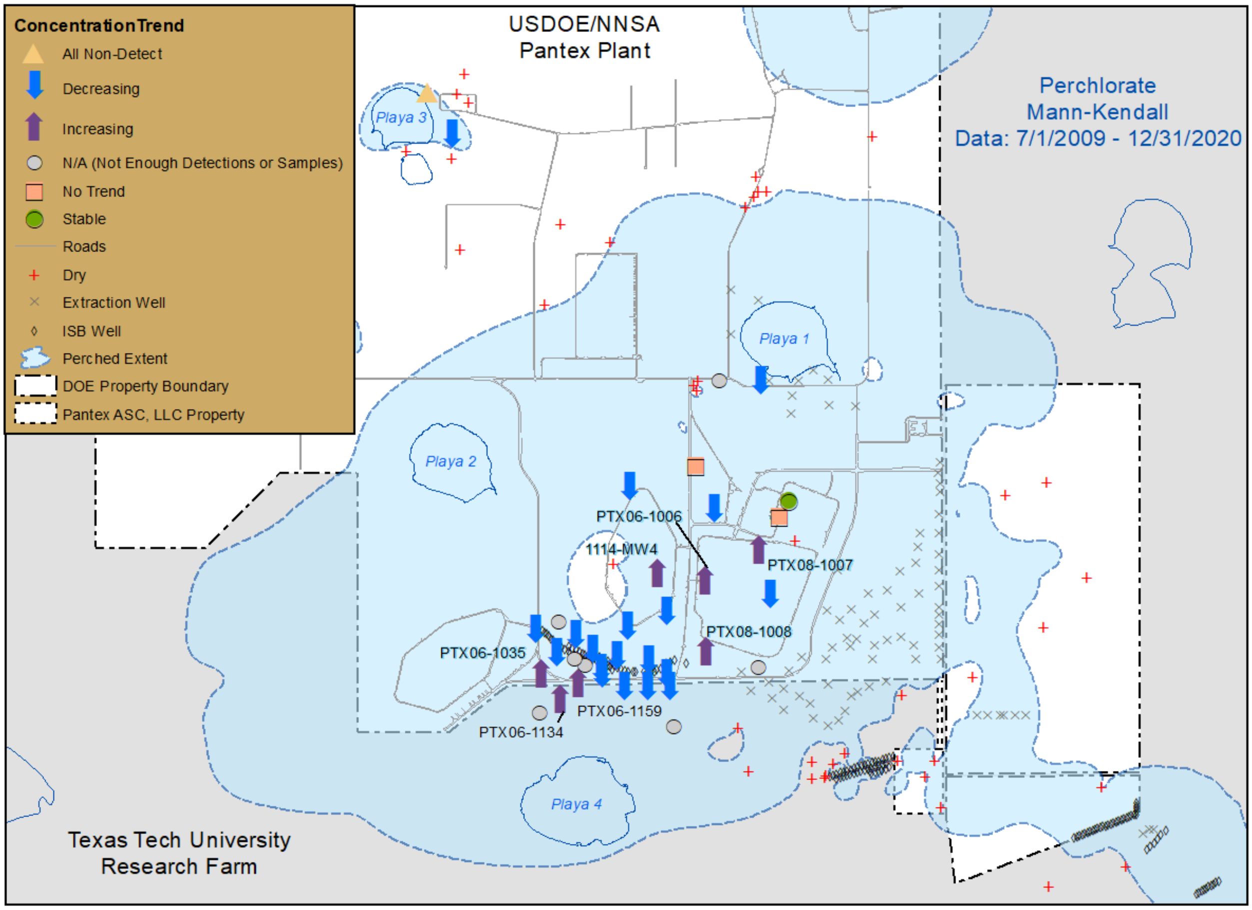

Figure 3-9. Perchlorate Trends in the Perched Aquifer

3.1.4.4 TCE Trends

As depicted in Figure 3-10, the following 19 monitoring wells are exhibiting increasing trends in TCE concentration since the start of remedial actions:

- An apparent increasing trend was identified for OW-WR-38 located northeast of Playa 1. Detections have been sporadic since 2009, and all sample results have been below the sample PQLs. The identified increasing trend is the result of low-level detections and the use of one-half the detection limit in the trending and does not indicate actual increasing concentrations in this area.
- The apparent increasing TCE trend in PTX06-1005 is likely caused by the return of unaffected conditions in this area after injection of treated water at SEPTS injection well PTX06-INJ-12A, located approximately 200 ft to the east, ceased. Almost 70 Mgals of treated water were injected into the perched aquifer at PTX06-INJ-12A from the time it was installed in 2008 through 2012 when injection was ceased

because of failure of the well. Over the last five years, concentrations have fluctuated between approximately 20 to 40 ug/L in this well, and the last four samples indicate a decreasing trend.

- An increasing trend was identified for PTX06-1006 where TCE had been consistently detected below the sample PQL from 2011 through 2018. The most recent two samples in 2019 and 2020 demonstrated detections slightly above the PQL. The increasing concentrations could be caused by changes in gradients and plume movement from the SWMU 5-13A ditch or the return to unaffected TCE concentrations after injection ceased. As discussed in several prior annual progress reports, historic injection at SEPTS injection well PTX06-INJ-02 (1996–2006) affected COC concentrations and trends in wells installed east of PTX06-1006.
- An increasing trend was observed for PTX06-1010 in the eastern part of Zone 12. Although the trend indicates increasing TCE, concentrations in this well have declined to below the GWPS from historical levels above GWPS, have remained well below GWPS since 2009, and the last four samples indicate “No Trend.”
- PTX06-1011, located in Zone 11, has fluctuating detections of TCE near the GWPS since 1995. “No Trend” is indicated for the last four samples and for all data.
- PTX06-1035 and PTX06-1134, which are downgradient of the western side of the Zone 11 ISB, are exhibiting increasing trends in TCE concentration due to general plume movement downgradient. The ISB system conceptual site model predicted treated water would not reach these wells for many years, and these wells are not expected to demonstrate TCE treatment until 10 years or longer after system operations began. TCE concentrations in PTX06-1035 slightly exceeded the GWPS for the first time in 2019 but subsequently declined in both samples collected in 2020. Data for the last four samples at PTX06-1134 indicate no trend.
- TCE is exhibiting a probably increasing trend in PTX06-1048A, located northeast of Playa 1, which has not historically been nor is expected to be under the effect of remedial action. TCE was first detected in this well in 2000 and has generally been detected at levels near the PQL and below the GWPS. The last four samples indicate no trend.
- PTX06-1095A is within the influence of the SEPTS well field but is also located less than 50 ft downgradient of the PRB pilot study wells PTX06-PRB01A and

PTX06-PRB02. Since 2014, detections have been highly variable. The increasing trend is likely due to the PRB losing treatment effectiveness and concentrations returning to baseline conditions. A decreasing trend was exhibited by the last four samples.

- An apparent increasing trend below the GWPS was identified for PTX06-1098, located on the upgradient side of the ISB pilot system. These results correspond to a decrease in cis-1,2-dichloroethene (cis-1,2-DCE) and indicate reduced treatment provided by the ISB pilot system along with movement of the plume out of this area.

- An apparent increasing trend was identified for PTX06-1101; however, the most recent sample was only slightly above the GWPS, and the last four samples indicate a decreasing trend. This well is located on the downgradient side of the Southeast ISB pilot study well field, and these results correspond to recent decreases in cis-1,2-DCE to below the PQL. The increase in TCE indicates reduced treatment provided by the ISB pilot system along with movement of the plume out of this area.

- An increasing trend was identified for PTX06-1127 located upgradient of the Zone 11 ISB system. Concentrations began increasing in 2015, but no trend is indicated for the last four samples. This well is located downgradient from the identified sources in Zone 11, so the variations likely reflect general plume movement in the area.

- PTX06-1148, PTX06-1149, and PTX06-1150 are downgradient of the original part of the Zone 11 ISB. TCE concentrations at PTX06-1150 have been increasing since 2010, while TCE concentrations at PTX06-1148 and PTX06-1149 began increasing in 2018. Concentrations of TCE are at the GWPS in PTX06-1148 and have increased above it in PTX06-1149 and PTX06-1150. These data indicate that TCE is not being effectively treated on the eastern side of the Zone 11 ISB. Additional evaluation of the ISB system performance is provided in Section 3.2.3.1.

- PTX06-1173 is a downgradient well on the western side of the Zone 11 ISB and the only well downgradient of this portion of the system not demonstrating strong treatment of TCE. Concentrations have fluctuated in this well, but the most recent sample shows a large decline in TCE. Further details are provided in Section 3.2.3.1.

- An increasing trend was identified for PTX06-1180 located southwest of Zone 11 and upgradient of the Zone 11 ISB system. Concentrations have been variable but generally increasing in this well since it was installed in 2015. This well is located downgradient from the identified sources in Zone 11, so the variations likely reflect general plume movement in the area.
- The increasing trend in PTX08-1006, which is located downgradient from the identified sources in Zone 11, is likely due to general plume movement to the southeast, which may also be influenced by SEPTS operations. Concentrations have been highly variable in this well, and the last four samples indicate a stable trend.
- TCE was below the GWPS in 2020 at PTX08-1008, located southwest of Zone 12. TCE has been detected near the PQL for a number of years, and recent data do not indicate a trend.

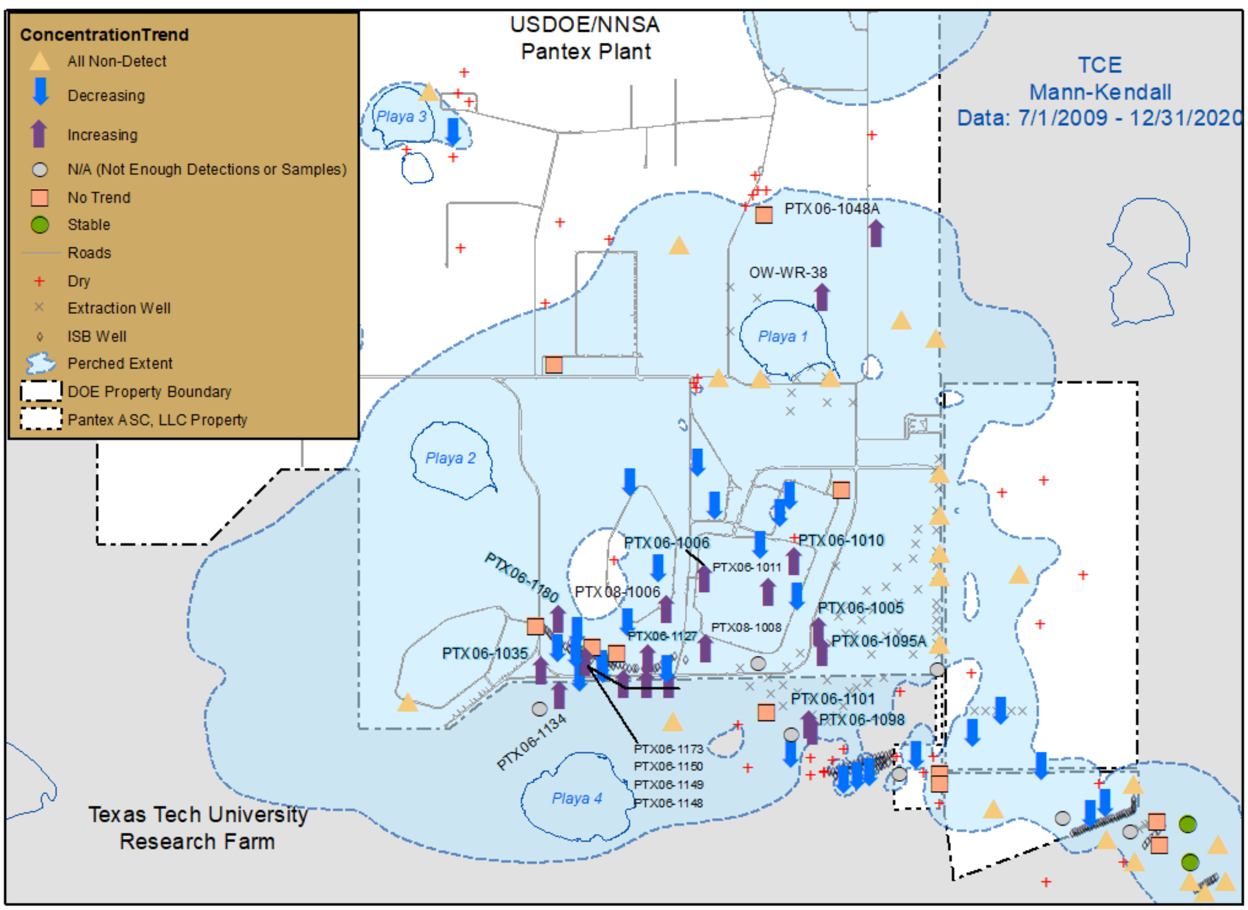

Figure 3-10. TCE Trends in the Perched Aquifer

3.1.5 Concentration Trends Compared To Expected Conditions

Of the 116 monitor wells with expected COC concentration conditions defined in the LTM Design Report, the 34 wells depicted in Figure 3-11 did not exhibit trends consistent with the expected conditions since the start of remedial actions. These wells were discussed in Section 3.1.4. Additional detail on all LTM wells is located in Appendix E's Table E-1.

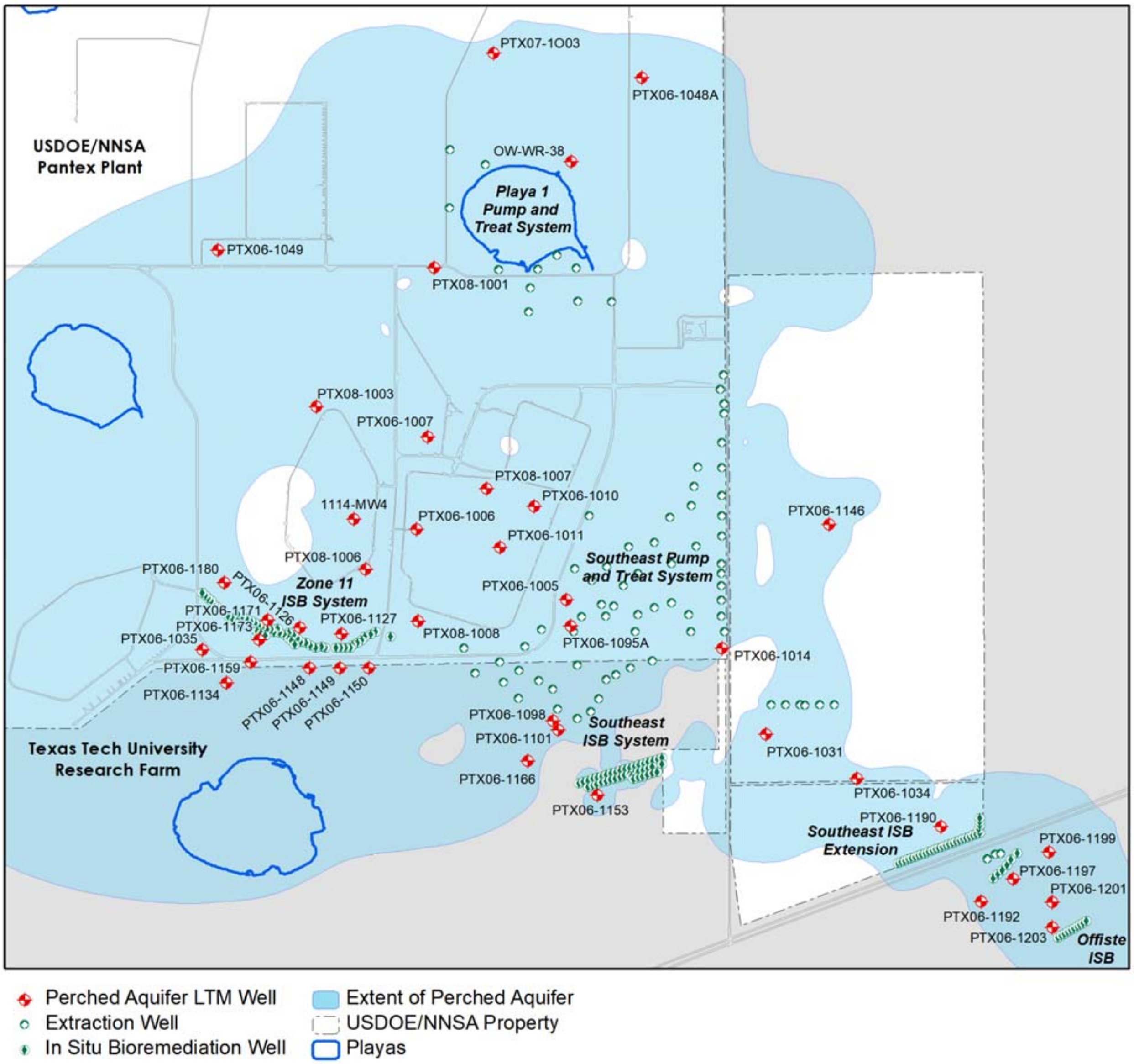

Figure 3-11. Perched Wells with Unexpected COC Trends

3.1.6 Plume Mapping

This section presents isoconcentration maps of indicator constituents (i.e., COCs and breakdown products of RDX and TCE) in the perched aquifer. Perched aquifer indicator parameters were proposed in the SAP. Isoconcentration maps for this annual report were produced from groundwater data collected in 2020.

Each isoconcentration map presents the highest detected concentration for each constituent using validated analytical data from January to December 2020. COC plumes were delineated to the approved GWPS as was done for the *2014 Annual Progress Report* (Pantex, 2014). The GWPS isoconcentration contour is highlighted by a yellow line outlined in black.

Constituent concentrations for samples from the extraction wells located within the two extraction well fields were used to generate the isoconcentration contours, but the analytical concentration data from these wells may differ from those of the investigative wells because of the different sampling techniques used for the extraction wells. The extraction wells are clearly identified on the figures with an "EW" in the well identification label and a distinct symbol. Pump and treat system injection wells are identified on the figures with an "INJ," and ISB injection wells are identified with an "ISB" in their respective well identification labels.

Constituent concentrations for samples collected from wells within the ISB treatment zones and downgradient zones of influence were generally used to generate the isoconcentration contours; however, for some constituents, including metals and HEs, these data were not used because the concentrations were indicative of the ISB treatment zone rather than the surrounding formation. Additionally, most downgradient ISPM wells are indicating treatment effects of the ISB treatment zone as well as the effects of expansion of the treatment zone. When these effects resulted in concentrations that were not believed to be representative of the surrounding formation and the overall plume shape, they were not included in the contouring process. The estimated downgradient areas under the influence of the ISB systems are depicted on plume maps, where appropriate. COC data obtained from the wells immediately downgradient from the three in-situ remediation pilot project areas were not used to generate the isoconcentration contours. Concentrations observed at these wells are typically much lower than surrounding plume concentrations and represent the localized influence of the pilot-scale remediation projects.

Table 3-1 identifies all indicator constituents for the perched aquifer. Figure 3-12 through Figure 3-26 are isoconcentration maps for RDX, 4-amino-2,6-dinitrotoluene (DNT4A), hexavalent chromium, perchlorate, and TCE. Maps for hexahydro-1-nitroso-3,5-dinitro-1,3,5-triazine (MNX), hexahydro-1,3-dinitroso-5-nitro-1,3,5-triazine (DNX), hexahydro-1,3,5-trinitroso-1,3,5-triazine (TNX), trinitrotoluene (TNT), 2-amino-4,6-dinitrotoluene (DNT2A), 1,3,5-trinitrobenzene, 1,4-dioxane, 1,2-dichloroethane, cis-1,2-DCE, and vinyl chloride are presented in Appendix F.

Table 3-1. Perched Aquifer Indicator Parameters

HEs	Metals	Inorganics	Volatile Organics
RDX	Boron	Perchlorate	Chloroform
HMX	Chromium		1,2-Dichloroethane
MNX	Hexavalent Chromium		1,4-Dioxane
DNX			*cis*-1,2-Dichloroethene
TNX			*trans*-1,2-Dichloroethene
TNT			PCE
1,3-Dinitrobenzene			TCE
2-Amino-4,6-dinitrotoluene			Vinyl Chloride
4-Amino-2,6-dinitrotoluene			
2,4-Dinitrotoluene			
2,6-Dinitrotoluene			
1,3,5-Trinitrobenzene			

Isoconcentration maps for other indicator constituents, such as octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX), 1,3-dinitrobenzene, 2,4-dinitrotoluene, 2,6-dinitrotoluene, boron, *trans*-1,2-dichloroethene, tetrachloroethylene (PCE), and chloroform, were not prepared because none of the measured concentrations exceeded the GWPS or detections were isolated to only a few wells and could not be used to map a distinct plume. The following paragraphs provide specific information detailing the reasons maps were not prepared for these constituents as well as for total chromium.

HMX

HMX was not detected above the GWPS of 360 ug/L in any perched aquifer well sampled in 2020. Therefore, an isoconcentration map was not prepared for this compound.

1,3-Dinitrobenzene

1,3-Dinitrobenzene was not detected above the PQL or GWPS in any perched aquifer well sampled in 2020. Therefore, an isoconcentration map was not prepared for this compound.

2,4-Dinitrotoluene

2,4-Dinitrotoluene was detected above the GWPS of 1 ug/L in one perched aquifer well sampled in 2020. This isolated exceedance could not be used to map a distinct plume. Low levels of 2,4-dinitrotoluene are expected within the capture zone of the SEPTS. Therefore, an isoconcentration map was not prepared for this compound.

2,6-Dinitrotoluene

2,6-Dinitrotoluene was detected above the GWPS of 1 ug/L in one perched aquifer monitor well and four SEPTS extraction wells in 2020. These isolated exceedances could not be used to map a distinct plume. Low levels of 2,6-dinitrotoluene are expected within the capture zone of the SEPTS. Therefore, an isoconcentration map was not prepared for this compound.

Boron

Boron did not exceed the GWPS of 7,300 ug/L in any perched aquifer well sampled in 2020. Therefore, an isoconcentration map was not prepared for this compound.

Chromium

A map of total chromium isoconcentrations for the perched aquifer was not prepared for 2020. Historically, wells constructed with stainless-steel well screens have exhibited elevated concentrations of chromium and other components of stainless steel. Several of these wells have been shown by video observation to be corroded and/or have bacterial growth present, and statistical analyses of the concentrations of chromium and other components of stainless steel (i.e., manganese, molybdenum, and nickel) show strong correlations among the concentrations of these metals in samples obtained from these wells. This evidence indicates some degree of corrosion occurring in all perched aquifer stainless-steel wells at Pantex. In addition, chromium risks are associated with the hexavalent form of chromium. Because the map of hexavalent chromium shows the extent of chromium contamination in the perched aquifer, a separate map based on total chromium concentrations was not prepared.

Chloroform

Chloroform was detected above the GWPS of 80 ug/L in one perched aquifer well sampled in 2020. This isolated exceedance could not be used to map a distinct plume. Therefore, an isoconcentration map was not prepared for this compound.

Trans-1,2-Dichloroethene

Trans-1,2-dichloroethene was not detected above the PQL or GWPS in any perched aquifer well sampled in 2020. Therefore, an isoconcentration map was not prepared for this compound.

PCE

PCE was detected above the GWPS of 5 ug/L in two perched aquifer wells sampled in 2020. These isolated exceedances could not be used to map a distinct plume. Therefore, an isoconcentration map was not prepared for this compound.

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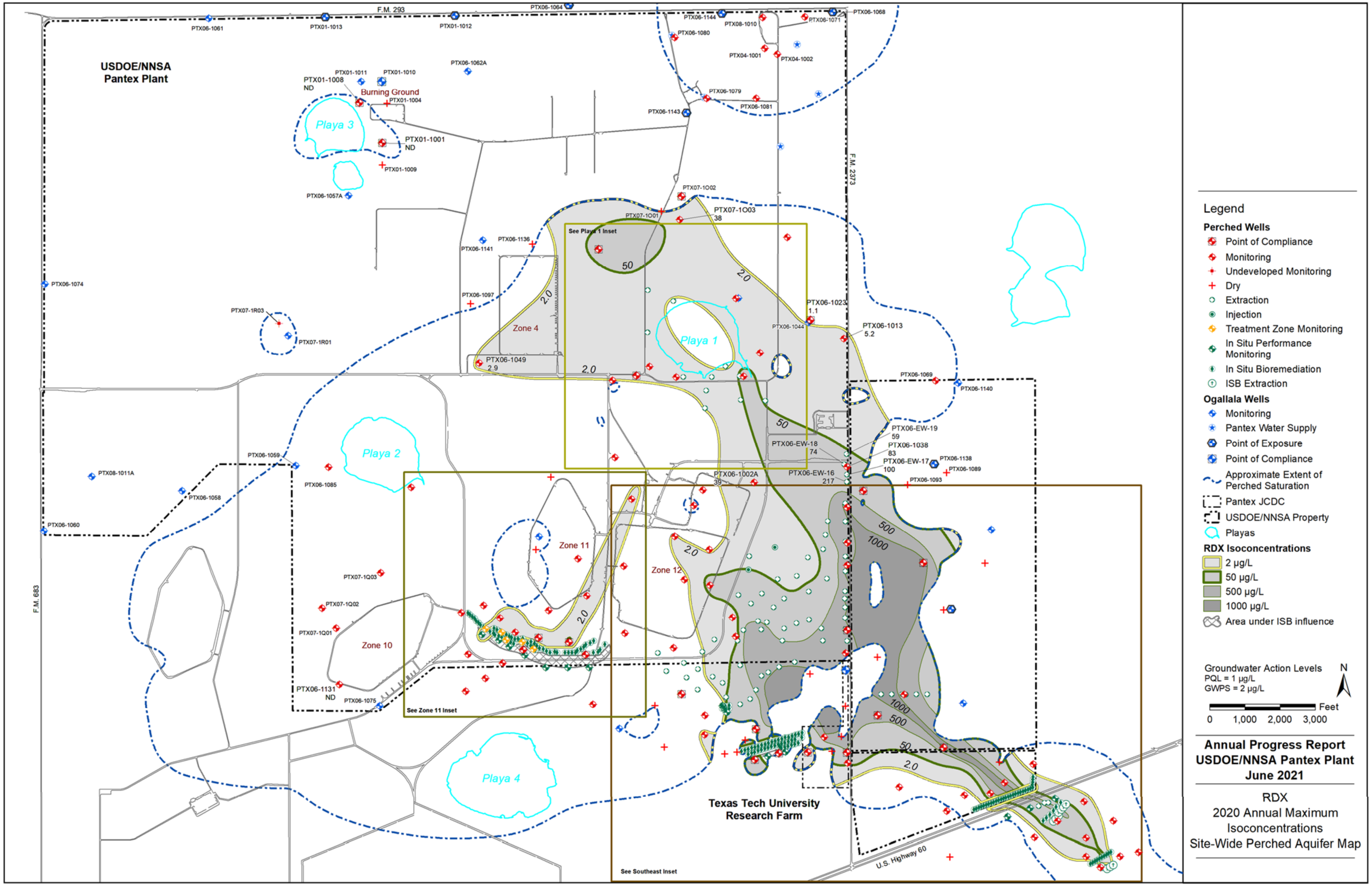

Figure 3-12. RDX Isoconcentration Map

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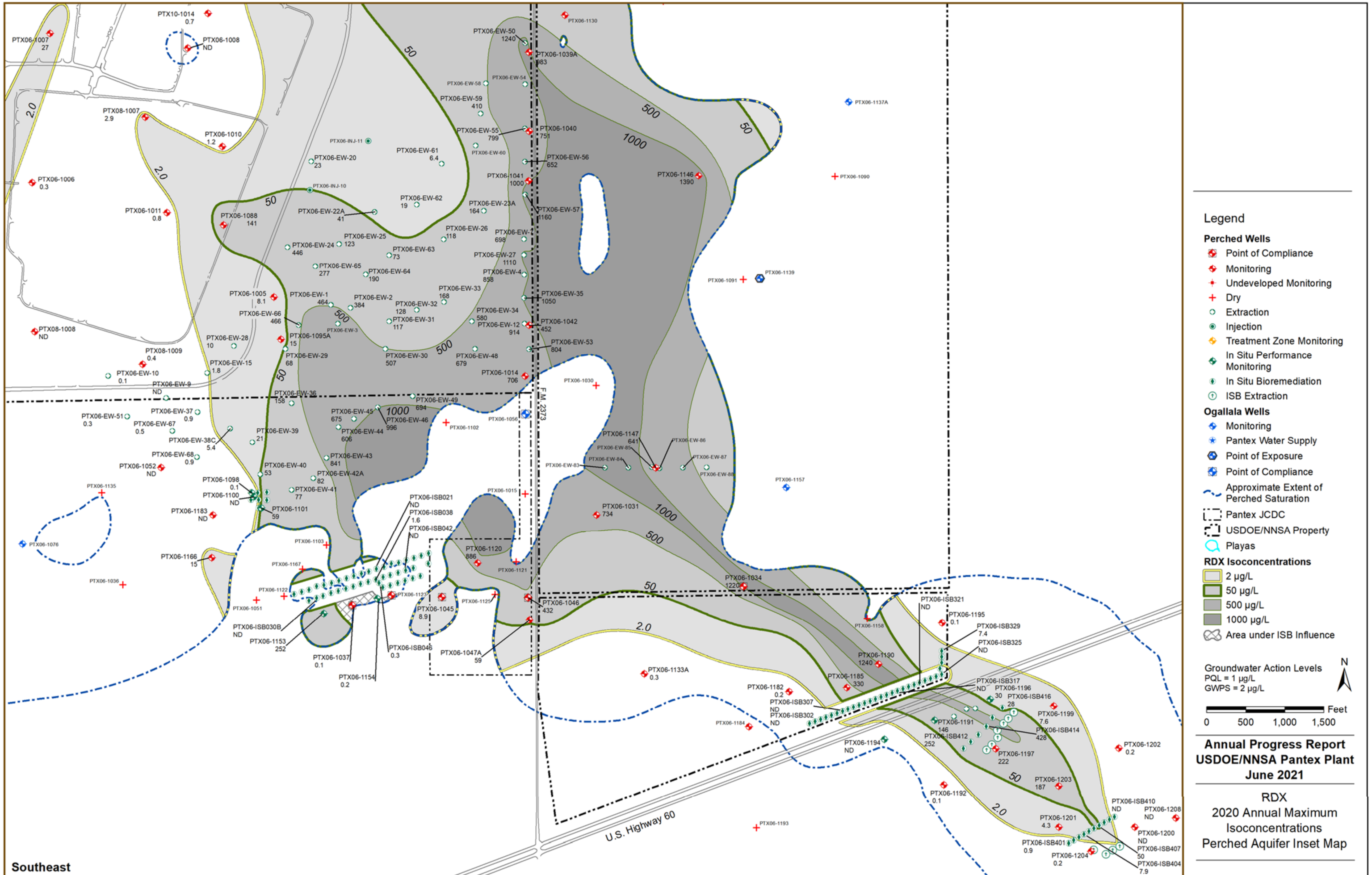

Figure 3-13. RDX Isoconcentration Southeast Inset Map

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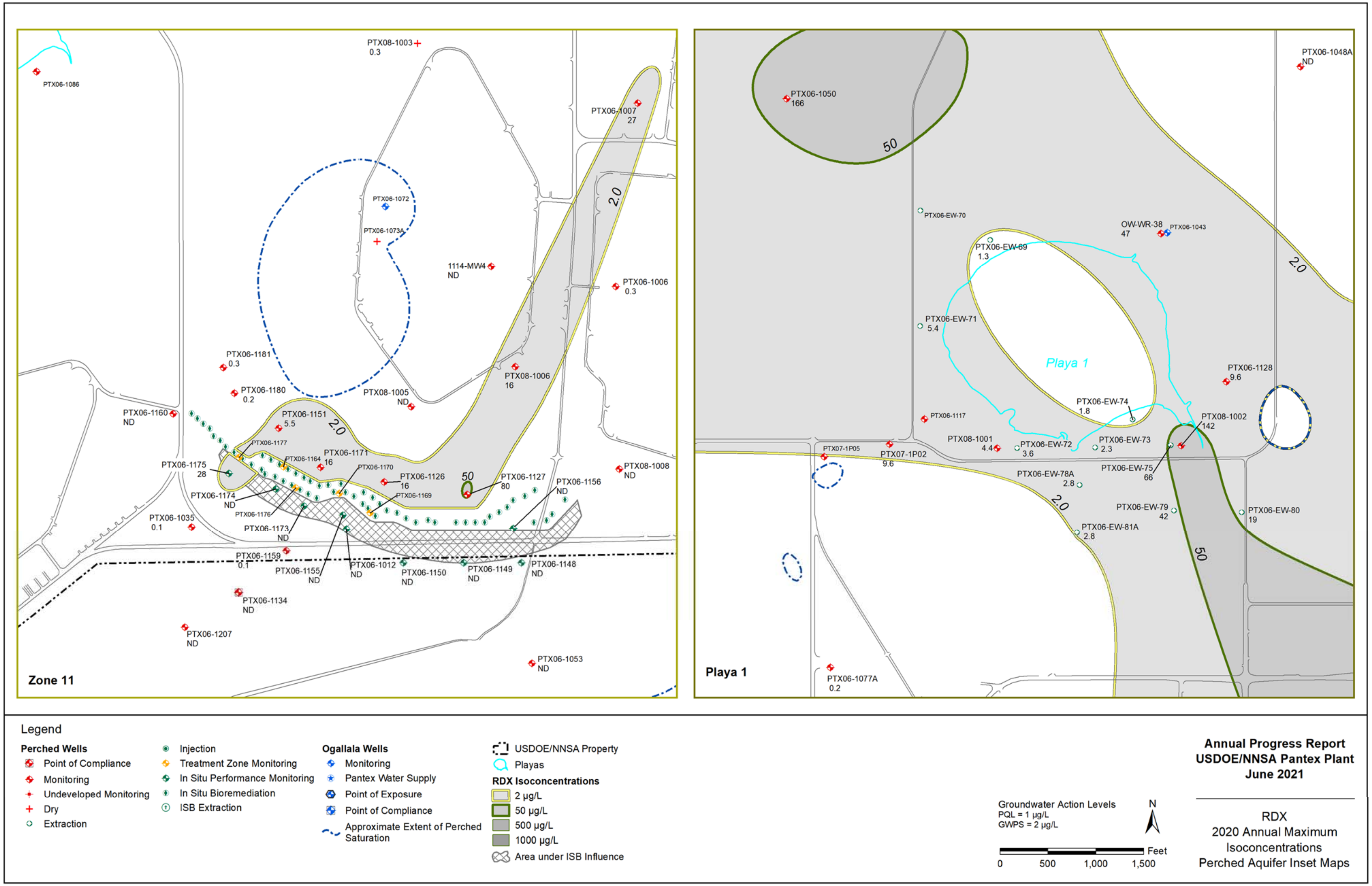

Figure 3-14. RDX Isoconcentration Zone 11 and Playa 1 Inset Maps

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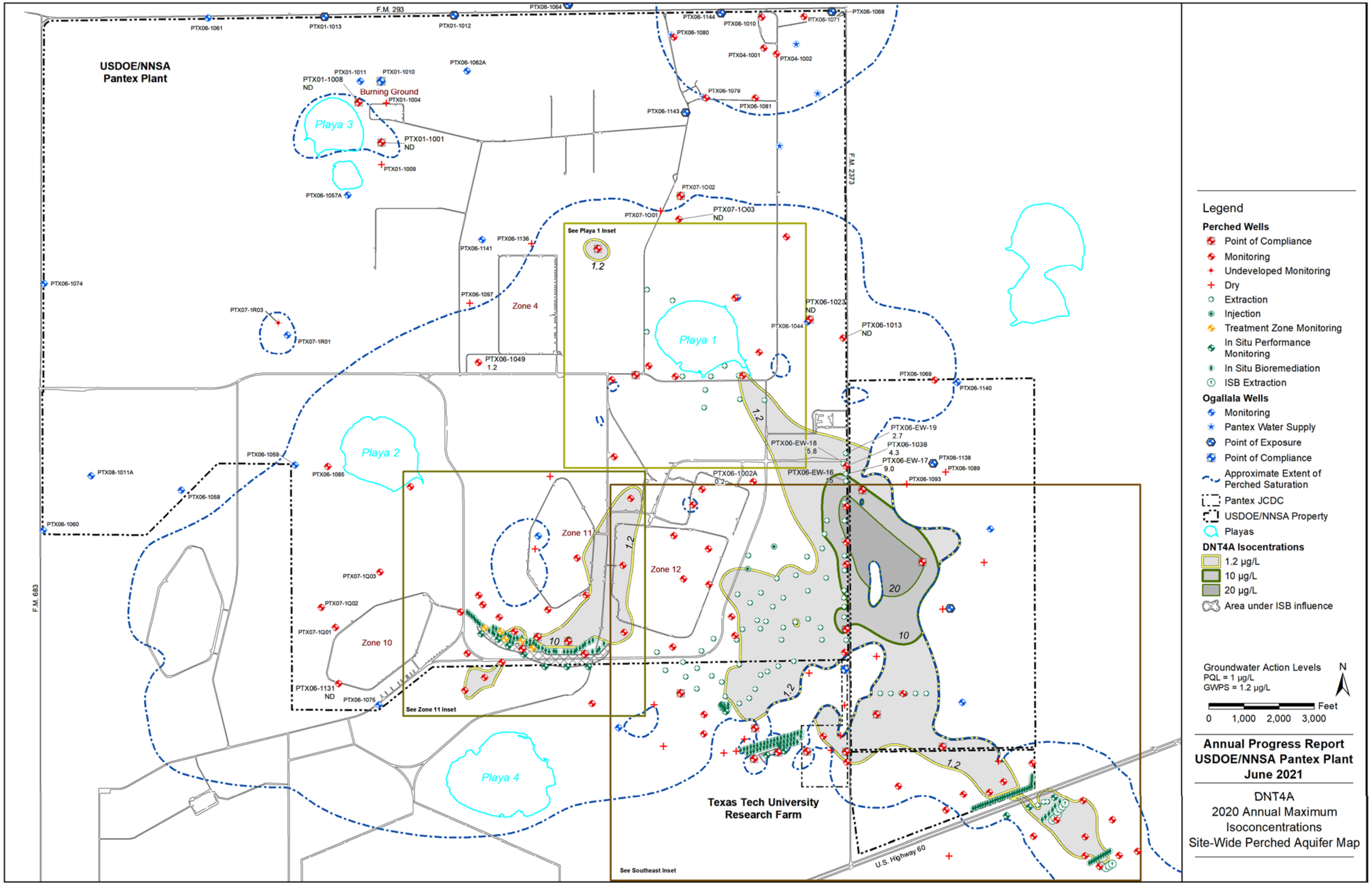

Figure 3-15. DNT4A Isoconcentration Map

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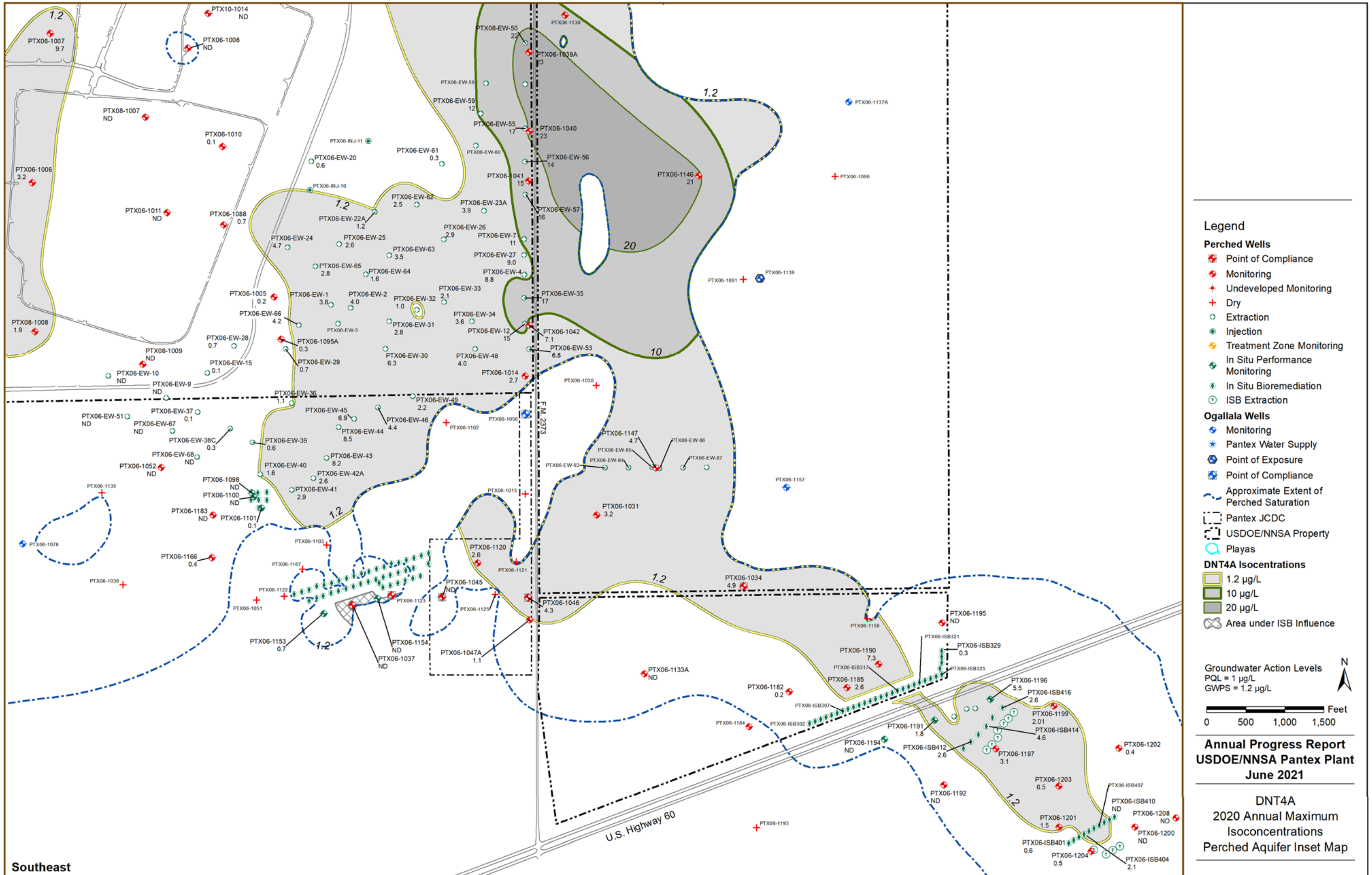

Figure 3-16. DNT4A Isoconcentration Southeast Inset Map

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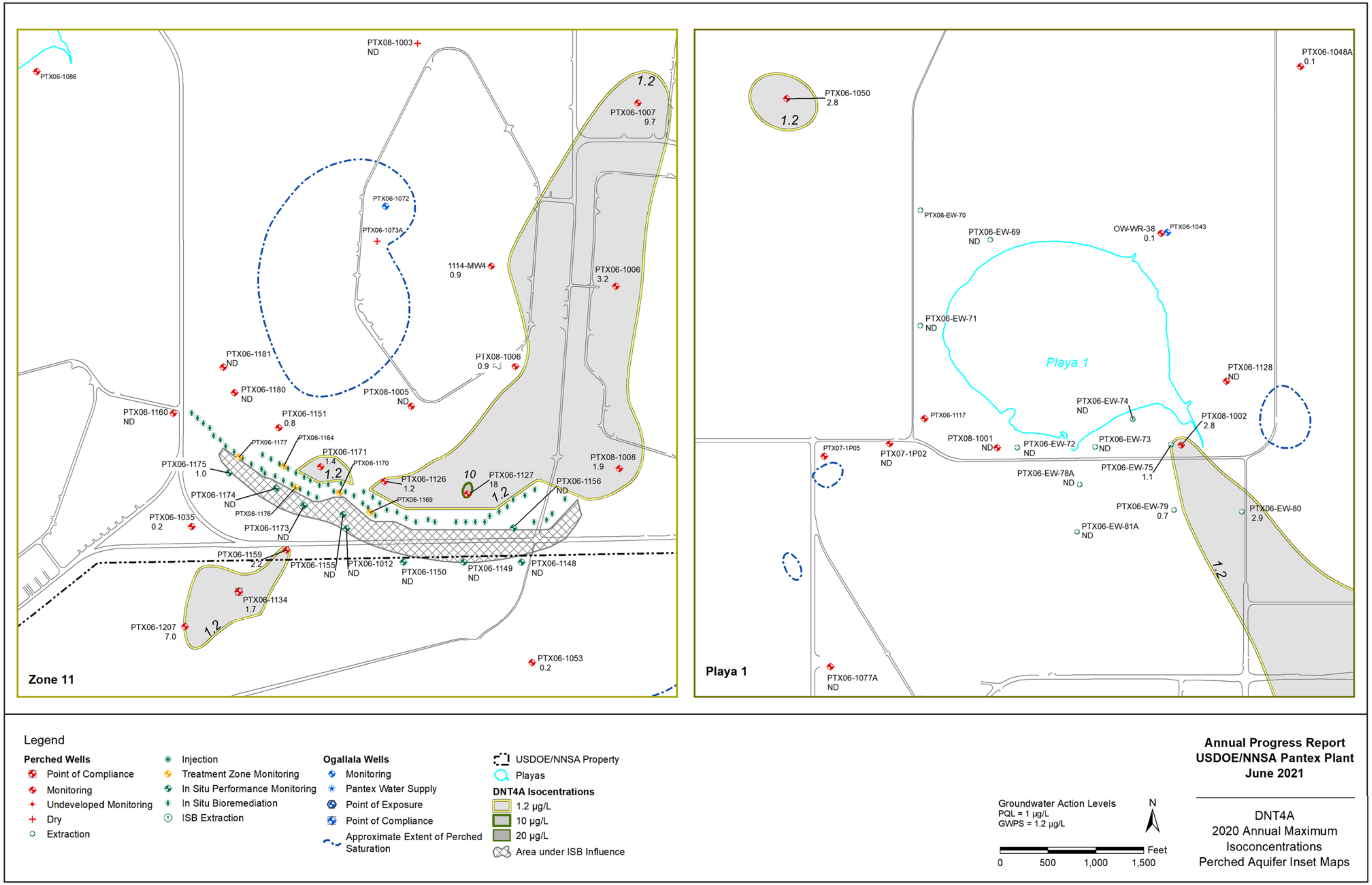

Figure 3-17. DNT4A Isoconcentration Zone 11 and Playa 1 Inset Maps

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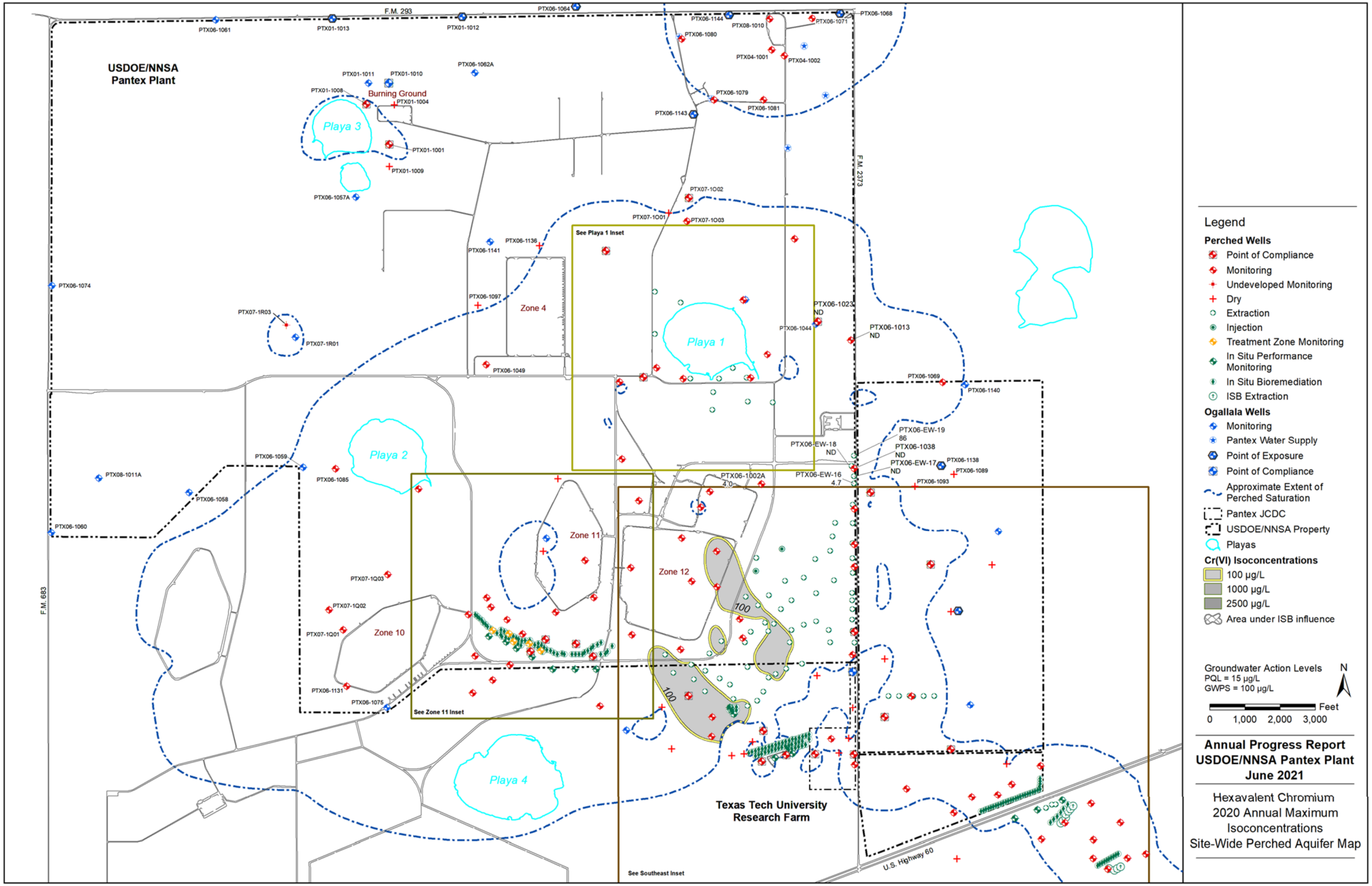

Figure 3-18. Hexavalent Chromium Isoconcentration Map

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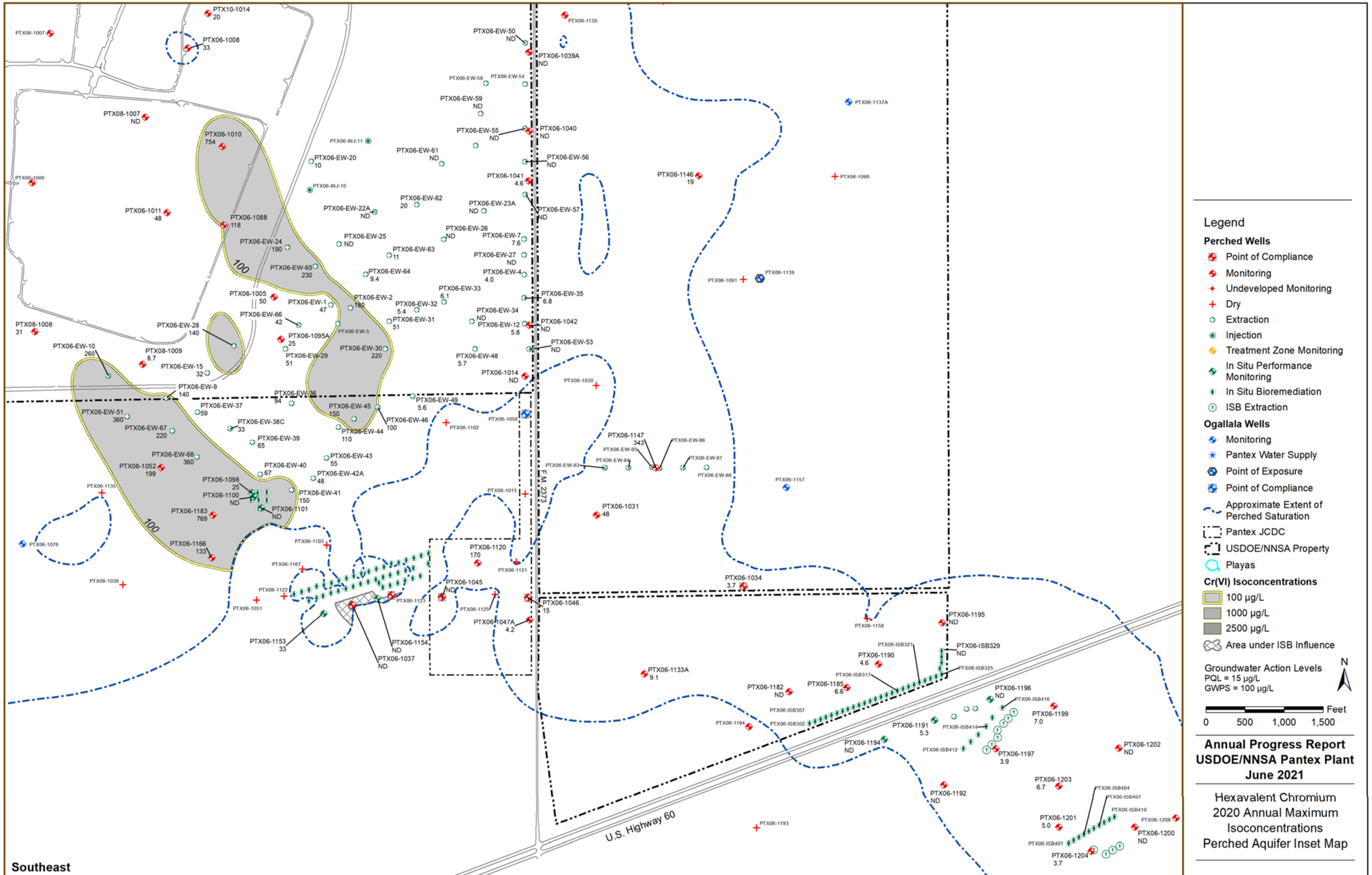

Figure 3-19. Hexavalent Chromium Isoconcentration Southeast Inset Map

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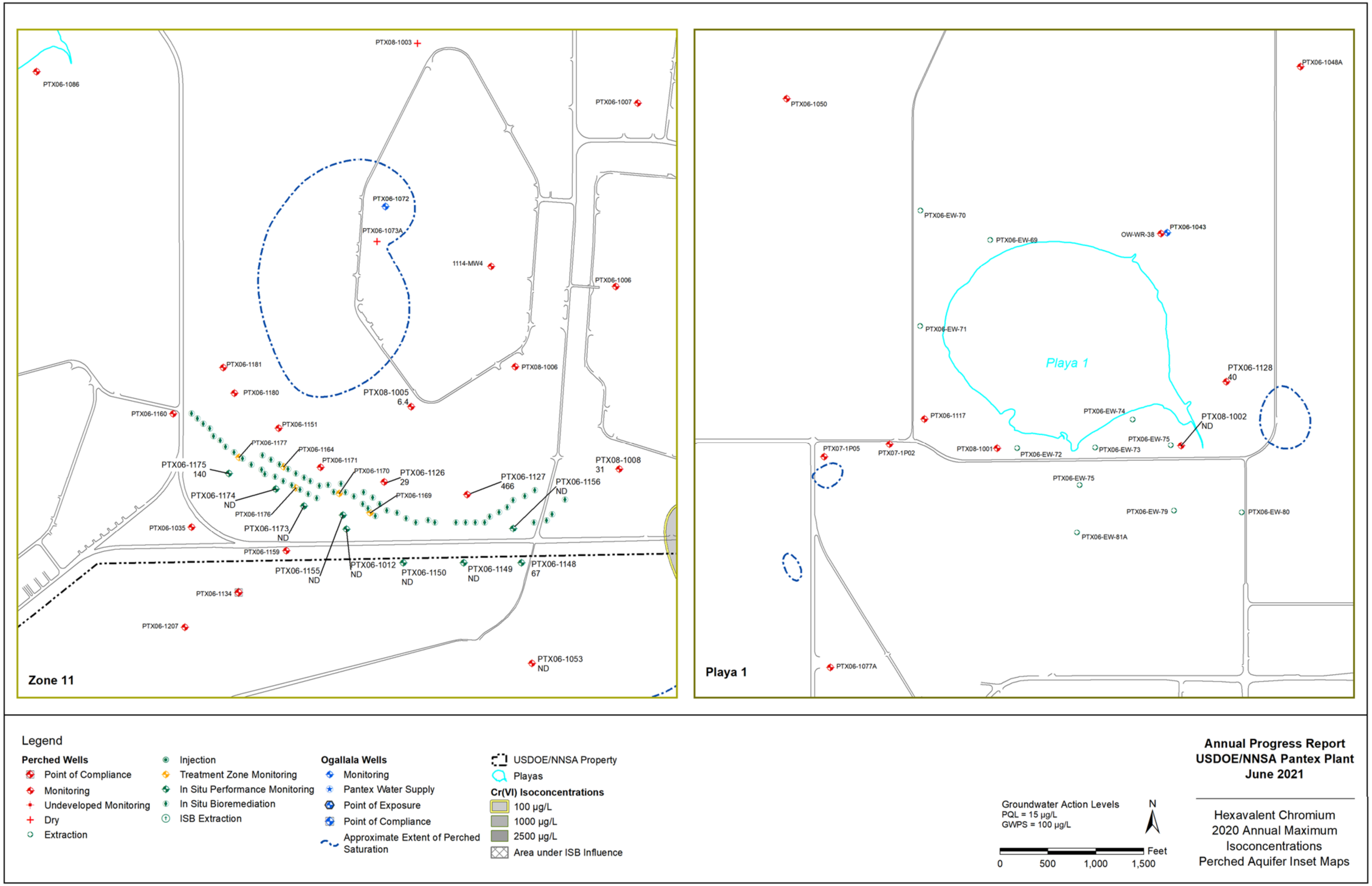

Figure 3-20. Hexavalent Chromium Isoconcentration Zone 11 and Playa 1 Inset Maps

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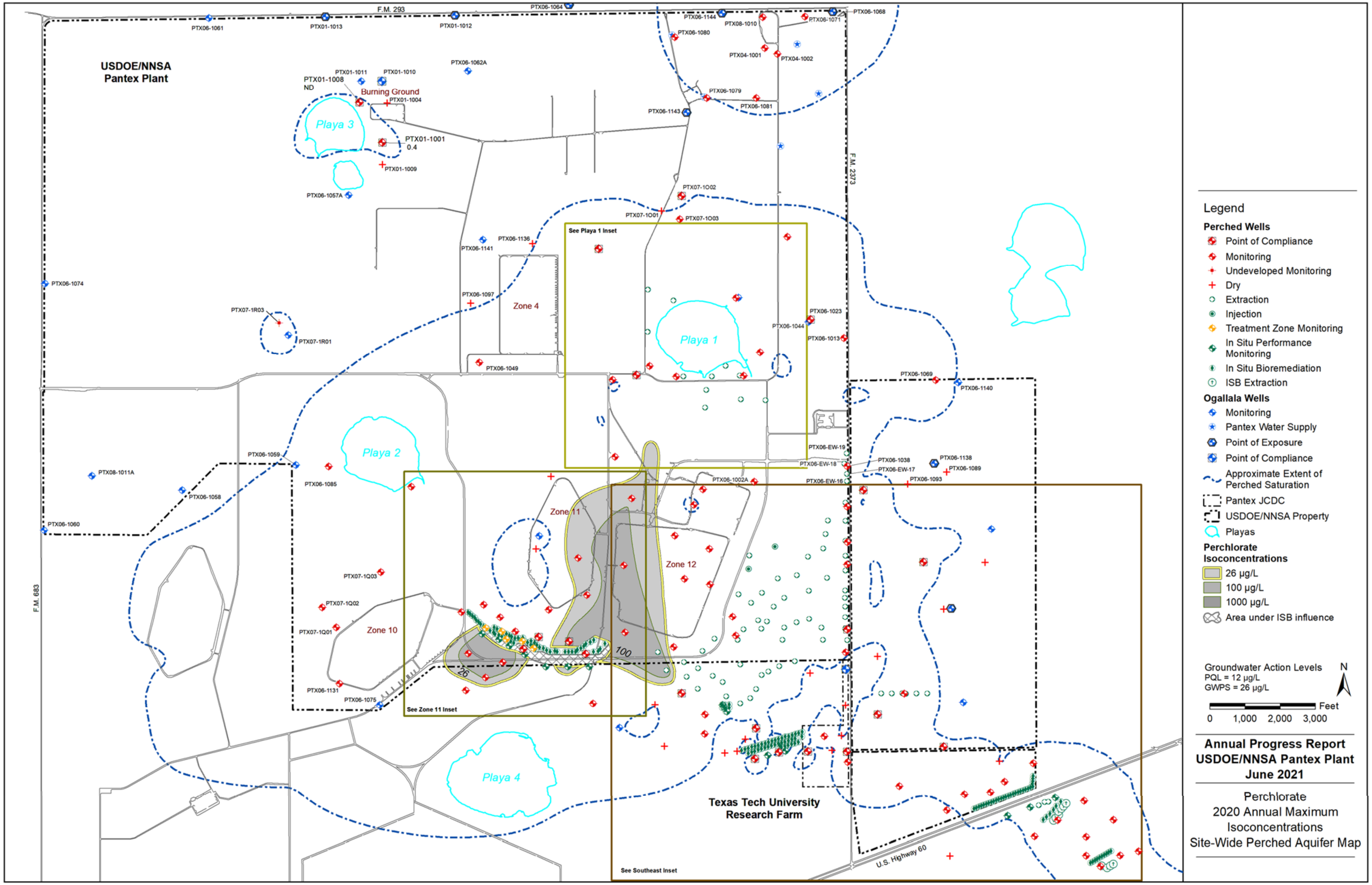

Figure 3-21. Perchlorate Isoconcentration Map

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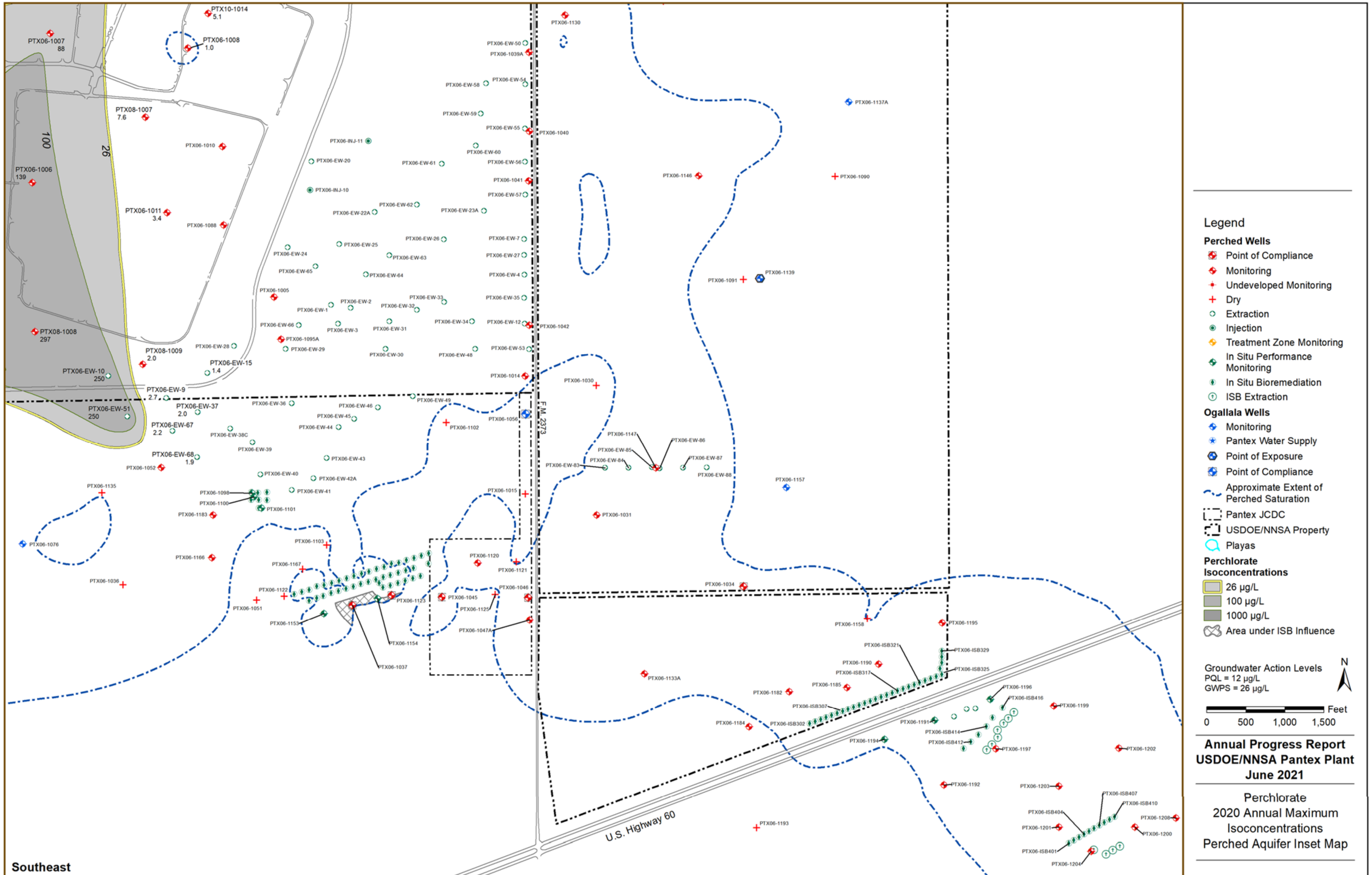

Figure 3-22. Perchlorate Isoconcentration Southeast Inset Map

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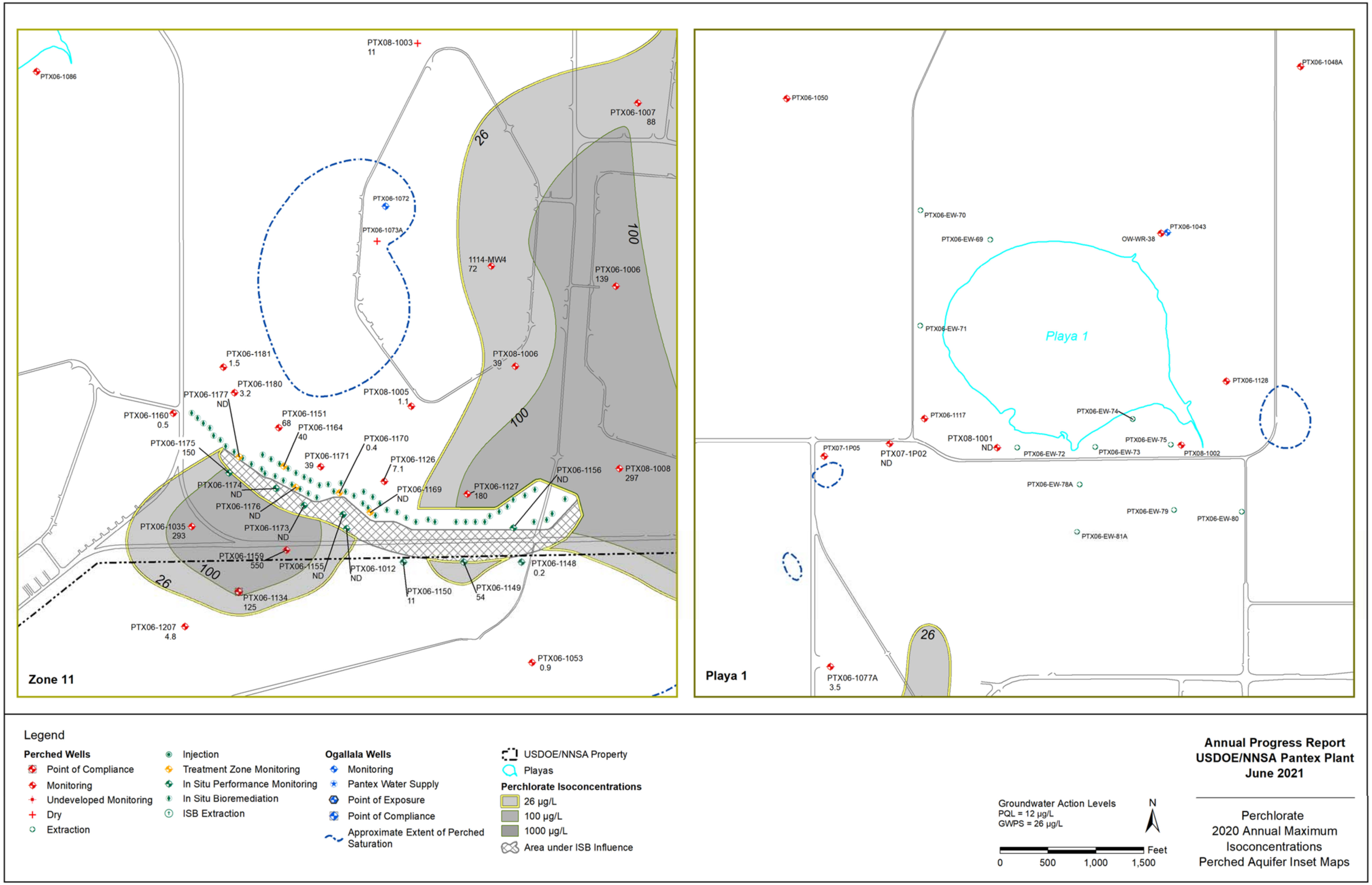

Figure 3-23. Perchlorate Isoconcentration Zone 11 and Playa 1 Inset Maps

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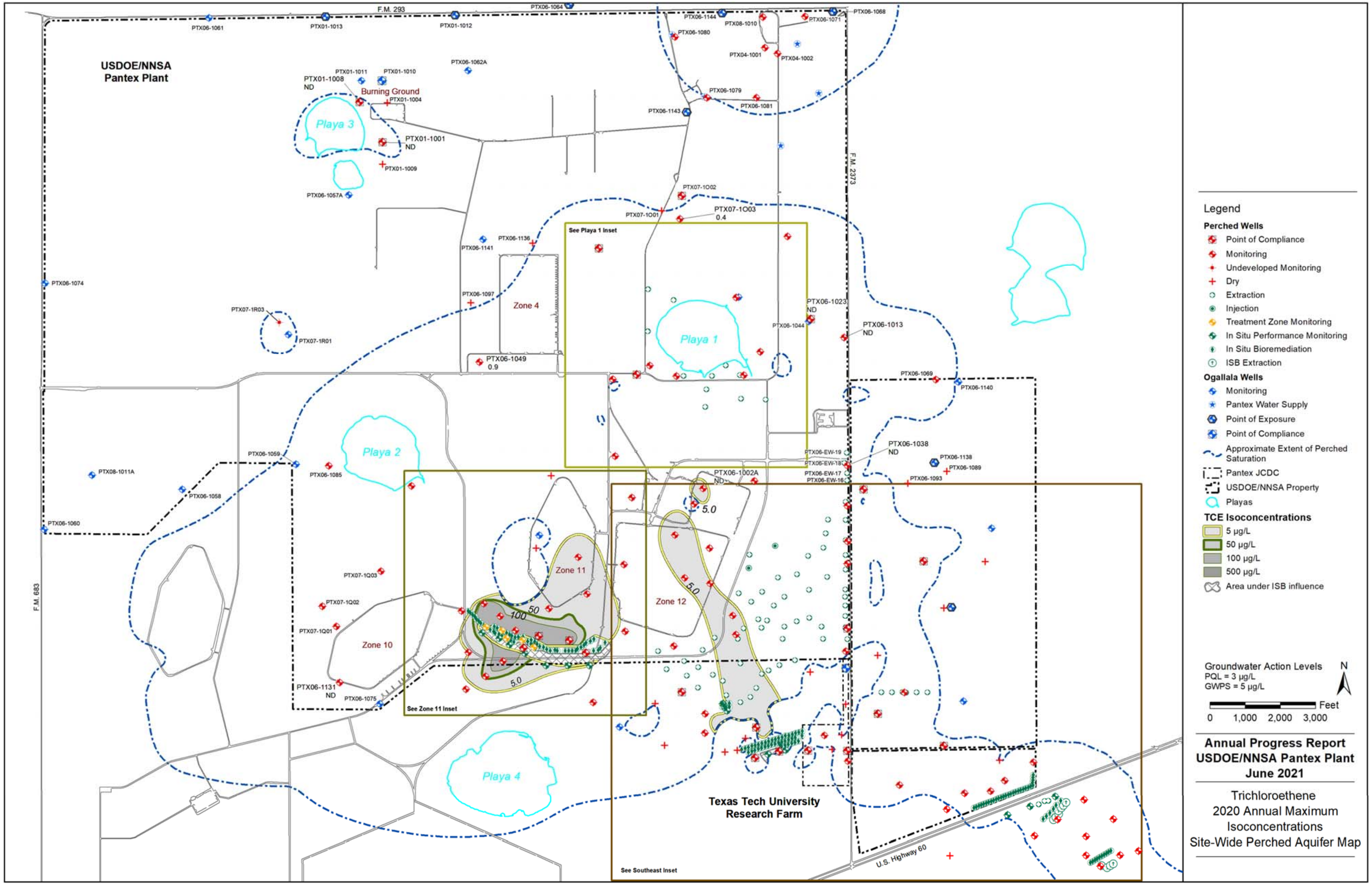

Figure 3-24. TCE Isoconcentration Map

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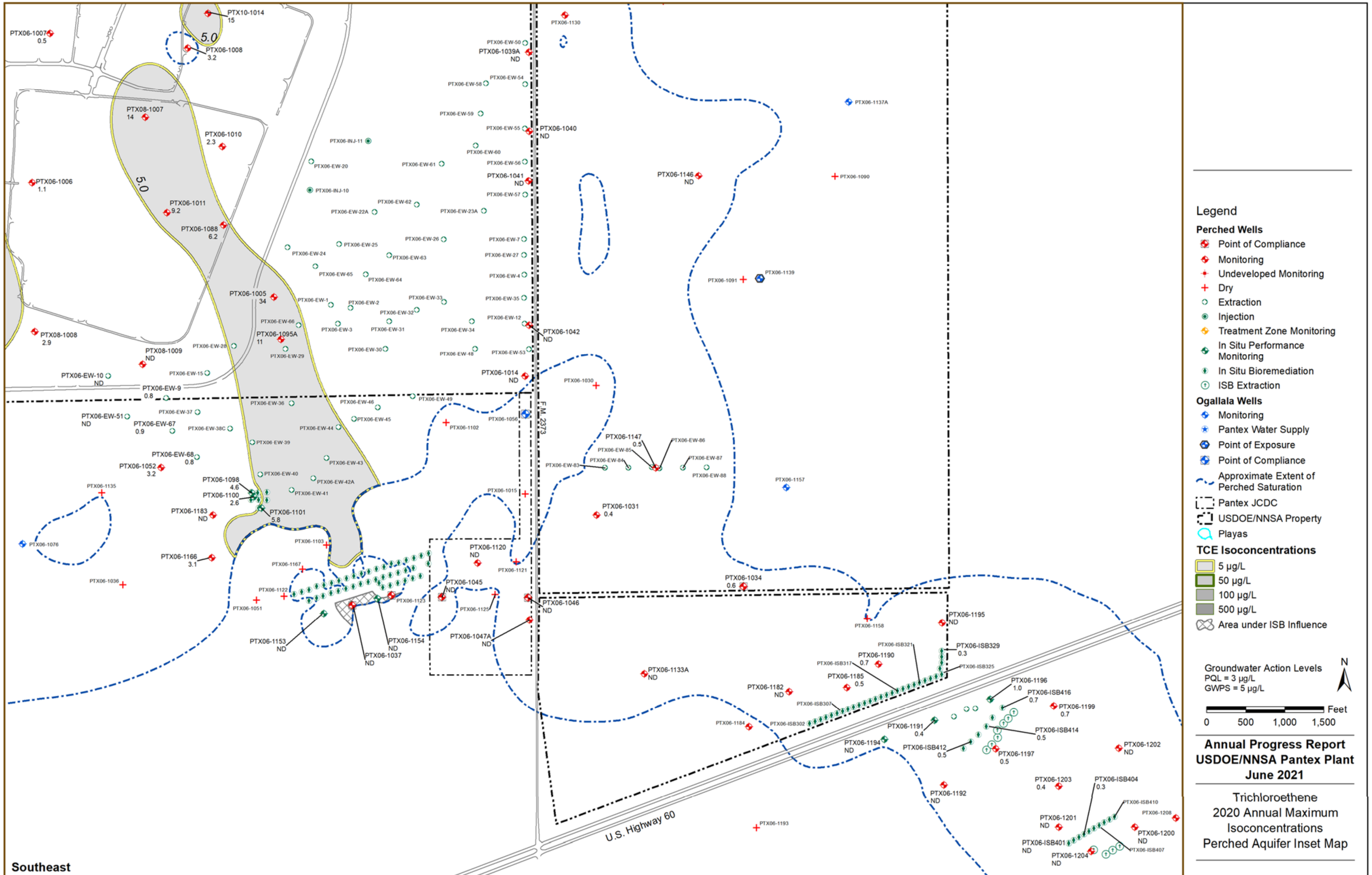

Figure 3-25. TCE Isoconcentration Southeast Inset Map

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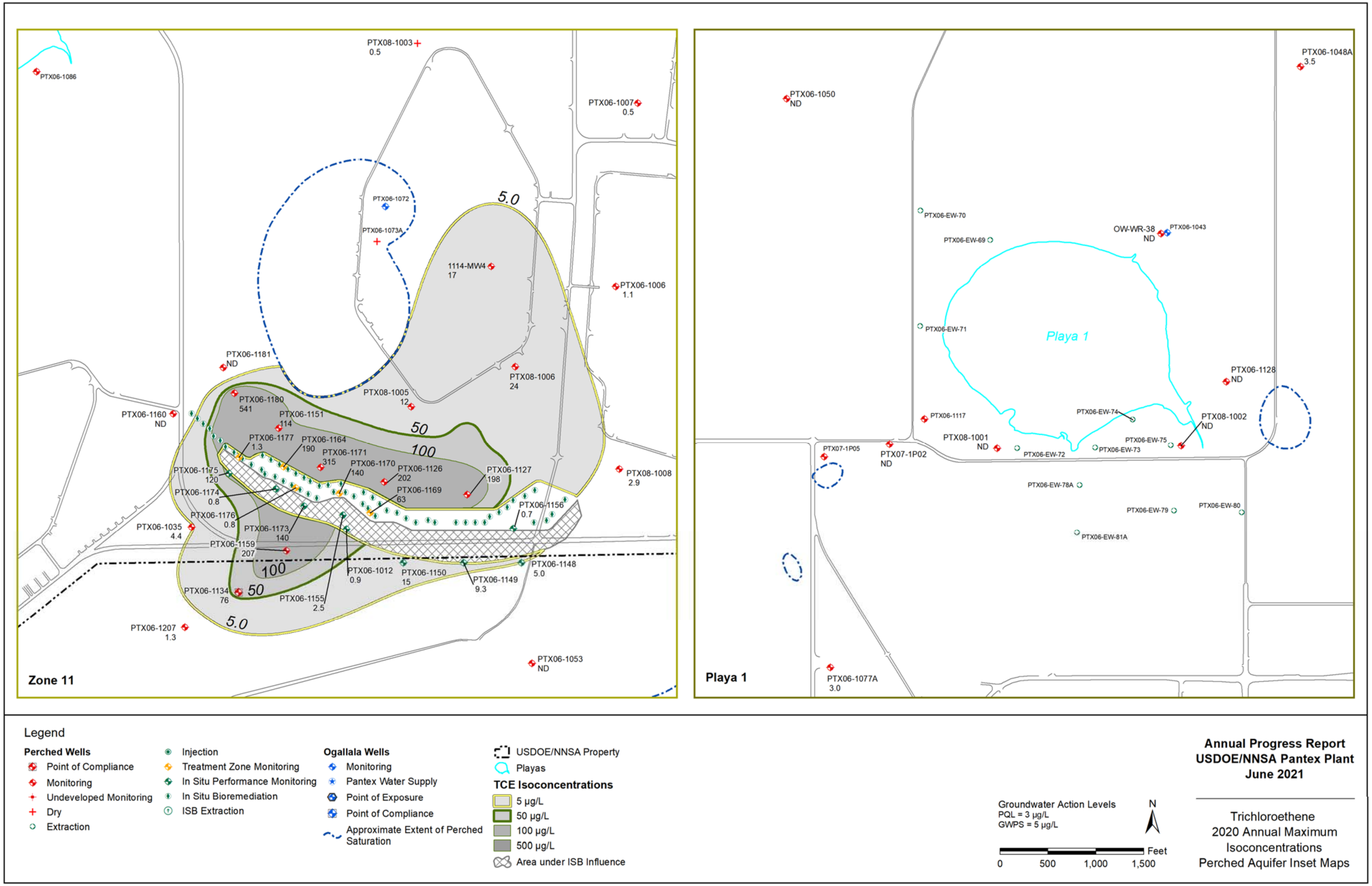

Figure 3-26. TCE Isoconcentration Zone 11 and Playa 1 Inset Map

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3.1.7 Estimate of Plume Movement

The unique characteristics of the perched aquifer, including the limited areal extent of the aquifer, cause difficulty when estimating the rate of migration of groundwater contaminants. Unlike a typical contaminant plume in a regional aquifer, the HE plume associated with Pantex (see Figure 3-12) extends to the edge of aquifer saturation, because this part of the aquifer was largely created by the infiltration of industrial wastewater discharges from legacy activities at Pantex. Furthermore, the movement of contaminants within the plume is difficult to assess because of the impacts of the groundwater treatment systems. COC concentration trends for individual wells are presented in Appendix E.

The approved LTM network has been in place since 2009, making it possible to compare the size and shape of plumes from specific time periods. Previous attempts to quantify plume movement by calculating plume centroids were unsuccessful, possibly due to asymmetrical plume shapes and remedial action effects. Therefore, only a qualitative discussion of plume movement from 2009 to 2020 is included in the following sections. Estimated plume boundaries for 2020 and/or select contours were compared with the 2009 isocontour maps. As additional data are collected, quantification of plume movement may be attempted again.

Groundwater contamination in the perched aquifer occurs as several overlapping plumes associated with historical release areas. Each of the principal plumes is discussed below.

3.1.7.1 High Explosive Plumes

Several HE plumes are present in the perched aquifer. These plumes are primarily composed of RDX and TNT, including breakdown products of those compounds, and other HE constituents. The largest plume having the highest concentrations, referred to as the Southeast Plume, is located east and southeast of Zone 12 and Playa 1 and extends offsite to the south and east to the extent of perched saturation. A second HE plume occurs beneath the southeast portion of Zone 11. Other HE plumes are present in the areas surrounding Playa 1.

The Southeast Plume was formed as a result of the discharge of HE-contaminated process waters into unlined ditches in Zone 12. The contaminated wastewater flowed through the ditches to Playa 1, but significant volumes of the water infiltrated through the ditches. The HE plume maps presented show that the highest concentrations of HEs in groundwater occur away from the ditches, indicating that contaminated perched groundwater has moved to the southeast, away from the source areas, and that concentrations of contaminated recharge water have declined over time. Trends in this plume’s historic analytical data indicate that source areas along the ditches continue to leach HEs into perched groundwater but at much lower concentrations than what has occurred historically.

This plume is being actively remediated by the SEPTS, which limits further migration of contaminants to the east. In addition, the P1PTS is actively treating the HE plume in the vicinity of Playa 1 as well as reducing the head driving the southeast plume movement. The Southeast ISB system is also actively treating the HE plume before reaching the area beneath TTU property where the FGZ becomes less resistant to vertical migration.

The Zone 11 plume was formed as a result of the discharge of HE-contaminated process waters into unlined ditches and ponds in Zone 11. Groundwater contaminant concentrations in wells located along the southeast perimeter of Zone 11 are increasing while concentrations at the south end of Zone 11 are decreasing. These increasing concentrations indicate movement of the plume away from upgradient source areas rather than increasing concentrations related to a source near the well.

HE plumes surrounding Playa 1 are likely associated with water infiltrating from the playa. Wells installed near Landfills 1 and 2 along with OW-WR-38 and PTX06-1049 are exhibiting some increasing trends in HEs. However, these trends are likely due to the reduction of saturated thickness and shifting gradients in the northern perched groundwater due to the P1PTS's operations rather than sourcing from the landfills. Trends will continue to be monitored at these locations.

To evaluate HE plume movement from 2009 to 2020, the RDX plume was chosen due to its size and distribution near the remedial actions. Considering the size and complexity of the RDX plume and the fact it is defined by the perched aquifer extent in many areas, the 1000-ug/L contours were included in the evaluation. These two contours represent the "hearts" of the two original plume sources (i.e., Playa 1 and Zone 12 ditches) that have since commingled in the southeast portion of the perched aquifer and are under the effects of the remedial actions.

As depicted in Figure 3-27, the 1,000-ug/L plume outlines have slightly shifted in the SEPTS well field and shifted to the southern and eastern edge of the perched aquifer extent. This is likely due to a combination of the SEPTS's operations and general plume movement in areas that are not under the SEPTS influence. For 2020, the RDX contour has extended into the far southeastern lobe of perched groundwater. This shift is the result of increases in RDX to above 1,000 ug/L at PTX06-1034, PTX06-1190, and PTX06-ISB124, coupled with recent additional investigation of the perched groundwater in this area. Movement of the plume in this area appears to be associated with faster groundwater flow paths along channel-type features on the top of the FGZ. Pantex determined the downgradient extent of the plume in early 2019 with the installation of six new wells to the southeast and, to intercept this plume as it migrates to the southeast, has completed a line of injection wells as part of an extension of the Southeast ISB remedy.

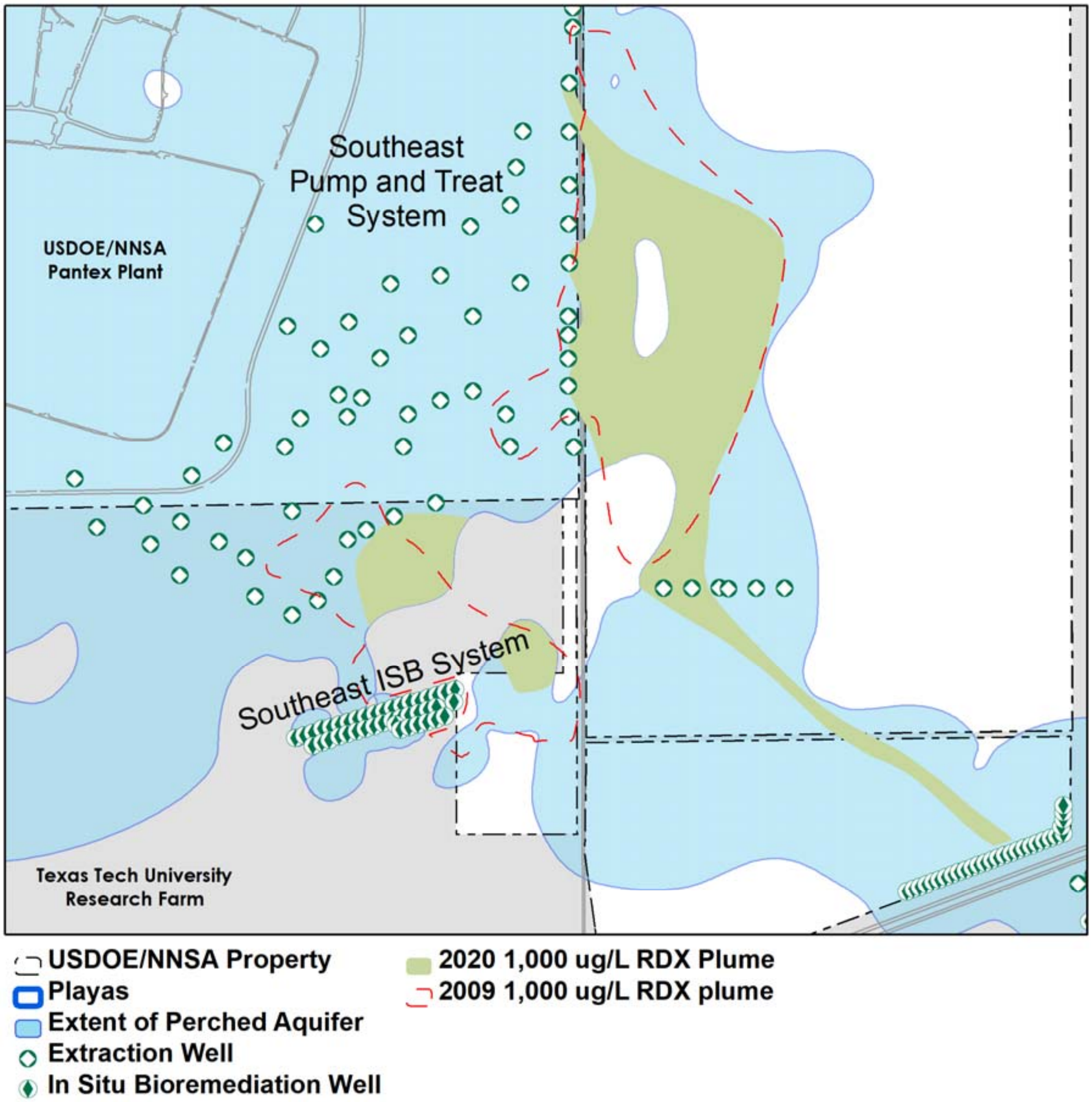

Figure 3-27. RDX Plume Movement, 2009-2020

3.1.7.2 Hexavalent Chromium Plumes

As shown in Figure 3-18 and Figure 3-19, hexavalent chromium is present in the perched aquifer in two commingled plumes originating in Zone 12. Both of these plumes are being actively remediated by the SEPTS.

The highest concentrations are associated with a source in waste management group (WMG) 5 outside the southwestern corner of Zone 12. Concentrations near the source area are decreasing, indicating that the source is declining. However, concentrations within the plume and in the far downgradient wells are variable, and the plume continues to move offsite to the southeast and extends to the limit of perched aquifer saturation on TTU property and the Southeast ISB system.

A smaller plume of hexavalent chromium emanates from the area of the Former Cooling Tower on the east side of Zone 12. Concentrations in this plume have decreased, but it is likely the source area continues to leach contamination to the perched groundwater.

When compared with the 2009 hexavalent chromium maps (see Figure 3-28), the shapes are similar, with the following exceptions:

- The northern lobe of the plume has apparently shifted to the east, likely due to a combination of the SEPTS's extraction well pumping and reduction of injection in the area.
- The southern portion of the plume has apparently shifted southwest because of downgradient movement of chromium beyond the influence of the SEPTS.

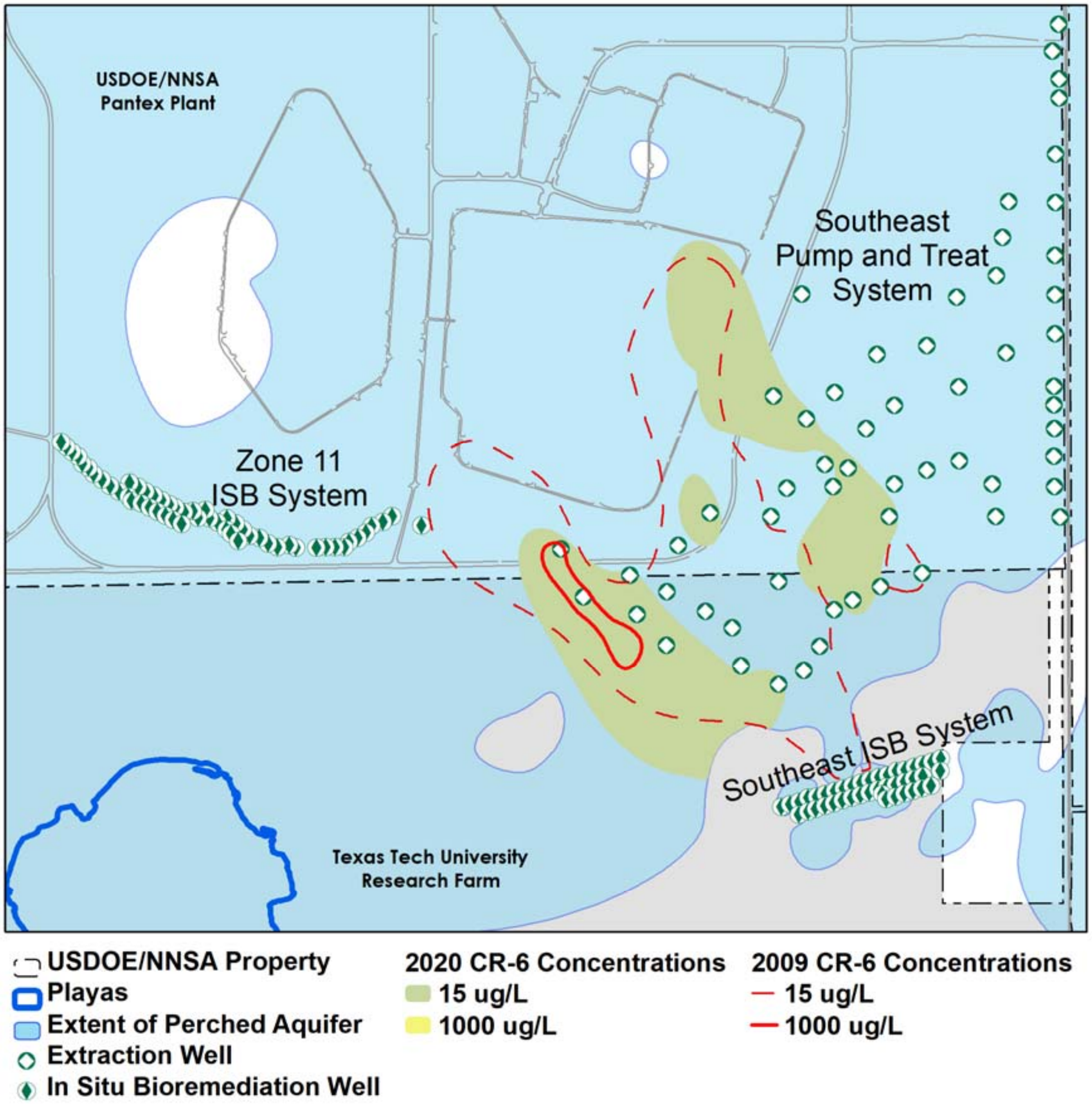

Figure 3-28. Hexavalent Chromium Plume Movement, 2009–2020

3.1.7.3 Perchlorate Plume

A single plume of perchlorate occurs in the perched aquifer underlying Zone 11 and the western portion of Zone 12. This plume extends northeast toward Playa 1 and southwest beneath the TTU property, as shown in Figure 3-21, Figure 3-22, and Figure 3-23. This plume is associated with the historical release of perchlorate from processes in Zone 11 to unlined ditches that carried the untreated water to the playa.

Concentrations of perchlorate in areas underlying the potential source areas in Zone 11 are generally decreasing, and perchlorate concentrations are decreasing or remain steady near the ditch to Playa 1. Perchlorate concentrations near the southern boundary of the Plant continue to generally increase. This plume is being actively remediated by the Zone 11 ISB System.

As depicted in Figure 3-29, the perchlorate plume shape is similar to the 2009 plume map, with the following notable exceptions:

- The northern lobe of the plume has contracted due to the decreasing concentrations in wells that define the boundaries in the area. However, these concentrations and resulting plume shapes have been quite variable since remedial actions began in 2009.
- The southern lobe of the plume has shifted to the south and west likely due to advection and dispersion as well as data collected from newly installed monitoring wells. Recharge from Playa 4 to the south may also have an influence on plume movement south of Zone 11.
- The southeastern boundary of the plume has shifted east because of the increase of perchlorate in PTX08-1008 first observed in 2008 and in the two westernmost SEPTS extraction wells.

The hydraulic gradient in the area between the southern parts of Zones 11 and 12 has shifted more eastward because of the influence of the SEPTS and the decline in perched water levels. This shift in the hydraulic gradient has allowed perchlorate to migrate east and southeast, with perchlorate moving into the SEPTS well field.

This portion of the perchlorate plume is being actively remediated by SEPTS at this time. The ion exchange resin used in the SEPTS to treat chromium can also treat perchlorate at lower concentrations. However, as concentrations increased, the two wells were turned off while plans were developed to upgrade the SEPTS with perchlorate resin vessels that treat the higher concentrations. The system is expected to be upgraded to include perchlorate pre-treatment by mid-2022.

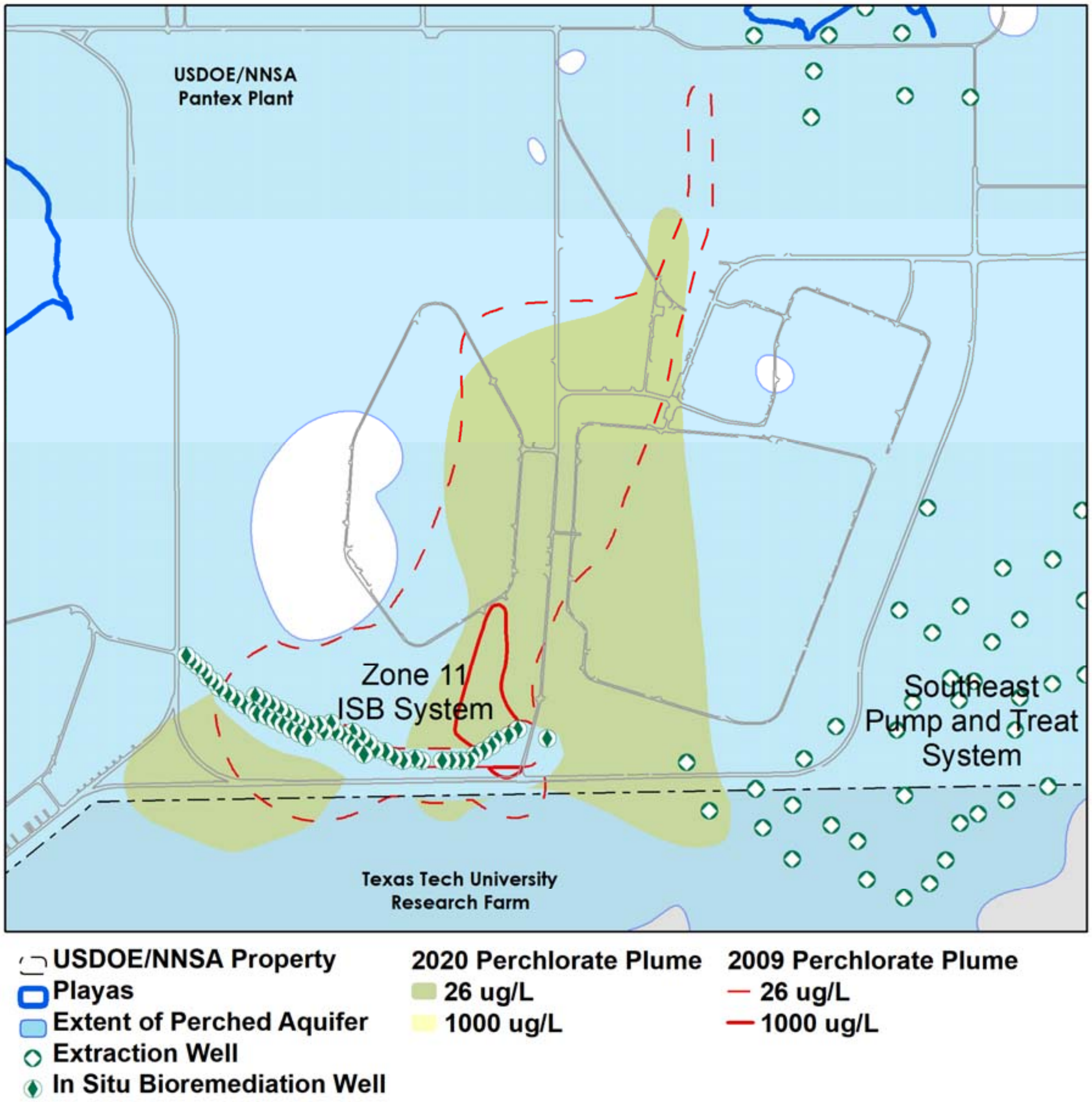

Figure 3-29. Perchlorate Plume Movement, 2009-2020

3.1.7.4 Trichloroethene Plumes

Several TCE plumes are present in the perched aquifer, as shown in Figure 3-24, Figure 3-25, and Figure 3-26. One plume originates in the north (source area in WMG 10) and the east (source area in SWMU 122b) sides of Zone 12 and extends to the southeast. Another TCE plume originates beneath Zone 11 and extends to the south off-site. TCE in the perched aquifer occurs from partitioning of TCE in soil gas into perched groundwater and TCE-contaminated process water associated with legacy discharges leaching into unlined former pits and ponds.

Groundwater concentrations of TCE in the wells on the east side of Zone 12 indicate a continuing source of TCE to the groundwater. This plume is being actively remediated by the SEPTS. PTX10-1014, which is near WMG 10 in the northern part of Zone 12, is exhibiting a decreasing trend in TCE.

The TCE plume underlying Zone 11 is associated with legacy HE operations that resulted in industrial wastewater infiltrating into the subsurface and TCE in soil gas originating from several areas within that zone. Concentrations in this plume are decreasing at all wells beneath Zone 11, except PTX08-1006 where concentrations are increasing; this indicates continuing migration of TCE in the perched groundwater from beneath Zone 11. This plume is migrating southward and observed concentrations at the TTU property boundary are increasing. As discussed in Section 3.2.3.1, this plume is being actively remediated by the Zone 11 ISB system.

As depicted in Figure 3-30, the 2009 and 2019 TCE plume shapes are similar, with the following notable exceptions:

- The plume originating from Zone 12 has contracted near this zone's source areas. However, the southern edge of the plume has shifted to the west due to data collected at monitoring well PTX06-1166 and decreasing TCE concentrations in the Southeast ISB's ISPM wells.
- The plume originating from Zone 11 has shifted to the south and west due to the area's general gradient and recently installed wells to the west. The TCE plume beneath Zone 11 has also expanded to the east as a result of the shifting flow gradients in perched groundwater.

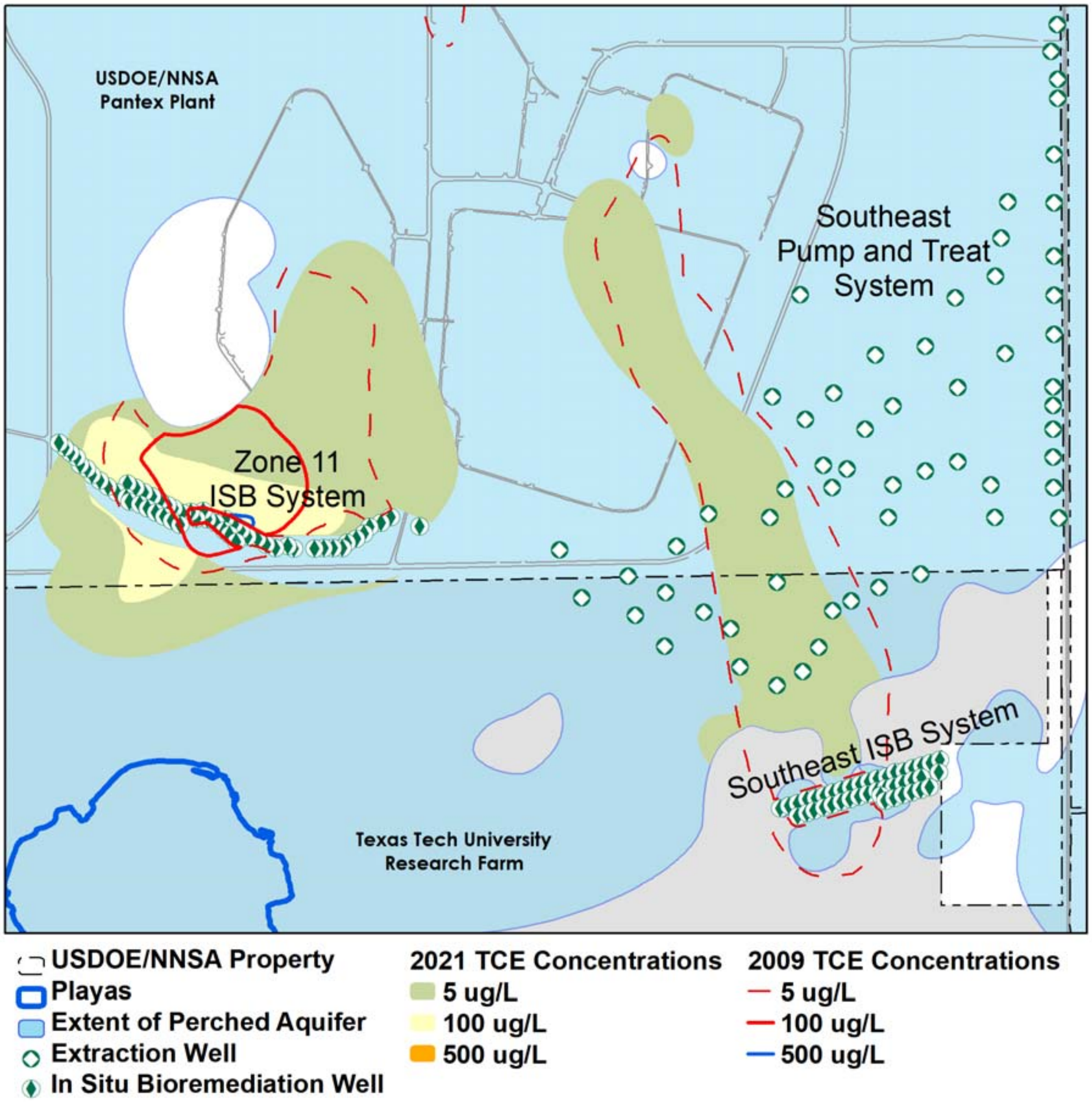

Figure 3-30. TCE Plume Movement, 2009-2020

3.2 Remedial Action Effectiveness

3.2.1 Southeast Pump and Treat System

The objective of the SEPTS (see Figure 1-7) is to remove contaminated perched groundwater and treat it for industrial and/or irrigation use. While the capability is being maintained for injection of treated water back into the perched zone, the intent is to permanently remove perched groundwater to gradually reduce the saturated thickness in this zone and to achieve the following two important goals:

- A gradual reduction of the volume of perched groundwater and contamination moving downgradient toward the extent of saturation.
- A reduction in the head (i.e., driving force) for vertical migration of perched groundwater into the FGZ and toward the drinking water aquifer.

The SEPTS has altered the groundwater flow direction and gradient at localized areas near the extraction wells in the perched aquifer. Figure 3-31 illustrates the influence of this pump and treat system and the P1PTS. Water levels measured at the extraction wells were not used in the interpretation of water table contours so that cones of depression would not be overestimated. Localized cones of depression are present surrounding several extraction wells, but the formation of an extensive cone of depression throughout the system is limited by the aquifer's thin saturated thickness.

The water table map indicates groundwater is still flowing southward across the USDOE/NNSA property boundary onto TTU property. However, extraction wells located on the TTU property limit the further migration of perched groundwater contaminants to the south. Water table contours along FM 2373 indicate groundwater is flowing primarily to the south along the USDOE/NNSA property boundary, thus limiting the transport of perched aquifer contaminants eastward. The hydraulic gradient varies greatly in this area because of the influence of the SEPTS. Very steep gradients occur locally near many of the extraction wells, and the southerly flow direction is reversed in some areas.

3.2.1.1 Hydrodynamic Control

By using extraction wells to alter the hydraulic gradient, hydrodynamic control limits the horizontal migration of contaminants. Because of the limited saturated thickness of the perched aquifer, complete hydraulic containment of the contaminant plume is not possible. However, the SEPTS has effectively altered the hydraulic gradient to limit the movement of contaminants.

Analysis of groundwater flow directions, as indicated by water table contours, shows that the SEPTS has reduced the eastward movement of perched groundwater across FM 2373 and limited expansion of the plume south of the extraction wells on TTU property. In addition, removing perched groundwater has caused the extent of perched saturation on TTU property to significant retreat. Figure 3-31 shows the approximate radius of influence of the groundwater treatment systems and the directions of perched groundwater flow gradients outside the radius of influence. Capture zones, shown in Figure 3-31 for the extraction wells, were calculated using a single-layer groundwater flow model of the perched aquifer. Average 2020 extraction flow rates for each well were used in the calculations.

Operation of the pump and treat systems was affected in 2020 by repairs at the WWTF and the break at the irrigation system's filter bank. This break is expected to be a long-term impediment to operations because repairs are only focused on restoring a portion of the irrigation system. Once repaired, the irrigation system is expected to support release of water from the WWTF as a priority, restricting flow from the P1PTS more than in the past. As a result, the capture zone is expected to be impacted until Pantex can put other systems in place to manage treated water. Operation of new wells east of FM 2373 that were tied into the system in March 2019 has improved the capture of water to the east of FM 2373 but, as the new wells are prioritized for operation, other areas may continue to be impacted by the lower flow rates at the SEPTS.

To address issues regarding the release or use of treated water, Pantex is pursuing more than one option to enable consistent operation of the systems in the future and provide the flexibility needed to balance the impacts associated with each option implemented alone. To provide additional long-term use of treated water, Pantex is currently designing other irrigation alternatives on the property east of FM 2373. Funding was received in FY 2021 to design and construct infrastructure for irrigation on land east of FM 2373 using center-pivot sprinklers. Pantex completed the design of the new irrigation system in May 2021, and construction is expected to begin in late FY21 after contracting is complete.

Pantex also identified funding to design and construct three new perched injection wells to the east of Playa 2 and northwest of the Zone 11 ISB. Construction of the injection wells and infrastructure is underway, with the project scheduled to be complete in June 2021. These new injection wells will provide a consistent outlet for approximately 150 gpm of treated water when irrigation is unavailable for the beneficial use of treated water. These wells will also provide a method to inject the treated water without affecting the movement and capture of plumes in the southeast area.

With both of these options implemented, the systems will be able to consistently operate at or near capacity.

3.2.1.2 System Effectiveness

Because the primary goal of both pump and treat systems is to affect plume movement and reduce saturated thickness in the perched aquifer, the plume stability discussion in Section 3.1 can be used to determine the effectiveness of these systems. Overall, the pump and treat systems continue to be effective in 2020. When comparing 2020 conditions to the LTM design's expected conditions, the majority of monitoring wells are meeting expected conditions in the eleventh year of the remedial action. The LTM wells not meeting expected conditions for water levels are summarized in Section 3.1.4.

As a part of the secondary goal of mass removal for the SEPTS, the system continued to remove both HEs and hexavalent chromium and treated 99 Mgals of extracted water to concentrations below the PQL and the GWPS during 2020. As discussed in Section 2.1.2, the SEPTS was primarily affected by the loss of throughput to the WWTF and irrigation system after the irrigation system's filter bank broke and the WWTF was forced to shut down for COVID-19. As a result, the SEPTS did not consistently meet all throughput goals during 2020; however, Pantex continues to optimize the system operation. Pantex is currently conducting a formal optimization analysis for the SEPTS and P1PTS using a fate and transport model of the perched aquifer. The results of the analysis, which are expected in September 2021, will be used to develop an extraction strategy that maximizes mass removal and plume control while reducing saturation and guide the operation of the pump and treat systems in the future.

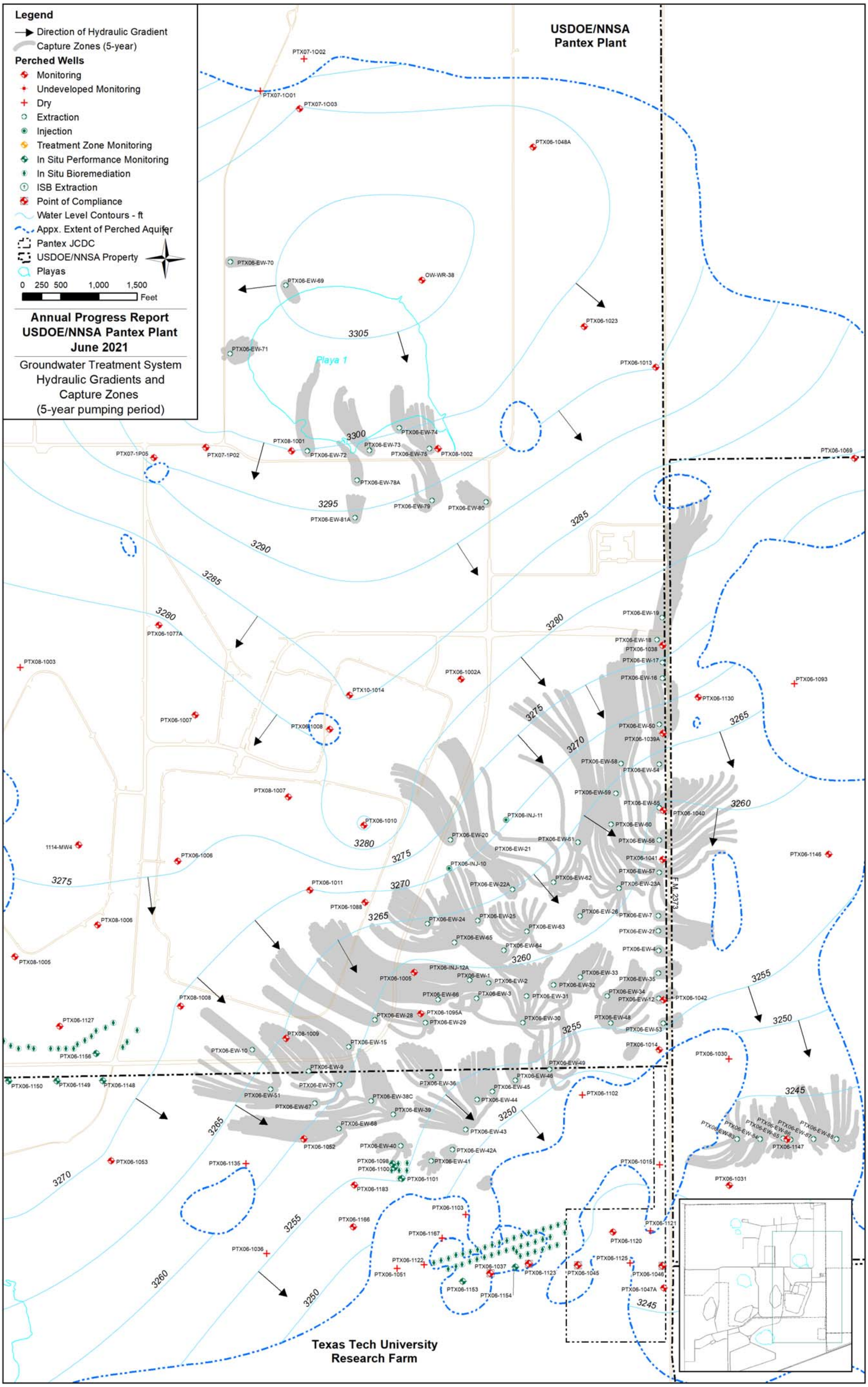

Figure 3-31. Pump and Treat System Capture Zones

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3.2.2 Playa 1 Pump and Treat System

The P1PTS was completed in 2008 with operations starting in September 2008. This system extracts water from 11 wells near Playa 1 (see Figure 1-6) and treats the water through a series of GAC beds and ion exchange process units to reduce HEs and metals below the GWPS established in HW-50284 and the ROD. The objective of this system is to achieve mass removal and reduce the mound of perched groundwater associated with Playa 1, which affects the movement of the southeast plume by reducing the hydraulic head.

The P1PTS appears to be influencing local water levels, as well as the hydraulic gradient, in the Playa 1 area. Figure 3-31 illustrates the influence of both groundwater pump and treat systems. Water levels measured at the extraction wells were not used in the interpretation of water table contours so that cones of depression would not be overestimated.

The water table map indicates the mound of groundwater beneath Playa 1 has been reduced since the groundwater high in the perched aquifer is now to the north; however, groundwater levels near the playa are increasing because the volume of treated water extracted and discharged to the playa has been reduced while the irrigation system remains down. Groundwater is still generally flowing away from the Playa 1 region then to the south and southeast across the USDOE/NNSA property boundary onto TTU property. As the perched aquifer's saturated thickness continues to be reduced in this region, this flow should decrease and reduce the driving head. In addition, the SEPTS extraction wells limit the further migration of perched groundwater contaminants to the south.

The hydraulic gradient is affected by pumping at the P1PTS well field and is difficult to estimate. Very steep gradients occur locally near most of the extraction wells, and the general flow patterns are reversed in some areas.

3.2.2.1 System Effectiveness

As noted for the SEPTS, the pump and treat systems continue to be effective in 2020. When comparing 2020 conditions to the LTM design's expected conditions, most wells are meeting expected conditions.

During 2020, the system treated approximately 16.3 Mgals of extracted water. As discussed in Section 2.1.1, total flow at the P1PTS was limited to allow higher recovery at the SEPTS because increased recovery at SEPTS provides better control of the RDX plume movement to the southeast.

Impacts from the irrigation system break also affected operations at the P1PTS. Evaluation of effluent data indicates the system treated the recovered groundwater to concentrations below the PQL and GWPS.

3.2.3 ISB Systems

Pantex has installed and operates three ISB systems: The Zone 11 ISB, Southeast ISB, and Southeast ISB Extension. The objective of the ISB systems is to establish anaerobic biodegradation treatment zones capable of reducing COCs to the GWPS by injecting the necessary amendments and nutrients to stimulate resident bacteria. The microbial growth first consumes oxygen and then, in turn, consumes other electron acceptors, creating reducing geochemical conditions. Under reducing conditions, biotic and abiotic treatment mechanisms occur.

The following sections provide an understanding of the expected conditions at the ISB systems and downgradient concentrations of COCs. This information is used to determine whether or not further injections are required for continued treatment of COCs and to ensure that COC concentrations are being reduced downgradient of the treatment zone.

To monitor the effectiveness of the treatment zones, geochemical conditions and amendment longevity become important. These indicators are used to determine if conditions are within an acceptable range for oxidation-reduction (i.e., redox) potential, electron acceptor concentrations (i.e., dissolved oxygen, nitrate, and sulfate), and nutrient supply (i.e., TOC). These parameters are important because reducing conditions and adequate nutrients must be present to treat COCs.

Because of problems with plugging of the wells, Pantex has moved to increasing soluble carbon during injection events and reducing the emulsified vegetable oil (EVO), as recommended in the *2017 Annual Progress Report* (Pantex, 2017). An amendment dose response study performed in 2018 found that the use of more soluble carbon source amendments, such as molasses, in combination with the use of larger volumes of water and amendment results in better distribution of amendment between the injection wells and produces deeper reducing conditions within the treatment zone.

Based on the dose response study, future operation of all ISBs is focused on using a more soluble carbon (e.g., molasses) to achieve the distribution needed at the systems. Molasses was injected at the Zone 11 ISB in 2019 and used at the Southeast ISB Extension. This measure is expected to help avoid issues with well plugging or formation by the EVO and resulting biomass. Pantex will continue to evaluate available data and make appropriate recommendations for treatment in future progress reports.

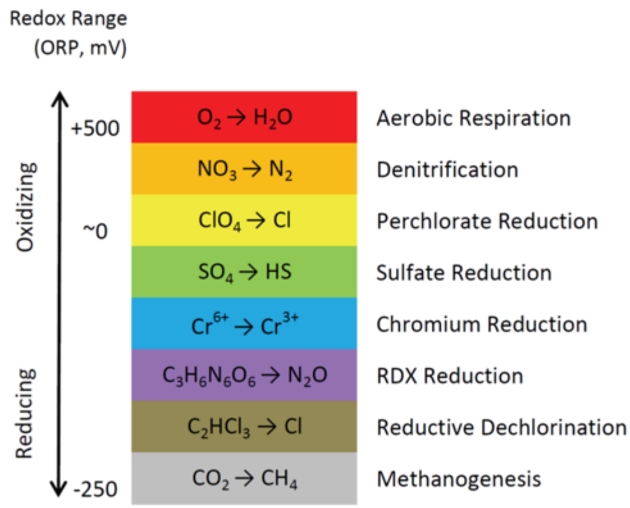


Figure 3-32. Typical Geochemical Redox Ranges

Geochemical conditions can be evaluated to determine if adequate reducing conditions exist to achieve reduction. Figure 3-32 presents the redox ranges for the reduction of various COCs. TCE and perchlorate are the primary COCs in the Zone 11 area while HEs, primarily RDX, and hexavalent chromium are the primary COCs in the southeast area. Perchlorate degradation does not require as strongly reduced conditions as RDX or TCE.

To document the effectiveness of COC removal, downgradient wells are monitored for specific target indicators chosen for each ISB system. Target indicators include COCs that are most widespread and have the potential to affect human health if the water were to be used for residential purposes (note that perched groundwater use is controlled to prevent any potential for exposure). In addition, breakdown products are monitored to determine if complete degradation is occurring. Specific indicators are discussed separately for each system below.

In addition to specific indicators that help determine if additional injections are required, Pantex monitors for TOC, metals, and general chemistry parameters. TOC was selected as an indicator for adequate carbon sources that have remained available for continued ISB treatment. Specific metals are monitored in downstream ISPM wells to ensure that metals are returning to background conditions after leaving the treatment zone. Specific metals are expected to increase in the treatment zone because of reducing conditions that release naturally occurring metals in the formation soils. However, as water moves away from reducing conditions, the metals are expected to precipitate onto the soil matrix. The general chemistry parameters are also monitored to determine if the water is returning to baseline conditions.

3.2.3.1 Zone 11 ISB

The Zone 11 ISB system (see Figure 1-8) has a well-established treatment zone in the original portion of the system where injection has occurred since 2009. Portions of the expansion area have received more than three injections, so deeper reducing conditions are likely established at the injection wells. Reducing conditions are not yet expected at the six new wells that were injected for the first time starting in 2020. Pantex continues to evaluate the expansion area to determine if bioaugmentation with *Dehalococcoides spp*. (DHC) is needed to potentially boost the treatment efficiency for TCE. More frequent injections are anticipated for molasses and are planned at least annually for the Zone 11 ISB due to the need to continue reducing conditions. Pantex will continue to evaluate the system to ensure appropriate timing of injections using molasses.

COCs targeted for treatment by this system are perchlorate and TCE. Indicator constituents evaluated for trends at downgradient ISPM wells include TCE and its degradation products (i.e., cis-1,2-DCE and vinyl chloride) along with perchlorate. Indicator constituent concentrations are expected to decline at the downgradient monitoring wells at their estimated travel times from the treatment zones, which are discussed later in this section.

Dissolved oxygen, redox potential, nitrate, sulfate, and TOC are evaluated in the ISB treatment zone performance wells to determine if the treatment zone is rebounding to baseline conditions, thus requiring amendment injection. Redox potential and electron acceptor (i.e., dissolved oxygen, nitrate, and sulfate) concentrations in the treatment zone wells are expected to decline after injection. As shown in Figure 3-32, strongly reducing conditions must be achieved for the reductive dechlorination of TCE to occur. The redox potential should decline from the baseline and be below –50 millivolts (mV) to reduce TCE and near 0 mV to reduce perchlorate. Concentrations of TOC should increase after injection but decline over time as the amendment is consumed.

During 2020, Pantex monitored five TZM wells, seven injection wells, and nine downgradient ISPM wells in accordance with the SAP to evaluate the Zone 11 ISB (see Section 1.4.2 map). Pantex also monitors two treatment zone wells in the second row to better evaluate conditions on the east side of the system where injection was discontinued in the second row of wells. The ISPM wells are used to monitor characteristics indicative of the microorganisms' health and overall performance of the remedial system.

Table 3-2 summarizes the current and maximum COC concentrations in each ISB, TZM, and ISPM well. One of the monitored treatment zone wells (PTX06-ISB075) is a replacement of the original ISB injection well but is not currently used for injection. The original PTX06-ISB075 well continues to receive amendment and will be used until the well fails.

The Zone 11 ISB has a well-established treatment zone in the original portion of the system, where injection has occurred since 2009, as well as in the initial expansion area that has received four injections; therefore, deeper reducing conditions are likely established at the injection wells. Deep reducing conditions have been more difficult to establish at TZM wells located between the injection wells in the expansion area. Improved conditions have been noted across the western side of the Zone 11 ISB after moving to the use of molasses in recent years. However, some wells have limited ability to accept injection, and those areas will likely continue to demonstrate milder reducing conditions until the wells can be replaced. With the exception of PTX06-1175, all wells downgradient of the system have indicated the arrival of treated water.

Evaluation of data in the treatment zone indicates very mild to strong reducing conditions, with the oxidation-reduction potential (ORP) ranging from -182 to 214 mV and sulfate from 0.25 to 200 mg/L across the Zone 11 ISB. Note that, although included in Table 3-2, PTX06-ISB135 is not included in these evaluations because the first injection occurred in the fourth quarter of 2020, and the well has not been sampled after injection occurred. Monitored conditions inside the treatment zone indicate that sulfate was reduced in 2 of 11 wells, and negative ORP was observed in all but 3 wells, indicating deeper reducing conditions in those areas.

Perchlorate was not detected at any monitored injection well. Conditions improved at most of the non-injected wells in the northwest expansion area, following the molasses injections that began in 2018. TCE continues to be reduced to cis-1,2-DCE, with TCE concentrations below the GWPS in 8 monitored wells inside of the treatment zone and cis-1,2-DCE present at concentrations below the GWPS in 4 of the 11 monitored wells. The presence of TCE and cis-1,2-DCE continues to indicate partial treatment in three of six non-injected treatment zone wells, given that TCE concentrations tend to be higher in the non-injected wells.

When greater amounts of TCE and cis-1,2-DCE are being degraded, ethene and vinyl chloride are expected to be detected. Vinyl chloride was detected in the five sampled wells inside the treatment zone, and ethene was detected at low concentrations in four wells; these findings indicate improvements over previous results. The low vinyl chloride results, coupled with the detection of ethene, indicate that a portion of the TCE is being completely degraded in some areas of the treatment zone. When TCE concentrations inside the treatment zone are low (i.e., <300 ug/L), these low degradation rates may be enough to treat TCE and its breakdown products to the GWPS, as indicated by downgradient monitoring well data. Upgradient data still indicate TCE concentrations periodically fluctuating above 300 ug/L, with a concentration of 540 ug/L indicated at an upgradient monitoring well in 2020. Data collected at treatment zone well PTX06-1170 during 2020 indicate TCE concentrations at 140 ug/L.

Pantex evaluates performance at nine downgradient ISPM wells for the Zone 11 ISB and two former ISB injection wells, PTX06-ISB079 and PTX06-ISB082. Perchlorate was detected above the GWPS in two downgradient ISPM wells in 2020 but was not detected or below the GWPS in the other seven wells. TCE concentrations are below the GWPS in four of nine ISPM wells plus the two former injection wells.

The first breakdown product of TCE, cis-1,2-DCE, was detected above the GWPS in three downgradient wells, PTX06-1012, PTX06-1155, and PTX06-1173; the presence of cis-1,2-DCE was also detected in PTX06-1148, PTX06-1149, PTX06-1150, PTX06-1156, PTX06-1174, and PTX06-1175. These data indicate that, because of treatment, concentrations of TCE and its breakdown products are very close to meeting the GWPS in treated water from the original portion of the system.

The only downgradient wells not demonstrating strong treatment are PTX06-1173 and PTX06-1175. Wells upgradient of PTX06-1173 have been difficult to inject into during recent injection events. However, the most recent sample from PTX06-1173 shows a sharp decline in TCE concentrations to near the GWPS. Meanwhile, PTX06-1175 is downgradient of the expansion area on the northwest side of the system and downgradient of a single row of injection wells. Because of its distance downgradient of the injection wells and expected time of travel, this well was not expected to show strong treatment for several years. However, recent data show fluctuating TCE concentrations and the presence of cis-1,2-DCE, which may indicate that treated water is now reaching this well. Pantex will continue evaluating this data to determine the need for a second row of injection wells in this part of the ISB system.

The results for upgradient well PTX06-1127 indicate that TCE is increasing above the GWPS on the eastern side of the ISB. Neither TCE nor its degradation products were detected in PTX06-ISB079 and PTX06-ISB082 in 2020; TCE and cis-1,2-DCE were detected below the

GWPS at PTX06-1156. In 2020, TCE was detected at or above the GWPS in three downgradient wells, PTX06-1148, PTX06-1149, and PTX06-1150. PTX06-1149 had demonstrated complete treatment of perchlorate until early in 2020 when perchlorate was detected above the GWPS. These exceedances may indicate problems with injection in the upgradient ISB wells. Pantex is planning to add another row of injection wells upgradient of this location to ensure the treatment of TCE as well as perchlorate.

Metals concentrations have been increasing in all downgradient ISPM wells since the start of remedial actions and some are exceeding GWPS. For example, arsenic concentrations in PTX06-1012, PTX06-1149, PTX06-1150, PTX06-1155, PTX06-1156, PTX06-1173, and PTX06-1174 and barium concentrations in PTX06-1156 exceeded the GWPS in 2020. However, metals concentrations in the downgradient ISPM wells are much lower than observed in the treatment zone. These concentrations are expected to decrease as the treated water moves downgradient, the water returns to more oxidized conditions, and the metals precipitate onto the soil matrix, as discussed in Section 3.2.3. Several wells are already indicating a return to oxidized conditions with recent arsenic trends not increasing in all nine ISPM wells and recent barium trends not increasing in seven of the nine wells.

Table 3-2. Summary of 2020 Zone 11 ISB Monitoring Well Data for Perchlorate and TCE

Well ID	Perchlorate			TCE		
	Max[a]	1S	2S	Max[a]	1S	2S
In-Situ Bioremediation Wells						
PTX06-ISB055	3000	<10UJ	<100UJ	16	<50	<250
PTX06-ISB059	970	<10UJ	<100UJ	<3	<10	<250
PTX06-ISB064	<100	<10UJ	<100UJ	<250	<2.5	<250
PTX06-ISB068	<100	<10UJ	<100UJ	<250	<2.5	<250
PTX06-ISB073	380	<10UJ	<100UJ	560	<25	<2.5
PTX06-ISB075[b]	97	<1	<1UJ	440	<2.5	7.1
PTX06-ISB135	2.2	--	2.2J	310	--	310J-
In-Situ Treatment Zone Monitoring Wells						
PTX06-1164	130	37	40J	180	190J	130J
PTX06-1169	<12	<1	<1UJ	13	63J	8.7
PTX06-1170	<120	0.4	<1UJ	500	140	31
PTX06-1176	240	<1	<1UJ	220J	0.77	<2.5
PTX06-1177	210	<1	<100UJ	130	1.2	1.3
In-Situ Performance Monitoring Wells						
PTX06-1012	341	<1	<1	580	0.86J	0.42
PTX06-1155	487	<1	<1	660	0.59J	2.5
PTX06-1156	2140	<1	<1	7.4	0.26J	0.71
PTX06-1148	1290	<10	0.22J	3.6	4.7	5.0
PTX06-1149	684	45	54J	5.3	7.8	9.3
PTX06-1150	235	9.3	11J	8.3	10	15
PTX06-1173	16J	<1	<1	140J	140J	10
PTX06-1174	170J	<1	<1	160J	0.83J	0.75
PTX06-1175	340J	2.4J	150J	150	120J	110
PTX06-ISB079	<24	<1	<100	<3	<2.5	<2.5UJ
PTX06-ISB082	3090	<1	<1UJ	9.6	<2.5	<2.5UJ

Concentrations provided in µg/L.

Highlighted cells indicate concentrations less than or equal to the GWPS. GWPS: Perchlorate = 26 µg/L and TCE = 5 µg/L.

The "--" symbol indicates no samples were collected.

When COC was not detected, a "less than" with the detection limit is provided.

[a]The maximum value reported in each well is used as a baseline for comparison, regardless of the date on which it was collected.

[b]Due to well damage, PTX06-ISB075 was replaced in September 2012, and the replacement well was first sampled during 2013.

J Analyte was detected below the PQL but above the MDL.

J+ The associated numerical value is an estimated quantity with a suspected positive bias.

J- The associated numerical value is an estimated quantity with a suspected negative bias.

UJ The material was analyzed for but was not detected. The sample quantitation limit is an estimated quantity.

3.2.3.2 Southeast ISB

The Southeast ISB system is on TTU property south of Pantex (see Figure 1-9). Constituents targeted for treatment by this system are RDX, other HE COCs (e.g., dinitrotoluenes and 1,3,5-trinitrobenzene), and hexavalent chromium. Indicator constituents evaluated for trends at downgradient performance monitoring wells include RDX and its degradation products (i.e., DNX, MNX, and TNX) and total and hexavalent chromium. Concentrations of indicator constituents in the performance monitoring wells are expected to decline over time, and all degradation products of RDX are not anticipated to be detected or will be present in low concentrations, thus indicating complete breakdown is occurring. Dissolved oxygen, redox potential, nitrate, sulfate, and TOC are also evaluated at the ISB treatment zone performance wells.

Meanwhile, redox potential and electron acceptor (i.e., dissolved oxygen, nitrate, and sulfate) concentrations in the treatment zone wells are expected to decline after injection. Redox potential should be less than 0 mV for the reduction of RDX and hexavalent chromium.

As provided in the SAP, six treatment zone wells and five downgradient performance monitoring wells are used to evaluate the Southeast ISB. One ISPM well (PTX06-1123) for the Southeast ISB has gone dry and has not been monitored since 2015. PTX06-1045, a point of compliance well, was dry from 2011 until the fourth quarter of 2018 when water was reported in the well. Water levels were sufficient to collect samples in the first quarter of 2020. In addition, limited sampling has occurred at PTX06-1037 since November 2017 because of declining water levels; however, this well had sufficient water to allow sampling in 2020. Five of the six treatment zone wells were sampled in 2020; one well, PTX06-ISB048, could not be sampled because of low water levels or dry conditions.

Table 3-3 summarizes the current and maximum COC concentrations in each ISB and ISPM well. Graphs of the amendment indicators and COCs for the sampled ISB injection wells, as well as concentrations for target indicators at the performance monitoring wells for this system are included in Appendix E. The conditions in the treatment zone and performance monitoring wells are discussed below.

Evaluation of treatment zone data indicates that, during 2020, mild to deep reducing conditions were present for the treatment of HEs and hexavalent chromium. The ORP was between –222 mV and 195 mV at all five wells in 2020. The positive ORP value may have been anomalous based on observed dissolved oxygen data, which indicated deeper reducing conditions at PTX06-ISB042. Sulfate was reduced to values less than 3 mg/L in the third quarter at all wells except PTX06-ISB042. TOC results indicated that a continued food source was available to maintain reducing conditions. RDX was detected below the GWPS at PTX06-ISB038 and PTX06-ISB046 in the third-quarter samples; MNX, DNX, and TNX were non-detect in the sampled treatment zone wells.

The ISB system has effectively treated HEs and hexavalent chromium at three of the closest downgradient ISPM wells, PTX06-1037, PTX06-1154, and PTX06-1123, for the Southeast ISB. RDX and hexavalent chromium concentrations in these wells are either non-detect or below the GWPS. These wells indicate that the reducing zone has extended beyond the treatment zone because the ORP is negative or less than 10 mV, nitrate and sulfate concentrations are reduced, and organic carbon is present.

Table 3-3. Summary of 2020 Southeast ISB Monitoring Well Data for RDX and Hexavalent Chromium

Well ID	Hexavalent Chromium			RDX		
	Max[a]	1S	2S	Max[a]	1S	2S
In-Situ Bioremediation Wells						
PTX06-ISB021	NE	NE	NE	3570	<1	<0.5
PTX06-ISB030B[b]	NE	NE	NE	2.7	<1	<0.5
PTX06-ISB038	NE	NE	NE	421	<1	1.6
PTX06-ISB042	NE	NE	NE	2920	<0.26	<0.26
PTX06-ISB046	NE	NE	NE	4350	<1	0.32
PTX06-ISB048[b]	NE	NE	NE	0.82	--	--
In-Situ Performance Monitoring Wells						
PTX06-1037[b]	109	<0.02UJ	<0.02	2800	0.12J	<0.26
PTX06-1123[b]	10	--	--	4300	--	--
PTX06-1153	159	5.9	8.8	838	252	210
PTX06-1154	29.2	<0.02UJ	<0.02	630	0.15U	<0.26

Concentrations provided in µg/L.
Highlighted cells indicate non-detect or concentrations less than the GWPS. GWPS: Cr(VI) = 100 µg/L and RDX = 2 µg/L.
NE – Hexavalent chromium was not evaluated in the ISB treatment zone due to interference from the amendment.
The "--" symbol indicates that no data are available.
[a]The maximum value reported in each well is used as a baseline for comparison, regardless of the date in which it was collected.
[b]PTX06-ISB48 and PTX06-1123 were either dry or had limited water and could not be sampled for all or part of 2020.
Data from ISPM Well PTX06-1045 is not included in this table. PTX06-1045 is the furthest downgradient ISPM well that may have little to no hydraulic connection to the Southeast ISB treatment zone.
J Analyte was detected below the PQL, but above the MDL.

J- The associated numerical value is an estimated quantity with a suspected negative bias.
UJ The material was analyzed for but was not detected. The sample quantitation limit is an estimated quantity.

Although PTX06-1153 continues to exhibit RDX concentrations above the GWPS, a steep decline in RDX has occurred since the peak observed in August 2019. Hexavalent chromium concentrations continue to demonstrate a decreasing trend and have remained below the GWPS since 2016. Pantex is continuing to investigate the cause of the unexpected results in PTX06-1153. As discussed in the *2013 Annual Progress Report* (Pantex, 2013), the conditions could be due to any number of hydrologic issues and proving (or disproving) them may be difficult, though it is possible that this well is not hydraulically connected to the Southeast ISB. Several confounding issues complicate the investigation efforts in the area, including significant heterogeneity in the FGZ, potential changes in formation properties due to biologic growth or other injection effects, and the potential reduction of saturated thickness upgradient due to the pump and treat operations.

Pantex injected this system with molasses during the 2019 injection to attempt better distribution of amendment. Additionally, to affect treatment at the well, Pantex extracted water from the well at a flow rate of approximately 1.25 gpm for two weeks during the fourth quarter of 2019. During 2020, PTX06-1153 demonstrated signs of partial treatment with the sharp decline in RDX, and breakdown products of RDX were detected at concentrations above the GWPS. Based on these results, the molasses injection, possibly in combination with the low-rate extraction, appears to have increased the level of treatment observed at PTX06-1153.

Metals concentrations have increased in all downgradient performance monitoring wells, with some exceeding the GWPS. Arsenic and barium concentrations exceeded the GWPS in PTX06-1037 and PTX06-1154 during 2020. TOC data suggest the treatment zone has expanded into these wells, and the reduced conditions continue to mobilize naturally occurring metals. However, these concentrations are expected to decrease as the treated water moves out of the treatment zone and returns to more oxidized conditions.

Pantex also monitors for degradation products of RDX to evaluate whether or not complete breakdown is occurring. Monitoring results for the system indicate that RDX and breakdown products (i.e., MNX, DNX, and TNX) are present in downgradient performance monitoring wells. TNX, the final degradation product, is a better indicator of degradation because the other intermediate products (MNX, DNX) degrade rapidly and do not accumulate in the environment (SERDP, 2004). Both RDX and TNX have been reduced to concentrations below the GWPS at PTX06-1037 and PTX06-1154 since 2011 and 2015, respectively, indicating complete breakdown of RDX. RDX and TNX were non-detect or below the PQL at both wells throughout 2020. These results indicate that near-complete treatment of RDX is occurring in all wells except PTX06-1153, as discussed previously.

3.2.3.3 Southeast ISB Extension

The first post-injection treatment zone data for the Southeast ISB Extension were collected in the second quarter of 2019. Five wells in the injected area of the ISB were sampled during the fourth quarter of 2020.

Treatment zone data indicate that mild reducing conditions are present for the treatment of HEs. The ORP was between -24 mV and 47 mV and nitrate was reduced in all wells, but sulfate values ranged from 1.9 to 250 mg/L. However, soluble metals (i.e., arsenic and manganese) increased, indicating that reducing conditions are being established, and TOC results indicate that a sufficient food source is available to continue establishing these conditions at the wells. Sampling results from the ISB wells indicate HEs were not detected.

The downgradient wells did not demonstrate treatment during 2020. The downgradient wells in or near the faster moving core of the plume are expected to demonstrate treatment during 2021.

Table 3-4. Summary of 2020 Southeast ISB Extension Monitoring Well Data for RDX

	RDX		
Well ID	**Max[a]**	**1S**	**2S**
In-Situ Bioremediation Wells			
PTX06-ISB302	<0.26	<0.26	<1UJ
PTX06-ISB307	12.3	<0.26	<0.5UJ
PTX06-ISB317	718	<0.5	<1UJ
PTX06-ISB319	774	--	--
PTX06-ISB321	279	<0.26	<1UJ
PTX06-ISB325	21.8	<0.26	<1UJ
PTX06-ISB327	8.5J+	--	8.5J+
PTX06-ISB329	7.4J+	--	7.4J+
In-Situ Performance Monitoring Wells			
PTX06-1191	164	115	146
PTX06-1194	0.15	<0.26UJ	<0.26
PTX06-1196	29.9	24.4J	29.9

Concentrations provided in μg/L.
Highlighted cells indicate non-detect or concentrations less than the GWPS. RDX GWPS = 2 μg/L.
The "--" symbol indicates that no data are available.
[a]The maximum value reported in each well is used as a baseline for comparison, regardless of the date on which it was collected.
J+ The associated numerical value is an estimated quantity with a suspected positive bias.
UJ The material was analyzed for but was not detected. The sample quantitation limit is an estimated quantity.

3.3 Natural Attenuation

Natural attenuation is the result of processes that naturally lower concentrations of contaminants over time. Pantex monitors this process to help determine where and under what conditions natural attenuation is occurring and to possibly identify a rate of attenuation. This is an important process for RDX, the primary risk driver in perched groundwater, because it is widespread and extends beyond the reach of the groundwater remediation systems in some areas.

Natural Attenuation Processes

- Biodegradation: Soil microbes cause the contaminants to break down into less harmful products.
- Sorption: Contaminants are bound to soil particles so that movement through groundwater is stopped or slowed, allowing time for other processes to work.
- Dispersion: Contaminants are dispersed through the groundwater as they move away from the source so that concentrations are diluted.

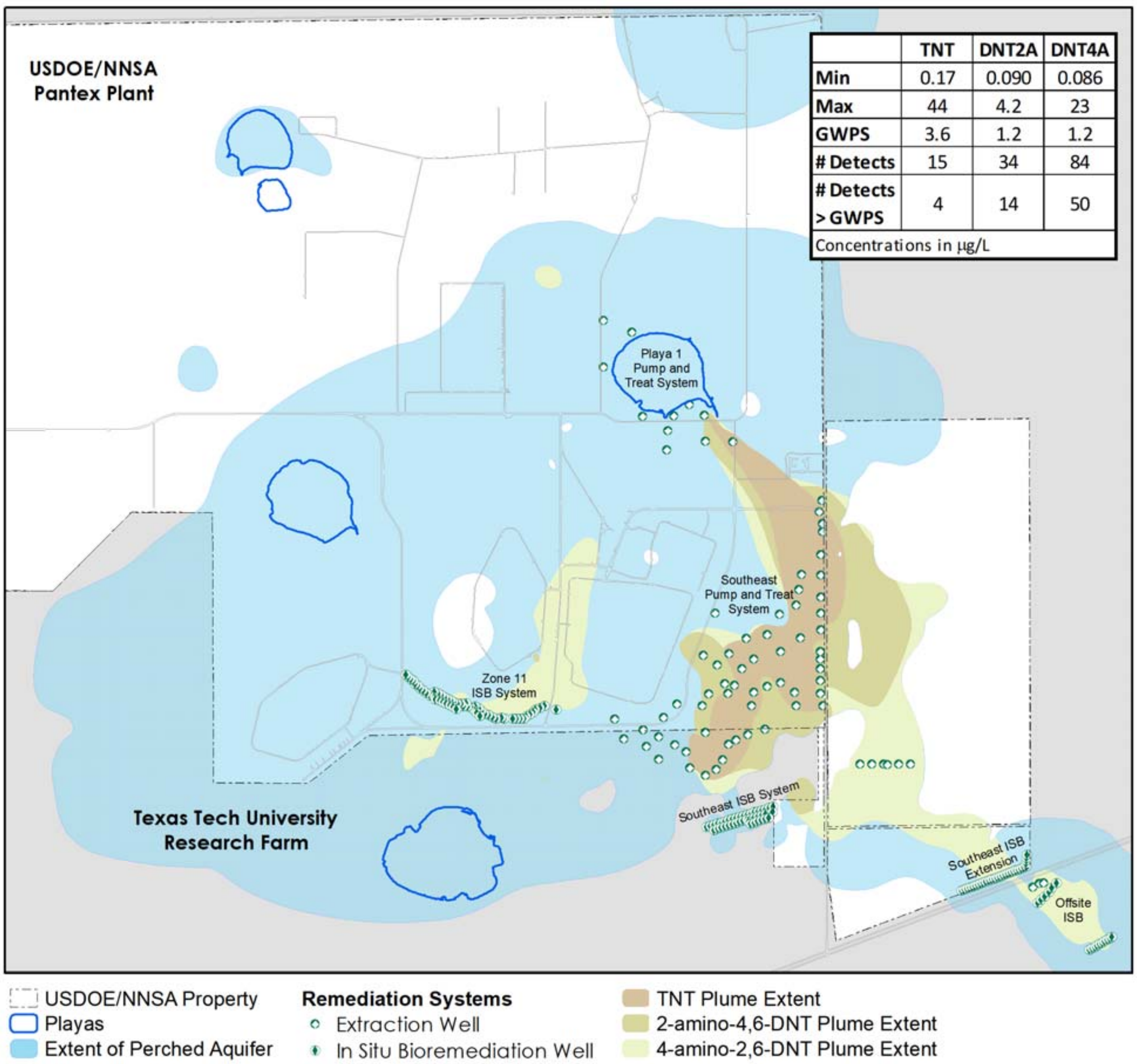
Because the right microbes for biodegradation are present in the perched sediments, Pantex is also interested in monitoring for breakdown products of RDX. In July 2009, Pantex started monitoring for degradation products of RDX in all monitoring wells after testing analytical methods to ensure they can reliably detect and quantify those products. Since analytical methods are readily available, Pantex has monitored degradation products of TNT and TCE in the past and continues to monitor them in key areas.

Other groundwater conditions that may affect attenuation, such as dissolved oxygen and redox potential, are also monitored in each well. The concentration data, as well as dissolved oxygen and redox potential, are detailed in electronic form in Appendix D.

RDX can degrade under aerobic and anaerobic conditions but achieves the best reduction under anaerobic conditions. As more data are collected, trending and statistical analyses can be used to evaluate the degradation of RDX. Trending of concentrations is also performed at each well to determine if concentrations are declining as expected.

Based on monitoring results for TNT and its breakdown products, DNT2A and DNT4A, TNT has naturally attenuated over time (see Figure 3-33). TNT has been manufactured at Pantex since the 1950s and, yet, is only present in the central portion of the overall southeastern plume, within the SEPTS well field and near Playa 1. The first TNT breakdown product, DNT2A, occurs near the TNT plume and extends slightly beyond.

The final monitored breakdown product, DNT4A, extends out to the edges of the perched aquifer saturation at low concentrations. Only TNT breakdown products are present in perched groundwater beneath Zone 11 and north of Playa 1. Concentrations of the breakdown products are still above the GWPS, but most wells with detections have recently showed decreasing or stable trends. A table of natural concentration ranges for wells outside the influence of the ISB systems is included in Figure 3-33.



	TNT	DNT2A	DNT4A
Min	0.17	0.090	0.086
Max	44	4.2	23
GWPS	3.6	1.2	1.2
# Detects	15	34	84
# Detects > GWPS	4	14	50
Concentrations in µg/L			

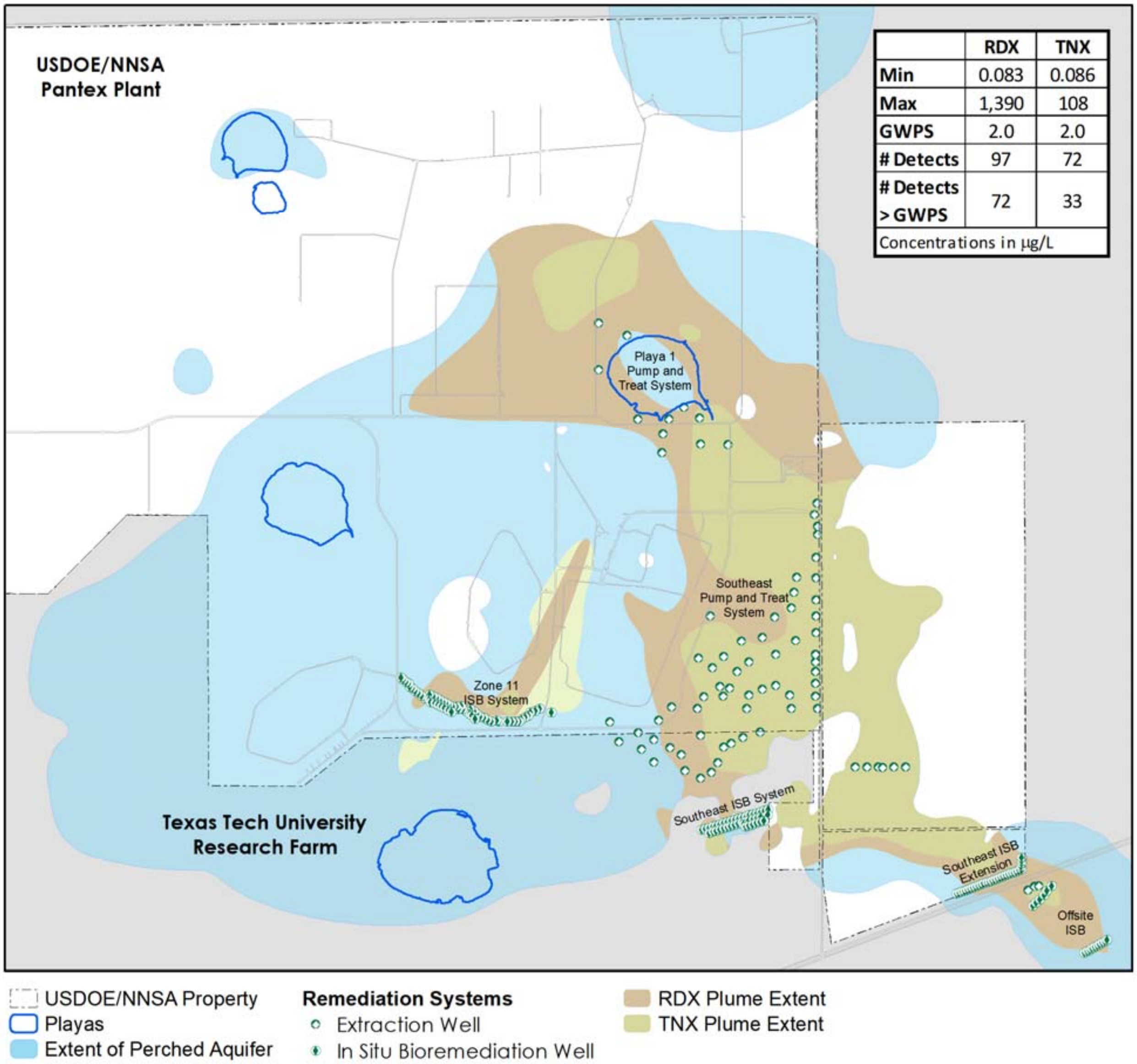
Figure 3-33. TNT and Degradation Product Plumes

Perched aquifer sampling results for RDX and breakdown products (i.e., MNX, DNX, and TNX) indicate that the breakdown products are present throughout most of the RDX plume, with TNX, the final degradation product, being the most widespread. If complete biodegradation of RDX were occurring, RDX and all breakdown products would be expected to decrease over time. Figure 3-34 depicts the overall RDX and TNX plume as well as a table of concentration ranges for wells outside the influence of the ISB systems.

A Strategic Environmental Research and Development Program (SERDP) study (2014) provided evidence that aerobic degradation is occurring in the Pantex RDX plume but was unable to quantify the rates of attenuation. This study provided new methods for evaluating RDX degradation including carbon and nitrogen fractionation (CSIA) approaches. These approaches, along with the ability to quantify 4-nitro-2,4-diazabutanal (NDAB), an aerobic degradation product, allows Pantex to better evaluate the degradation of RDX.

Pantex subsequently contracted with the SERDP study's leading researcher, Dr. Mark Fuller with APTIM Corporation, for a project to evaluate lines of evidence for the natural attenuation of RDX at the Plant. The study included both aerobic and anaerobic degradation with evidence of both occurring. The predominant attenuation process is aerobic biodegradation by bacterial strains. Biodegradation rates of 0.016 to 0.168 per year were calculated, translating into RDX half-lives of approximately 5 to 50 years.

The project found that the rates of RDX biodegradation are likely limited by the available labile organic carbon in the groundwater. The project went on to identify several lines of evidence for natural attenuation of RDX as well as the potential to enhance aerobic biodegradation of RDX by introducing low levels of labile organic carbon. Recommendations were presented for additional treatability studies, bioaugmentation, and additional proteomics analyses of degrading bacterial strains.



	RDX	TNX
Min	0.083	0.086
Max	1,390	108
GWPS	2.0	2.0
# Detects	97	72
# Detects > GWPS	72	33
Concentrations in µg/L		

Figure 3-34. RDX and Degradation Product Plumes

Pantex has monitored breakdown products of TCE for many years, and a strong indication of natural attenuation of TCE has not been observed in the perched aquifer. Quantitative polymerase chain reaction (qPCR) data collected upgradient and within the Zone 11 ISB system does not indicate that indigenous microbes are able to completely degrade TCE. However, the TCE plumes at Pantex are being actively treated by the SEPTS and ISB treatment zones.

3.4 UNCERTAINTY MANAGEMENT/EARLY DETECTION

The uncertainty management wells in perched and Ogallala groundwater have the following purposes:

- To confirm expected conditions identified in the RCRA facility investigations and ensure there are not any deviations.
- Fill in potential data gaps.
- Fulfill long-term monitoring requirements for soil units evaluated in a baseline risk assessment.

Meanwhile, the purpose of early detection wells is to monitor for the breakthrough of constituents to the Ogallala Aquifer from the overlying perched aquifer or from potential source areas in the unsaturated zone before potential points of exposure are impacted. These wells were proposed in the LTM design to evaluate the effectiveness of the soil and groundwater remedial actions. Additionally, the perched aquifer data were evaluated with respect to field observations. In 2020, no evidence of NAPL was observed in the sampled perched aquifer wells.

This report focuses on subsets of the uncertainty management/early detection wells, as depicted in Figure 3-35. The wells are evaluated with respect to the following groups:

- Group 1: 37 locations (designated by boxes in Figure 3-35) where contamination has not been detected or confirmed, or previous plume locations where concentrations have fallen below the GWPS, background, or PQL (e.g., Burning Ground and OSTP areas). These are typically Ogallala Aquifer wells, although some perched aquifer wells are located in areas without active groundwater remedial actions. These wells were evaluated in the quarterly reports.
- Group 2: 27 uncertainty management wells (all other wells in Figure 3-35) near groundwater contamination source areas. This group is established to confirm that source strength and mass flux are decreasing over time. Every five years, these wells are also evaluated for new COCs from source areas.

Because of differing frequencies in sampling, all available data for the uncertainty management/early detection wells are used in this evaluation.

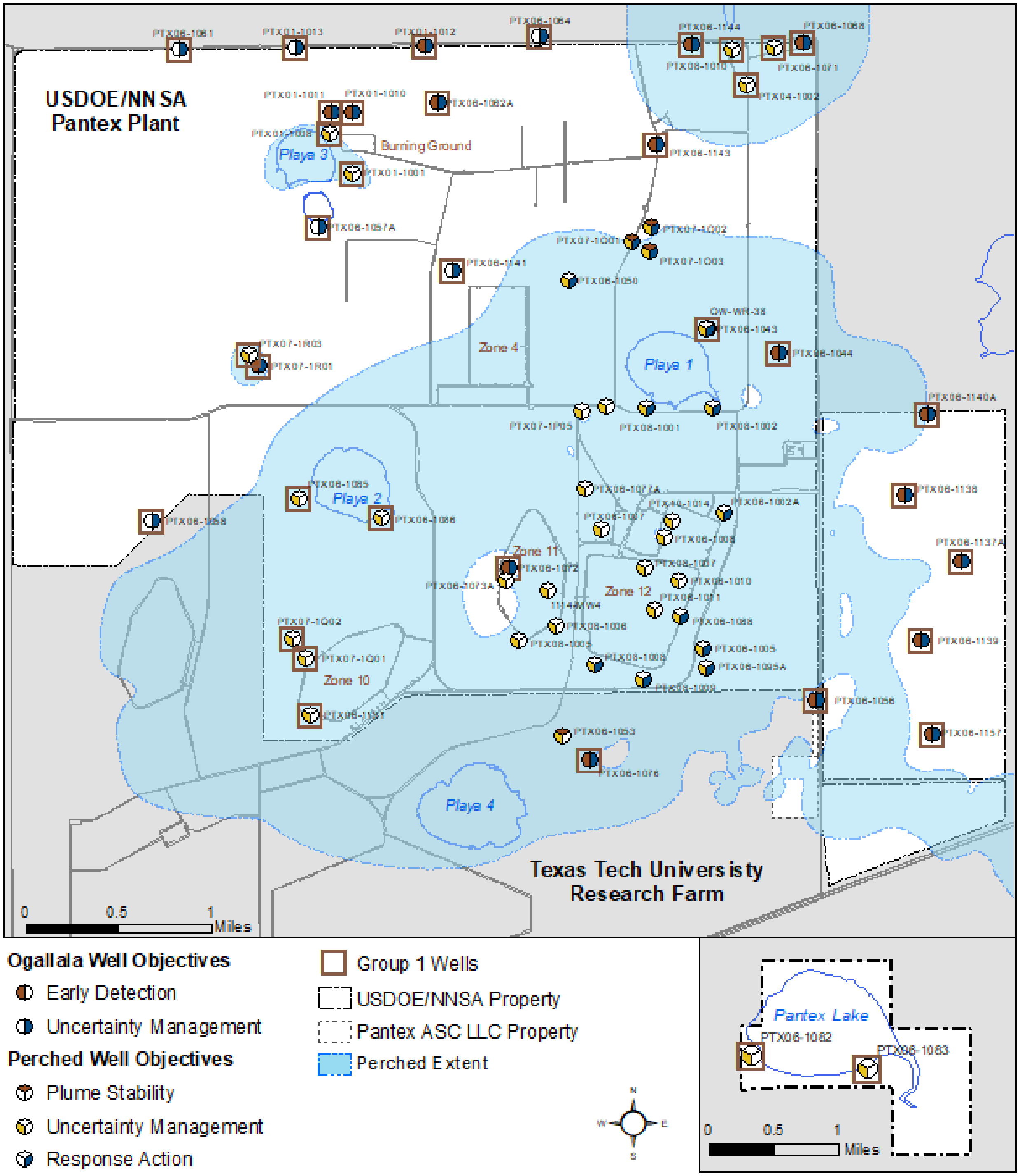


Figure 3-35. Uncertainty Management and Early Detection Wells

3.4.1 Group 1 Wells

No Group 1 perched aquifer wells had unexpected conditions in 2020. Detections of indicator COCs occurred in three Group 1 perched aquifer wells, PTX01-1001, PTX01-1008, and PTX06-1131. All detections of indicator COCs at these wells were below the GWPS.

3.4.1.1 Ogallala Aquifer Wells

In 2020, detection of organic constituents or perchlorate above background occurred in four Ogallala wells. Perchlorate was detected above background but below the GWPS in one well, and organics were detected in three wells with all detections less than the GWPS. Data for these detections are provided in Appendix D's Table D-2. Boron was detected at levels slightly above background in eight wells; these detections represent natural variability in background. Boron detections are summarized in Table D-3.

Perchlorate was detected above background in one well, PTX01-1012, in 2020; this detection was below the GWPS of 26 ug/L. At PTX01-1012, perchlorate was detected slightly above the background value of 0.96 ug/L at a measured value of 1.03 ug/L using method SW-6850. This detection likely represents background variability.

PTX06-1056 continues to demonstrate detections of DNT4A, a breakdown product of TNT, first detected in April 2014, and the VOC 1,2-dichloroethane, detected for the first time in August 2015. DNT4A was detected in both semi-annual samples in 2020 at values up to 0.65 ug/L, above the PQL of 0.25 to 0.26 ug/L, but below the GWPS of 1.2 ug/L. 1,2-Dichloroethane was detected in both samples in 2020; both detections were near the PQL of 1.0 ug/L, but below the GWPS. Trends of these analytes were performed using Mann-Kendall statistics; both DNT4A and 1,2-dichloroethane continue to demonstrate slight increasing trends across all data.

Pantex has proactively evaluated potential sources for the contamination. A nearby perched well that was drilled deep into the FGZ was plugged to address that potential source. An outside review indicated that, based on fate and transport modeling, the perched well was the most likely source of the contamination. A cement bond log was run on PTX06-1056 in October 2016 to determine the competency of the concrete seal at the FGZ. The log indicated that the seal is competent and that PTX06-1056 is likely not acting as a preferential pathway for contamination to reach the Ogallala Aquifer. As of May 2020, Pantex returned to semi-annual sampling for PTX06-1056 as approved by regulatory agencies. Further actions will be determined based on sampling results and in accordance with the *Pantex Plant Ogallala Aquifer and Perched Groundwater Contingency Plan* (Pantex, 2009d).

DNT4A was detected at 0.09 ug/L, below the PQL, which is approximately 0.26 ug/L, at PTX06-1076 in the second quarter of 2020; the detection was confirmed with a verification sample collected in August and a subsequent sample collected in October. Additionally, RDX was detected at 0.21 ug/L, below the PQL of 0.256 ug/L at PTX07-1R01. Reanalysis of the sample indicated a similar low-level detection. Because these Ogallala detections were below the PQLs, sampling will continue as approved in the SAP and in accordance with the *Pantex Plant Ogallala Aquifer and Perched Groundwater Contingency Plan* (Pantex, 2019c). Further actions will be determined based on the results of future sampling and this plan.

As presented in Table D-3, boron was detected at concentrations slightly above the background value of 194 ug/L in eight Ogallala wells in 2020, including PTX01-1011, PTX06-1043, PTX06-1044, PTX06-1056, PTX06-1137A, PTX06-1140, PTX06-1144, and PTX06-1157. Because boron concentrations at these wells were very close to background and observed boron concentrations tend to vary considerably, these concentrations also appear to represent background. Evaluation of historic boron data in these wells results in variable trends. However, the measured concentrations are well below the GWPS of 7,300 ug/L. Pantex will continue to monitor these wells according to the SAP.

In addition to the comparison of measured concentrations to the GWPS, all Ogallala Aquifer wells were evaluated to determine if specific constituents that were detected are trending upward (see Appendix E). For the trending analysis, chromium, hexavalent chromium, boron, and a small list of HEs (i.e., RDX and the dinitrotoluenes) were evaluated. The metals are naturally occurring, and the HEs have been sporadically detected in the past at a few wells.

The Mann-Kendall trending results, summarized in Table 3-5, indicate that, across all data, 12 wells are indicating increasing or probably increasing trends.

Table 3-5. Increasing Trends in Ogallala Aquifer Wells

Well	COC	Concentration Trend
PTX06-1043	B	Increasing
PTX06-1043	CR	Increasing
PTX06-1044	B	Increasing
PTX06-1056	DNT4A	Increasing
PTX06-1056	DCA12	Increasing
PTX06-1056	CR	Increasing
PTX06-1058	B	Probably Increasing
PTX06-1058	CR	Increasing
PTX06-1072	B	Increasing
PTX06-1076	CR	Increasing
PTX06-1138	MO	Probably Increasing
PTX06-1140	B	Increasing
PTX06-1143	B	Increasing
PTX06-1144	B	Increasing
PTX06-1157	B	Increasing
PTX06-1157	CR	Increasing
PTX06-1043	B	Increasing
PTX06-1043	CR	Increasing

Six wells indicate increasing trends for chromium. However, the detections were below background. These chromium trends may also be related to the stainless-steel screens and the confirmed presence of bacterial growth that has been found in many perched aquifer and Ogallala Aquifer wells at Pantex. Typically, chromium levels drop in these wells after they are brushed and bailed. PTX06-1033 was plugged and abandoned in 2017 because well damage made it unusable; that well had similar chromium detections, which may indicate that corrosion of the stainless-steel well screens is also affecting these six wells.

Mann-Kendall trending across all data also indicates that boron is increasing or probably increasing in nine Ogallala Aquifer wells. However, all boron detections are well below the GWPS of 7,300 ug/L and likely represent background variability.

As discussed above, PTX06-1056 exhibited increasing trends in DNT4A and 1,2-dichloroethane across all data, but detected concentrations remain below the GWPS, and recent data indicate no trend.

Mann-Kendall trending across all data indicates a probably increasing trend for molybdenum in PTX06-1138. However, molybdenum was detected at levels far below background, and recent data indicate no trend.

3.4.2 Group 2 Wells

These wells are near source areas and generally have contamination at levels above the GWPS. The purpose of this evaluation is to determine if source strength is declining.

The ditches and playas are expected to continue contributing contamination to the perched aquifer for 20 years or more but at much lower concentrations than in the past (Pantex, 2006). For many of these wells, concentrations are expected to stabilize, with an eventual long-term decreasing trend below the GWPS.

Table D-4 in Appendix D presents the evaluation of the Group 2 wells' COC trends since the start of remedial actions against expected conditions that were developed in the LTM Design Report. A full reporting of all trends versus expected conditions is included in Appendix E.

The following indicator parameters were not included in Table D-4:

- HE breakdown products (i.e., MNX, TNX, DNX, 1,3-dinitrobenzene, DNT2A, and DNT4A) were not included since increasing trends are not indicators of continued sourcing.
- TCE breakdown products (i.e., cis-1,2-DCE, *trans*-1,2-dichloroethene, and vinyl chloride) were not included since increasing trends are not indicators of continued sourcing.
- Total chromium was not included in lieu of hexavalent chromium.

Ten wells that have detections of COCs are already meeting the wells' expected conditions. Several wells have increasing or probably increasing historical COC trends. PTX06-1005 and PTX06-1095A are exhibiting increasing trends in multiple COCs, but these wells are under the influence of remedial actions, and these trends more likely reflect the influences of the remedial actions rather than increased mass flux from the source areas.

One or more constituents in PTX10-1014 are not exhibiting a trend, although expected conditions are long-term decreasing trends. However, statistical trend analysis does not indicate that trends are increasing.

Water levels in PTX06-1003 and PTX07-1O06 have declined since the start of remedial actions. All of these wells are dry, have water only in the well sump, or have insufficient water to sample.

Twelve wells that are exhibiting increasing trends, when their expected condition is a decreasing or stable trend, are discussed below. The trends in these wells are affected by changing flow gradients in perched groundwater that have been caused by the remedial actions and a decline in perched water levels. Thus, all of the increasing trends discussed below are associated with changes in plume movement rather than the continued or increasing release of contaminants from source areas.

- 1114-MW4, located in central Zone 11, is exhibiting increasing trends for perchlorate, possibly due to changing flow gradients and plume movement away from the source (i.e., Hypalon pond and nearby ditches).
- OW-WR-38, located northeast of Playa 1, is exhibiting increasing trends for RDX and TCE. RDX concentrations have been fluctuating near the GWPS since 2009 but increased to near 50 ug/L in the most recent sample collected in 2020. Although elevated RDX has not been previously observed at this well, other wells north of Playa 1 (e.g., PTX06-1050 and PTX07-1O03) have exhibited higher concentrations of RDX in the past. The trend may be due to the effects of the P1PTS or recent changes in the discharge of treated water to Playa 1, which have dramatically affected water levels and gradients in this region of perched groundwater. Detections of TCE have been sporadic at levels below the PQL and GWPS. The identified increasing trend is the result of low-level detections and the use of one-half the detection limit in the trending and does not indicate actual increasing concentrations in this area. TCE was not detected in the sample collected in 2020.
- PTX06-1002A, located north of Zone 12, is exhibiting an apparent increasing trend for 1,2-dichloroethane; however, 1,2-dichloroethane has not been detected in this well since 2012 and has never been detected above the PQL. The apparent increasing trend is the result of historical low-level detections and the use of one-half the detection limit in the trending and does not indicate actual increasing concentrations in this area.
- PTX06-1007, located between and north of Zones 11 and 12, is exhibiting a probably increasing trend in RDX. RDX has been detected at levels near the PQL in this well

since 2002 with only one detection above the GWPS of 5 ug/L in 2017. However, in 2020, RDX increased from near the PQL to 27 ug/L. This increase could be caused by changes in flow gradients and plume movement from the SWMU 5-13C ditch.

- PTX06-1008, located in Zone 12, is exhibiting increasing concentrations of chloroform and 1,2-dichloroethane above the GWPS. 1,2-dichloroethane has been gradually increasing in this well and has been above the GWPS since 2009. Chloroform has similarly been gradually increasing since 2009 but has remained below the GWPS until 2020. Recent data for both constituents indicate no trend. Both constituents are associated with a soil gas plume from SWMU 136. The increasing trends may be linked to the repair of several major water leaks that occurred in Zone 12 in recent years. The leaking water from the surface may have diluted VOC concentrations in groundwater beneath Zone 12. If these plumes migrate from beneath Zone 12, the plumes should be captured by the SEPTS, and both constituents will be effectively treated by GAC.

- PTX06-1010 is exhibiting increasing trends in TCE and chloroform, although the expected condition is a long-term decreasing trend. Although the trend indicates increasing TCE, concentrations in this well have declined to below the GWPS from historical levels and have remained well below the GWPS since 2009. The last four samples indicate "No Trend." Chloroform is fluctuating near the PQL with an overall increasing trend, but concentrations, again, remain well below the GWPS.

- PTX06-1011 is exhibiting probably increasing trends in hexavalent chromium and TCE and increasing trends in chloroform and 1,2-dichloroethane, although the expected condition is a stable or decreasing trend below the GWPS. Hexavalent chromium has fluctuated in this well at levels below the GWPS since 1998. The identified increasing trend is partially the result of low-level detections and use of one-half the detection limit in the trending but may also reflect the variable influence of the remedial actions and general plume movement in this area; however, data for the last four samples indicate a decreasing trend. Detections of TCE at PTX06-1011 have fluctuated near the GWPS since 1995. Trends for the last four samples and for all data indicate no trend. Although increasing in recent data, chloroform concentrations in this well remain near the PQL. Although it was detected above the GWPS in the late 1990s, 1,2-dichloroethane was not detected for many years and has only been detected since 2017 at low levels near the PQL.

The indicated increasing trend is the result of using one-half the detection limit in the trending.

- PTX06-1088 is exhibiting an increasing trend in chloroform since the start of remedial actions. Chloroform has been increasing since 2017 but has been stable in recent data, and concentrations remain well below the GWPS.
- PTX07-1O03 is exhibiting an increasing trend in RDX, although the expected condition is a long-term decreasing trend. However, RDX concentrations are much lower than the historical maximum for this well, and, considering all data, the RDX trend is decreasing. The observed trend may be due to the effects of the P1PTS or recent changes in the discharge of treated water to Playa 1, which may be affecting the RDX plume north of the playa. The continued presence of RDX at this well is not believed to be related to Landfill 1.
- PTX07-1P02 is exhibiting an increasing but variable trend in RDX, but concentrations remain far below historical levels for this well. The apparent increasing trend may be due to the effects of P1PTS since system operations have dramatically affected water levels and gradients in this region of perched groundwater.
- PTX08-1006 is exhibiting an increasing trend in TCE, although the expected condition is a long-term decreasing trend. The increasing trend in PTX08-1006, which is located downgradient from the identified sources in Zone 11, is likely due to general plume movement to the southeast that may also be influenced by SEPTS operations. Concentrations have been highly variable in this well, and the last four samples indicate a stable trend.
- PTX08-1007 is exhibiting increasing trends in perchlorate, chloroform, and 1,2-dichloroethane, although expected conditions are long-term decreasing trends. Perchlorate has been detected below the PQL since 2014, and recent data do not indicate a trend. Chloroform concentrations have fluctuated at levels below the GWPS since the well was completed in 1996; however, concentrations have been increasing since 2012, though they remain below the GWPS. 1,2-dichloroethane has been detected near the PQL for many years with only one detection above the GWPS in 2008. However, 1,2-dichloroethane was detected above the GWPS in 2017 and has continued increasing through 2020. Concentrations of chloroform and 1,2-dichloroethane are associated with a soil gas plume from SWMU 136, and the

increasing trends may be linked to the repair of several major water leaks in Zone 12 in recent years. The leaking water from the surface may have diluted VOC concentrations in groundwater beneath Zone 12.

- PTX08-1008 is exhibiting increasing trends in perchlorate, TCE, and 1,4-dioxane, and chloroform, although the expected condition is a long-term stabilization of concentrations. As discussed in Section 3.1.1.3, the increasing trend in perchlorate may be due to general plume movement to the southeast, which has been influenced by SEPTS operations. However, perchlorate has been decreasing in this well over the last two years. 1,4-dioxane had been detected at low levels near the PQL since 2016; in 2020, concentrations increased to near 4 ug/L but remain below the GWPS, and recent data do not indicate a trend. TCE has been detected near the PQL for a number of years; an increase to near 3 ug/L was observed in 2020, but recent data do not indicate a trend. Chloroform was detected below the PQL in 2020; chloroform has been below the PQL or non-detect in all samples since 2009, and the apparent trend is caused by using one-half the sample detection limit in the trend analysis.

Many other wells show the stabilization of concentrations or no trend rather than a decreasing trend. However, the expected condition is that most of these wells will present a long-term decreasing trend over the next few years.

Table D-5 in Appendix D summarizes all detections of analytes above the laboratory PQL and site-specific background, if calculated, that are not considered to be indicator parameters. 1,1-dichloroethene was detected above the laboratory PQL in PTX06-1005. 1,1-Dichloroethene occurs as a dominant intermediate breakdown product of TCE in certain environments and was recently added to the groundwater analyte list in 2020. Therefore, the occurrence of 1,1-dichloroethene in wells downgradient of TCE source areas is not unexpected.

Manganese and nickel were detected above background in 2020. Manganese was detected in PTX06-1095A near the background value of 16 ug/L and below the GWPS of 1,716 ug/L. Manganese is naturally occurring and can be released from aquifer sediments by reducing conditions, so is not unexpected to occur at low levels in perched groundwater. The detection of nickel occurred in PTX10-1014 above the background value of 15 ug/L at a measured value of 238 μg/L. Nickel is an indicator of corrosion of stainless-steel screens, and this well has a stainless steel screen and was constructed in 1992.

3.4.3 Other Unexpected Conditions

Pantex routinely evaluates data as results are received from the laboratory to determine if data are off-trend, at an all-time high, or represent a new detection that may require further sampling or evaluation. Through the well maintenance program, Pantex also inspects wells at least every five years to ensure they are not silting in and evaluate whether or not the wells remain in contact with the formation. No additional unexpected conditions were noted in 2020.

3.5 POC and POE Well Evaluation

As part of the approved changes to HW-50284, Pantex has designated POC and POE wells. As defined by HW-50284, POC wells demonstrate compliance with the GWPS while POE wells demonstrate compliance with the GWPS and are used to evaluate the effectiveness of the remediation program.

POC/POE Wells

- 21 perched aquifer POC wells, with 15 exceeding the GWPS.
- 2 Ogallala Aquifer POC wells, with no GWPS exceedances.
- 8 Ogallala Aquifer POE wells, with no GWPS exceedances.

The remediation program must continue until the POC and POE wells are compliant with the GWPS. The POC and POE wells approved in HW-50284 are depicted in Figure 3-36. All but two POC wells are in the perched aquifer. All POE wells are in the Ogallala Aquifer and are not expected to exhibit detections of organic COCs or detections above background values for inorganic COCs.

All POC and POE wells were evaluated against the established GWPS. Evaluation of the data indicates that only three perched aquifer POC wells had concentrations below the GWPS. This is an expected condition at these wells because the full remedial actions were started in 2009. The Ogallala Aquifer wells were evaluated in Section 4 to determine if any COCs were detected above the background or PQL. All well data, along with comparisons to the laboratory PQL, background, and GWPS, are provided in Appendix D.

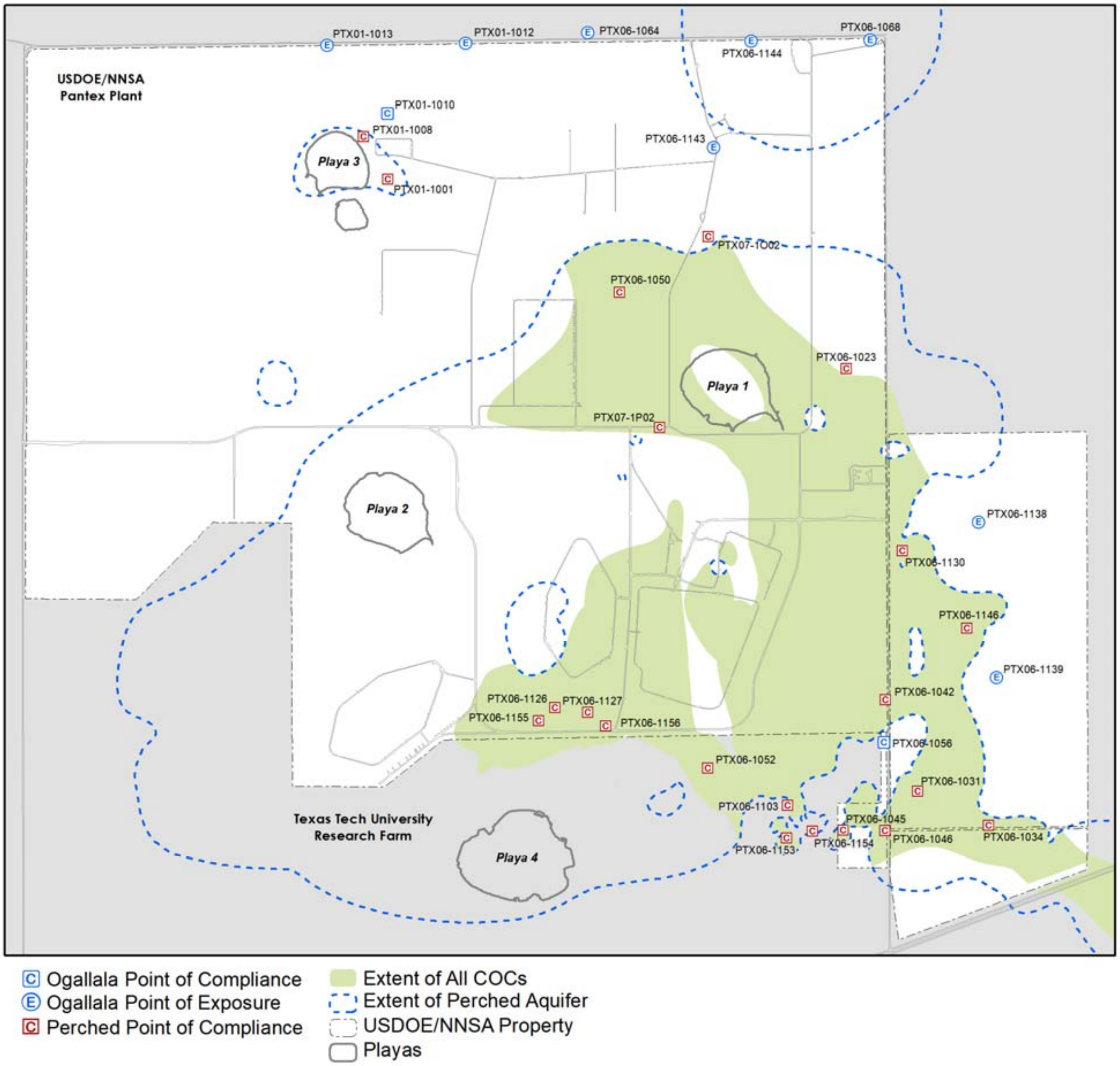


Figure 3-36. POC and POE Wells

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4.0 Soil Remedial Action Effectiveness

To prevent cross-contamination from soils to groundwater, three soil remedial actions were implemented, which were to install soil covers on landfills, a ditch liner in Zone 12, and the Burning Ground SVE. This evaluation focuses on the following two aspects of effectiveness:

1. Remedial action effectiveness of the SVE.
2. Uncertainty management.

4.1. SVE Remedial Action Effectiveness

The Burning Ground SVE system consists of a small-scale CatOx system that has been operating since April 2012, when it replaced a large-scale CatOx system. The small-scale system is used to treat residual NAPL and soil gas at a single extraction well, SVE-S-20, near the source area.

The Burning Ground SVE system operated for only half of 2020 with approximately 4,316 hours of operation during the year, which translates to being 49% operational. Operation of the system was negatively affected by several problems in 2020 including heat controller issues, a forced shutdown due to COVID-19, and implementation of the pulsing plan.

Figure 4-1 shows that the system was not operated until mid-March, only to be shut down again in the second quarter. The system was operated at 100% throughout the third quarter and 70% of the fourth quarter through mid-December. The system was shut down again during the second week of December as part of the pulsing plan for a path to closure for the system. The system was restarted in April 2021.

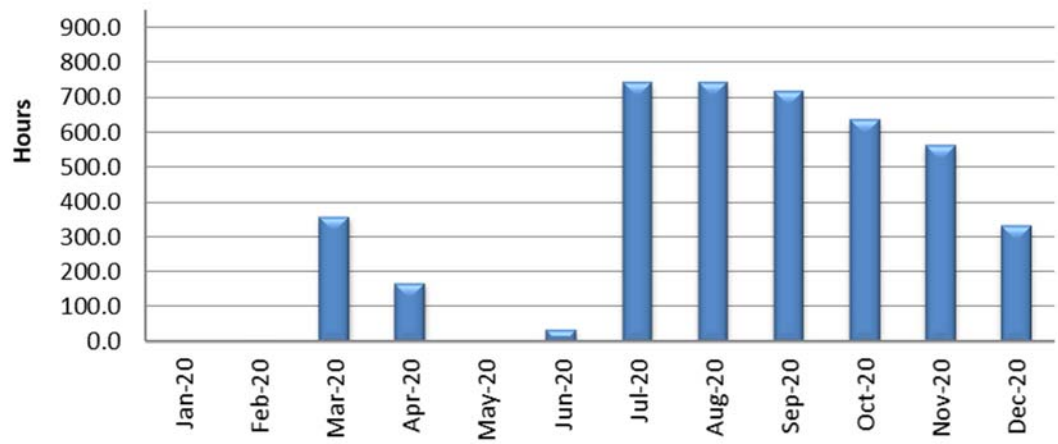

Figure 4-1. SVE system operational hours in 2020

The small CatOx/wet scrubber system continues to focus on treating residual soil contamination and soil gas at SVE-S-20, where soil gas concentrations continue to remain relatively high. To enhance the removal of the NAPL source through increased volatilization and stimulation of aerobic bioremediation, the system was modified in 2017; specifically, airflow was increased through the formation by opening pipes from wells surrounding SVE-S-20 to ambient air. The system removed approximately 269 lbs of VOCs during 2020. PID data collected at the SVE system's effluent port compared to that of the influent port suggests that the overall system destruction efficiency was approximately 99% in 2020.

Figure 4-2 shows the mass of the four highest VOC compounds (i.e., acetone, toluene, TCE, and tetrahydrofuran [THF]), removed each month of 2020. The hourly VOC removal rate has declined significantly since 2017 and continues to remain low throughout 2020.

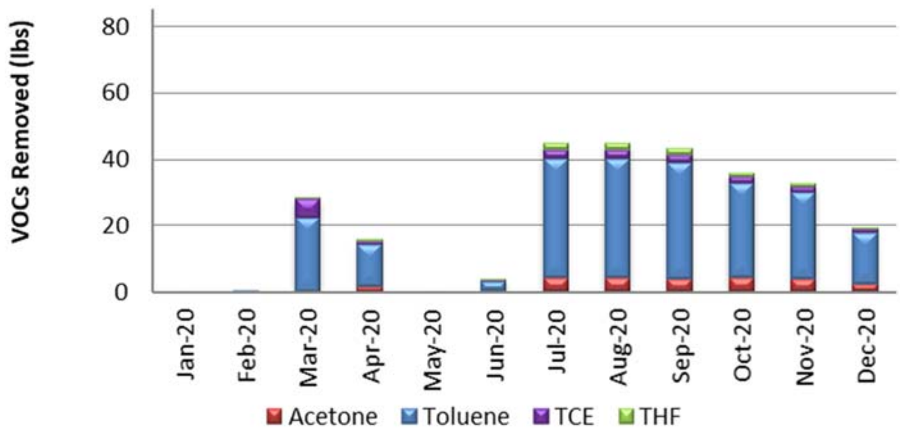

Figure 4-2. SVE System 2020 VOC Removal

Influent and effluent PID readings are taken at the SVE system prior to the oxidizer and at the scrubber stack. The sampling frequency is weekly to ensure compliance with the permit-by-rule. Pantex also collects monthly influent samples that are sent to a laboratory for analysis. The analytical samples are used to estimate the SVE system's mass removal. In 2020, a total of nine samples were collected for laboratory analysis from March through November.

Table 4-1 summarizes detected 2020 data in influent samples and the average concentrations from 2007 to 2008. The 2020 data were collected at the current SVE system's influent port. The average of 2020's measured values is lower than what was documented from 2007 to 2008, with the exception of methylene chloride, which was below the detection limit from 2007 to 2008. The lower 2020 average concentrations may indicate that the primary NAPL source has been depleted. Maximum and average values are lower than the baseline concentrations, with the majority of the COC maximum concentrations now one or two orders of magnitude lower than baseline maximums.

Methylene chloride was detected in two of the nine samples in 2020 and has been present since 2010, although it was not detected in the baseline data. This COC had been detected prior to 2007 at low concentrations in the large-scale system or individual soil gas wells. Other COCs may be detected at low levels in the future because detection limits are expected to decrease as major COC concentrations decrease and sample dilutions by the laboratory lessen.

Table 4-1. Burning Ground SVE Data Summary

Analyte	2020 Measured Value			2007-2008 Measured Value		
	Mean*	Max	Min	Mean	Max	Min
Acetone	15,260	24,000	ND	82,666	140,000	38,000
Toluene	75,690	130,000	250	477,307	990,000	45,000
Methylene chloride	2,530	4,900	ND	ND	ND	ND
1,1,2,2-Tetrachloroethane (PCA)	3,620	5,400	820	3,356	6,300	760
Trichloroethene (TCE)	5,470	18,000	1,500	26,714	41,000	13,000
Tetrahydrofuran (THF)	3,940	9,100	450	20,107	26,000	9,500

Results for 2020 are based on laboratory analysis of samples of influent to the SVE system. Measured concentrations in parts per billion by volume (ppbv).

Indicates values greater than the baseline 2007-2008 concentration.

*Mean of measured values; non-detect results not included.

To verify whether or not VOC concentrations are decreasing, the nonparametric Mann-Kendall trend test was applied. This method of statistical investigation was performed on all available SVE analytical data collected since the small-scale CatOx system was installed in early 2012.

Mann-Kendall trends were calculated based on all data collected from 2013 to the present (i.e., the last four measurements collected at the system's influent port). Since the analytical results can be affected by multiple factors (e.g., extraction equipment, sample port location, system conditions), no effort was made to statistically trend the new results with the analytical data associated with the old systems. Generally, current concentrations are lower than those collected in the previous large-scale CatOx or GAC system. These lower concentrations appear to reflect a significant decline in the residual NAPL source.

Table 4-2 summarizes the statistical trending. The results indicate that all four main COCs (i.e., acetone, toluene, TCE, and THF) exhibit decreasing trends, considering all data collected since 2013. The last four concentration measurements indicate a decreasing trend for THF while no trend is indicated for the other three main COCs.

Table 4-2. Mann-Kendall Results for Soil Gas COCs

COC	Trend-All Data	Recent Trend
Acetone	Decreasing	No Trend
Toluene	Decreasing	No Trend
TCE	Decreasing	No Trend
THF	Decreasing	Decreasing

The average monthly PID measurements collected at the system influent, summarized in Figure 4-3, show some variability, but 2020 monthly averages ranged between approximately 27 to 237 parts per million (ppm). The orange circles on the chart show the 12-month rolling average, which illustrates a strong decline in average concentrations since the system modification in mid-2017. Two very high PID readings in June 2018 that were determined to be unrepresentative were omitted from the 12-month averages. Through the third quarter of 2020, average PID readings were lower than observed since the small-scale system began operating in 2012. The observed decline in influent PID readings was expected and indicates NAPL source depletion.

In the *Five-Year Review Report* (Pantex, 2013d), Pantex recognized the conflicting data and uncertainty concerning the reduction of soil gas VOCs and mass of NAPL remaining in the soil near SVE-S-20. However, no expected conditions or paths toward closure were defined for the SVE system, other than "significant reduction in soil gas VOCs."

Therefore, in the First FYR, Pantex recommended developing a Burning Ground SVE Performance Monitoring Plan to define expected conditions of system performance as well as a clear path toward an endpoint of active SVE operations. In anticipation of this plan, four rebound tests were attempted in 2014 and 2015 to establish baseline conditions against which future rebound tests could be compared; however, none of the rebound tests were successful. Based on the system operational data and data collected during the four attempted rebound tests, it does not appear the SVE performance-based approach will be technically practicable in attaining closure at the SEP/CBP area of the Burning Ground.

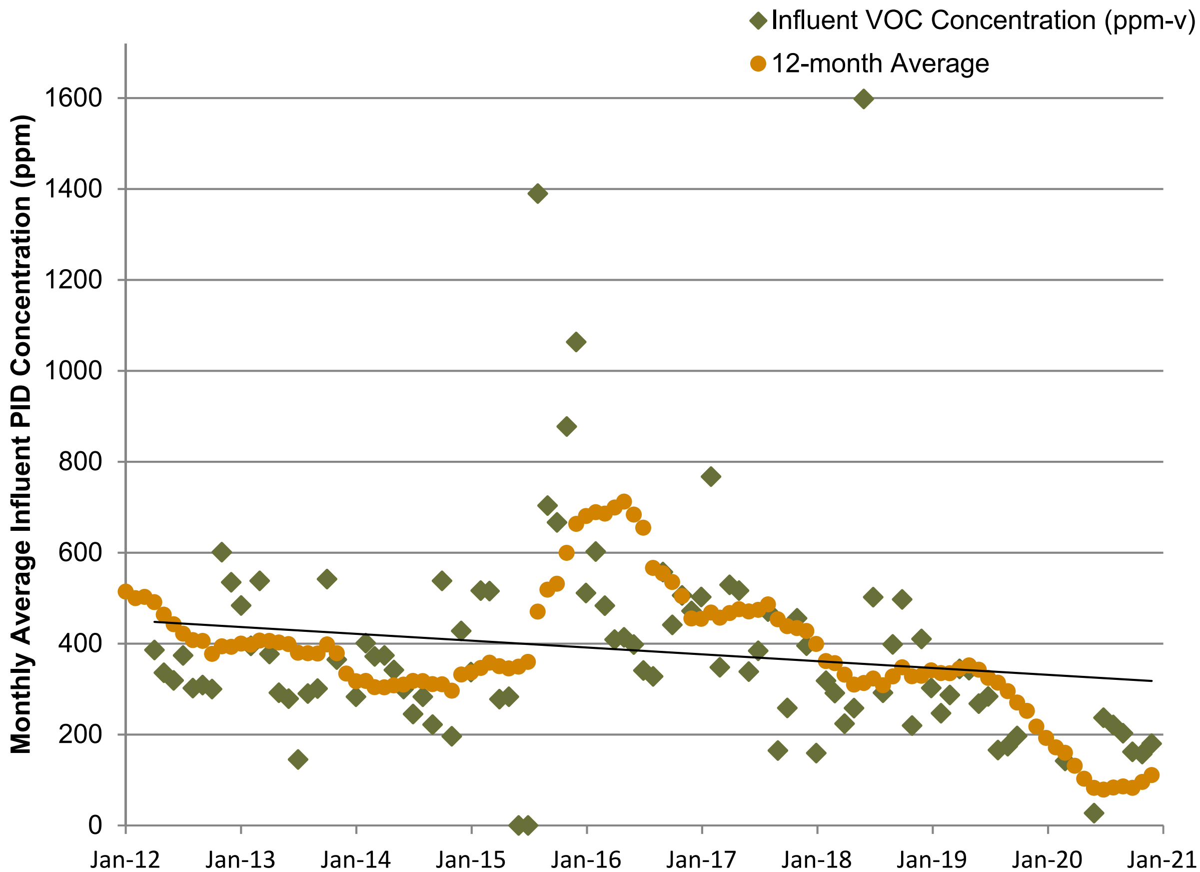

Figure 4-3. Influent Average PID VOC Concentrations vs. Time

Pantex has evaluated other paths to an endpoint of active remediation for this system. After evaluation of influent concentrations and system performance, Pantex recommended an approach to enhance bioremediation and volatilization by potentially moving to a passive remediation approach.

In the *4th Quarter 2016 Progress Report*, Pantex recommended that up to seven inactive SVE extraction wells surrounding the active extraction well SVE-S-20 be modified with goose-neck pipes extending aboveground with screens and shut-off valves so that, while the system is operating, airflow through the formation can be enhanced by opening the pipes to ambient air. This enhancement helps to stimulate naturally occurring aerobic bacteria that degrade the NAPL source and increase volatilization.

The modifications were completed in May 2017, with baseline samples collected in June. Flow was increased from an initial rate of approximately 32 scfm to 44.5 scfm during the fourth quarter of 2017. Hourly VOC removal rates increased with increased flow. In the fourth quarter of 2017, the SVE system's performance improved with a 50% increase in VOC mass removal rate over first-quarter baseline values and an increase of 34% in the extraction air flow rate. The mass removal rate improvement lasted through the first quarter of 2018 and has since declined, but the hourly removal rate has remained consistently low throughout 2020.

The drop in removal rates combined with declining influent PID measurements (Figure 4-3) appears to indicate that the system has reached a point where the residual NAPL mass will not be effectively treated through the system's continued operation. The SVE system has removed approximately 21,230 lbs of VOCs from soil gas and residual NAPL in the SEP/CBP area and has successfully mitigated the potential vertical movement of VOCs to groundwater.

4.2. Uncertainty Management

One of the purposes of the uncertainty management wells is to confirm the following expected conditions from the soil units:

1. Declining source contributions from soil units that have historically contributed to groundwater.
2. No new source contributions to currently impacted groundwater.
3. Areas that have no historical contamination in the uppermost groundwater will not exhibit signs of sourcing to groundwater.

In accordance with the SAP, Pantex analyzes indicator constituents at all wells to determine possible impacts to areas that were previously unaffected or to ensure that source area strength is declining in impacted areas. This evaluation is presented in Section 3.4.

In 2020, no Group 1 perched aquifer wells had unexpected conditions. Organic constituents or perchlorate were detected above background in four Ogallala wells. Perchlorate was detected above background but below the GWPS in one well, and organics were detected in three wells with all detections less than the GWPS. At PTX01-1012, perchlorate was detected slightly above the background value of 0.96 ug/L at a measured value of 1.03 ug/L using method SW-6850. This detection likely represents background variability.

PTX06-1056 continued to demonstrate detections of DNT4Asince its initial detection in April 2014. Sample results since that time have been variable, with values slightly exceeding the PQL since 2016. This trend continued in 2020, with DNT4A values exceeding the PQL in the first and fourth quarters. These values did not exceed the GWPS. Additionally, 1,2-dichloroethane exceeded the PQL for the first time in the third quarter. 1,2-dichloroethane has been variably detected in well PTX06-1056 since August 2015, but all detections had been below the PQL. Both DNT4A and 1,2-dichloroethane continue to demonstrate a slight increasing trend across all data.

DNT4A was detected at 0.09 ug/L below the PQL of approximately 0.26 ug/L at PTX06-1076 in the second quarter of 2020; the detection was confirmed with a verification sample collected in August and a subsequent sample collected in October. Additionally, RDX was detected at 0.21 ug/L below the PQL of 0.256 ug/L at PTX07-1R01. Reanalysis of the sample indicated a similar low-level detection. Because these Ogallala detections were below the PQLs, sampling will continue as approved in the SAP and in accordance with the Pantex Groundwater Contingency Plan. Further actions will be determined based on results of future sampling and the *Pantex Plant Ogallala Aquifer and Perched Groundwater Contingency Plan* (Pantex, 2009d).

No Ogallala aquifer uncertainty management wells indicated impacts from a soil source area.

5.0 Conclusions and Recommendations

5.1 Conclusions from the 2020 Annual Report

Overall, the groundwater remedial actions have been effective in 2020. They continue to operate and meet short-term expectations for cleanup of the perched groundwater in areas under the influence of the remediation systems. While the remedial actions continue to operate to meet long-term goals, perched water levels are declining in most areas, COC mass is being removed or reduced, and institutional controls protect against the use of impacted groundwater. The influence of both pump and treat systems will continue to expand as saturated thickness is reduced in the perched aquifer.

The groundwater remedies are considered to be protective for the short term since untreated perched groundwater use is controlled to prevent human contact and monitoring data continue to indicate that the remedial actions remain protective of the Ogallala Aquifer. One Ogallala Aquifer well, PTX06-1056, had continued detections of 4-amino-2,6-DNT and 1,2-dichloroethane above the laboratory PQL, but below the GWPS, indicating the possible migration of perched groundwater to the Ogallala Aquifer. In response to these detections, Pantex has fully implemented the conditions specified in the *Pantex Plant Ogallala Aquifer and Perched Groundwater Contingency Plan* (Pantex, 2019c) and will continue sampling for HEs and VOCs in accordance with the SAP at this well.

Pantex has also proactively evaluated potential sources of the contaminants. A nearby perched well that was drilled deeply into the FGZ was plugged to address that potential source. An outside review indicated that the perched well was the most likely source of the contaminants based on fate and transport modeling. A cement bond log was run on PTX06-1056 in October 2016 to determine the competency of the concrete seal at the FGZ. The log indicates that the seal is competent and that PTX06-1056 is not likely acting as a preferential pathway for contaminants to reach the Ogallala Aquifer.

The pump and treat systems' throughput performance was affected by shutdowns for repairs to the break at the irrigation system's filter bank and subsequent repairs of the irrigation lines and communication system. In accordance with Permit #WQ0002296000, all treated wastewater effluent and the P1PTS's treated water are being routed to Playa 1. The SEPTS is injecting treated water into the perched aquifer and sending water to Playa 1 when P1PTS is not operating. The P1PTS was only operated once per quarter to ensure continued functionality and to allow SEPTS to fully operate to capture water in high-priority locations. This operation scheme was implemented to control migration of plumes and minimize injection into the perched aquifer. To develop protective measures for workers and approve return-to-work at each area, a shutdown occurred from April to June 2020 at Pantex, which affected the pump and treat systems.

The Zone 11 ISB system has a well-established treatment zone in the original portion of the system, where injection has occurred since 2009, as well as in the initial expansion area, which has received four injections. Deep reducing conditions have been more difficult to establish at TZM wells located between the injection wells in the expansion area. Improved conditions have been noted across the western side of the Zone 11 ISB after moving to the use of molasses amendment in recent years. However, some wells have limited abilities to accept injection, and those areas will likely continue to demonstrate milder reducing conditions until the wells can be replaced.

The TZM wells' data indicate very mild to strong reducing conditions across the Zone 11 ISB. With the exception of PTX06-1175, all wells downgradient of the system have indicated the arrival of treated water. In 2020, perchlorate was detected above the GWPS in two downgradient ISPM wells but was not detected or below the GWPS in the other seven wells. TCE concentrations are below the GWPS in four of nine ISPM wells and two former injection wells. The only downgradient wells not demonstrating strong treatment are PTX06-1173 and PTX06-1175. Wells upgradient of PTX06-1173 were difficult to inject into during recent injection events. PTX06-1175 is downgradient of a single row of injection wells.

The Southeast ISB system has been effectively treating HEs and hexavalent chromium at three of the closest downgradient ISPM wells, PTX06-1037, PTX06-1154, and historically at PTX06-1123. These wells indicate that the reducing zone has extended beyond the treatment zone, and RDX and hexavalent chromium concentrations in these wells are either non-detect or below the GWPS.

PTX06-1153 continues to exhibit RDX concentrations above the GWPS, but hexavalent chromium concentrations continue to demonstrate a decreasing trend and have remained below the GWPS since 2016. During 2019 and 2020, this well demonstrated signs of partial treatment. Breakdown products of RDX were detected at concentrations above the GWPS.

Upgradient dry wells were injected during the previous 2015 and 2018 injection events in an attempt to affect PTX06-1153. Pantex also moved to the use of molasses at this system to attempt better distribution of a carbon source across the treatment zone and installed a pump at PTX06-1153 during injection to try to induce flow to the well. Data indicate the well was impacted by the injection, but it will take time to determine the extent of the impact. As with other locations, water levels at this well continue to decline.

The new Southeast ISB Extension was injected for the first time in 2019. One injection event was completed at the system during 2020, using molasses. Monitoring ISB wells indicates complete treatment of the HE plume that is extending offsite. However, given the distance to the downgradient wells offsite, treatment results are not expected to be observed in wells near the faster portion of the plume until later in 2021.

Soil remedies have been effective at Pantex: Workers and the public are protected from exposure to contaminated soils, and data do not indicate that new contamination is migrating to the underlying groundwater from soil source areas. The landfill covers and ditch liner are operating as designed, and recent rainfall continues to improve vegetative cover on the landfills.

Yearly inspections and the second FYR indicated that several landfills require the soil covers to be maintained. Pantex has completed some of the maintenance and continues to plan repair and maintenance of the landfill soil covers using a combination of on-site and contract resources. Pantex will continue to address the needed landfill maintenance as budget and availability of onsite resources allow.

The ditch liner prevents the infiltration of water that would cause HEs in soils to migrate to the perched aquifer. Maintenance of the ditch liner is required to ensure continued conveyance of runoff through the ditch system.

The SVE system is actively removing soil gas and residual NAPL in soils at the Burning Ground, thereby mitigating vertical movement of VOCs to the Ogallala Aquifer. The system was shut down variably due to repairs that required contracting as well as for the first planned pulsing period, which began in December 2020. Data indicate a strong decline in influent concentrations in 2020, indicating that the NAPL source may be near depletion.

Institutional controls are in place for soils and groundwater, providing short-term protection of human health and the environment while active remedies continue to operate. Pantex will continue to evaluate areas that are not currently under the influence of active remedies to determine if additional actions are needed to provide permanent, long-term protection.

To address the identified issue of HE plumes expanding east of FM 2373 and in the southeast lobe of the perched aquifer to offsite properties, Pantex updated the perched groundwater fate and transport model to assist in evaluating treatment options for the off-site plume. Once the model was updated and calibrated, the model was used to optimize a treatment system for the offsite plume. The results indicated that a combination of ISB and pump and treat on one property would effectively remediate the offsite plume within 25 years.

Pantex installed the first and second phases of the Offsite ISB wells in 2020, with infrastructure planned to be complete in June 2021. The system requires two more phases of installation, subject to availability of annual funding and finalization of landowner agreements. Injection at this system is scheduled to begin in June 2021.

5.2 Conclusions from the Five-Year Reviews

The first FYR report for the Pantex Remedial Action was submitted in December 2012 and received final approval in August 2013. The second FYR report was submitted in May 2018 and received final approval in September 2018. The results of the FYRs 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.

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 must be evaluated, planned, and implemented.

This section is provided to track the recommendations and actions from the FYRs to completion. The following three recommendations or issues remain from the first FYR and were carried into the second FYR:

1. The issue of expanding plumes to the southeast.
2. The issue of incomplete treatment at the Southeast ISB at well PTX06-1153.

3. The recommendation to develop criteria for ceasing active SVE system operations.

The table below details the issues and recommendations contained in the second FYR. Items that have been addressed have been greyed out. Plans for completion or summary of work completed are provide for each item. While no items were completed in 2020, Pantex continues to work toward completing the remaining items by the end of 2022.

Table 5-1. Second FYR (2018) Issues and Recommendations

Issue	Recommendations & Follow-Up	Milestone Date	Completion Date	Actions
		Issues		
Soil Remedies				
Minor deficiencies in protective soil covers including erosion, slope instability, animal burrows, and settling.	Prepare and implement a work plan to restore slopes and fill holes on soil cover surfaces.	Dec-2022		Pantex prepared a plan to address the issues identified in the FYR as well as those identified through continuing annual landfill inspections. See Section 2 for a discussion of the plan. Pantex is planning to use onsite and contract work to fulfill these requirements. New funding has been requested for FY21-25 to address landfill issues.
New EPA protective dose calculations for radionuclides.	Meet with the EPA to discuss the risk assessment process and data for radionuclides	Dec-2019	Dec-2019	Discussed at a regulatory meeting on November 14, 2018. The EPA requested a letter to close out the radionuclide issue. The letter closing out the issue was sent on December 11, 2019.
Groundwater Remedies				
Plumes of HEs (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.	Phased approach through 2020, deed restrictions extended to end of 2022	Sep-2019	Pantex updated the fate and transport model and conceptual site model based on the latest data collected to the southeast of Plant property. The model was used to optimize an offsite remedy. The new offsite system was discussed in the *2019 2nd Quarter Progress Report.*
	Connect six new extraction wells east of FM 2373 to the SEPTS.		Mar-2019	Wells were drilled and connected to the SEPTS in March 2019.
	Design and implement an ISB system along Highway 60 southeast of the Pantex Plant.		Feb-2019	ISB injection wells were installed in 2018, and the first injection event was completed in February 2019.
	Confirm deed restrictions encompass property affected by the migration of the HE plume.			Pantex has confirmed the extent of contamination for the deed restriction. The remediation system is designed to keep concentrations below the GWPS at the boundary of the deed restriction area. Pantex is continuing to work with the DOE, U.S. Army Corp

Issue	Recommendations & Follow-Up	Milestone Date	Completion Date	Actions
				of Engineers, and offsite landowners to put restrictions in place. Pantex requested an extension to complete the necessary deed restrictions, with completion scheduled by the end of 2022.
The Zone 11 TCE plume extends west and outside of the Zone 11 ISB system.	Continue evaluating alternatives to treat the TCE plume. Remedial systems to be considered include expanding and/or updating the ISB system or implementing a pump and treat system.	Sep-2020	Jun-2018	Pantex completed an evaluation of remedial options. The final recommendation was to extend ISB to the untreated area and add recirculation to optimize treatment. Pantex has installed six new injection wells to the northwest of the ISB to expand injection to the edge of the plume. Injections are scheduled to begin in 2020.
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.	Sep-2019	Jun-2019	Pantex continues to evaluate data and optimize the ISB systems. A study conducted in 2018 using a soluble carbon (i.e., molasses) indicates improved distribution of amendment between the wells. As recommended in the *2018 Annual Progress Report*, Pantex injected molasses during the 2019/2020 injection event as part of an optimized strategy to impact PTX06-1153. Additionally, a pump was installed in PTX06-1153 to induce flow to the well while injection occurred upgradient. The results of the study will be evaluated over time.
Perchlorate plume potential migration to SEPTS.	Continue monitoring the perchlorate plume southeast 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.	Sep-2019	Jan- 2019	Pantex has increased sampling at the SEPTS to semi-monthly and semi-annually at the affected wells. Pantex has included modification of the SEPTS to include perchlorate resins in our 2021 budget and scope for extending irrigation to the east of FM 2373. Current concentrations are low at the SEPTS, and the chromium resin can treat the perchlorate. Wells will be turned off in response to higher concentrations that cannot be treated until Pantex can modify the SEPTS to include treatment vessels for perchlorate.

Issue	Recommendations & Follow-Up	Milestone Date	Completion Date	Actions
The GWPS for perchlorate is 26 mg/L, the TRRP PCL is 17 mg/L, and the EPA LHA is 15 mg/L.	Include perchlorate as part of the risk assessment meeting and discussion with EPA described under Issue 2 (Soil radionuclides risk assessment). Update the GWPS as needed in potential explanation of significant difference (ESD).	Sep-2022		The perchlorate issue was discussed at a meeting held in November 2018. Pantex plans to implement a change in the perchlorate GWPS when the ESD is completed (see issue below). Pantex is already working towards implementing a lower GWPS at the pump and treat systems as part of the upgrade to the system to include resin treatment of perchlorate. No further meetings are required to address the perchlorate GWPS issue.
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.	Sep-2022		Pantex plans to include the offsite treatment system into a single ESD that covers the expansion of the Zone 11 ISB and new treatment systems for the expanded southeast plume. Pantex also plans to implement a change to the perchlorate GWPS. Any other changes made to the system to expand treatment at the Zone 11 ISB or possible changes at the Southeast ISB will also be included if needed.
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 the 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 the GWPS of 5 mg/L.	Annually through Progress Reports	Ongoing	Cadmium sampling at PTX06-1010 and one downgradient well have been included in the yearly data quality objectives and schedule for sampling.
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.	Annually through Progress Reports	Ongoing	Cr(VI) sampling at PTX08-1005 and two downgradient wells has been included in the yearly data quality objectives and schedule for sampling.
1.4-dioxane in Zone 11 plumes	Continue monitoring for 1,4-dioxane in the Zone 11 plume and downgradient from the ZN11ISB	Annually through	Ongoing	1,4-dioxane sampling is conducted at all upgradient and downgradient wells for the Zone 11 ISB as well as Zone 11 areas where a release could have

Issue	Recommendations & Follow-Up	Milestone Date	Completion Date	Actions
	system to evaluate potential expansion of the plume.	Progress Reports		occurred. This sampling has been included in the yearly data quality objectives and schedule for sampling.
Recommendations				
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.	As needed after review of influence of recent upgrades to system	Ongoing – trial shutdown began December 2020	Pantex modified the SVE system in 2017 to pull in ambient air and increase volatilization and bioremediation. Pantex will continue monitoring for drops in concentrations and removal rates that indicate that the system has effectively removed NAPL in intermediate soils. A trial shutdown and pulsing plan began in December 2020.
Groundwater Remedies				
Repair or 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.	Jul-2019	New options identified Jun-2019	See Section 2 for discussion of system O&M and recommendations to increase extraction and throughput. Plans include the following: -Playa 2 injection contract started in 2019. Construction is expected to be complete by the end of FY20. -Design of changes to the SEPTS and new irrigation system east of FM 2373 design have been requested for the 2021 budget/scope. -The filter bank at the existing system has been repaired. After repairs to the filter bank, the system must be tested and repaired in the field. Testing of irrigation tapes and necessary repairs is underway. The existing system is expected to be running by the end of FY20.
Consider optimization of the pumping network in the SEPTS.	Computational or qualitative optimization of extraction could improve the following: -Control of migration of perchlorate plume.	Sep-2021		Pantex has initiated a long-term contract for fate and transport modeling and evaluation of treatment. Work is scheduled to be complete by the end of September 2021.

Issue	Recommendations & Follow-Up	Milestone Date	Completion Date	Actions
	-Continued reduction of saturation in the SEISB. -Control of the plume migrating in the southeast lobe of the perched unit.			
Consider optimization of the SEISB injection effort may be reduced in areas where groundwater COC concentrations have dropped below the GWPS.	Consider amendment injections in wells around PTX06-1153 (even if they appear dry) to target one area where COC concentrations are not responding.	Sep-2020	Jun 2019	See actions in Issues section above.
	Schedule a reduced amendment injection frequency at the SEISB in areas where groundwater concentrations have dropped below the GWPS.		Jun 2019	Pantex has reduced soybean oil injection events for the SEISB. One more injection event is planned in 2022. No further injections may be required due to declining water levels.
	Evaluate data annually and during the next FYR period to determine the effects of the optimized strategy.		Ongoing	Pantex will include an evaluation of evolving strategies in each annual progress report.
LTM Network				
Evaluate current conditions in Ogallala Aquifer monitoring wells to determine if changes are needed to implement an improvement plan (2014).	Check the 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.	Sep-2019	Nov 2018	All Ogallala wells were evaluated with respect to screens with blanks and current water levels. A diverter was added to one Ogallala well, PTX01-1011. Sampling will continue at the current upper screened section of this well.
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 the TCEQ and EPA. Adjust sampling frequencies and add analytes where identified. Other	Sep-2019	Sep-2019	Pantex has updated the LTM Design and SAP and sent them to the TCEQ and EPA. Those documents have been approved. Pantex implemented changes to the network in accordance with the updated LTM Design and SAP beginning January 2020.

Issue	Recommendations & Follow-Up	Milestone Date	Completion Date	Actions
	needed revisions resulting from this FYR should be incorporated in this effort.			
Institutional Controls				
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.	Phased approach through 2022		Pantex and the DOE's Albuquerque Real Estate Office started working with neighbors to address treatment and deed restrictions in 2019. Well drilling in 2019 and new installations in 2020 indicate the plume is well-defined, and no further restrictions are required to address the plume. The previously identified deed restrictions are being pursued by Pantex, DOE, and the U.S. Army Corp of Engineers and are expected to be complete by the end of 2022, as approved by the EPA and TCEQ.
Community Involvement				
Implement measures to better inform neighbors of the RA.	Update the community involvement plan, neighbor mailing lists, and distribute the annual newsletter and public meeting invitations accordingly to improve communication with Pantex neighbors/ local officials.	Dec-2019	May 2019	The community involvement plan was fully updated to reflect new community information and updated contract information. Neighbor mailing lists are updated annually. Public meeting invitations are sent based on those updates, as well as expressed interest from stakeholders. The annual newsletter is sent to the full list of neighbors by October of each year, in advance of the public meeting that is held in November.
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 the TCEQ and EPA. This will ensure that RA progress and the new information on wells installed and water quality encountered is available to PGWD	Annually	Jun-2018	The PGWD is now included in the distribution list for delivery of all quarterly and annual progress reports.

Issue	Recommendations & Follow-Up	Milestone Date	Completion Date	Actions
	staff for use in protecting and conserving groundwater resources critical to the future of the Panhandle region.			

5.3 Recommendations

Pantex plans to continue currently approved remedial actions. The groundwater remedies are considered protective for the short term since untreated perched groundwater use is controlled to prevent human contact, and Ogallala Aquifer data continues to indicate COC concentrations either non-detect or below the GWPS. The systems are also proving to be effective in reaching long-term objectives for cleanup.

Soil remedies have also been effective at Pantex: Workers and the public are protected from exposure to contaminated soils, and data do not indicate that new contamination is migrating to the underlying groundwater from soil source areas. The SVE system is actively removing soil gas and residual NAPL in soils at the Burning Ground, thereby mitigating the vertical movement of VOCs to the Ogallala Aquifer.

Based on issues identified in the FYR and this report, several changes are recommended or have already been implemented to enhance the effectiveness of the remedies in some areas and to better monitor the actions' overall effectiveness. Those recommendations are provided in the following sections.

5.3.1 Recommended Changes to the Selected Remedies

Pantex plans to release an ESD, describing changes to the southeast and Zone 11 remedies. The scheduled date for completion of this action, as provided in the second FYR, is September 2022.

5.3.2 Recommended Changes to the Pump and Treat Systems

Pantex has implemented a previously recommended change to the operation of the SEPTS and P1PTS. The P1PTS is now only operated once each quarter to allow the SEPTS to fully operate and continue to more effectively capture perched groundwater and contaminant plumes moving to the southeast. Pantex expects to fully operate both systems once all repairs to the onsite irrigation system are complete or the new pivot irrigation system is complete. Impacts to the operation are expected until later in 2021 unless major repairs or upgrades are required to the communication system for the onsite subsurface irrigation system.

Pantex will complete the construction and tie-in of the new injection wells near Playa 2 in June 2021. Once SEPTS can utilize the injection wells, operations at P1PTS may be able to resume at a minimal level, while continuing to operate SEPTS. The key objective to control plumes and water movement to the southeast will require that SEPTS be operated in accordance with Pantex goals. P1PTS operation will be adjusted or shutdown to achieve that objective.

Pantex is currently evaluating methods to optimize the pump and treat systems to better capture plumes and remove water for the protection of the underlying Ogallala Aquifer. Optimizing the systems to control the perchlorate plume was identified as an issue in the second FYR and is scheduled to be complete by September 2022.

5.3.3 Recommended Changes to the ISB Systems

Pantex continues to evaluate the ISBs and make changes, as appropriate, to address incomplete treatment in certain areas.

5.3.3.1 Southeast ISB

Pantex has injected a more soluble carbon (i.e., molasses) to improve the distribution of amendment at the ISB, implemented pumping of PTX06-1153 during injection to induce flow to the well, and injected in dry upgradient wells. These changes will require evaluation over time to determine their full impact. Water levels will continue to be monitored since only one more injection is anticipated to be needed at this system.

5.3.3.2 Southeast ISB Extension

Pantex completed injections into this new ISB in 2020. Because data collected at the eastern fence line indicate that extra wells are needed to completely encompass the plume, two new injection wells are being installed in 2021 to address the treatment gap.

5.3.3.3 Zone 11 ISB

Pantex had previously recommended installing a recirculation system across the western side of the ISB where TCE plumes are present at high concentrations. Due to the SEPTS's continued removal of water, flow gradients in Zone 11 have changed, and the TCE plume in over half of the Zone 11 ISB is now moving to the southeast.

To address the higher TCE concentrations moving into the south-central portion of the system, Pantex has opted to install a second row of tightly spaced injection wells to ensure the complete treatment of TCE. Installation of the new injection wells will be complete by the end of 2021.

5.3.3.4 Offsite ISB

Due to available funding, the first two phases of the Offsite ISB were installed in 2020, which accelerated work planned for 2021. Injections will begin in 2021. Two more phases of installation are planned at this system in 2022 and 2023, subject to finalization of landowner agreements and funding availability.

5.3.4 Recommended Changes to the Monitoring Network

No changes are recommended at this time.

5.3.5 Recommended Changes to Soil Remedies

No changes to the landfill remedies are recommended.

Pantex is continuing to evaluate SVE data after modifying the system in May 2017. Further recommendations for a path to closure will be made once data obtained during system pulsing are evaluated.

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