Pantex Plant

2016 Annual Progress Report

Remedial Action Progress

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

June 2017

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

Pantex Plant Remedial Action Systems

CERTIFICATION STATEMENT

2016 Annual Remedial Action Progress Report
Pantex Plant, June 2017

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.

James C. Cantwell 6/19/2017

James C. Cantwell
Senior Director
Environment, Safety, and Health
Consolidated Nuclear Security, LLC

Date

Susan D. Morris 6/22/17

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

Date

2016 Annual Remedial Action Progress Report in Support of Hazardous Waste Permit #50284 and Pantex Plant Interagency Agreement for the Pantex Plant, Amarillo, Texas

June 2017

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.

Tony Biggs
Licensed Professional Geologist No. 2693
Environmental Projects
Consolidated Nuclear Security, LLC

6/20/17
Date

Project Team

CNS:
- Tony Biggs
- Clifton Britten
- Meagan Brown
- Jesse Flores
- Michelle Jarrett
- Matt Monroe
- Jennifer Pylant
- Joe Theriot
- Tammy Vincent

Contractor:
- Carollo Engineers, Inc.
  - Dr. Jeff Stovall
  - Michael Pinckney
- Harkins Engineering, Inc.
  - Dr. Victoria Harkins
- DBS&A
  - Gundar Peterson

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, 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 two areas. A soil vapor extraction (SVE) system has been installed to remediate volatile organic compounds (VOCs) in soils at the Burning Ground area. Other soil remedies (fencing, soil covers, and ditch liner) 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 (HW) 50284 to provide information on the remedial action system performance and components. The focus for this report is the data and information collected for the soil and groundwater remedies during 2016. Data are evaluated according to criteria outlined in the *Long-Term Monitoring System Design Report* (Pantex, 2009a), 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. Those actions and their objectives are described in the highlight box below.

Groundwater Remedial Actions

Two Pump & Treat Systems

- Reduce saturated thickness
- Reduce contaminant mass
- Plume stabilization

Two In Situ Bioremediation Systems

- Reduce contaminant concentrations as groundwater migrates through the treatment zone

Institutional Controls

- Control perched groundwater usage and drilling in contaminated areas

Soil Remedial Actions

Ditch Liner and Soil Covers on Landfills

- Protect future groundwater

Institutional Controls

- Protect workers

Soil Vapor Extraction System

- Clean up soil gas and residual non-aqueous phase liquid (NAPL) in 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 continued removal of perched groundwater to reduce saturated thickness of the perched aquifer. The first goal of 90% system operation was not applicable at all times during the year due to shutdowns for upgrades, maintenance, and power losses. The pump and treat system performance for 2016 is depicted in Figure E-1.

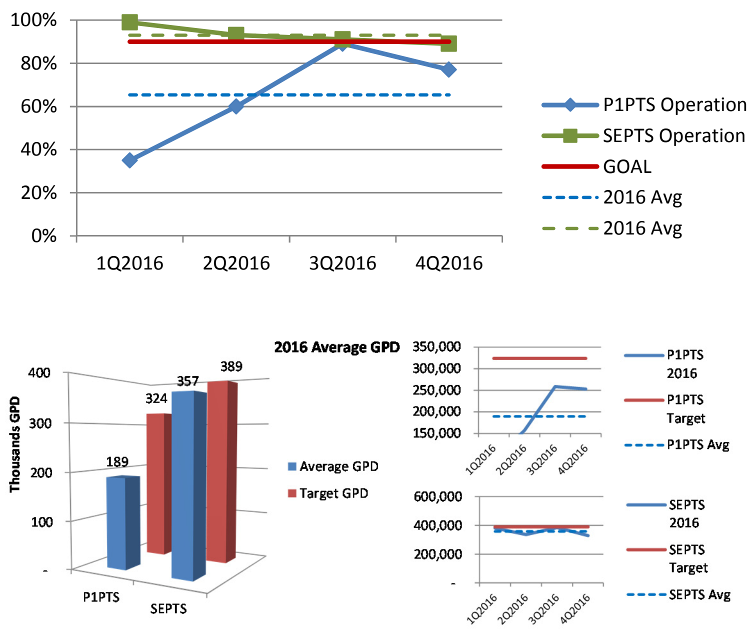

Figure E-1. Pump and Treat Systems Performance

Overall, both systems met the operational goal of 90% excluding the intentional shutdown for P1PTS system maintenance. While treatment throughput was not a primary goal after June 2014, 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 WWTF and irrigation system or shutdown of system wells. As depicted in Figure E-1, P1PTS operated 65% of the year with an average gallon per day (gpd) throughput of about 189,000 gpd. SEPTS operated 93% of the year, with an average throughput over 357,000 gpd.

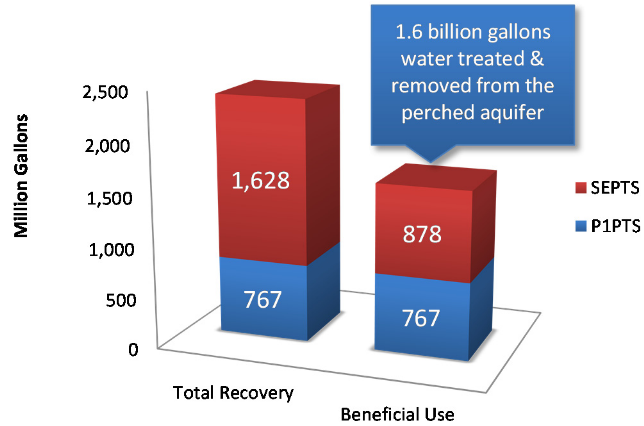

Figure E-2. Pump and Treat Recovery

Overall, the systems have operated efficiently to treat contamination and reduce saturated thickness. As depicted in Figure E-2, Pantex has treated approximately 2.4 billion gallons since the startup of the systems, with more than 1.6 billion gallons removed and beneficially used. Pantex continues to reduce reliance on injection of treated water, and as recommended in the Five-Year Review, Pantex has implemented new throughput goals to align operations with the goal of reducing saturated thickness. During 2016, 100% of the treated water was beneficially used.

In addition to removing impacted water from the perched aquifer, the pump and treat systems remove contaminant mass from the groundwater that is extracted from the aquifer. The P1PTS primarily removes the high explosive RDX and the SEPTS primarily removes RDX and hexavalent chromium (CR(VI) in Figure E-3). The figures below provide the mass removal for high explosives (HEs) and chromium for 2016, as well as totals since startup of the systems. The SEPTS has been operating longer than the P1PTS and the greatest concentrations of HEs are found in the SEPTS extraction well field, so mass removal is much higher at that system. During 2016, SEPTS removed about 693 lbs of contaminants and P1PTS removed about 30 lbs of contaminants.

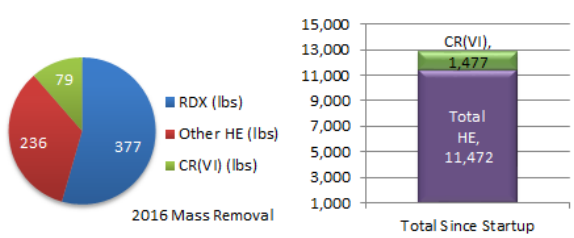

Figure E-3. SEPTS Mass Removal

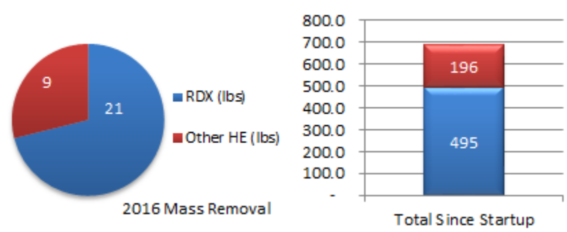

Figure E-4. P1PTS Mass Removal

E.2.2 In Situ Bioremediation Systems

For the treatment zone wells, this report evaluates whether the reducing conditions are present to degrade the contaminants of concern (COCs) in each area, as well as the presence of a continued food source for the bacterial reduction of COCs. Downgradient monitoring wells are evaluated to determine if COCs are being reduced to the GWPS and that complete degradation is occurring.

Installation of the Zone 11 ISB Remedial Action was completed in 2009, with initial amendment injection completed in 2009 and yearly injections thereafter. Data indicate that a reducing zone has been established and a fair to good food source is available for continued biologic growth. An eighth injection was completed in August 2016. The seventh injection event included bioaugmentation of the western side of the original Zone 11 ISB where reducing conditions are established with *Dehalococcoides spp.* (DHC). To avoid loss of reducing conditions that could affect the DHC, Pantex injected anaerobic makeup water mixed with amendment in the areas where bioaugmentation previously occurred. Pantex will collect more samples in 2017 to continue to evaluate the effectiveness of the bioaugmentation.

Perchlorate concentrations were non-detect in four of the nine downgradient ISPM wells during 2016. Perchlorate is exhibiting a decreasing trend in PTX06-1150, and has been decreasing in PTX06-1148 although an increase was observed during 2016 in this well. TCE concentrations were non-detect or below GWPS in four of the nine downgradient ISPM wells during 2016 and were decreasing in PTX06-1012 with the last sample below GWPS. TCE concentrations in PTX06-1150 were slightly increasing. The remaining three wells are downgradient of the expansion area and are not expected to exhibit decreasing trends until late 2018.

Pantex previously recognized in the 2013 Annual Progress Report that complete TCE treatment may be constrained by a lack of DHC that are necessary for complete dechlorination of TCE and began working on a Bioaugmentation Plan in 2014. The seventh injection event, completed in 2015, included bioaugmentation of the western side of the original Zone 11 ISB where reducing conditions are established and where the heart of the TCE plume is treated.

Pantex is monitoring the impact of the bioaugmentation through the use of qPCR and compound specific isotope analysis (CSIA) sampling which began in February 2016. The qPCR and CSIA data, combined with other monitoring data from the Zone 11 ISB area, indicate that complete dechlorination is limited due to low counts of DHC and mild reducing conditions in many areas of the Zone 11 ISB where bioaugmentation has occurred. Additional sampling for CSIA and census DNA for DHC and 1,4-dioxane will be conducted at the Zone 11 ISB during 2017. These analyses will be used to determine the effectiveness of bioaugmentation and to evaluate other potential processes that may be helping degrade TCE and 1,4-dioxane through cometabolic processes. Bioaugmentation in the expanded treatment zone described in Section 2.2.1 will not occur until the weight of evidence suggests the proper reducing conditions exist for DHC survival and growth.

The Southeast ISB was installed in 2007, with injection completed by March 2008. This system has established an adequate reducing zone for HEs and chromium, based on geochemical conditions monitored at the treatment zone. A sixth injection event was completed in October 2016. The system has adequately treated the primary COCs (RDX and hexavalent chromium) at three downgradient monitoring wells to concentrations below their respective GWPS during 2016. HE breakdown products were also treated to levels below their respective GWPS in these three wells during 2016. Pantex continues to investigate why one downgradient well, PTX06-1153, has not responded as strongly to treatment of RDX and hexavalent chromium. Two other performance monitoring wells (one upgradient and one farther downgradient) were dry and could not be sampled during 2016. Other wells in the treatment zone, as well as one other downgradient well, showed dry or limited water conditions in 2016. This condition is expected to continue as the pump and treat systems continue to remove water upgradient.

Passive flux meters (PFMs) were deployed in fall 2016 to assess the impact of dewatering within and around the Southeast ISB on groundwater flow and to support long-term decisions regarding Southeast ISB injection. A primary objective of the PFM testing was to evaluate the hypothesis that contaminant concentrations have persisted in PTX06-1153 because groundwater in the vicinity of this well is stagnant. Results of the PFM testing show that measureable groundwater flux was observed in PTX06-1153, although flow to the well is limited. Given the location of PTX06-1153, apparent groundwater flux through the well may indicate a groundwater-flow pathway around the western end of the Southeast ISB.

E.2.3 Soil Remedial Actions

A small-scale Catalytic Oxidation SVE system was installed at the Burning Ground in early 2012. 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 continuously operated except for testing, maintenance, repairs, or freezing weather that affects influent flow. Mass removal calculated for 2016 for VOCs contributing more than 1% of the total VOC concentration is presented in Figure E-5 along with total mass removed since the SVE was installed as an interim action in 2002. The system removed about 664 lbs of VOCs during 2016.

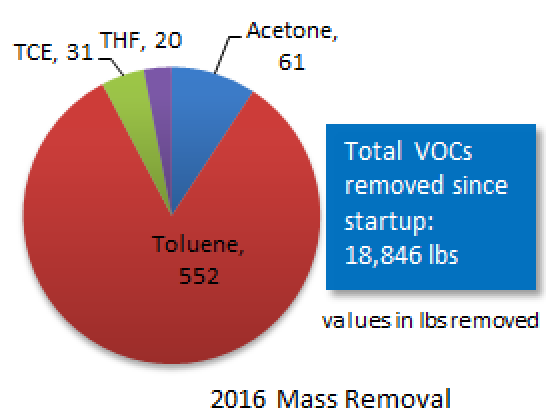

Figure E-5. Burning Ground SVE Mass Removal

In addition to the active soil remediation at the Burning Grounds, 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 to prevent spread of contaminated soils. SWMU interference was approved for ten new projects that required work in a SWMU in 2016. Pantex also regularly inspects and maintains all soil covers, fences, signs, postings, and ditch liners. Pantex will continue to evaluate the landfills annually and report the findings of the review and any plans that are developed to address holes, depressions, or bare areas. Problems identified will be addressed annually through the landfill maintenance contract and larger issues, such as erosion, will be addressed through separate contracts.

During 2016, Pantex continued to evaluate the landfill cover reseeding conducted in 2013. The rainfall that occurred in 2015 and 2016 significantly improved vegetative cover at all landfills. However, the heavy rainfall also caused erosion in some areas, with the largest problems identified at Landfill 3. Pantex has contracted for design of improvements to address the erosion at Landfill 3. Construction of the upgrades is expected to occur by 2018.

Pantex also noted during inspection that the ditch liner in Zone 12 was degrading, pulling away from the top anchor trenching, and had a few small tears. Because the liner is near the end of its life cycle, Pantex contracted to replace the liner in 2017, with installation completed in March. The new liner will be more resistant to UV light and is heavier to provide a longer life cycle for the liner.

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. The concentration data were also combined with the water level data to generate plume maps for each 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 (Pantex, 2009a) 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 LTM wells. Of the 43 monitor wells with expected water level conditions defined in the LTM Design Report, only seven wells exhibited conditions inconsistent with the current expected conditions or trends. However, six of the seven wells are located near Playa 1 or one of the main ditches and were affected by above normal precipitation during 2015 which caused water levels to rise up to several feet in some areas of the perched aquifer. Long-term water levels have declined in all of these wells, and it is expected that water levels will continue to decline.

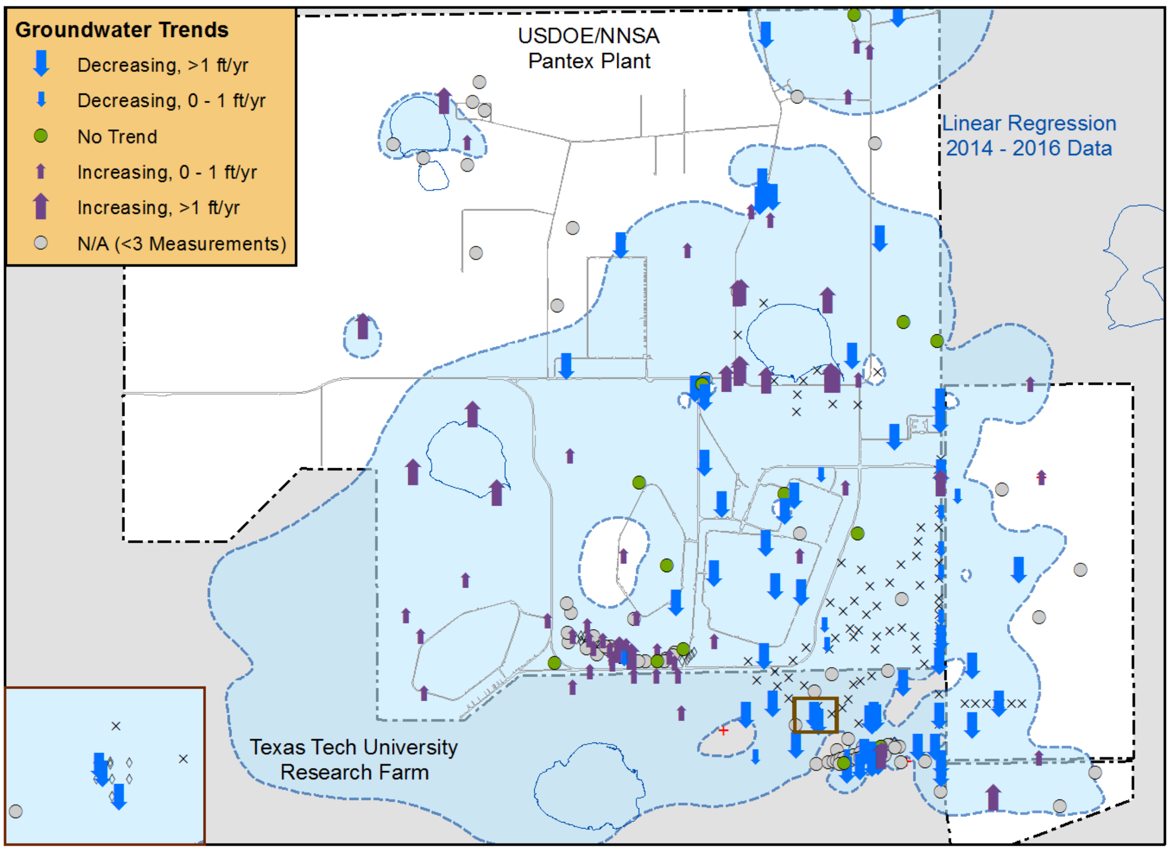

Figure E-6. Perched Aquifer Water Level Trends

Of the 103 monitor wells with expected COC concentration conditions defined in the LTM Design Report, 27 wells did not exhibit trends consistent with the expected conditions for the four major COCs (RDX, hexavalent chromium, TCE, and perchlorate). It is anticipated for these trends to meet expected conditions as the 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 a remedial action.

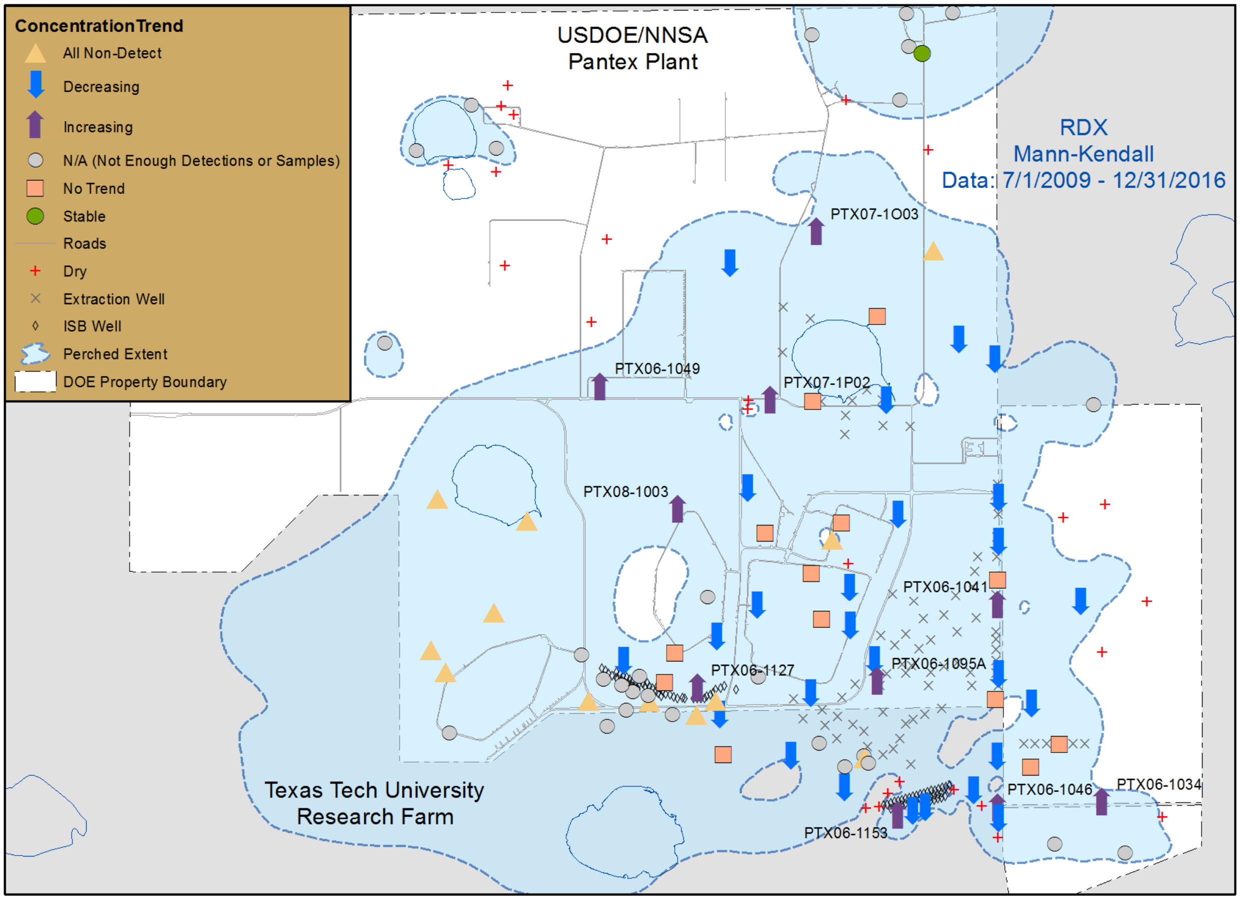

Figure E-7. RDX Trends in the Perched Aquifer

Generally, 2016 plume shapes are similar to the 2009 COC plumes. The major changes in plume size and shape were due to 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. The major COC plumes of interest are depicted in Figure E-8.

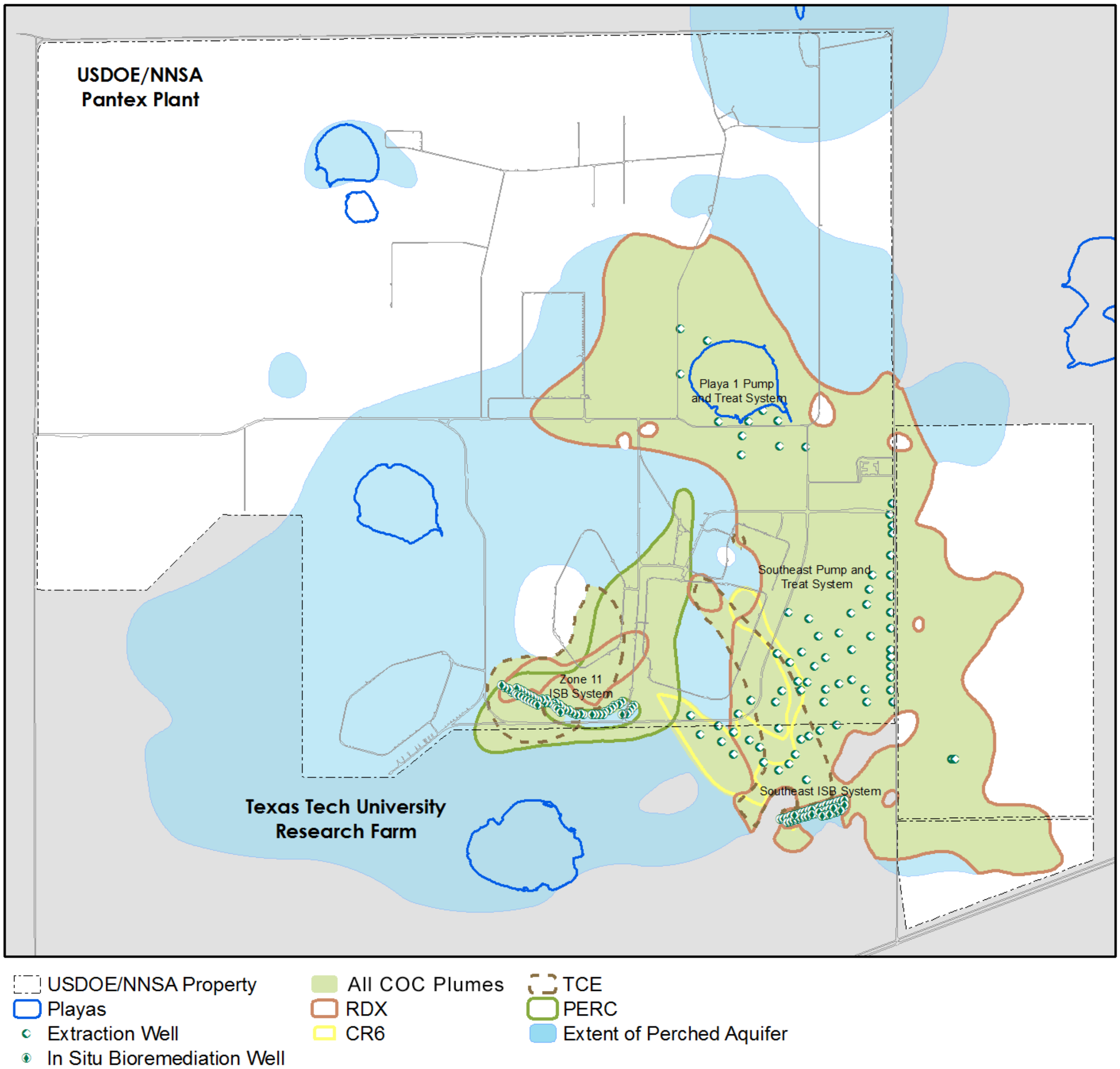

Figure E-8. Major COC Plumes in the Perched Aquifer

E.3.2 Remedial Action Effectiveness

Considering that one goal of both pump and treat systems is to affect plume movement, the plume stability evaluation can be used to determine the effectiveness of these systems. To this end, the pump and treat systems have been very effective in 2016. 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. When comparing the 2016 conditions to LTM Design expected conditions, the majority are meeting expected conditions. 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 2016 indicates that it is effective in meeting the treatment objectives set in the *Remedial Design/Remedial 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, 1123, and 1154) demonstrate that reduction of RDX, HE degradation products, and hexavalent chromium has occurred resulting in concentrations below the GWPS, with most not detected. The fourth downgradient well (PTX06-1153) continues to exhibit RDX concentrations above 200 ug/L and variable hexavalent chromium concentrations near the GWPS. Pantex continues to monitor this well and other new wells installed nearby to determine if treated water is slow to arrive, or if this well may not be hydraulically connected to the Southeast ISB. Results of the PFM testing show that measureable groundwater flux was observed in PTX06-1153; this result indicates that PTX06-1153 is not located in a stagnant groundwater zone although the calculated seepage velocity does suggest that flow to the well may be inhibited. Given the location of PTX06-1153, apparent groundwater flux through the well may indicate a groundwater-flow pathway around the western end of the Southeast ISB.

Monitoring data collected in 2016 also indicate the Zone 11 ISB system has been effective in its eighth year of operation. Data indicate that an adequate reducing zone has been established for perchlorate and conditions appear to be favorable for reductive dechlorination of TCE. Pantex is monitoring the impact of the bioaugmentation through the use of qPCR and CSIA sampling which began in February 2016. The qPCR and CSIA data, combined with other monitoring data from the Zone 11 ISB area, indicate that complete dechlorination is limited at this time due to low counts of DHC and mild reducing conditions in many areas of the Zone 11 ISB where bioaugmentation has occurred. Additional sampling for CSIA and census DNA for DHC and 1,4-dioxane will be conducted at the Zone 11 ISB during 2017. These analyses will be used to determine the effectiveness of bioaugmentation and to evaluate other potential processes that may be helping break down TCE and 1,4-dioxane through cometabolic processes. Bioaugmentation in the expanded treatment zone will not occur until the weight of evidence suggests the proper reducing conditions exist for DHC survival and growth.

E.3.3 Uncertainty Management/Early detection

The purpose of uncertainty management wells in the High Plains Aquifer (commonly and hereafter referred to as the Ogallala Aquifer) and perched aquifer is to confirm expected conditions identified in the Resource Conservation and Recovery Act (RCRA) Facility Investigations and ensure there are not any deviations, fill potential data gaps, and 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 potential source areas in the unsaturated zone before potential points of exposure have been impacted. These wells were proposed in the LTM Design Report for purposes of evaluating 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 GWPS, background, or practical quantitation limit (PQL). These wells were evaluated in the quarterly reports. No Group 1 perched aquifer wells had unexpected conditions in 2016.

Several Ogallala Aquifer Group 1 wells had nickel, manganese, and boron detections exceeding background levels. However, these exceedences are likely due to stainless steel well screen corrosion, influence from deeper formations, sample turbidity, or background variability. All of these metals detections are significantly lower than their respective GWPS.

Hexavalent chromium was detected below the GWPS of 100 ug/L in eleven wells (PTX06-1043, PTX06-1061, PTX06-1062A, PTX06-1068, PTX06-1072, PTX06-1138, PTX06-1139, PTX06-1140, PTX06-1141, PTX06-1144, and PTX06-1157) in 2016. The detections in all but two of the wells were below the laboratory PQL of 10 ug/L. These detections are likely a result of one or more of the following:

- Low-level background of hexavalent chromium in the Ogallala aquifer as suggested in a study by Texas Tech University completed in 2014. Pantex worked with the Texas Tech University Water Resources Center to investigate the occurrence, distribution, and speciation of chromium in the Ogallala Aquifer system in the Texas Panhandle. In this study, 19 wells distributed across the Texas Panhandle were sampled and analyzed for total chromium and hexavalent chromium using an ultra-high resolution method (PQL = 0.015 ug/L). Low-level hexavalent chromium (approximately 0.5 – 5 ug/L) was detected in all 19 wells sampled. Furthermore, when both total and hexavalent chromium were detected in the same sample (total chromium was analyzed using a standard resolution method with a PQL of 10 ug/L), the ratio of hexavalent to total chromium ranged from approximately 0.5 to 1, with an average of 0.74. These results suggest that the oxidized conditions in the Ogallala Aquifer are converting the naturally occurring chromium to the hexavalent oxidation state, creating a low-level hexavalent chromium background in the aquifer.

- Lower detection limits for Method SW-7196 based on improvements to the method. MDLs dropped from 5 ug/L to 3.3 ug/L and the PQL dropped from 15 ug/L to 10 ug/L in June 2013. The revised detection limits allow low-level background concentrations to be estimated above the new MDL and below the PQL.

- Corrosion of stainless steel screen/casing. Specific wells at Pantex have documented evidence of corrosion and conversion of total chromium to hexavalent chromium is possible due to oxidized conditions in the Ogallala Aquifer.

- False positive detections near the MDL due to the use of a colorimetric analytical method. Typically, these detections are not confirmed by total chromium results.

It is likely that most of these sporadic detections are related to the lower detection limits and the ability to quantify low-level background detections. For example, hexavalent chromium was not detected in seven of the eleven wells in 2015, while four wells that had detections in 2015 did not have detections in 2016.

PTX06-1056 continues to demonstrate detections of 4-amino-2,6-DNT, a breakdown product of the high explosive TNT, first detected in April 2014 and the VOC 1,2-dichloroethane, detected for the first time in August 2015. 4-Amino-2,6-DNT was detected in all four quarterly samples in 2016 at values up to 0.304 ug/L, slightly above the PQL of 0.27 ug/L, but below the GWPS. Two of those detections were below the PQL. 1,2-Dichloroethane was detected in three of four quarterly samples in 2016; all detections were below the PQL and GWPS. Pantex has fully implemented the conditions specified in the *Pantex Plant Ogallala Aquifer and Perched Groundwater Contingency Plan* (Pantex, 2009d) and will continue quarterly sampling for HEs and VOCs at this well to determine if further actions are necessary.

Pantex has proactively evaluated potential sources for the contamination. A nearby perched well that was drilled deeply into the FGZ was plugged to address that potential source. An outside review conducted by with Daniel B. Stephens & Associates, Inc. indicated that the perched well was the most likely source of the contamination, 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 contamination to reach the Ogallala Aquifer.

Group 2 wells are perched wells near source areas and generally have contamination above the GWPS. The purpose of the Group 2 well annual evaluation is to determine if source strength is declining. The ditches and playas are expected to continue to source contaminants to the perched aquifer for a long period of time (20 years or more), but at much lower concentrations than in the past (Pantex 2006). For many of these wells, it is expected that concentrations will stabilize with an eventual long-term decreasing trend below the GWPS.

Most of the Group 2 wells that have detections of COCs already meet expected conditions at the well. There are 12 wells that do not yet meet expected conditions, i.e., 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 while some could be due to changing gradients and/or plume movement away from the source. Pantex will continue to evaluate these trends over time. Several other Group 2 wells had metals detections above their site-specific backgrounds, but were below GWPS. These metals detections are likely due to either well screen corrosion or variation in background.

Other Unexpected Conditions

Two perched groundwater wells demonstrated unexpected conditions in 2016. During the 3rd quarter, one perched groundwater well, PTX06-1005, demonstrated an all-time high detection of 1,4-dioxane that was measured at 7.71 ug/L, slightly above the GWPS of 7.7 ug/L. This concentration was not expected at this location because previous data and upgradient well data did not indicate a plume of 1,4-dioxane with concentrations near or exceeding the GWPS. This well is on the western edge of the SEPTS extraction well field and is of concern because the system may not be able treat 1,4-dioxane using GAC at current flow rates. Additional sampling of nearby wells is discussed in Section 2.1.2. Further actions will be determined based on results of sampling and in accordance with the *Groundwater Contingency Plan*.

Additionally, a new perched groundwater well installed outside the current defined extent of the southeast lobe of the perched aquifer indicates that water and contamination have migrated further to the southeast. Confirmed sample results from PTX06-1182, installed in 2016, indicate the presence of the HEs 4-amino-2,6-DNT and RDX at concentrations exceeding the PQL and GWPS (results of 6.73 and 15 ug/L and GWPS of 1.2 and 2 ug/L, respectively). Pantex plans to install new downgradient wells in 2017 to determine perched groundwater and contaminant extent.

E.3.4 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 natural attenuation is occurring, under what conditions it is occurring, and to eventually 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 (since 2009), 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 of TCE 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 breakdown products (MNX, DNX, and TNX) indicate that the breakdown products are present throughout most of the RDX plume, with TNX being the most widespread. If complete biodegradation of RDX is occurring, RDX and all breakdown products would be expected to decrease over time. A recent SERDP study (2014) provided evidence that aerobic degradation is occurring in the Pantex RDX plume with strong evidence of aerobic degradation found in two monitoring wells. This study provided new methods for better evaluating RDX degradation at Pantex. Pantex has contracted with leading researchers for further study at the Pantex Plant to apply the CSIA and other new analytical techniques to determine where and what type of degradation is occurring across the RDX plume. Groundwater samples for this study have been collected, and the study is expected to be completed by the end of 2017.

Overall, it appears that natural attenuation of HEs may be occurring at Pantex. More data will be required over time to determine trends and possibly estimate rates of attenuation.

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.

E.5 Recommendations and Conclusions

Pantex plans to continue the current approved remedial actions. The groundwater remedies are considered protective for the short-term as untreated perched groundwater use is controlled to prevent human contact and Ogallala Aquifer data continues to indicate COC concentrations either non-detect or below GWPS. The systems are proving to be effective in reaching long-term established objectives for cleanup. Soil remedies have been effective at Pantex as 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 vertical movement of VOCs to the Ogallala Aquifer.

Based on issues identified in the Five-Year Review and during completion of this report, several changes are recommended or have been implemented to enhance the effectiveness of the remedies in some areas and to better monitor the effectiveness of the actions. Those recommendations are provided in the following sections.

E.5.1 Recommended changes to the Pump and Treat Systems

There are no new recommendations for changes to the pump and treat systems based on review of 2016 data.

E.5.2 Recommended Changes to the ISB Systems

E.5.2.1 Southeast ISB

As discussed in Section 2.2.2.4, Pantex plans to reinject the Southeast ISB in three years (2019). Organic carbon data collected before the latest injection indicated that additional amendment was not necessary to sustain treatment while data from the Pilot Study also indicate that a longer period between injections is achievable once reducing conditions are adequately established. The Design Basis indicates that less frequent injections would be appropriate in later years. The timing or need for further injections will be evaluated after the next injection because predicted water levels in six years, based on current trends, indicate that very few ISB injection wells will have significant saturated thickness.

Because no clear cause for the unexpected conditions in PTX06-1153 has been identified, it is recommended to continue monitoring the water level and analytical data collected in and around the Southeast ISB to continue to attempt to discern groundwater flow patterns. Results of the PFM testing show that measureable groundwater flux was observed in PTX06-1153, and PTX06-1153 is not located in a stagnant groundwater zone. The reduced seepage velocity calculated for PTX06-1153 does suggest that flow to the well may be inhibited. Given the location of PTX06-1153, apparent groundwater flux through the well may indicate a groundwater-flow pathway around the western end of the Southeast ISB. Pantex will install a new well west of the Southeast ISB in 2017 and will continue to evaluate data collected and develop a path forward for this area as needed.

E.5.2.2 Zone 11 ISB

As discussed in Section 2.2.1.4, Pantex will to change injection frequency to two years within the original portion of the system. The Design Basis Document and the RD/RA Work Plan recognize that the period between injections may be lengthened once the system is fully developed. Pantex will continue to inject annually in the expanded portion of the system and will evaluate the expanded portion of the system to determine the appropriate time to change to a two-year frequency.

E.5.3 Recommended Changes to the Monitoring Network

PTX06-1182 was installed in 2016 in an area that was previously thought to be beyond the extent of perched saturation; the presence of RDX above the GWPS has been confirmed with the most recent sample showing a concentration of 19 ug/L. This well will continue to be monitored and will provide valuable information on the movement of contaminants in this area of the perched groundwater. Pantex plans to install additional wells downgradient in 2017 to determine perched groundwater and contaminant extent in this area.

E.5.4 Recommended Changes to Soil Remedies

Vegetative loss on landfill covers was identified as an issue in the first Five-Year Review Report, primarily caused by drought conditions in the Texas Panhandle. Therefore, Pantex proposed to develop and implement a phased plan to revegetate the landfill covers as outlined in Section 2.3.2. Pantex completed reseeding in 2013 and evaluated the effectiveness of reseeded landfill covers annually through 2016. Based on the 2016 evaluations, the rainfall that occurred in 2015 and 2016 significantly improved vegetative cover at all landfills. Pantex will continue to evaluate the landfills annually and report the findings of the review and any plans that are developed to address holes, depressions, or bare areas. Problems identified will be addressed annually through the landfill maintenance contract and larger issues, such as erosion, will be addressed through separate contracts.

The small-scale SVE system continues to remove VOCs from SVE-S-20 and the VOC source area may be slowly decreasing. As discussed in the Five-Year Review and 2012 Annual Progress Report, no expected conditions or path toward closure were defined for the SVE system, other than “significant reduction in soil gas VOCs”. Therefore, Pantex recommended the development of a Burning Ground SVE Performance Monitoring Plan, which will define expected conditions of the system performance as well as a clear path towards an end point of active SVE operations and potential transition to a passive system. To this end, three rebound tests were conducted in 2014 resulting in conflicting or unusable data. Using lessons learned from the 2014 testing, another rebound test was conducted in 2016 but was also unsuccessful, indicating that this approach will not be successful at Pantex. Therefore, Pantex has recommended an approach to enhance bioremediation and move toward passive remediation. Pantex recommended (Pantex 4th Quarter 2016 Progress Report) that up to seven inactive SVE extraction wells be modified to enhance air flow through the formation by opening the pipes to ambient air. This change will enhance removal of the NAPL source through increased volatilization and bioremediation. The system flow will be slowly increased to its maximum design capacity to enhance air flow. Pantex will continue to monitor the system for mass reduction in the influent vapor stream and for evidence of bioremediation.

Once influent data indicate that COCs are reduced to levels that are no longer practicable for active remediation, Pantex will recommend moving to a passive remediation system.

CONTENTS

Appendices

Appendix A – SWMU Status Table

Appendix B – Extraction Well Flow Data

Appendix C – Well Logs

Appendix D – Data Evaluation Table and Electronic Data

Appendix E – Expected Conditions Evaluation and COC Concentration Trends

Appendix F – Water Level Expected Conditions and Well Hydrographs

Appendix G – Well Certifications and Completion Diagrams

Appendix H – Implementation and Maintenance Reports for Remedial Actions

Appendix I – Hydrologic Evaluation – East and Southeast Zones of the Perched Aquifer at the Pantex Plant

List of Tables

List of Figures

List of Acronyms

amsl	above mean sea level
AOC	Area of Concern
bgs	below ground surface
btoc	below top of casing
CatOx	Catalytic Oxidation
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
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
DNX	hexahydro-1,3-dinitroso-5-nitro-1,3,5-triazine
DO	dissolved oxygen
EPA	Environmental Protection Agency
FM	Farm-to-Market Road
FS	Firing Site
ft	feet
FGZ	fine-grained zone
GAC	granular activated carbon
gpm	gallons per minute
gpd	gallons per day
GWPS	groundwater protection standard
HE	high explosive
HMX	octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine
in	inches
IAG	Interagency Agreement
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

LTM	long-term monitoring
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
O&M	operation and maintenance
ORP	oxidation reduction potential
OSTP	Old Sewage Treatment Plant
P&A	plugging and abandonment
P1PTS	Playa 1 Pump and Treat System
PCA	1,1,2,2 - tetrachloroethane
PCE	perchloroethene
PFM	passive flux meter
PID	photoionization detector
POC	point of compliance
POE	point of exposure
ppmv	parts per million by volume
PQL	practical quantitation limit
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
SEP/CBP	Solvent Evaporation Pit/Chemical Burn Pit
SEPTS	Southeast Pump and Treat System
SERDP	Strategic Environmental Research and Development Program
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
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, 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).

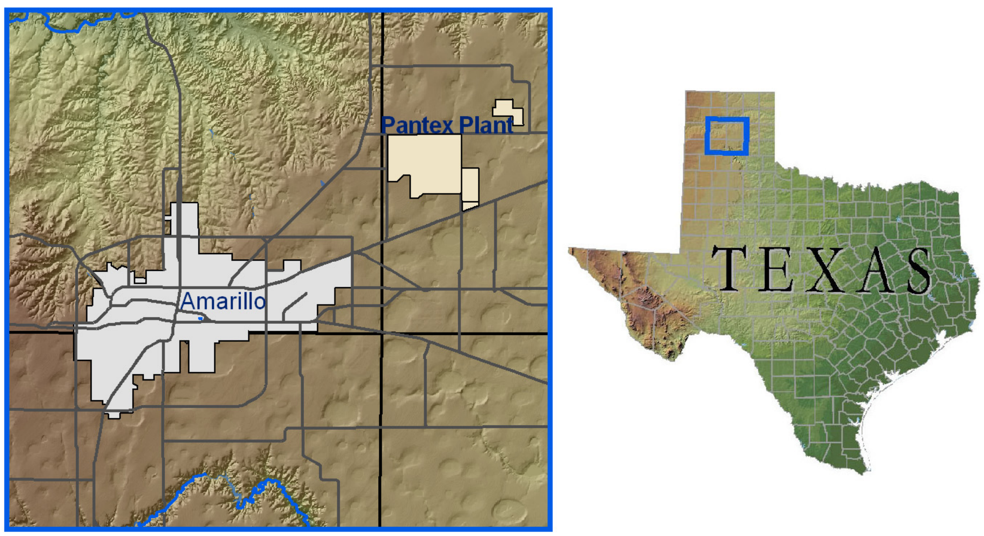

Figure 1-1. Location of Pantex Plant

The main Pantex 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. Remaining USDOE/NNSA-owned land serves safety and security purposes. Approximately 1,526 acres east of FM 2373 was purchased in 2008 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, Texas Tech University property to the south, and property east of FM 2373. The extent of perched groundwater and the major contaminant plumes are depicted in Figure 1-2. Pantex has implemented remedial actions to mitigate perched groundwater contamination and to prevent contamination of the deeper drinking water aquifer.

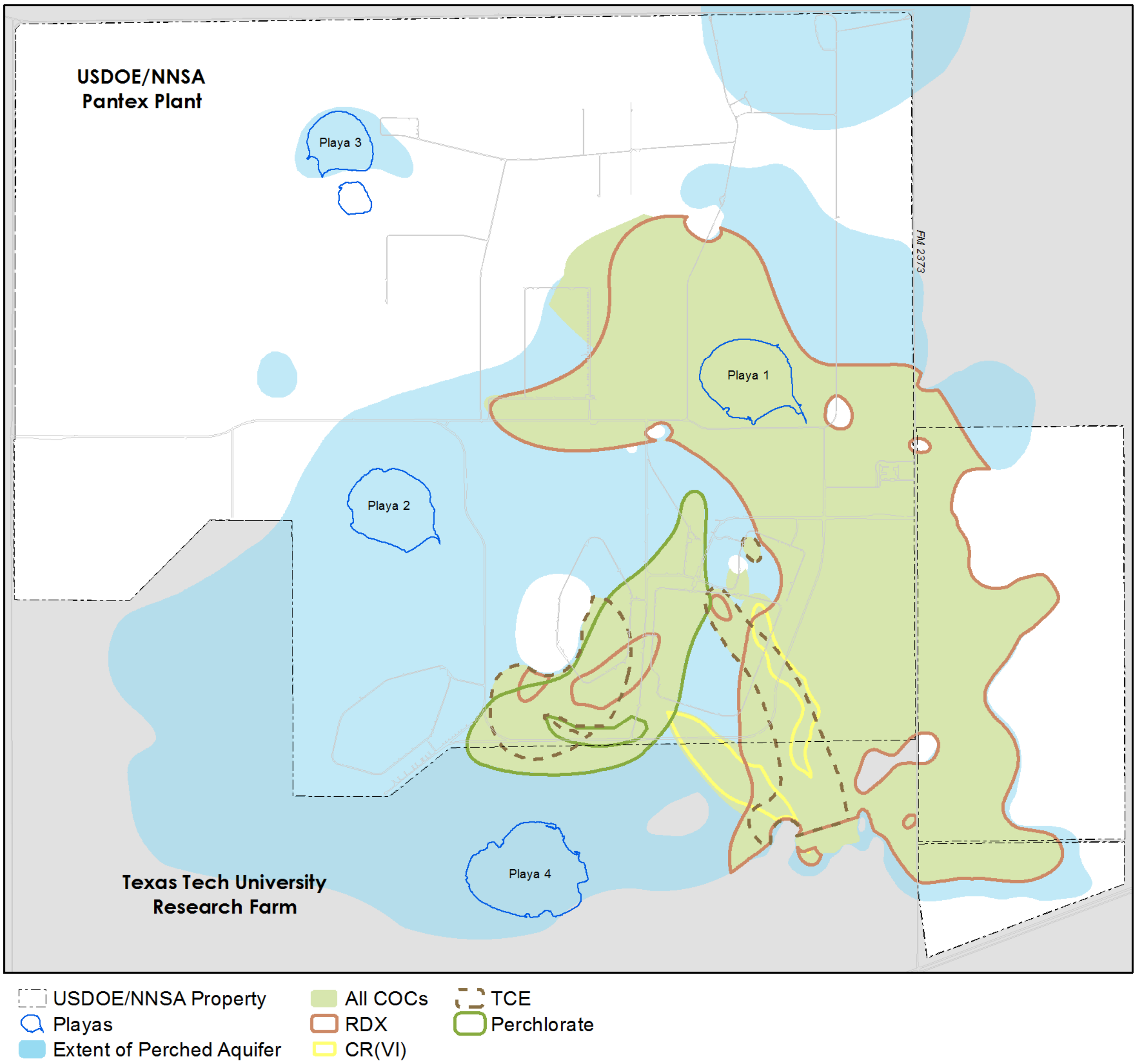

Figure 1-2. Extent of Perched Groundwater and Contaminant Plumes Exceeding GWPS

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 Pantex vicinity.

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 maintenance of soil covers and ditch liners to prevent infiltration of water and downward migration of contaminants to groundwater. Fencing and signs are also maintained to control worker use and traffic in the soil units.

1.1 Regulatory Background

Pantex implemented its remedial actions in accordance with the Compliance Plan for Industrial Solid Waste Management Sites, originally issued on October 21, 2003, and subsequently updated on September 16, 2010 to include final remedial actions, under the provisions of Texas Health and Safety Code Annotated, Chapter 361 and Chapter 26 of the Texas Water Code. The Compliance Plan is a Texas Commission on Environmental Quality (TCEQ) permit, which stipulates the requirements for conduct of corrective actions and groundwater monitoring programs according to Resource Conservation and Recovery Act (RCRA). The 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 Pantex to also investigate and cleanup according to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). Pantex meets the requirements of CERCLA through the Pantex Interagency Agreement (IAG), effective February 22, 2008. Table 1-1 lists the Compliance Plan and IAG, 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 for stabilization of groundwater plumes and monitoring of that action.
Interagency Agreement for the Pantex Superfund Site	2/22/2008	Established an agreement between the Environmental Protection Agency (EPA), TCEQ, and USDOE for the final remedial actions, framework for responding to and implementing CERCLA requirements, and 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 into the permit. Minor changes include corrective action observation wells changes and minor edits. Compliance plan requirements are included in 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 the 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* (Pantex, 2009a) and *Sampling and Analysis Plan* (Pantex, 2009b) are approved through the Compliance Plan as the bases for monitoring and reporting of the remedies. The 2009 documents were updated and submitted in January 2014 (Pantex, 2014a and 2014b). The updated reports were approved by the TCEQ in March 2014 so those changes were fully implemented by July 2014. 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 (compliance plan) requires reporting of information pertaining to effectiveness of the remedies, treatment of perched groundwater, contaminant data and plumes, and monitoring. Information on operation and maintenance of corrective action systems and components, new construction, condition and status of corrective actions/remedies, and recommendations for change is also required.

The IAG is a legally binding agreement among the USDOE, EPA, and the 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 general purpose of the IAG is to:

1. Ensure that the environmental impacts associated with past and present activities at 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 the Parties (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 chapters or section of the annual or quarterly report where 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 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 in the development of 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 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 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.
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: a. Development and maintenance of a cone of depression during operation of the system; b. Direction and gradient of groundwater flow; c. Effectiveness of hydrodynamic control of the contaminated zone during operation; and, d. Estimation of the rate and direction of groundwater contamination migration.	Sections 3.1.5, 3.1.7, and 3.2.

Item	Program	Reporting Frequency	Requirements	Location of Information in Progress Reports
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.
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

Item	Program	Reporting Frequency	Requirements	Location of Information in Progress Reports
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 1.4.
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.
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.

Item	Program	Reporting Frequency	Requirements	Location of Information in Progress Reports
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: Section 2.1 and see 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. Quarterly Report: Pump and Treat Systems Section and Appendix B
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: Section 2.1. Quarterly Report: 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. Section 2.1 and see 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.
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 five-year review was conducted in 2012 with a Final Report approved in 2013. A summary of the major conclusions and recommendations from the Five-Year Review is included in Chapter 5 of the 2013 Annual Progress Report. A summary of complete and outstanding action items are included in Chapter 5 of this report.

Item	Program	Reporting Frequency	Requirements	Location of Information in Progress Reports
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 1.5 of the annual report contains the 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 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: These data are summarized in Section 3.4 and 3.5. 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.
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 1.5.

1.2 Remedial Action Background

Pantex has implemented soil and groundwater remedial actions to mitigate contamination that resulted from historical waste management practices.

1.2.1 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 and associated groundwater were submitted to the TCEQ and EPA in the form of RCRA Facility Investigation Reports. Those investigation reports closed many units through interim remedial actions and no further 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 16 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. A detailed summary of actions for the 254 units can be found in the ROD (Pantex and Sapere Consulting, 2008).

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

Soil remedial actions focus on:

- Cleanup of soil gas and 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), and
- Maintenance of soil remedies (ditch liner 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.

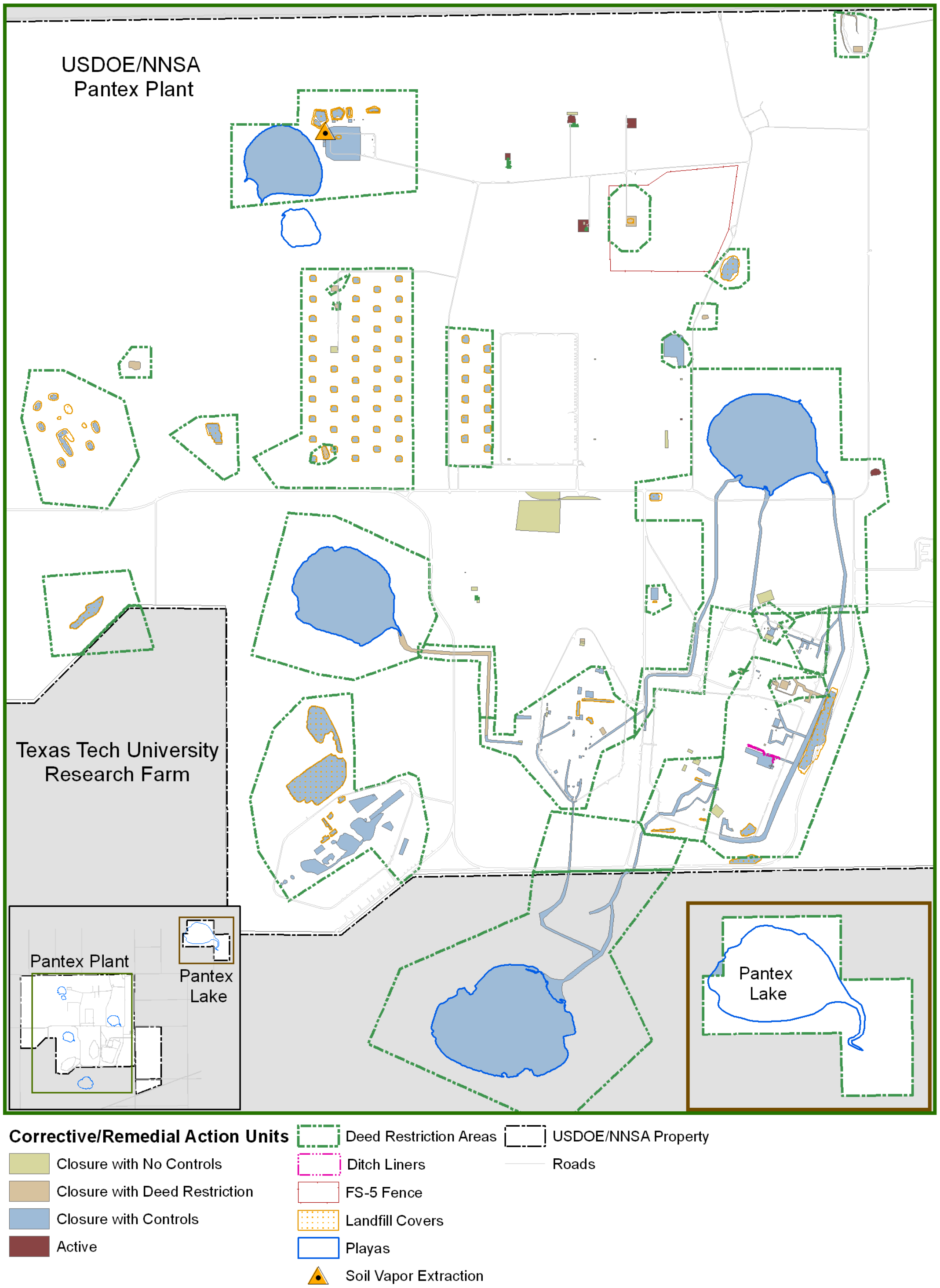

Figure 1-3. Status of Corrective/Remedial Action Units

1.2.2 Groundwater Remedial Actions

In accordance with the IAG and HW-50284, Pantex has implemented remedial actions to remediate the contaminated perched groundwater. Two types of active remediation systems (see Figure 1-4) were installed to address the contamination: pump and treat systems and in situ bioremediation (ISB) systems. Institutional controls are also part of the final remedy for groundwater.

Groundwater remedial actions focus on the following:

- Cleanup of perched aquifer to the GWPS,
- Reduction of perched water levels to protect the underlying drinking water aquifer (Ogallala Aquifer) and to prevent growth of plumes; and
- Institutional controls to restrict perched groundwater use without treatment and to control drilling into and through the perched aquifer to prevent cross contamination.

Groundwater Remedial Actions

Pump & Treat Systems
- Playa 1 Pump and Treat
- Southeast Pump and Treat

In situ Bioremediation Systems
- Zone 11 ISB
- Southeast ISB

Institutional Controls

The pump and treat systems were installed to address contamination in areas where there is generally greater than 15 ft of saturation in the perched aquifer. These systems are designed to remove and treat perched groundwater to achieve contaminant mass reduction and reduction in the saturated thickness of the perched aquifer. 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 in situ bioremediation systems to reduce the concentration of contaminants as they migrate through the remediation zone in targeted areas of the groundwater plumes.

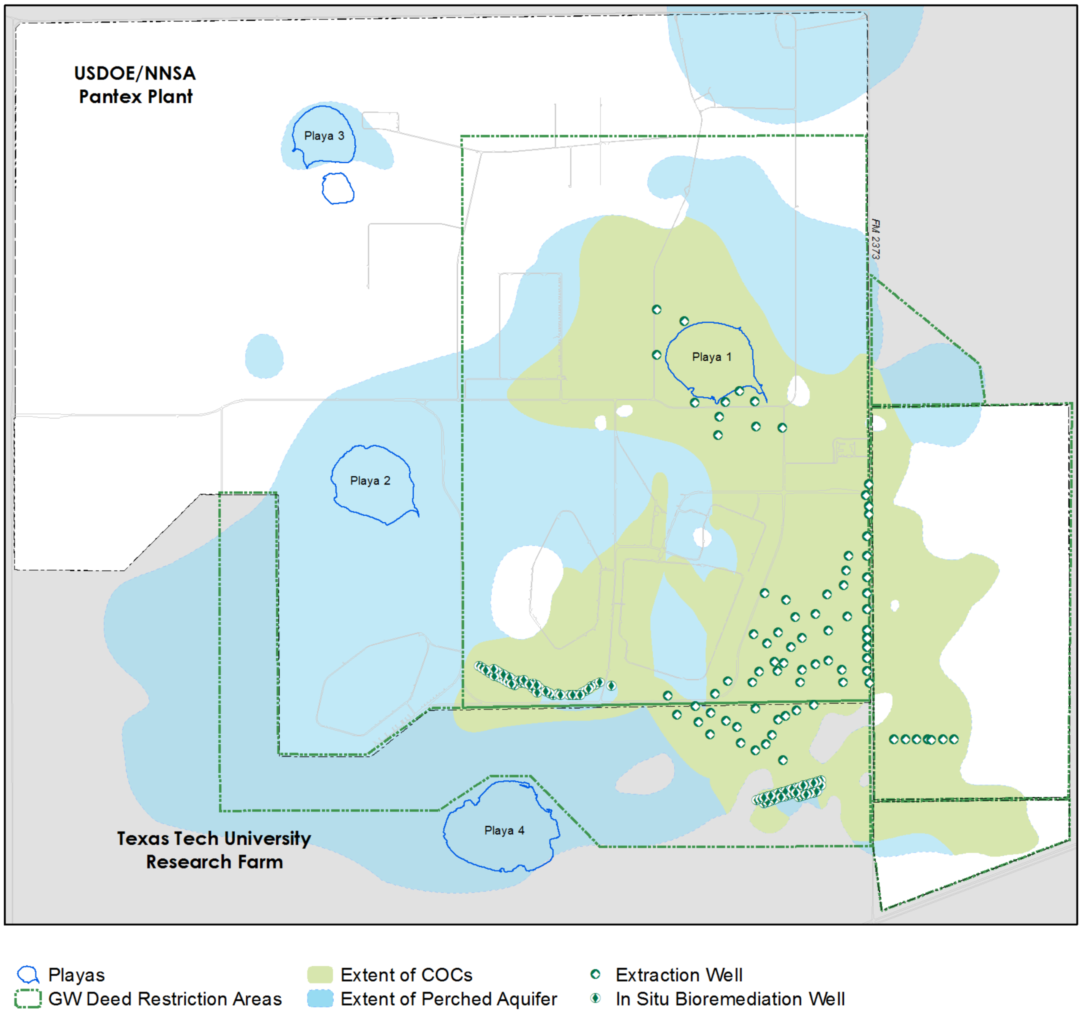

Figure 1-4. Groundwater Remedial Actions

1.3 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 for this report is the data and information collected for the soil and groundwater remedies during the previous year. 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. This report provides information on its operation, mass removal, and effluent readings during 2016. 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.

Groundwater Remedial Action Evaluation Criteria

- Plume Stability
- Remedial Action Effectiveness
- Uncertainty Management
- Early Detection
- Natural Attenuation of COCs

This progress report provides information for the maintenance and operation of the groundwater remediation systems and components. Data are evaluated according to criteria outlined in the *Update 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 of the report. Detailed information such as statistical trending of concentrations and water levels at each well, electronic data, and SWMU status is included in the appendices. Contractor operational reports for the ISB and well drilling reports are also included in the appendices.

1.4 Long-Term Monitoring of Remedial Actions

Pantex has developed a long-term monitoring network to evaluate the effectiveness of the remedial actions, ensure that remedial action objectives (from the ROD) are achieved, and to confirm expected future conditions within the perched aquifer and the Ogallala Aquifer. The long-term monitoring design and evaluation criteria are provided in the *Update to the Long-Term Monitoring System Design Report* (Pantex, 2014a). The final system design was incorporated into the compliance plan when it was issued. The design was further detailed in the compliance plan to include point of exposure and point of compliance wells where the GWPS is required to be met.

1.4.1 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. The network consists of:

- 123 perched wells – 20 of those wells are monitored for continued dry or limited water conditions; 87 sampled for indicator COCs and other applicable analytes including natural attenuation products, corrosion indicators, and general water quality indicators; and 16 are monitored as in situ performance monitoring (ISPM) wells for the ISB systems. The ISPM wells are monitored for COCs, degradation products, and ISB treatment zone parameters. All 123 perched LTM wells and 42 additional wells not included in the LTM network have water levels measured semi-annually.

- 53 wells are sampled semi-annually, 34 wells annually, 14 wells quarterly, and 6 wells are sampled every five years.
- 42 of the sampled wells (including 36 of the annual and semi-annual sampled wells) are sampled every five years using a modified 40 CFR Part 264 Appendix IX groundwater list to satisfy uncertainty management requirements. The five-year sampling was conducted in 2016 (Figure 1-5).
- Four indicator areas were defined for the perched groundwater. COCs to be monitored are defined for each of those areas.
- One LTM well, PTX01-1002, was plugged and abandoned in early 2017 due to a break in the casing at 25 ft below ground surface. This LTM well removal was approved January 4, 2017. This well was sampled in 2016, with results included in this report.
- PTX06-1182 and PTX06-1183 were added to the network in 2016. Preliminary analytical results were collected in 2016 after the wells were installed. These wells will be regularly sampled starting in 2017.

Table 1-3 lists all wells in the perched LTM network and HW-50284, their LTM objective, indicator monitoring area, Compliance Plan objective (point of compliance/point of exposure [POC/POE] well), 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 CP Table VII requirements. Figure 1-5 depicts the current active LTM wells listed in Table 1-3.

Table 1-3. 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	Inactive			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	Active	UM		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		Active	UM		3772643.95	638901.00
PTX06-1081	Miscellaneous	Y	Y	6/9/2003		Active	UM		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
PTX06-1R01	Southeast	Y	Y	6/9/2003		Active	RA	POC	3753348.03	644674.92
PTX06-1034	Southeast	Y	Y	6/9/2003		Active	RA	POC	3752434.98	646555.62
PTX06-1036	Southeast	Y	Y	6/9/2003		Active	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		Dry	RA		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		Active	UM		3772334.66	641458.10
PTX06-1049	Miscellaneous	N	Y	9/16/2010		Active	PS, UM		3763376.96	633343.53
PTX06-1055	Miscellaneous	N	Y	9/16/2010		Dry	PS		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		Dry	PS, UM		3766548.35	630823.57
PTX06-1097	Miscellaneous	N	Y	9/16/2010		Dry	PS, UM		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		Active	UM		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		Active	PS		3766771.76	634860.83
PTX07-1O01	North	N	Y	9/16/2010		Active	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		Active	PS, UM, RA		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		Active	UM, RA		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		Dry	PS		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		Active	RA		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		Active	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		Dry	PS		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		Active	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		Dry	PS		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		Active	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, UM	POC	3755562.85	635034.72
PTX06-1127	Zone 11	N	Y	9/16/2010		Active	PS, UM	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		Active	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		Active	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

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 as observation wells. These wells are not listed in HW-50284 Table V, so the corresponding date of HW-50284 approval corresponds to either the date of inclusion in a compliance plan modification or approval letter date for the corresponding progress report where the recommendation was made to include the well in the monitoring network.

[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.

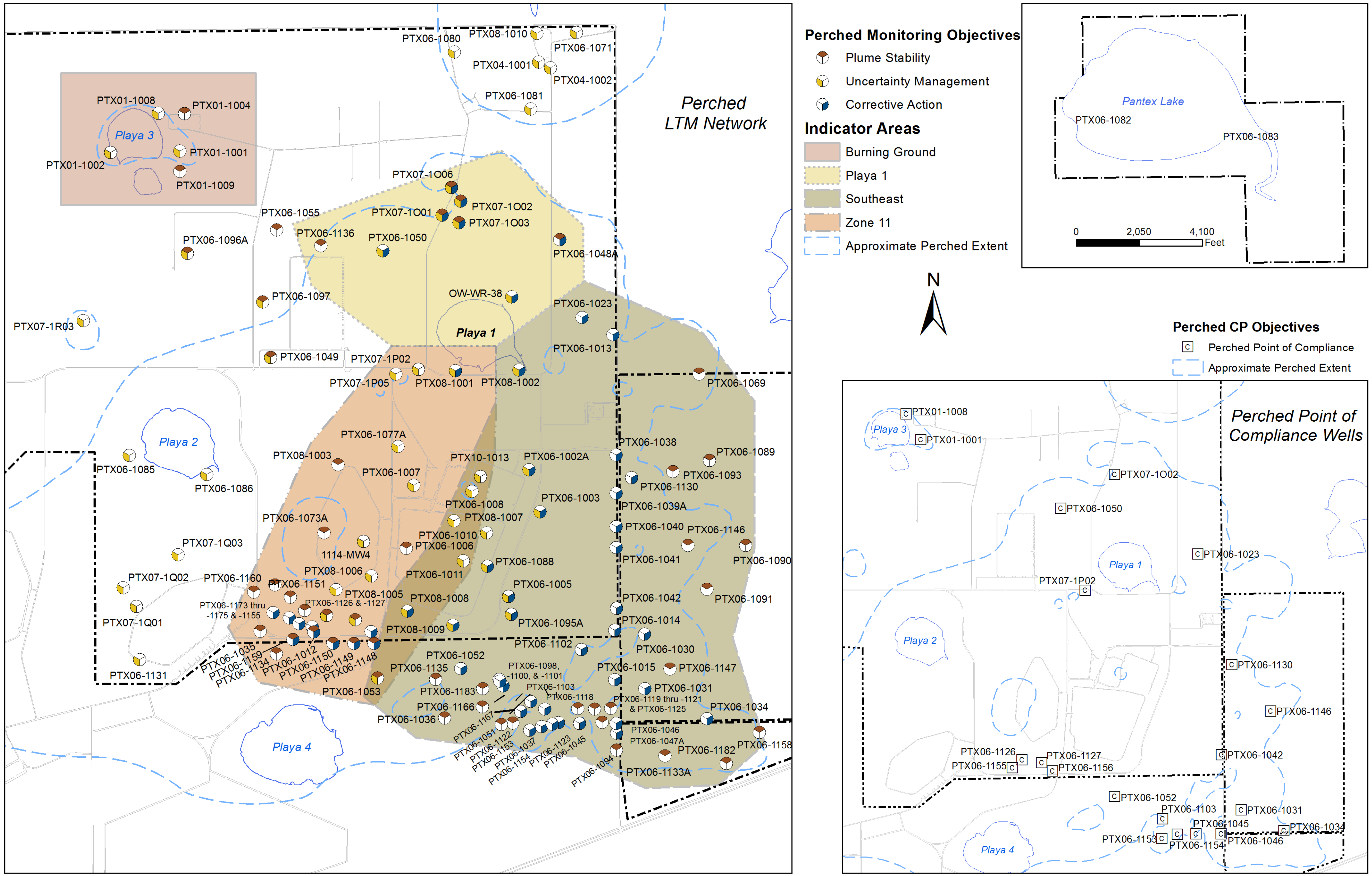

Figure 1-5. Perched LTM Network and Compliance Plan Wells

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1.4.2 Ogallala Aquifer Long-Term Monitoring Network

The final Ogallala Aquifer LTM network consists of the following.

- 26 LTM wells are monitored for indicator COCs and water levels. An additional well is used for monitoring water levels in the Ogallala Aquifer.
- 23 wells are sampled semi-annually and 3 are sampled annually. One well is sampled quarterly for HEs and VOCs.
- Seven 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 future five-year reviews. The five-year sampling was conducted in 2016. An eighth well, PTX06-1137A, was installed with two sampling intervals; however, water levels dropped below the first interval so the well is now only sampled in one interval, at the deepest sampling depth.
- 10 wells are sampled every five years using a modified 40 CFR Part 264 Appendix IX groundwater list to satisfy uncertainty management requirements. That sampling was conducted in 2016.
- Two indicator areas were defined for the Ogallala wells and indicator COC monitoring lists were developed for each of those areas.
- Four additional monitoring wells along the southern and western boundaries are monitored annually to evaluate the quality of groundwater upgradient of the Plant.

Table 1-4 lists all wells in the LTM network and HW-50284, with the corresponding LTM objective, indicator monitoring area, CP objective (POC/POE well), date of inclusion or removal from HW-50284, and coordinates. Figure 1-6 depicts the current active monitor wells listed in Table 1-4, as well as the additional four wells monitored along the southern and western boundaries. The wells are listed in chronological order according to the date of inclusion in HW-50284, in accordance with CP Table VII requirements.

Table 1-4. Ogallala Aquifer LTM and Compliance Plan Wells

Well ID	Indicator Area	ISM Well[1]	LTM Well[2]	CP Approval Date	CP Removal Date	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		Active	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[3]		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[4]		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[3]		Y	N	6/9/2003	9/16/2010	Active				620994.02	3765626.52
PTX06-1075[3]		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		Active	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	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[3]		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]These wells are retained for monitoring water upgradient to Pantex Plant but are not considered as LTM wells.

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

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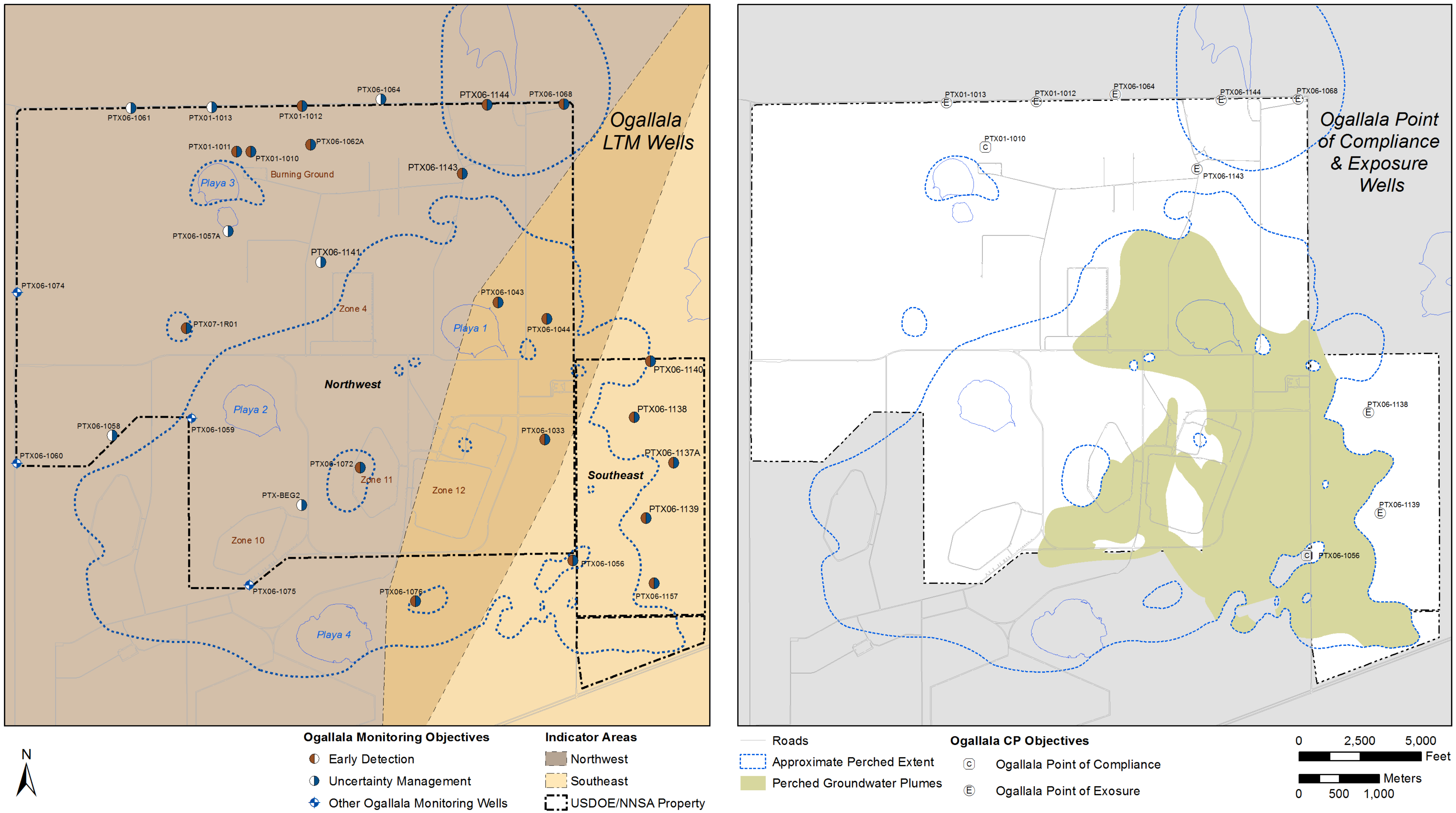

Figure 1-6. Ogallala Aquifer LTM and Compliance Plan Wells

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1.4.3 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, two ISB systems, and an SVE system.

Table 1-5 details all installed wells for the pump and treat systems, as well as their current status, date of plugging and abandonment, and coordinates. Table 1-6 details all installed wells for the ISB systems, as well as their current status, date of plugging and abandonment, and coordinates. Table 1-7 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.

- Seventeen ISB wells are used to monitor treatment zone conditions in the two ISB systems.
- All available extraction wells (pumping at time of sampling) are monitored during June/July of each year. These data are used to support the plume mapping.
- The SVE system is monitored to evaluate remedial action effectiveness and to provide information for the Air Quality Monitoring Report for the TCEQ.

The following changes to the Remedial Action Systems occurred during 2016:

- Four second row wells on the perchlorate (eastern) side of the Zone 11 ISB were permanently removed from injection rotation. This change was approved with the 2015 Annual Progress Report. The wells will not be plugged, but will be considered as inactive.
- PTX06-EW-081A was tied into the P1PTS during 2016 and became operational.
- Five new extraction wells were drilled east of FM 2373 to extend the SEPTS operations to that area.
- Two previously drilled pump test wells east of FM 2373 will be connected to the SEPTS as extraction wells.

The seven new SEPTS extraction wells are included in Table 1-5, but will not be active until design and construction is complete for the tie-in to the SEPTS.

Table 1-5. 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	9/15/1996	Active		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	Active		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
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

Well ID	Completion/ Replacement Date	Current Status	P&A Date	Easting	Northing
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	07/26/16	Active		644481.36	3753953.55
PTX06-EW-83	07/24/16	Active		644782.02	3753953.69
PTX06-EW-84	07/21/16	Active		645082.73	3753954.16
PTX06-EW-85	09/14/15	Active		645382.52	3753959.20
PTX06-EW-86	09/13/15	Active		645482.05	3753946.07
PTX06-EW-87	08/03/16	Active		645782.09	3753953.71
PTX06-EW-88	09/12/16	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
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	Active		641005.96	3757505.73
PTX06-INJ-11	8/28/2004	Active		641752.09	3758137.05
PTX06-INJ-12A	1/24/2008	Active		640737.15	3756104.67
		Playa 1 Pump and Treat System			
PTX06-EW-69	7/22/2007	Active		638869.86	3765146.41
PTX06-EW-70	8/11/06	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

Well ID	Completion/ Replacement Date	Current Status	P&A Date	Easting	Northing
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

P&A = plugging and abandonment
[1]Due to low well yield and need for monitoring data, extraction well was converted to monitoring well rather than plugged and abandoned.
[2]Pantex completed connection to the system in June 2016, with well becoming operational by November 2016.

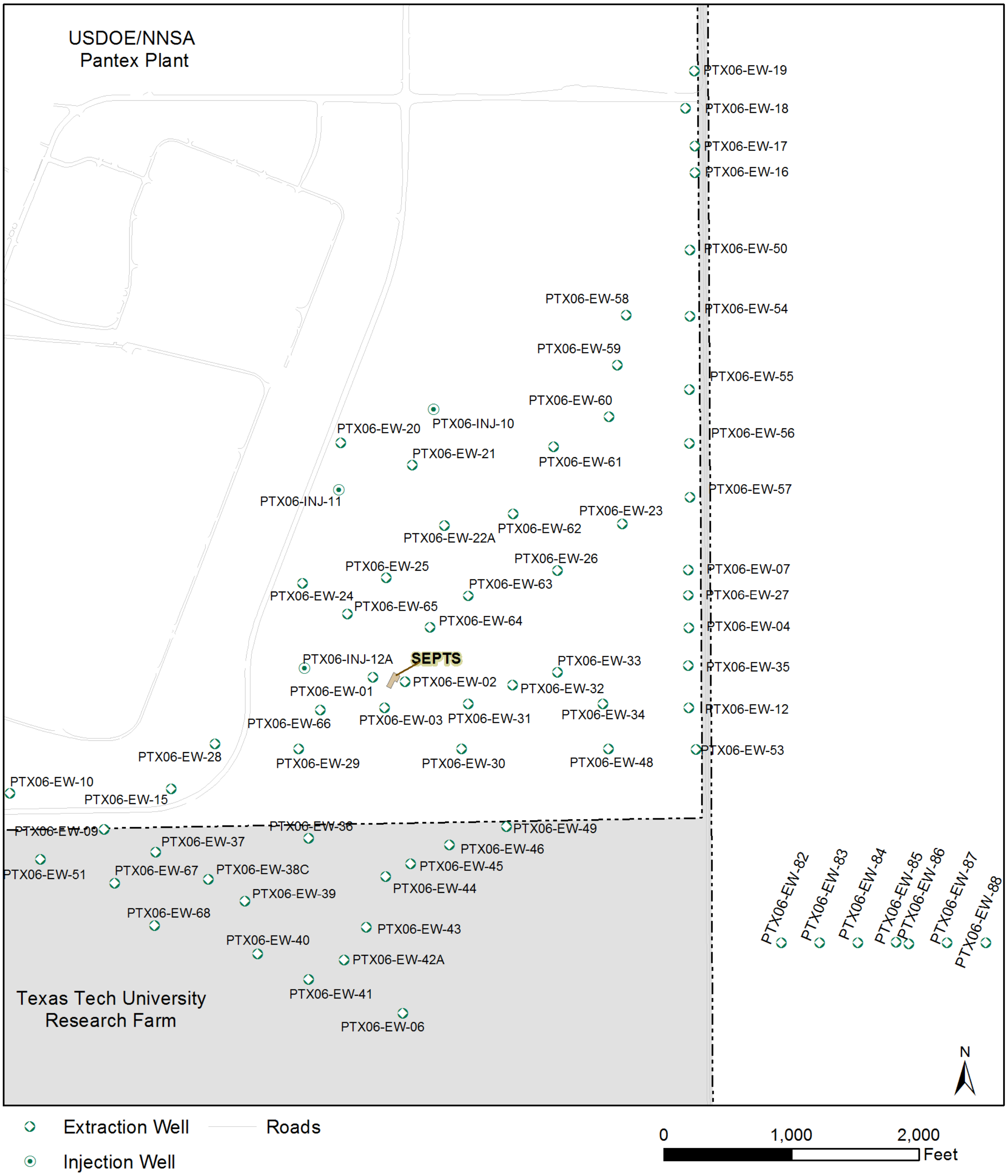

Figure 1-7. SEPTS Wells

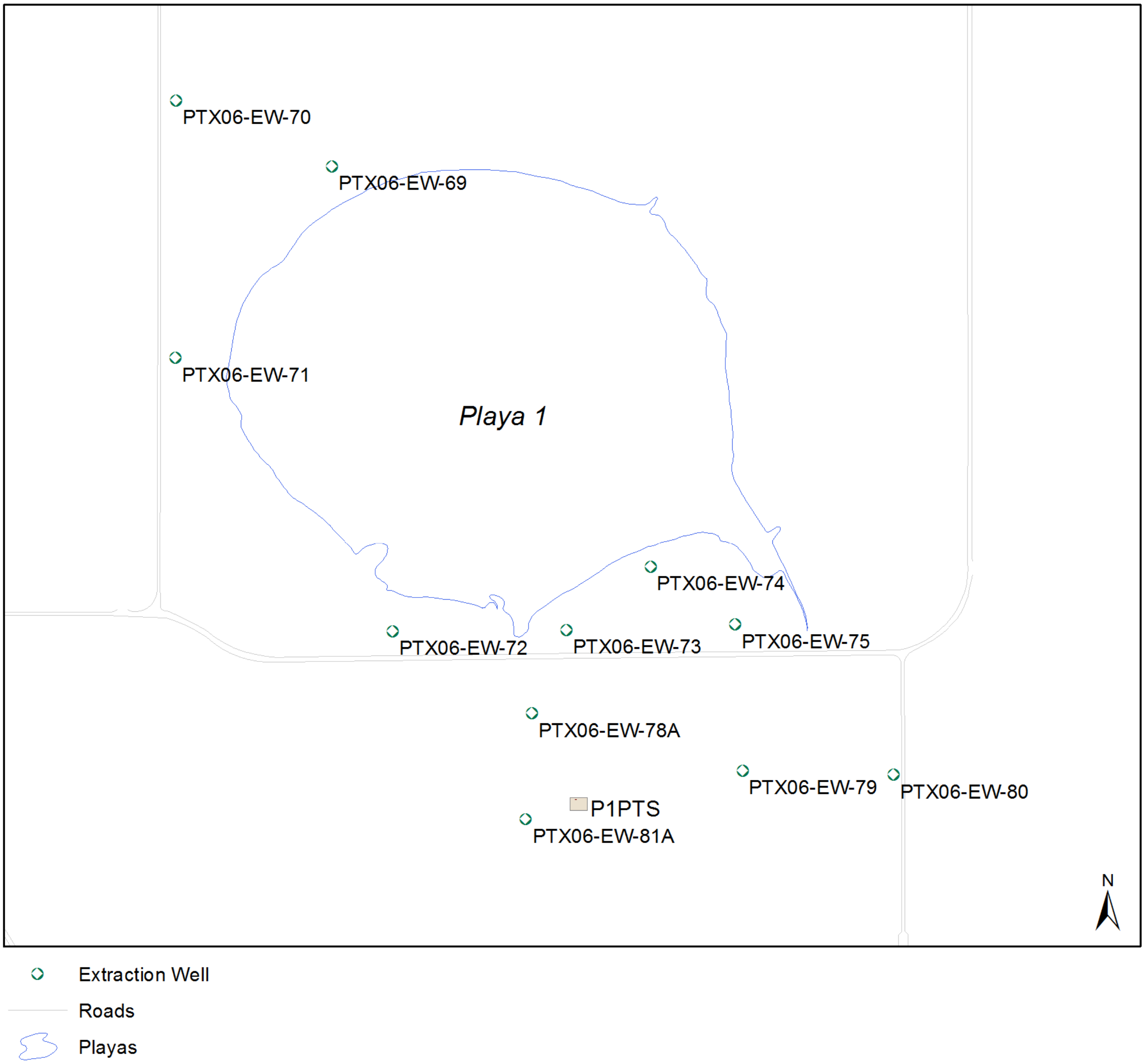

Figure 1-8. P1PTS Wells

Table 1-6. 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
			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

Well ID	Completion Date	Current Status	Replacement Date	P&A Date	Easting	Northing
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	07/24/14	Active			634360.64	3755523.08
PTX06-ISB088A	09/23/14	Active			634266.60	3755570.13
PTX06-ISB089	07/12/14	Active			634200.34	3755606.47
PTX06-ISB090	07/10/14	Active			634117.26	3755650.38
PTX06-ISB091	09/09/12	Active			634032.91	3755697.13
PTX06-ISB092	09/11/12	Active			633944.35	3755745.69
PTX06-ISB093	07/16/14	Active			633857.23	3755794.35
PTX06-ISB094	07/07/14	Active			633769.25	3755838.98
PTX06-ISB095	07/24/14	Active			633652.63	3755742.68
PTX06-ISB096	06/22/14	Active			633559.57	3755807.06
PTX06-ISB097	08/27/14	Active			633470.54	3755870.31
PTX06-ISB098	08/19/14	Active			633384.06	3755929.79
PTX06-ISB099	08/11/14	Active			633757.56	3755690.13
PTX06-ISB100A	09/16/14	Active			633791.28	3755646.03
PTX06-ISB101	08/07/14	Active			633899.71	3755616.85
PTX06-ISB102	07/31/14	Active			633985.55	3755572.69
PTX06-ISB103	09/02/14	Active			634073.50	3755527.39
PTX06-ISB104	08/19/14	Active			634160.38	3755482.36
PTX06-ISB105	08/06/14	Active			634245.60	3755438.20
PTX06-ISB106	07/29/14	Active			634332.49	3755393.36

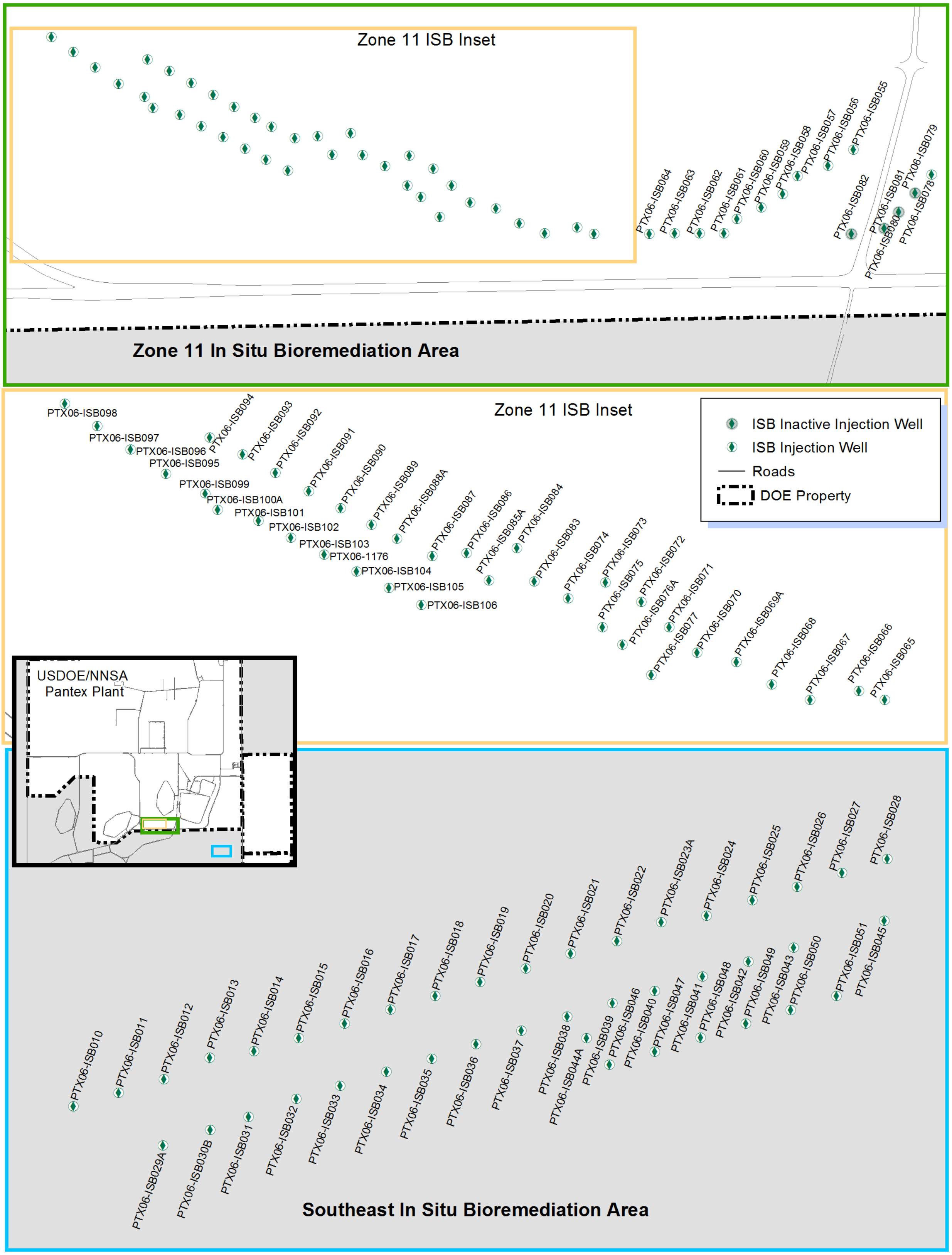

Figure 1-9. ISB System Wells

Table 1-7. 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 20-45 ft and 50-90 ft bgs. The intermediate depth wells are screened from 95-180 ft and 190-275 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.

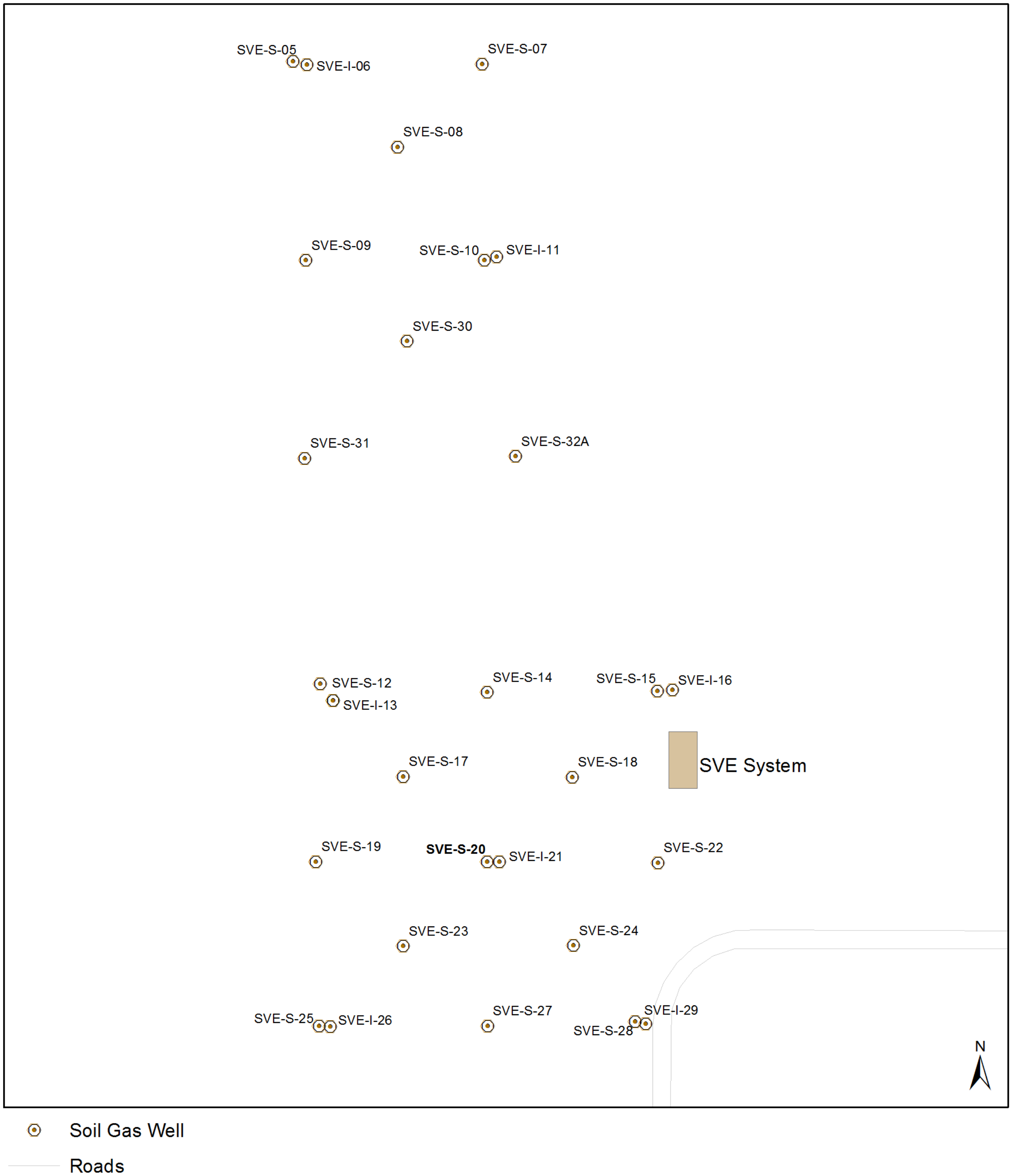

Figure 1-10. Burning Ground SVE Wells

1.5 Schedule of Activities

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

Activities completed in 2016, in 2017 prior to publication of this report, and projected completions for July 2017-June 2018 are summarized in Table 1-8. The schedule of activities included in the 2015 report was the basis for this table. Revisions of that schedule are noted in Table 1-8 and are explained in the following text.

Pantex completed most activities related to the Five-Year Review, recommendations from previous reports, as well as completing all normally scheduled monitoring and operation of remedial actions.

The significant actions completed in 2016 in relation to the Five-Year Review include:

- Phased review of landfills that were previously seeded was completed. Pantex has seen overall improvement in the landfill covers due to heavy rainfall in 2015 and 2016. Pantex has implemented a long-term contract to address holes and necessary seeding on an annual basis to address issues noted during inspections at all landfills. The 2016 landfill maintenance started in late 2016 and completed in early 2017. The maintenance contract and improved covers will close-out this five-year review issue.
- Pantex committed to evaluating the expanding plumes of high explosives east of FM 2373. To address the plume expansion, Pantex completed the initial actions identified in the Five-Year Review. However, the initial actions identified further work that is necessary; therefore, Pantex completed the following in 2016:
    - Pantex installed five additional extraction wells east of FM 2373 in 2016 and will use the previously installed pump test wells as two extraction wells. The design of the tie-in of the new extraction wells to the SEPTS started in 2016. Construction is expected to complete in 2017. Pantex expects the new wells to be operational in 2018.
    - Pantex contracted for RDX natural attenuation research. The research will determine the type of attenuation as well as spatial variability. A rate of attenuation will be quantified for each identified area of attenuation, if data support the calculation. Well sampling commenced in December 2016 and was completed in February 2017. A report is expected by the end of 2017.
    - PTX06-1182 was installed outside the previous known extent of the perched aquifer to the southeast. This well indicated that water and low levels of HE

contamination are present. Further wells will be installed in 2017 to evaluate the extent of the plume.

- Pantex recommended completion of an SVE Performance Monitoring Plan to establish criteria for ceasing active SVE system operations. Due to continued problems with rebound tests, Pantex contracted to have the system evaluated. Pantex has recommended (see 4th Quarter 2016 Progress Report) making modifications to the extraction wells to enhance air flow through the subsurface to increase volatilization and promote aerobic degradation of the NAPL source. Those modifications were completed in early 2017. Pantex will continue to monitor influent concentrations to determine the path forward.
- To address incomplete treatment of contaminants (HEs and hexavalent chromium) downgradient of the west end of the Southeast ISB (at PTX06-1153), Pantex completed a passive flux meter study in 2016. Results of the study are discussed in Section 2.2.1.

Pantex has also implemented several other recommendations made in the 2015 Annual Progress Report and 2015 Quarterly Progress Reports including:

- Pantex replaced the ditch liner at SWMUs 5-05 and 2 in Zone 12. The work commenced in late 2016 and was completed in March 2017.
- Pantex placed Closure Turf on Landfill 2 at Pantex, using specially provided funds for improvement of the remedial action. The work commenced in late 2016 and was complete in April 2017.
- Pantex has completed a chromium background study for the Ogallala Aquifer. That report will be released separately to regulatory agencies for review.
- Pantex contracted for a design to improve the cover on Landfill 3. The cover was damaged due to erosion from heavy rainfall.

In-progress and upcoming activities continue to focus on operation, maintenance, and monitoring of the remedial actions, operation and maintenance of soil actions, start of the second five-year review in 2017, completion of the RDX natural attenuation study, upgrade of the SEPTS to extend extraction east of FM 2373, construction of the Landfill 3 improvement design, modification of the Burning Ground SVE to increase NAPL removal and enhance bioremediation, and installation of new wells to address plume movement in areas outside the influence of the remedial actions. Some of the reporting and plans will require regulatory review and approval and are provided in bold in Table 1-8.

Pantex revisions to the schedule contained in the 2015 Annual Progress Report are as follows:

- Pantex encountered issues with getting some projects contracted during 2016 causing delays in completion of up to six months for some projects. Those projects have been contracted and work has commenced or completed in early 2017.
- The Landfill 3 erosion control design was delayed to ensure engineering comments were considered in the final design. The construction contracting will commence once the final design is complete and approved.

Table 1-8. Complete, In-Progress and Upcoming Activities

Activity	Start Date	Scheduled Complete Date	Actual Completion	CP Provision or Requirement	Origin of Recommended Action
Completed Work					
Zone 11 ISB Injection	Mar 2016	Jul 2016	Aug 2016	IAG Article 8 HW-50284 Provision XI.E.1	
Southeast ISB Injection	May 2016	Sep 2016	Oct 2016	IAG Article 8 HW-50284 Provision XI.E.1	
2016 installation of new wells –1 LTM well replacement, 3 new monitoring wells, and 5 extraction wells	Jun 2016	Sep 2016	Sep 2016	HW-50284 Provision XI.F	4Q2015, 2015A
Replacement of the SWMU 5/5 and 2 ditch liner	Jan 2017	Apr 2017	Mar 2017	IAG Article 8.9 HW-50284 Provision XI.E	2015A
Annual Landfill Maintenance	Jul 2016	Sept 2016	Feb 2017	IAG Article 8.9 HW-50284 Provision XI.E	4Q2015, 2015A
LiDAR study for evaluation of Pantex Landfills	Aug 2016	Nov 2016	Apr 2017	IAG Article 21 and HW-50284 CP Table VII, Item 26	FYR
Modification of the Burning Ground SVE to increase air flow into formation	Feb 2017	April 2017	May 2017	HW-50284 XI.B.3	4Q2016
Phased Plan to restore vegetation coverage on Landfills				IAG Article 21 and HW-50284 CP Table VII, Item 26	FYR
Phase II – Assess the effectiveness of landfill reseeding	Aug 2016	Sep 2016	All complete		
Phase III – Additional seeding of targeted areas	Jul 2017	Sep 2017	Feb 2017		
Landfill 2 Closure Turf® Design and Construction	Jul 2016	Dec 2016	Feb 2017	IAG Article 8.9 HW-50284 Provision XI.E	2015A
Notice of start of Five-Year Review in Amarillo Globe News and the Panhandle Herald	Apr 2017	May 2017	May 2017	IAG Article 21 and HW-50284 CP Table VII, Item 26	

Activity	Start Date	Scheduled Complete Date	Actual Completion	CP Provision or Requirement	Origin of Recommended Action
2nd Quarter 2016 Progress Report	Aug 2016	Sep 2016	Sep 2016	HW-50284 Provision XI.G.3 and IAG Article 16.4	
3rd Quarter 2016 Progress Report	Nov 2016	Dec 2016	Dec 2016	HW-50284 Provision XI.G.3 and IAG Article 16.4	
4th Quarter 2016 Progress Report	Feb 2017	Mar 2017	Mar 2017	HW-50284 Provision XI.G.3 and IAG Article 16.4	
1st Quarter 2017 Progress Report	Apr 2017	Jun 2017	Jun 2017	HW-50284 Provision XI.G.3 and IAG Article 16.4	
2016 Annual Progress Report	Mar 2017	Jun 2017	Jun 2017	HW-50284 Provision XI.G.3 and IAG Article 16.4	
2nd Semi-Annual 2016 Groundwater Sampling - Monitoring Wells	Jul 2016	Dec 2016	Dec 2016	HW-50284 Provision XI.F	
3Q2016 Groundwater Sampling - ISB System Wells	Jul 2016	Sep 2016	Sep 2016	HW-50284 Provision XI.F	
4Q2016 Groundwater Sampling - ISB System Wells	Oct 2016	Dec 2016	Dec 2016	HW-50284 Provision XI.F	
1st Semi-Annual 2017 Groundwater Sampling - Monitoring Wells	Jan 2017	Jun 2017	Jun 2017	HW-50284 Provision XI.F	
1Q2017 Groundwater Sampling - ISB System Wells	Jan 2017	Mar 2017	Mar 2017	HW-50284 Provision XI.F	
2Q2017 Groundwater Sampling - ISB System Wells	Apr 2017	Jun 2017	May 2017	HW-50284 Provision XI.F	
Work In-Progress					
Design for erosion control at Landfill 3	Apr 2016	Aug 2016		IAG Article 8.9 HW-50284 Provision XI.E	3Q2015
2017 Well Drilling and Plugging – drilling 6 new wells, plugging two wells, and repair of casing at PTX06-1139	Apr 2017	Jun 2017		HW-50284 XI.B.1 and XI.B.2	3Q2016 4Q2016

Activity	Start Date	Scheduled Complete Date	Actual Completion	CP Provision or Requirement	Origin of Recommended Action
Extending SEPTS east of FM 2373 – Design	Jun 2016	Sept 2016		IAG Article 8 HW-50284 Provision XI.E.1	2015A
RDX Natural Attenuation Study	Dec 2016	Dec 2017			2015A
Contract Five-Year Review support	Jan 2017	Jun 2017		IAG Article 21 and HW-50284 CP Table VII, Item 26	
Kick-off Meeting to review annotated outline, agree upon schedule for 2nd Five Year Review, and site inspection	July 2017	Aug 2017		IAG Article 21 and HW-50284 CP Table VII, Item 26	
CR(VI) and Total Cr Groundwater Background Study				HW-50284 Provision XI.F.1	4Q2013
Prepare Draft Final Cr Groundwater Background Report	May 2016	Nov 2016*	Feb 2017		
Regulatory Meeting/Review of Background Report	May 2017*	Jun 2017*			
Prepare Final Cr Groundwater Background Report	Aug 2017*	Sep 2017*			
Upcoming Work					
Extending SEPTS extraction east of FM 2373 – Construction	Jul 2017	Dec 2017		IAG Article 8 HW-50284 Provision XI.E.1	2015A
Zone 11 ISB Injection	Aug 2017	Nov 2017		IAG Article 8 HW-50284 Provision XI.E.1	
Landfill 3 Erosion Control Construction	Aug 2017	Dec 2017		IAG Article 8.9 HW-50284 Provision XI.E	3Q2015
FY 18 Well Drilling	Oct 2017	May 2018			
Annual Landfill Maintenance	Dec 2017	Feb 2018		IAG Article 8.9 HW-50284 Provision XI.E	4Q2015, 2015A
Prepare Draft Final Five-Year Review Report	Jul 2017	Jan 2018		IAG Article 21 and HW-50284 CP Table VII, Item 26	

Activity	Start Date	Scheduled Complete Date	Actual Completion	CP Provision or Requirement	Origin of Recommended Action
Regulatory Review of Draft Final Five-Year Review Report	Feb 2018	Mar 2018		IAG Article 21 and HW-50284 CP Table VII, Item 26	
Prepare Final Five-Year Review Report	Apr 2017	May 2018		IAG Article 21 and HW-50284 CP Table VII, Item 26	
EPA/TCEQ Approval of Final Five Year Review Report	July 2018	Aug 2018		IAG Article 21 and HW-50284 CP Table VII, Item 26	
Annual Public Meeting	Oct 2017	Nov 2017			
Develop SVE Performance Monitoring Plan	Sep 2014* To be revised pending review of data from modified SVE	Dec 2014* To be revised pending review of data from modified SVE		IAG Article 21 and HW-50284 CP Table VII, Item 26	FYR
2nd Quarter 2017 Progress Report	Aug 2017	Sep 2017		HW-50284 Provision XI.G.3 and IAG Article 16.4	
3rd Quarter 2017 Progress Report	Nov 2017	Dec 2017		HW-50284 Provision XI.G.3 and IAG Article 16.4	
4th Quarter 2017 Progress Report	Feb 2018	Mar 2018		HW-50284 Provision XI.G.3 and IAG Article 16.4	
1st Quarter 2018 Progress Report	Apr 2018	Jun 2018		HW-50284 Provision XI.G.3 and IAG Article 16.4	
2017 Annual Progress Report	Mar 2018	Jun 2018		HW-50284 Provision XI.G.3 and IAG Article 16.4	
2nd Semi-Annual 2017 Groundwater Sampling - Monitoring Wells	Jul 2017	Dec 2017		HW-50284 Provision XI.F	
3Q2017 Groundwater Sampling - ISB System Wells	Jul 2017	Sep 2017		HW-50284 Provision XI.F	

Activity	Start Date	Scheduled Complete Date	Actual Completion	CP Provision or Requirement	Origin of Recommended Action
4Q2017 Groundwater Sampling - ISB System Wells	Oct 2017	Dec 2017		HW-50284 Provision XI.F	
1st Semi-Annual 2018 Groundwater Sampling - Monitoring Wells	Jan 2018	Jun 2018		HW-50284 Provision XI.F	
1Q2018 Groundwater Sampling - ISB System Wells	Jan 2018	Mar 2018		HW-50284 Provision XI.F	
2Q2018 Groundwater Sampling - ISB System Wells	Apr 2018	Jun 2018		HW-50284 Provision XI.F	

*Dates have been impacted and final dates will be forthcoming.
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.

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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 (routine and unscheduled) ensure that the systems continue to operate optimally. A summary of the operation and maintenance (O&M) of the remedial action systems is provided to aid in understanding the effectiveness of the remedy.

2.1 Pump and Treat Systems

As part of the Remedial Action, Pantex installed two pump and treat systems, with 70 operating extraction wells and three injection wells that are currently treating up to a total of 550 gallons per minute (gpm) of contaminated perched groundwater. The systems address contamination in areas where there was generally greater than 15 ft of saturation in the perched aquifer at the time of installation. These systems were designed to remove and treat groundwater to achieve contaminant mass reduction and reduction 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. To achieve mass reduction and reduction in saturated thickness, the pump and treat systems treat the extracted water to remove contaminants from the water before the effluent is sent to the 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 during 2016 to allow beneficial use in accordance with the Texas Land Application Permit. While the primary use option is irrigation, the SEPTS retains the capability for injection back into the perched zone, as necessary.

The P1PTS began operating 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 been expanded with additional extraction wells and the capacity to treat boron and hexavalent chromium to become part of the final Remedial Action for the southeastern portion of the groundwater plumes. A list of the extraction and injection wells and their status is included in Section 1 of this report. Appendix B contains the monthly flow calculations for each active well.

The pump and treat systems continued to impact saturated thickness and contaminant mass in the southeast perched groundwater during 2016 as depicted above. These milestones demonstrate the systems are effective at removing mass and water from the perched aquifer

Pump and Treat Systems Milestones

2016

- 196.9 million gallons treated
- 100% of treated water beneficially used
- 723 lbs of contaminants removed

Since Startup

- 2.4 billion gallons treated
- 1.6 billion gallons beneficially used
- 13,640 lbs contaminants removed

and system operation continues to move towards meeting remedial action objectives for Pantex.

2.1.1 Playa 1 Pump and Treat System

The P1PTS extracts water from eleven wells near Playa 1 and treats the water through a series of granular activated carbon (GAC) beds and ion exchange process units to reduce HEs and metals 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, as well as achieving mass removal.

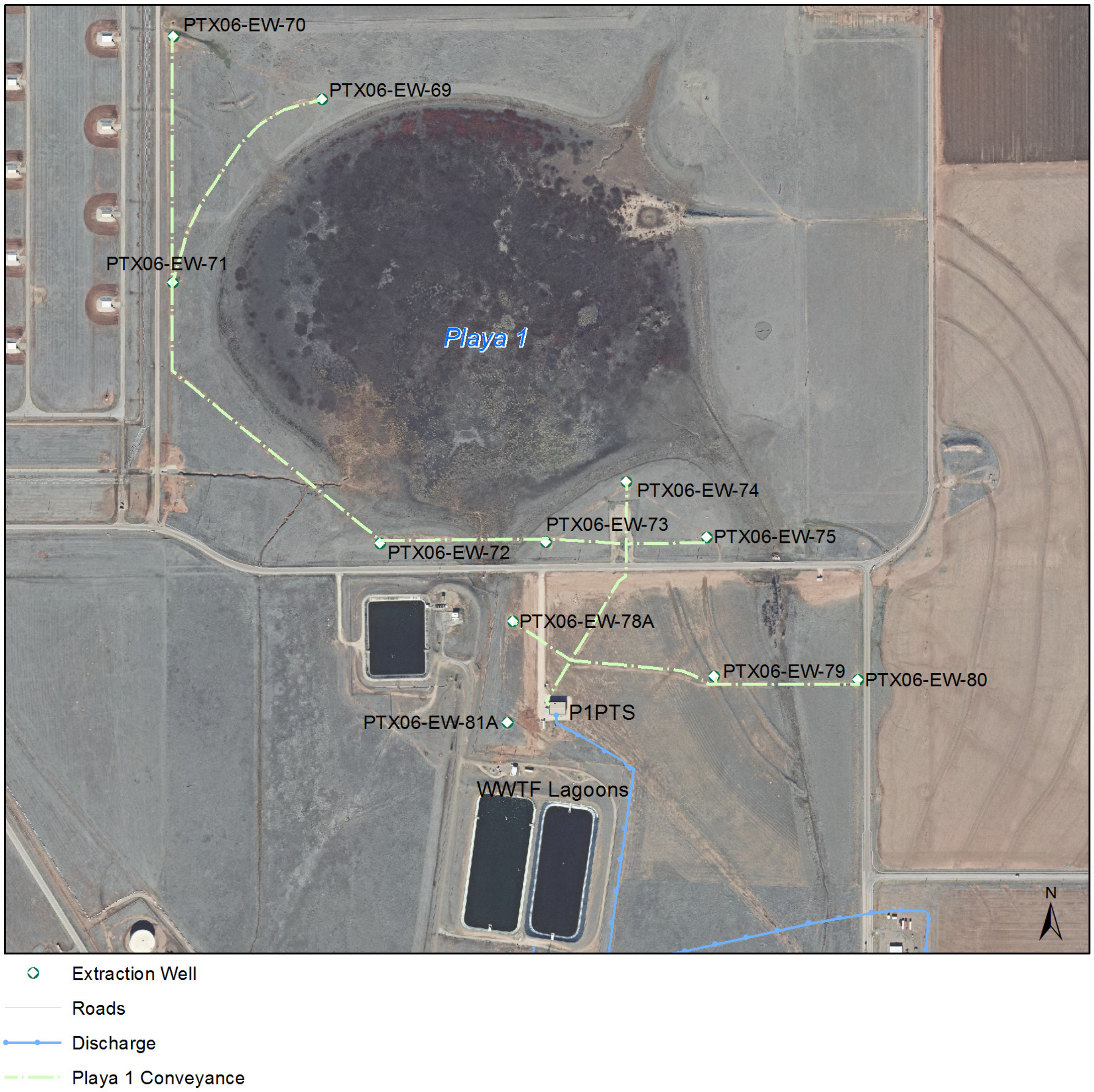
P1PTS Operational Goals

1. 90% Operation Time with no injection when WWTF/Irrigation System can receive all treated water.
2. When the WWTF/Irrigation system is limiting flow, no injection at SEPTS with minimum flow rates (125 gpm) maintained at both systems. Injection is used at SEPTS to maintain minimum flow if flow is limited below 250 gpm for the two systems.
3. 90% of system treatment or well field capacity, whichever is lower.

P1PTS beneficially uses all treated water by sending it through the WWTF to the irrigation system. Because this system does not have the capability to 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.

Figure 2-1 depicts the P1PTS wells and conveyance. Eleven wells operated during 2016. The newest well, PTX06-EW-81A, was installed previously but was not connected to the system until June 2016.

Figure 2-1. P1PTS Wells and Conveyance Lines



The operational goals for the systems were realigned in 2014 and are depicted in the highlight box at the head of this section. Goals are prioritized and will be met as conditions allow. The P1PTS was designed with a treatment capacity of 250 gpm or 360,000 gpd and could potentially treat up to 131 million gallons (Mgal) of water per year running at design capacity and 100% operation.

The P1PTS operation was below the annual system operational goal by operating 250 days during 2016 with an average annual operational rate of 65%, based on total hours operated versus total possible operation time. The actual percentage monthly system operational time versus target is depicted in Figure 2-2.

Figure 2-3 depicts the average gpm extracted from all wells by month, the percentage of design capacity achieved, and goals for the system as a measure of well operation efficiency. While operational rate of the system was the prioritized goal after June 2014, the 90% throughput goal is still depicted in the graphs and throughput is evaluated to identify potential issues with well operation.

The monthly system operation was primarily affected by the loss of two wells during the first two quarters of 2016 and in March and April for a planned GAC vessel replacement. In addition, P1PTS was operated intermittently during the first quarter of 2016 to avoid early GAC change out. Throughput continued to be affected by restricted flow to the WWTF in August, September, and December 2016.

The P1PTS system extracted an average of 200 gpm (about 80% of design throughput) from the well field while operating during 2016. The calculated gpm accounts for water extracted from the well field during the time the system operates and is affected by the yield from each well, well downtime, or reduced flow required by the WWTF/irrigation system.

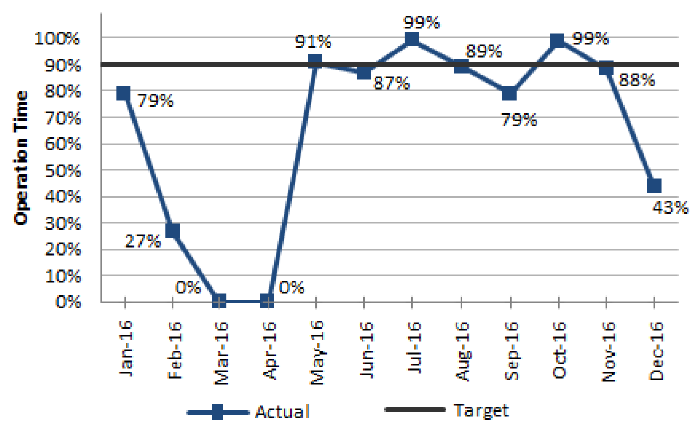


Figure 2-2. P1PTS Operation Time vs Target

Figure 2-4 reflects the operation time by well. The average annual well field operation was about 65%. Repairs to PTX06-EW-78A and 79 were not completed until June and August, respectively, which affected use of these wells in the first half of the year. PTX06-EW-72 was down from June through September, and PTX06-EW-80 was down from August through December. Additionally, PTX06-EW-81A was ready for use in October 2016 but operation was limited in

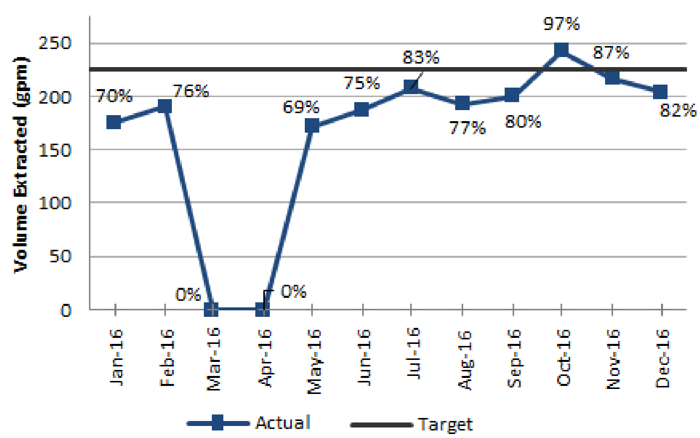


Figure 2-3. P1PTS Average GPM and % Capacity

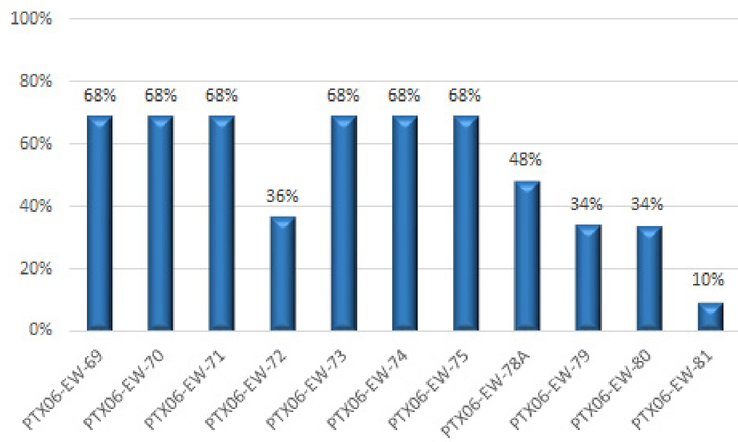


Figure 2-4. P1PTS Well Operation Time

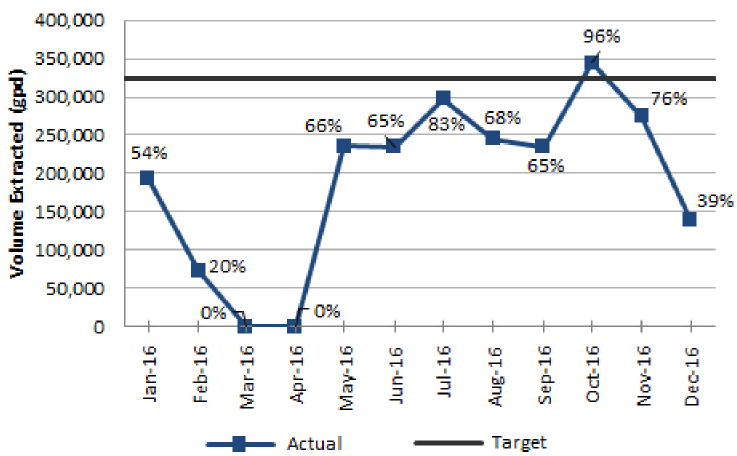


Figure 2-5. P1PTS Average GPD and % Capacity

December because of the WWTF reduction in flow. This well will help with meeting goals when other wells are down.

Figure 2-5 reflects the overall system efficiency considering system operation and well operation. The figure depicts the average gallons per day (gpd) by month, the percentage of design capacity achieved, and a 90% goal for the system. While treatment throughput was not a primary goal after June 2014, the 90% goal is still depicted in the graphs and throughput is evaluated to identify potential issues with well operation.

The system treated an average of about 271,600 gpd during 2016, about 75% 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. As discussed above, the overall operation and throughput was affected by a planned GAC vessel replacement, loss of wells, and shutdown due to the WWTF being unable to receive water later in the year. Minor loss of operation occurred due to carbon change-outs, power losses, and repairs. The system was shut down due to the WWTF/irrigation system for 9 days in August, 30 days in September, and 18 days in December. The loss of PTX06-EW-78A and 79 affected the system through July.

The system treated approximately 67.9 million gallons during 2016, with an average treatment volume of about 5.7 million gallons per month. The monthly treatment flow volumes are depicted in Figure 2-6. As discussed above, monthly total flow was low because of the loss of wells and shut-down for maintenance or the WWTF.

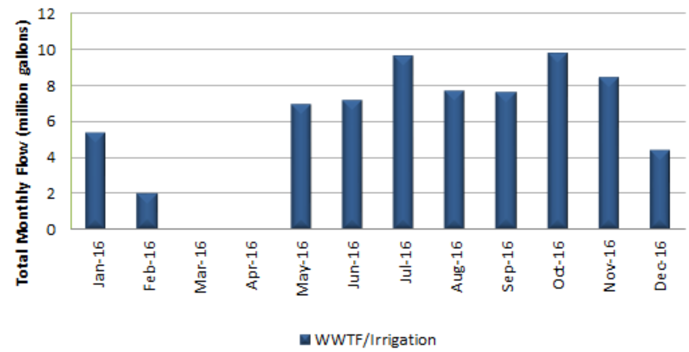


Figure 2-6. P1PTS System Monthly Total Flow

During 2016, the system removed approximately 21.2 lbs of RDX and 8.6 lbs of all other HEs (see Figure 2-7). The average removal rate of HEs was about 0.44 lbs per million gallons (lbs/Mgal) of treated water. The system has removed a total of 495 lbs of RDX and 196 lbs of all other HEs since startup in September 2008. HE mass removal is dependent on the wells operated within the system which affects the influent concentrations and throughput. Two wells (PTX06-EW-79, and 80) at the P1PTS have the greatest effect on the influent concentrations of HEs because they are in a more heavily contaminated portion of the plume. PTX06-EW-79 was not operated from January to July. PTX06-EW-80 was offline in September and October 2016. The downtime of these wells affected the mass removal of the system during those months. Additionally, operational downtime from February to April also affected mass removal at this system.

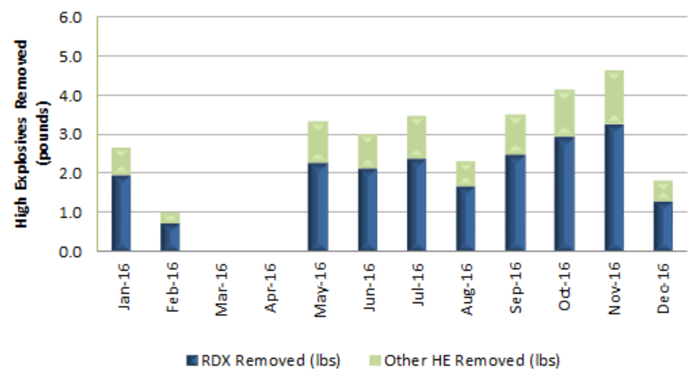


Figure 2-7. P1PTS Mass Removal by Month

Influent concentrations at P1PTS are also declining over time. The average influent concentration of RDX was 148 ug/L in 2009, while the average influent concentration in 2016 was 38.7 ug/L. The maximum influent RDX concentration in 2009 was 200 ug/L and 52.9 ug/L in 2016. This system primarily reduces saturated thickness and head on the southeast perched groundwater, although mass removal is also achieved.

Evaluation of effluent data indicates the system treated the recovered groundwater to concentrations below the laboratory PQL and the GWPS. There were no COCs detected within the effluent during 2016. The complete set of effluent data collected during 2016 is included in Appendix D electronic data tables.

Pantex also evaluates extraction wells near SWMU 5-12 for evidence of contamination from the SWMU 5-12 ditch that could impact P1PTS. Wells in that area indicate the presence of perchlorate and 1,4-dioxane, which are not treatable by GAC. Evaluation of extraction well data indicated the presence of 1,4-dioxane in one well (PTX06-EW-78A). The summary of extraction well data is presented in Table 2-1. The result was less than the laboratory PQL. There have been no detections of 1,4-dioxane in the influent or effluent of the P1PTS. There were no perchlorate detections in extraction wells or the influent or effluent of the P1PTS. Pantex will continue to monitor the appropriate extraction wells.

Table 2-1. Summary of 1,4-Dioxane Detections at P1PTS Extraction Wells

Well ID	Sample Date	Measured Value (ug/L)	Lab PQL (ug/L)	>Lab PQL?	GWPS (ug/L)	>GWPS?
PTX06-EW-78A	9/26/2016	0.454J	1	N	7.7	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).

During 2016, the P1PTS was in its eighth year of operation. Operational performance was below goals for portions of the year. Performance was primarily affected by the loss of wells, GAC vessel replacement and restricted flow to the WWTF/irrigation system, with carbon change-outs and minor maintenance also affecting the system for short periods. Pantex reevaluated 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/irrigation system, flow is restricted at both systems to avoid injection. In portions of August, September, and December 2016, the WWTF completely restricted flow, rather than partially restricting flow, so the operational goal could not be met during that time period. Pantex drilled an additional extraction well to help address decreased throughput when wells were down. Well PTX06-EW-81A was placed into service in November 2016 and should help increase throughput at the system.

2.1.2 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, 59 extraction wells, and 3 injection wells (see Figure 2-8). This system treats the water through a series of GAC vessels and ion exchange resin beds to reduce concentrations below the GWPS established in the ROD and HW-50284.

> **SEPTS Operational Goals**
>
> 1. 90% Operation Time with no injection when WWTF/Irrigation System can receive all treated water.
> 2. When the WWTF/Irrigation system is limiting flow, no injection at SEPTS with minimum flow rates (125 gpm) maintained at both systems. Injection is used at SEPTS to maintain minimum flow if flow is limited below 250 gpm for the two systems.
> 3. 90% of system treatment or well field capacity, whichever is lower.

The objective of the SEPTS 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. This will achieve two important objectives:

1. Gradual reduction of the volume of perched groundwater (and contamination) moving downgradient toward the extent of the perched aquifer, and
2. A reduction in the head (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 for this system were established, as presented in the highlight box. Goals are prioritized for system operation and will be met as conditions allow. The system is designed to treat up to 300 gpm or 432,000 gpd. The system has the capability to treat up to about 158 Mgal annually, if operated at 100%.

Figure 2-8. SEPTS Wells and Conveyance Lines

The SEPTS met the system operational goal of 90% for the year by operating all or part of 351 days during 2016 with an average operational rate of 93% based on total hours operated versus total possible operation time. The percent operation time (hours/day) versus target is depicted in Figure 2-9. The system operation was affected by loss of wells for maintenance in June and in September and December by the WWTF which required the system to reduce flow.

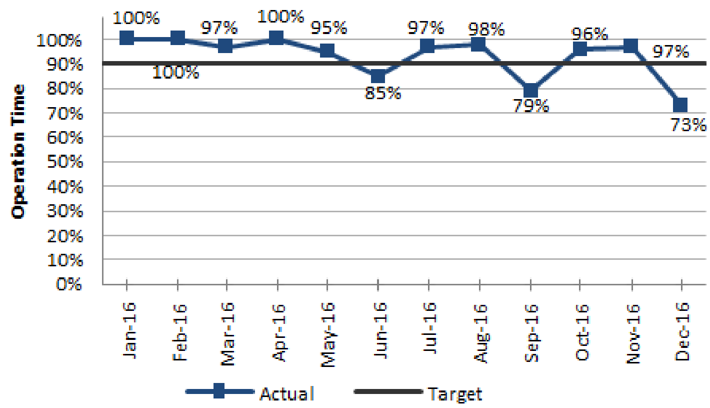


Figure 2-9. SEPTS Operation Time vs Target

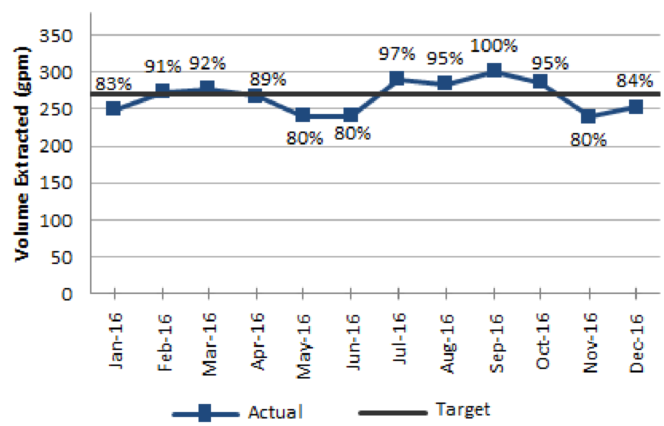


Figure 2-10. SEPTS Average GPM and % Capacity

Figure 2-10 depicts the average gpm extracted from all wells by month, the percentage of design capacity achieved, and goals for the system as a measure of well operation efficiency. While operational rate of the system was the prioritized goal after June 2014, the 90% throughput goal is still depicted in the graphs and well throughput is evaluated to identify potential issues.

The system extracted an annual average of 267 gpm (about 89% 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 the yield from each well, well downtime, or reduced flow required by the WWTF/irrigation system. When the WWTF/irrigation system was unable to receive full flow from the pump and treat systems, flow was reduced to avoid injection into the perched aquifer.

Because the SEPTS has 59 operating wells, it is currently capable of extracting more water than the maximum treatment capacity of the system. 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. There were a total of seven potential new EWs installed in 2016, EW-82 through EW-88, as part of the SEPTS expansion east of FM 2373. These wells will be connected in 2017 and are expected to be operational in early 2018.

Although perched groundwater levels are declining, the extractions rates from the well field currently exceed the capacity of the treatment system. Pantex extracts from the well field according to set priorities that best meet long-term objectives. The well extraction priorities for operating wells are depicted in Figure 2-11. Seven priorities were set:

- Priority 1 Wells: Wells along the eastern edge of the well field (along the eastern fence line) 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.
- Priority 2 Wells: Wells along the southern edge of the system that were installed to capture the highest concentrations of hexavalent chromium and to prevent further migration of the plume into areas where the FGZ is more permeable or to thinner saturated zones.
- Priority 3 Wells: Wells along the southeastern edge of the system that capture the highest concentrations of RDX and prevent further migration of the plume into areas where the FGZ is more permeable or to thinner saturated zones.
- 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 movement of the RDX plume 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-6 and EW-49, these wells will help with reducing saturated thickness in the perched aquifer and removing head that pushes the groundwater horizontally and vertically, but will not be as effective at controlling plume movement. EW-6 and EW-49 are in a low-

transmissive zone so are very low-producing wells. For this reason, they were not placed in a high priority for pumping.

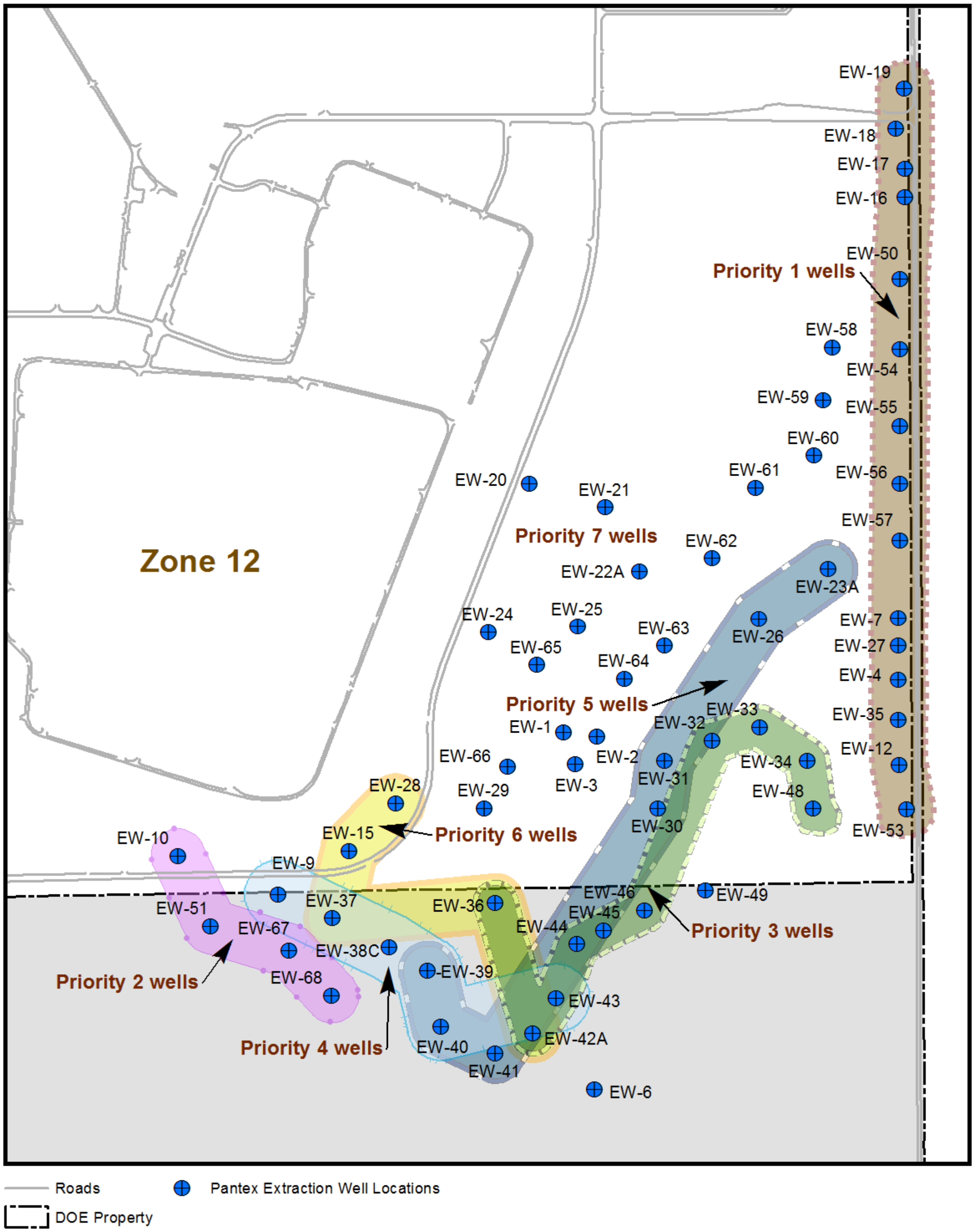


Figure 2-11. SEPTS Well Field Extraction Prioritization

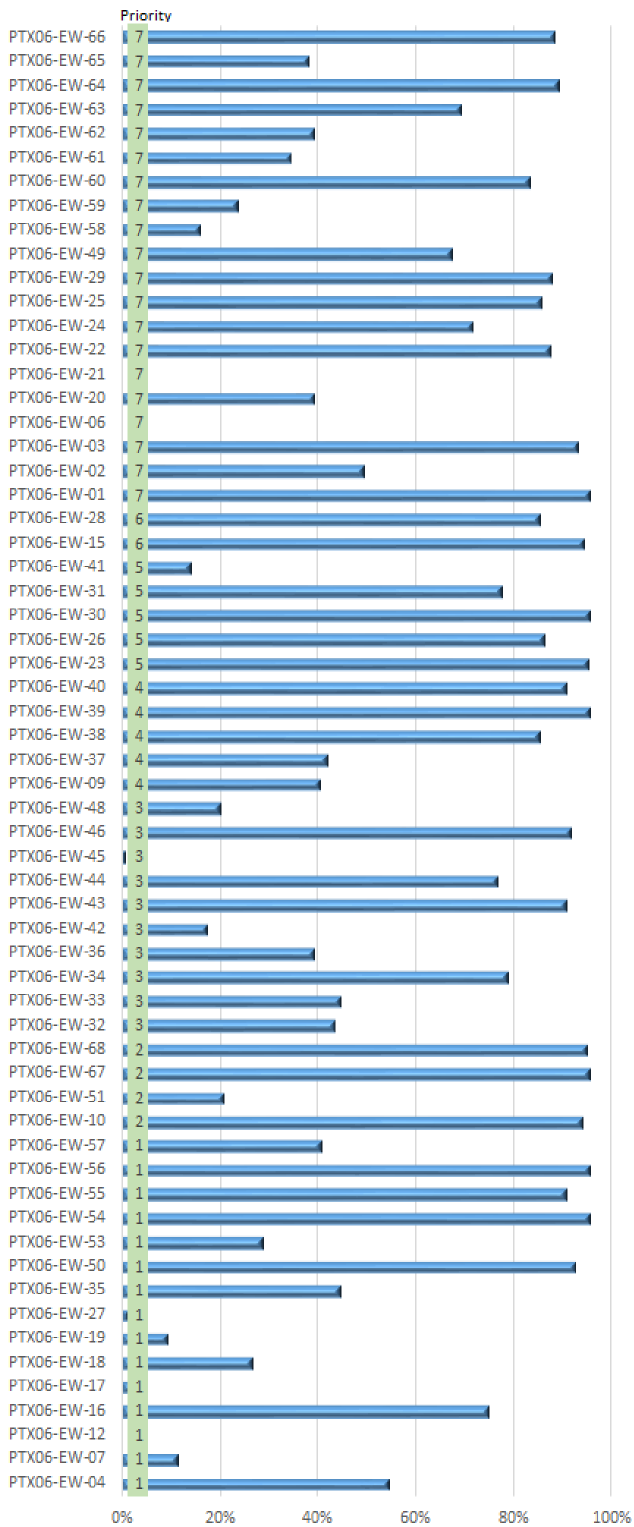


Figure 2-12. 2016 SEPTS Well % Operation

This prioritization was implemented in 2009 after the newly installed extraction wells were placed into operation. Figure 2-12 provides the percentage of days wells were operated in the SEPTS. Priority 1-5 wells are operated at a higher frequency with the exception of a few wells that experience electrical, mechanical, or pumping problems that affected operation of the well. Priority 6 and 7 extraction wells are operated periodically to ensure that wells remain operational. Priority 6 and 7 wells within the highest saturated zones are also operated at a higher frequency to meet the goal of reducing the saturated thickness in those areas and to meet throughput goals for the system. 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 so pumps are cycling on and off causing the well to be operated intermittently. This effect is becoming more prominent in many of the wells in thin saturated portions of the perched aquifer as the system continues to remove water from the perched aquifer. PTX06-EW-21 has gone dry and has not been used since 2014 and will be evaluated for plugging. The prioritization of the well pumping is expected to be discontinued in the future as the capacity of the pump and treat system will exceed extraction rates.

Figure 2-13 reflects the overall system efficiency considering system and well operation. The figure depicts the average daily treatment rate (gpd) by month, target, and percentage of total capacity achieved at the SEPTS. The SEPTS treated an annual average of about 367,521 gpd (about 85% of design capacity) for 2016 based on total possible hours of operation and total inflow from the well field.

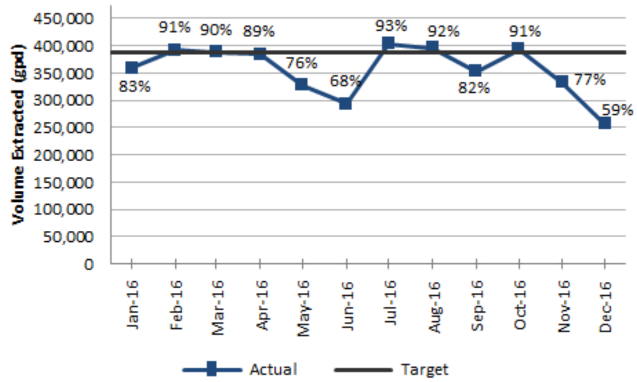


Figure 2-13. SEPTS Average GPD and % Capacity

The gpd is affected by system operational time, ability to extract water from the wells, and reduced flow to the WWTF and irrigation system. As discussed above, the system was affected by loss of wells and reduced throughput to the WWTF/irrigation system in December. Operational time was affected by the upgrades, maintenance (carbon and ion exchange change-out), floor maintenance, and power losses.

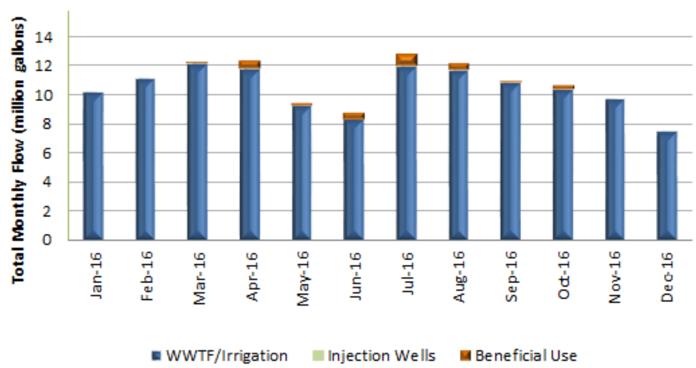


Figure 2-14. SEPTS Total Flow Volume and Disposition of Effluent

The system treated over 120 million gallons of extracted water during 2016. The total volume treated by month and the final disposition of the treated water is depicted in Figure 2-14. This system released about 98% of the treated water to the WWTF for use in the irrigation system, and the remaining 2% was beneficially used for injection of amendment in the ISB systems. No treated water was injected into the perched aquifer in 2016. With the implementation of the revised operational goals, Pantex expects to continue minimizing injection and reducing saturated thickness.

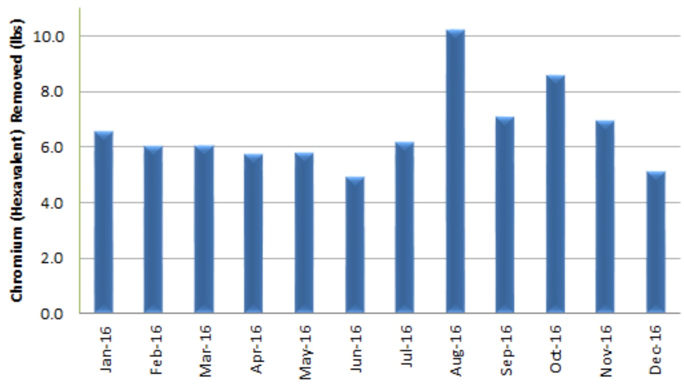


Figure 2-15. SEPTS Chromium Mass Removed by Month

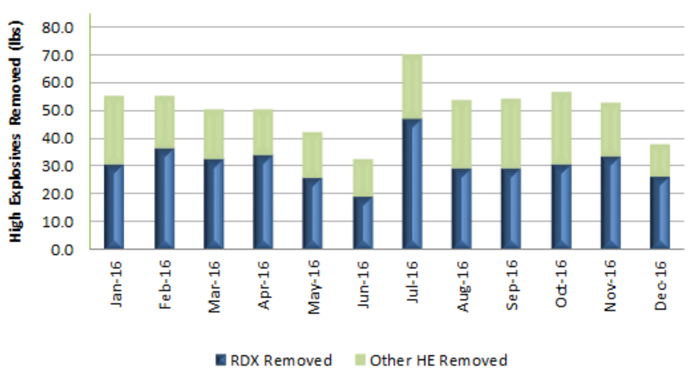


Figure 2-16. SEPTS High Explosive Mass Removed by Month

The SEPTS primarily removes RDX and hexavalent chromium from the perched groundwater. The system removed about 79 lbs of hexavalent chromium, 378 lbs of RDX, and 236 lbs of all other HEs during 2016. The total mass removed by month is depicted in Figure 2-15 and Figure 2-16. The average removal rate of hexavalent chromium was 0.6 lbs/million gallons (Mgal) of water, and the average removal rate for HEs was 4.8 lbs/Mgal of water. Hexavalent chromium mass removal is declining because concentrations in PTX06-EW-51 continue to decline. This well 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 hexavalent chromium plume has moved downgradient, and other extraction wells now capture portions of the plume although concentrations are much lower at these wells. HE mass removal is affected by the wells that operate in the higher concentration portions of the RDX plume. Overall, the average concentrations of RDX in the SEPTS influent has declined with concentrations about 570 ug/L in 2009, the first year of the full remedial action to about 350 ug/L in 2016. Hexavalent chromium average influent concentrations in 2009 were about 214 ug/L while concentrations were about 87 ug/L in 2016.

This system has treated approximately 11,472 lbs of HEs and 1,477 lbs of hexavalent chromium since it started operating. Evaluation of effluent data indicates the system treated the recovered groundwater to concentrations below GWPS.

The summary of COC effluent detections at the SEPTS is included in Table 2-2. The complete set of effluent data collected during 2016 is included in Appendix D.

Table 2-2. Summary of Effluent Detections at SEPTS

Sample Date	Analyte	Measured Value (ug/L)	Bkgd (ug/L)	> Bkgd?	PQL (ug/L)	> PQL?	GWPS (ug/L)	> GWPS?
2/1/2016	RDX	0.03J	--	NA	1	N	2	N
3/7/2016	Total Chromium	4.8J	31.8	N	10	NA	100	N
4/4/2016	Total Chromium	5.9J	31.8	N	10	NA	100	N
5/4/2016	Total Chromium	7.7J	31.8	N	10	NA	100	N
10/3/2016	Total Chromium	1.3J	31.8	N	10	NA	100	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 *Contingency Plan*, Pantex also evaluated eight extraction wells (five included in the SAP, EW-9, EW-10, EW-51, EW-67, and EW-68, and three at special request, EW-1, EW-65, and EW-66) for evidence of contamination from the Zone 11 area that could impact SEPTS. Due to removal of perched water, flow directions are changing along the eastern side of Zone 11; therefore, it is possible that perchlorate and 1,4-dioxane, which are not treatable by GAC, could move into the southwestern portion of the SEPTS extraction well field. Perchlorate was not detected in any extraction wells. See Table 2-3 for a summary of 1,4-dioxane results for 2016.

During 3rd quarter, one perched groundwater well, PTX06-1005, demonstrated an all-time high detection of 1,4-dioxane that was measured at 7.71 ug/L, slightly above the GWPS of 7.7 ug/L. This concentration was not expected at this location, as past data and upgradient well data did not indicate a plume of 1,4-dioxane with concentrations near or exceeding the GWPS. The well was resampled, with two samples sent to two different off-site laboratories and evaluated using two different methods. Results for both samples confirmed the original detection (results of 6.9 and 7.7 ug/L). This well is on the western edge of the SEPTS extraction well field and is of concern because the system may not be able to treat 1,4-dioxane using GAC at current flow rates. Further sampling was conducted in the wells east of PTX06-1005 during 4th quarter because 1,4-dioxane is not routinely sampled in those wells. Four wells were sampled, including three extraction wells (PTX06-EW-1, PTX06-EW-65, and PTX06-EW-66) and one monitor well (PTX06- 1095A). Results indicated that 1,4-dioxane is present in all of the wells, but none of the detected concentrations exceeded the GWPS of 7.7ug/L. The results of the sampling are presented in Table 2-3. Because 1,4-dioxane is entering the well field, annual sampling of PTX06-1005, PTX06-1095A, and the three extraction wells have been added to evaluate 1,4-dioxane. Further actions will be determined based on results of sampling and in accordance with the Contingency Plan.

Table 2-3. Summary of 1,4-Dioxane Detections at SEPTS Extraction Wells

Well ID	Sample Date	Measured Value (ug/L)	Lab PQL (ug/L)	>Lab PQL?	GWPS (ug/L)	>GWPS?
PTX06-EW-1	11/17/2016	0.764J	1	N	7.7	N
PTX06-EW-9	11/30/2016	0.884J	1	N	7.7	N
PTX06-EW-65	11/17/2016	0.544J	1	N	7.7	N
PTX06-EW-66	11/17/2016	4.7J	1	Y	7.7	N
PTX06-EW-67	9/21/2016	0.736J	1	N	7.7	N
PTX06-EW-68	9/21/2016	0.479J	1	N	7.7	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).

Overall the SEPTS continues to remove and treat water from the well field. Operational time and treatment throughput was near or exceeded goals when operating. The system was primarily affected by loss of wells, regular maintenance, and restrictions from the WWTF.

2.2 ISB Systems

Pantex has installed and operates two ISB systems as part of the final Remedial Action for groundwater. One system is southeast of Pantex Plant on TTU property and one is south of Zone 11. In 2016, the ISB systems consisted of 88 treatment zone injection wells and 15 in situ performance monitoring wells.

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.

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 (see Figure 2-17). The system, as operated in 2016, consists of 48 injection wells, five treatment zone monitoring wells, and nine downgradient performance monitoring wells installed in a zone of saturated thickness of approximately 15-20 ft. The system, originally consisting of 23 wells, was installed by March 2009. An additional nine wells were installed in September 2009 to better treat the perchlorate plume on the eastern side and the TCE plume on the western side of the ISB. One of the original wells was removed from active injection in 2013 (PTX06-ISB082). Pantex expanded the system in late 2014 to include an additional 20 injection wells (18 new wells and 2 previously installed pump test wells), 2 new downgradient ISPM wells, and 3 treatment zone monitoring wells (TZM) (1 TZM well was previously installed as a pump test well) that will not receive injection. Two additional TZM wells were also installed in the original system on the TCE side. The two wells are expected to eventually replace the monitoring of injection wells on that side of the system. The expansion was installed to address the plume that extended northwest of the system.

The 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 Texas Tech property near Playa 4. Based on the rate of perched groundwater flow and estimated amendment longevity, injections were estimated to be necessary about every 12 to 18 months. Pantex has been scheduling rehabilitation and injection activities every 12 months based on data collected in the treatment zone. Eight injection events have been completed for this system. Table 2-4 provides the list of injection events and date of completion.

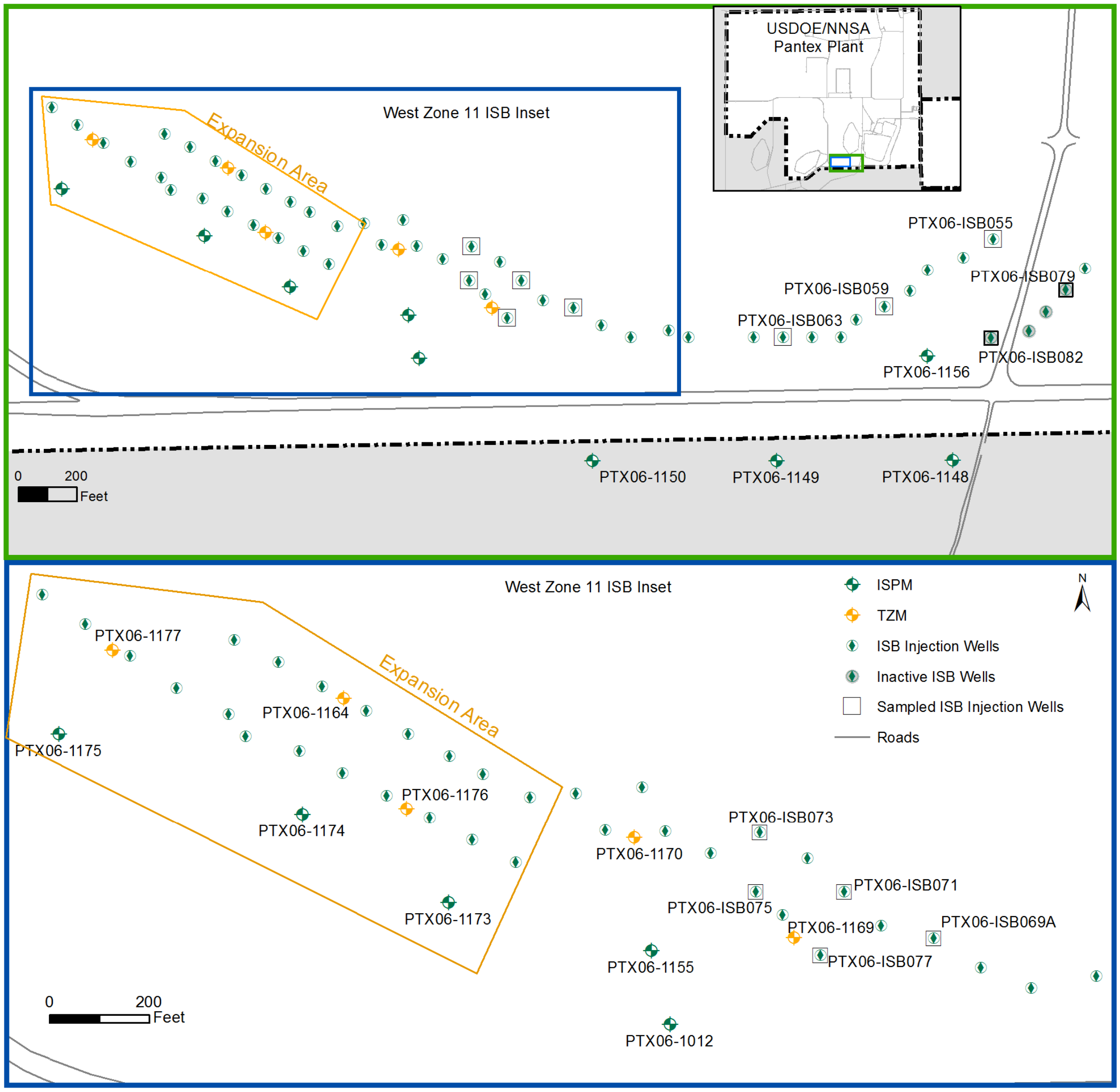


Figure 2-17. Zone 11 ISB Treatment Zone and Performance Monitoring Wells

Table 2-4. 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

During 2016, Pantex monitored five treatment zone (TZM) wells, eleven injection wells, and nine downgradient performance monitoring wells to evaluate the Zone 11 ISB (see Figure 2-17). Pantex also monitors three treatment zone wells in the second row to better evaluate conditions in higher concentration and/or flow areas. An additional treatment zone well (PTX06-1169) was installed to potentially replace nearby monitored injection wells PTX06-ISB071 and PTX06-ISB077. However, these two injection wells are defined as monitoring points in the SAP. Therefore, PTX06-1169 will be sampled concurrently with the monitored injection wells and a SAP revision will be requested if the data collected in the new well more accurately represents treatment zone conditions. Pantex collected baseline data from the three new downgradient wells in 2016 and will begin monitoring those regularly in 2017.

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.

Based on a previous recommendation, Pantex discontinued injection into PTX06-ISB082 after the fifth injection event in 2013 to evaluate the need for continued injection into the second row wells. Because mild reducing conditions are required for treatment of perchlorate, the eastern side of the ISB requires less amendment injection to continue to treat the plume. PTX06-ISB082 was rehabilitated to remove excessive biogrowth during the sixth injection event and was sampled in 4^{th} quarter 2014 for the first time in two years. Pantex evaluated the well in the *4th Quarter 2015 Progress Report*. In 2016, Pantex recommended discontinuing injection into the second row of wells on the perchlorate side based on information collected at PTX06-ISB082 and PTX06-1156.

Data collected since 2014 indicate that PTX06-ISB082 maintains deep reducing conditions and has ample food source for the continued degradation of perchlorate, even without injection for three events. 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. The *Design Basis Document* (Aquifer Solutions, 2008) did not include a second row of wells for the perchlorate portion of the Zone 11 ISB. Pantex installed those wells to capture a high-concentration portion of the plume that had moved past the first row of wells. Those wells have adequately reduced perchlorate and based on data evaluated in PTX06-ISB082 and PTX06-1156, treatment can be discontinued in those wells. Pantex currently monitors PTX06-ISB082 in accordance with the SAP. Although not included in the SAP, a second well (PTX06-ISB081) has been monitored to evaluate the effectiveness of the treatment zone. Pantex changed that monitoring point in 2nd quarter 2016 to PTX06-ISB079 to provide better coverage of the monitoring of the treatment zone on the perchlorate side. However, Pantex rehabilitated the second row wells in 2016 to provide continued sampling opportunities in those wells.

The *In Situ Bioremediation Corrective Measures Construction Zone 11 South Implementation Report* (Aquifer Solutions, 2009a) documents the implementation of the Zone 11 ISB. 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) that was 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). The well installations are documented in the *Well Drilling Implementation* Report (Trihydro, 2014) also included in the *2014 Annual Progress Report*. The *Bioaugmentation Implementation Plan* (Trihydro, 2015) provides the detailed plan for injection of DHC.

2.2.1.2 Operation of Zone 11 ISB

Pantex completed an eighth injection event at the Zone 11 ISB during 2016. Rehabilitation of wells was performed from February to June and injection was performed from April to July.

The well maintenance and post-injection reports for the Zone 11 ISB can be found in Appendix H of this report. Information regarding the effectiveness of treatment is provided in Section 3. A summary of the maintenance and injection is provided here.

To prepare for the injection, several activities were performed to determine if the well screens and/or the sand filter pack may be impaired due to biofouling. The following rehabilitation activities were performed from February to June 2016:

1. Well maintenance at 27 injection wells including Welgicide® reagent application followed by physical development using surging/brushing and airlifting techniques. The old PTX06-ISB075 well was maintained via bailer because it will continue to be used for injection until the well fails. The newly installed replacement well is used to monitor the treatment zone. PTX06-ISB082 was maintained via bailer to prevent further biofouling and to ensure continued sampling. Since no injection occurs in this well, no hydraulic testing was performed.
2. Jetting was performed at ten wells to evaluate more aggressive means of physical maintenance following the application of Welgicide rather than use of airlifting techniques. These wells were selected based on declining trends in historical amendment injection rates or hydraulic conductivity and specific capacity during the post-maintenance injection tests.
3. The 14 wells that were bioaugmented the previous year were maintained using a bailer rather than airlifting or jetting to reduce the potential to cause damage to introduced bacterium as a result of elevated pH and dissolved oxygen that may be introduced during traditional airlift maintenance procedures. These wells did not

receive Welgicide cleaner. Many of the bioaugmentation wells were unable to recharge at the rate that fluid was being removed by bailing, therefore, these wells were bailed dry on three separate occasions after letting the well recharge for a period of at least one day between bailing events.

4. Follow-up hydraulic testing including depth to water and saturated thickness measurement and constant-rate injection testing during amendment injection was performed at the 51 wells where maintenance was performed.

Saturated thickness values, calculated from depth to water measurements and fine-grained zone elevations, were within an average of 0.1 ft before and after well maintenance. The small magnitude of changes in depth to water (1 ft or less) following well maintenance suggests that the wells were generally in good hydraulic communication with the surrounding perched groundwater both before and after maintenance.

Overall, hydraulic testing results indicate transmissivity to be decreasing at 26 of the 33 wells with historic data (not including western expansion wells drilled in 2014). Of the six wells that are not decreasing, two are stable and four are improving. This data may suggest decreasing rehabilitative applicability, but may not diminish maintenance as a preventative measure. Wells maintained without the use of Welgicide decreased an additional 19% when compared to wells using Welgicide.

After rehabilitation was complete at each well, injection activities were started at the wells. Of the 52 injection wells, 46 received amendment injection during the 2016 injection event. All second row wells on the perchlorate side of the ISB no longer receive injection. Additionally, because of the loss of transmissivity and resulting inability to inject in some wells, two first-row wells on the perchlorate side were paused for injection in 2016 to determine if lengthening injection would improve transmissivity.

Dosing of amendment was calculated according to the volume of groundwater to be treated and a target amendment concentration of at least 5% per the design basis. To optimize the amendment injection, a ranking procedure was used at each well that considered groundwater flux and COC concentration. A higher ranking represented higher flux and COC concentration. Since the flux and COC concentration would dictate potentially faster rates of amendment consumption, the amendment dosage was optimized considering these parameters. Additionally, the volume of mixed amendment was increased in the western portion of the well field where the system treats TCE.

Bioaugmentation occurred at 14 of the 51 wells in 2015. Wells on the western side of the established ISB received the DHC culture and amendment. The 20 newer wells in the expansion zone were not bioaugmented in 2016. These wells will be bioaugmented once conditions conducive to growth and survival of the DHC are established.

Injection activities at each well consisted of the injection of mixed amendment, targeted at the concentration calculated as described, followed by a period of a water-only flush. The flush water represented approximately 10% of the target injection volume at each well. The intent of the water-only flush is to increase the radius of influence of the amendment delivery and to transport more of the amendment away from the direct vicinity of the well to potentially lessen the degree of biofouling. The target percentages and volumes also accounted for the water-only flush.

Forty-four of the 46 injection wells received an amendment dose equal to or greater than the target dose. Two wells, PTX06-ISB056A and PTX06-ISB061, were stopped short of the amendment injection target injection rates gradually decreased to less than 3 gpm, a level that became impractical for accurate injection using the current equipment in the injection trailer. Both wells are located on the perchlorate side of the system where performance data has consistently indicated complete degradation of perchlorate since implementation of ISB.

Bioaugmentation was performed at 14 wells on the TCE side of the original portion of the Zone 11 ISB System in 2015 to establish a community of DHC microbes capable of degrading TCE to ethene because sampling indicates these microbes may not be present at the Zone 11 ISB. As the first injection event following bioaugmentation of DHC, measures were taken to ensure make-up water used at these 14 wells were within specified optimal ranges for dissolved oxygen, oxidation reduction potential (ORP), and pH. The criteria established for this anaerobic makeup water was developed from discussions with SiREM (the producers of KB-1 bioaugmentation culture). ORP was used as the primary indicator, with a value of less than -75 millivolts (mV) deemed acceptable for injection. If ORP was between -75 mV and -50 mV, the injection rate was slowed to allow additional residence time in the holding tanks which decreased the ORP to levels below -75 mV. If ORP rose above -50 mV a temporary shutdown was performed until the ORP was reduced back within specifications.

To determine the effectiveness of the bioaugmentation, Pantex has planned a series of sampling events. The first sampling event occurred in February and March 2016. Seven wells in the treatment zone were targeted for sampling in 2016 at the Zone 11 ISB treatment zone. Sampling was conducted using both micropurge and Bio-Traps. Water samples were collected and sent to Microbial Insights for analysis. Results from either sampling method indicate current DHC counts were low and counts for the TCE and vinyl chloride reductase gene do not indicate that reductive dechlorination is occurring yet. Water samples collected in February 2016 were also analyzed for CSIA. CSIA evaluates the changes in isotopic ratios to evaluate the type of concentration changes that are occurring. In the case of degradation of TCE in the Zone 11 ISB treatment zone, the TCE molecules with the lighter carbon isotopes (12C) will be degraded before the TCE molecules with heavier carbon isotopes (13C), resulting in a heavier (less negative) ratio of 13C/12C. The qPCR and CSIA data combined with the recent dataset from the Zone 11 ISB area indicate that complete dechlorination is not likely occurring at this time due to low counts of DHC and mild reducing conditions in many areas of the Zone 11 ISB where bioaugmentation has occurred. To help maintain deep reducing conditions for the DHC that were previously injected, Pantex injected with anaerobic makeup water mixed with amendment during the 2016 injection event. Pantex plans to continue to monitor DHC, reductase genes, and CSIA. Details of the study are presented in Appendix A of the Pantex Quarterly Report First Quarter 2016.

2.2.1.3 Future Operation of Zone 11 ISB

Pantex has observed problems with sampling and continued injection of some wells in the established portion of the Zone 11 ISB since 2015. During the 2016 injection event, packers were installed in 4 wells to inject amendment under pressure. This trend of decreasing injection rate is expected to continue unless amendment injection frequency is changed and more aggressive methods of well rehabilitation are used.

Pantex started conducting studies to determine the effectiveness of reducing injection frequency, reducing lactate in the soybean amendment, and use of jetting for rehabilitating wells. Additionally, the original pilot study for the ISB systems was reviewed to evaluate the continued effectiveness of the system.

Pantex had decreased injection at a second row well, PTX06-ISB082, in the past to determine if pausing injection would be effective in reducing biomass and provide more effective sampling. This well had viscous white mass in the well when injection was discontinued. Rehabilitation was performed at the well for two years following the last injection to remove mass in the well. Within two years the well had improved. During the injection pause for this well, Pantex also evaluated the need for continued injection on the perchlorate side of the ISB. Based on this evaluation, injection has been discontinued at the well, and it will only be maintained as a monitoring well. However, the well water has greatly improved and sampling has continued at the well without encountering any problems. Deep reducing conditions have continued at this well even though it has not been injected since 2013.

During the 2016 injection event, lactate was reduced to a minimal level (0.2%) to evaluate the effect on pH drops that could impact the survival or growth of the DHC. Overall, the minimal lactate did not prominently change the pH levels to warrant a change in the lactate.

Jetting was performed at ten wells as a more aggressive maintenance method that avoids use of chemicals that can damage well casings. The study included wells from the original portion of the system and new wells from the expansion area. The jetted wells demonstrated a reduction in transmissivity, with varying degrees of reduction. The wells from the original part of the system showed the greatest reduction in transmissivity, but the new wells in the expansion area demonstrated a smaller reduction than in wells only maintained with Welgicide and airlift techniques. This technique may be of value to help maintain the newer wells.

To evaluate the effectiveness of continued treatment with less frequent injections, the ISB Pilot Study data were evaluated. A pilot study was conducted from October 2005 through May 2007 to assist with determining the feasibility of in situ bioremediation using an emulsified vegetable oil. The pilot study results served as a basis for the design of the two ISB systems at Pantex. For the pilot study, nine ISB wells were installed in a square configuration (three rows of three wells) in an area that is northeast of the current Southeast ISB. The system was designed to treat hexavalent chromium, RDX, and other HE contaminants. Saturated thickness in the area was over 10 ft at the time of injection. Six ISB injection wells were used for this study, with an initial injection occurring in November–December 2005. Only three wells (PTX06-INJ/BIO-001, -002 and -005) were injected a second time in October–November 2006. Three downgradient ISB wells were used to initially monitor results of the injection. Four other monitoring wells were also installed to monitor results within and downgradient of the system. Three of those monitoring wells continue to be sampled by Pantex. Figure 2-18 depicts the pilot study wells.

A similar amount of amendment was delivered to the Pilot Study as is currently injected at the Zone 11 and Southeast ISBs. The initial saturated thickness of the Pilot Study was greater than that of the Southeast ISB, but the saturated thickness at the Zone 11 ISB is greater. Residence time of the impacted groundwater that flows through the Pilot Study is faster than the Southeast ISB, but residence times are shorter at the Zone 11 ISB due to higher groundwater flux rates in that area. This can result in slightly different impacts at each ISB, but the Southeast ISB is expected to react similarly to the Pilot Study. Pilot Study results reflect expected treatment results for COCs that do not require the deep reducing conditions required for treatment of TCE.

Data at the monitoring wells installed at the Pilot Study indicated that complete treatment of HEs and hexavalent chromium occurred in less than two years at most downgradient wells, with the best results demonstrated at PTX06-1098, PTX06-1100, and PTX06-1101. PTX06-1099 did not treat as well possibly because of less favorable geologic conditions in that area preventing delivery of amendment to the maximum distance between wells. Pantex has continued monitoring the three monitoring wells listed above to determine long-term performance of the Pilot Study. All other well sampling was discontinued in 2008.

Figure 2-18. Pilot Study Wells

Where monitoring was continued at three wells, the results indicate that the ISB is continuing to treat RDX and hexavalent chromium with no further injections in the Pilot Study wells. RDX is no longer treated to GWPS (2 ug/L) at PTX06-1101, but concentrations remain low (<30 ug/L). Data collected from PTX06-1101 indicate that treatment started declining in 2013. Hexavalent chromium is being treated below the GWPS at all of the monitored wells. Results for these wells, along with the baseline concentrations is presented in Table 2-5.

These results indicate that treatment continued for at least 5 years after the final injection. This longevity of treatment is likely a result of adsorbed amendment in the soil pore space that is slowly released and recycling of biomass that provides a continued carbon source for bacterial breakdown of RDX and hexavalent chromium. Recycling of biomass has been documented in other ISB systems (Suthersan et. al, 2013).

Pantex has also evaluated residence time in the pilot study and ISBs. Residence time is considered as the amount of time that a COC will stay within the treatment zone before passing through the system. COCs that are easily treatable, such as perchlorate, will not require much residence time to be treated. RDX and TCE take longer to treat, with TCE being the most difficult to treat. Based on estimates, the residence time in the pilot study is about six years. Estimated residence times in the Southeast ISB vary from 20 to 40 years depending on the water velocity in the system. Residence time at the Zone 11 ISB is estimated to be about one to two years. Residence times could be a factor in the continued treatment of high concentrations of COCs, particularly TCE, in the ISBs.

Table 2-5. ISB Pilot Study Monitoring Results

	RDX			Hexavalent Chromium		
Sample Date	PTX06-1098 MV	PTX06-1100 MV	PTX06-1101 MV	PTX06-1098 MV	PTX06-1100 MV	PTX06-1101 MV
Baseline	836.4	1032.7	1271.1	441	398	525
GWPS	2	2	2	100	100	100
Mar-07	ND	1.5	ND	ND	ND	ND
May-07	ND	3.8	0.33	ND	ND	ND
Jul-07	ND	2.5	ND	ND	ND	ND
Sep-07	ND	5.5	ND	ND	ND	ND
May-08	ND	ND	ND	78	88	130
Aug-09	ND	ND	ND	8	52	14
Apr-10	ND	ND	ND	18	40	ND
May-11	ND	ND	ND	ND	14	13
May-12	ND	ND	ND	29	81	13
Apr-13	0.26	ND	ND	22	5	8
May-14	ND	ND	9.4	5.54	5.54	ND
Dec-15	ND	ND	14	ND	ND	ND
May-16	ND	ND	23.1	ND	ND	ND

MV = Measured Value in ug/L

MVs exceeding GWPS

2.2.1.4 Recommended Changes to Zone 11 ISB Operation

Evaluation of data, testing of the system, and literature research indicates that it would be appropriate to change injection frequency to two years within the original portion of the system. It is standard industry practice to inject every two to three years for slow-release emulsified vegetable oil-type systems (AFCEE, 2007). Additionally, the amendment loading into the system and difficulty with injection indicate that it is appropriate to lengthen the time between injections. Pantex will continue to inject annually in the expanded portion of the system. Pantex will continue to evaluate the expanded portion of the system to determine the appropriate time to change to a two-year frequency.

2.2.2 SOUTHEAST ISB

2.2.2.1 History of Southeast ISB

The Southeast ISB System is on TTU property south of Pantex. The system was installed in 2007 as an early action and consists of 42 injection wells within the treatment zone and six performance monitoring wells (see Figure 2-19). 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 Texas Tech property where the FGZ becomes less resistant to vertical migration.

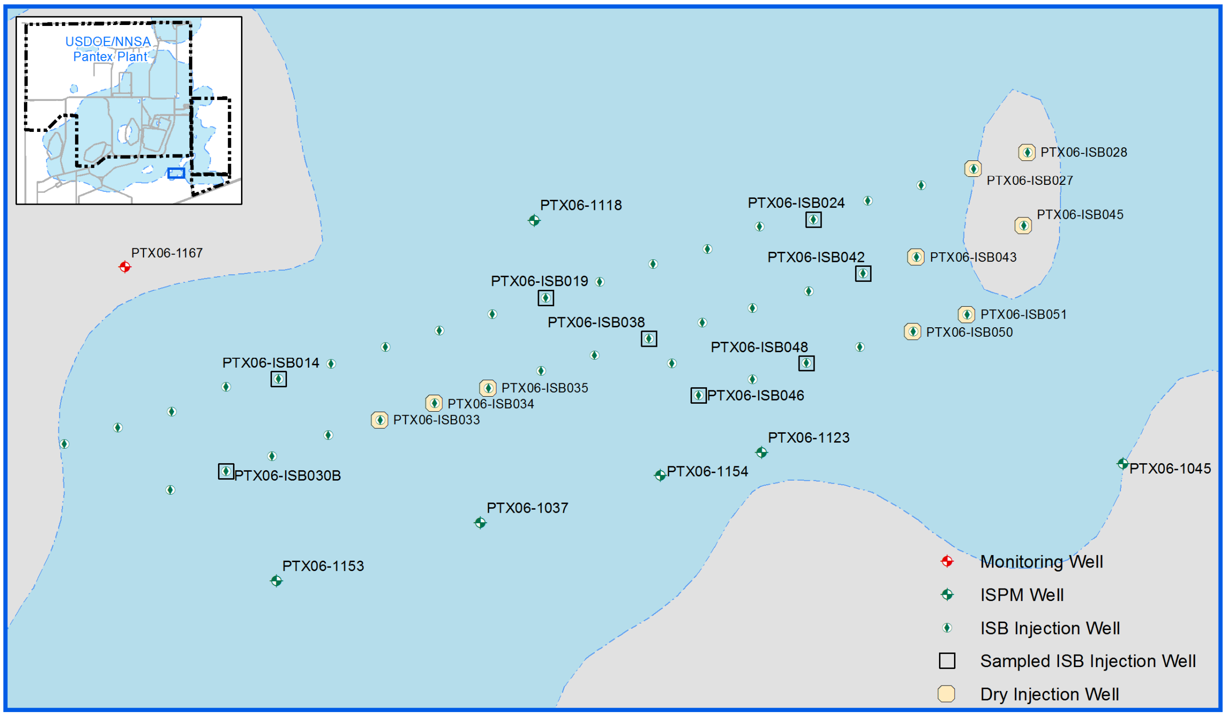


Figure 2-19. Southeast ISB Treatment Zone and Performance Monitoring Wells

Based on the rate of perched groundwater flow and estimated amendment longevity, injections were estimated to be necessary about every 12 to 24 months. Pantex has been scheduling injections about 18 months apart. Six injection events have been completed for the Southeast ISB as provided in Table 2-6.

Table 2-6. 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

Areas within and surrounding the Southeast ISB continue to demonstrate that water conditions are changing. ISPM wells PTX06-1045 and PTX06-1118 have not been sampled since 2009 and 2010, respectively, as water levels have declined in the wells. Downgradient ISPM well PTX06-1123 had water levels decline during 2nd quarter 2015 and remained dry through 2016. PTX06-1167, 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. As depicted in Figure 2-19, several areas inside the treatment zone are dry and injection does not typically occur in those wells. Other treatment zone wells also indicate changes in the system either due to the influence of the pump and treat systems or impacts to the well or formation. PTX06-ISB019 has not been sampled since late 2013 and remains dry. PTX06-ISB042 went dry in early 2015 and remained dry through 2016. It is expected that areas of the Southeast ISB may no longer require injection and/or that the period of time between injections may be increased in the future.

As provided in the SAP, eight treatment zone wells, six downgradient performance monitoring wells, and one upgradient performance monitoring well are used to evaluate the Southeast ISB. Two performance monitoring wells (PTX06-1045 and PTX06-1118) for the Southeast ISB have gone dry and have not been monitored since 2009 and 2010, respectively. A third ISPM well, PTX06-1123, was not sampled in 2016 as the well remains dry.

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 *Final Pantex Interim Remedial Action Report* (IRAR) (Pantex, 2010a).

2.2.2.2 Operation of Southeast ISB

Pantex completed a sixth injection event for the Southeast ISB in 2016. Rehabilitation of wells was performed from August to October 2016 and injection was performed from September to October 2016.

The well maintenance and post-injection reports for the Southeast ISB can be found in Appendix H of this report. Information regarding the effectiveness of treatment is provided in Section 3. A summary of the maintenance and injection is provided here.

To prepare for the injection, several activities were performed to determine if the well screens and/or the sand filter pack may be impaired due to biofouling. The wells that were rehabilitated from August to October 2016:

1. Well maintenance at 34 injection wells including Welgicide® reagent application followed by physical development using surging/brushing and/or airlifting techniques. Eight historically dry wells were confirmed to be dry in 2016 and were not maintained during this event.

2. Follow-up hydraulic testing was performed at 23 wells initially selected for injection in 2016 where maintenance was performed.

Post-maintenance injection tests were compared from maintenance events from 2012 to 2016. Based upon constant-rate injection results, there appears to be an overall increase in transmissivity in 2016 relative to post-maintenance tests from previous maintenance events.

After rehabilitation was complete at each well, injection activities were started. Of the 42 injection wells, 21 received amendment injection during the 2016 injection event. Wells that remained dry after maintenance or had very little saturated thickness (about 1 ft of water in the screen) were not injected because injection would not be expected to effectively distribute the amendment.

Dosing of amendment was calculated according to the volume of groundwater to be treated and a target amendment concentration of at least 5% per the design basis. To optimize the amendment injection, a ranking procedure was used at each well that considered groundwater flux and COC concentration. A higher ranking represented higher flux and COC concentration. Because the flux and COC concentration would dictate potentially faster rates of amendment consumption, the amendment dosage was optimized considering these parameters.

Injection activities at each well consisted of the injection of mixed amendment, targeted at the concentration calculated as described, followed by a period of a water-only flush. The flush water represented approximately 10% of the target injection volume at each well. The intent of the water-only flush is to increase the radius of influence of the amendment delivery and to transport more of the amendment away from the direct vicinity of the well to potentially lessen the degree of biofouling. The target percentages and volumes also accounted for the water-only flush.

A total of 475,040 gallons of fluids were injected into 21 injection wells during the 2016 injection event. Injection volumes per well ranged from about 11,000 gallons to more than 57,000 gallons. The target amendment concentration ranged from 5.0 to 5.8 percent. As calculated after completion of injection, the actual dosage range for most wells were very close or on target, with a range of 5.0 to 6.9 percent in all wells. The design target volume and dose was met or exceeded for all four injection zones. In addition, all injection wells received volumes equal to (within 0.3 percent) or greater than the 2016 informal operational targets.

Pantex deployed passive flux meters (PFMs) in eight monitoring wells within or near the SEISB System on September 12 to 14, 2016. The PFMs were deployed to assess the impact of dewatering within and around the SEISB on groundwater flow and to support long-term decisions regarding SEISB injection. The PFMs were deployed in monitoring wells and to directly measure flux for groundwater and select dissolved constituents. After the deployment period, subsamples are collected from the PFMs and extracted for either the groundwater tracers or target groundwater constituents. Key conclusions of the study included:

- Groundwater flux values are substantially higher in the three wells located north/northwest of the SEISB System than in the five wells located in or near the SEISB System. However, anomalous data at PTX06-PRB16 challenge this conclusion, and Pantex is further evaluating the data for this one well.
- PFM-measured groundwater flux values are generally higher than values calculated using transport times or Darcy's Law. This is likely due to differing calculation methods, and neither result is considered to be more accurate; the results represent different conditions that effect parameters used in the calculations.
- Measurable groundwater flux was observed in PTX06-1153, which refutes the hypothesis that the well is isolated from the SEISB System due to being present in a stagnant groundwater zone; an alternative explanation for the lack of treatment in PTX06-1153 involves groundwater flow to the west of the SEISB System.

Overall, the PFM deployment worked well and the data provided some potentially valuable insights into groundwater movement in the area of the SEISB. Details of the study are presented in Appendix A of the Updated Conceptual Site Model Report for ISB Operations and Maintenance dated January 31, 2017.

2.2.2.3 Future Operation of Southeast ISB

Pantex has observed problems with sampling and continued injection of some wells in the Southeast ISB system. As discussed above, injection flow rates are declining in some wells. Additionally, water levels are declining and injection into wells with very little water is not expected to distribute amendment effectively. Water level trends indicate that water is declining at a rate of 0.1 to 0.3 ft/yr in most of the ISB injection wells, with a few having much higher rates of decline. The system overall has very little saturated thickness, i.e. $<$10 ft of water, see Figure 2-20. The majority of saturation occurs through the center of the system. In past injection events, up to 33 wells were injected, regardless of the water levels in the well. During the 2016 injection event, only 21 of 42 wells were injected because water levels did not recover in some wells following rehabilitation efforts. Additionally, as discussed in the 2015 Annual Report, Pantex did not inject into dry wells. Based on water level trends and the continued upgradient extraction of water, it is expected that less than half of the system will be injected at the next injection event.

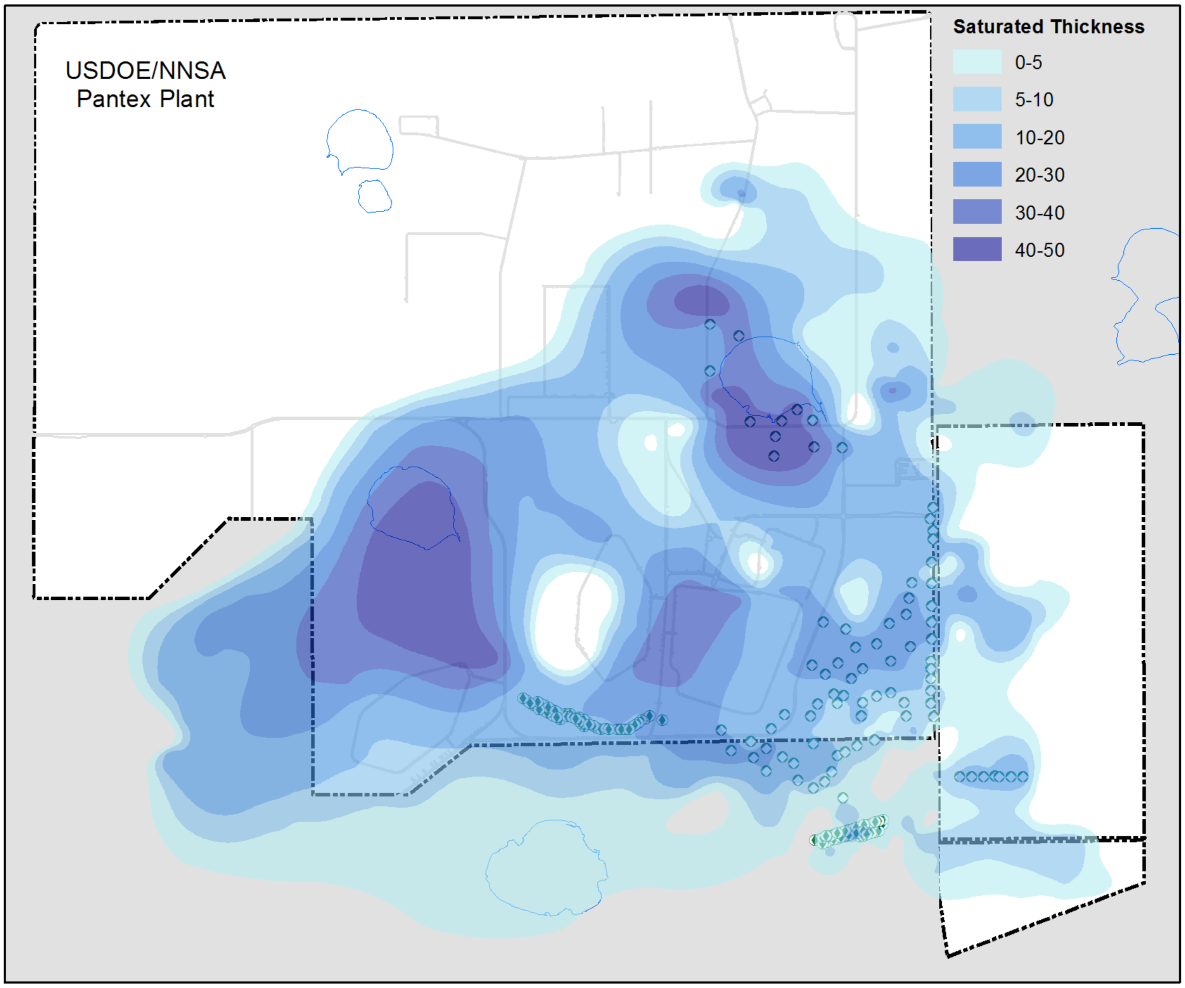


Figure 2-20. Perched Aquifer Saturated Thickness, 2016

Evaluation of water level trends indicates that water levels have decreased since the start of remedial action. Some wells have dramatically decreased and have gone dry. However, because of effects from biofouling, trends may not actually reflect the overall change in the aquifer in the ISB. For this reason, Pantex conducted a passive flux meter (PFM) study in 2016 to evaluate whether water continues to flux into select system wells, along with the downgradient wells. Three upgradient wells were also evaluated to determine if water continues to move to the southeast.

PFMs are designed to directly measure flux for groundwater and select dissolved constituents. The PFMs contain a sorptive media (GAC and resin) to sorb contaminants. The media in the PFMs are pre-loaded with tracers for measurement of groundwater flux; the mass of the tracer that is lost during the period of deployment is related to the quantity of groundwater that moves through the well. Similarly, dissolved-phase constituents sorb to the media in the PFM, such that the constituent flux can be determined by the quantity gained by the media. PFMs were installed in three first-row ISB injection wells (PTX06-ISB014, PTX06-ISB020, and PTX06-ISB024), two downgradient ISPM wells (PTX06-1153 and PTX06-1154), and three upgradient wells (PTX06-1166, PTX06-PRB016, and PTX06-INJ/BIO-007) in September 2016 (see Figure 2-21). The PFMs were deployed in the saturated portion of the well, where possible. Some wells had very little water and care was taken to remove only the saturated media for analysis.

All wells showed varying degrees of groundwater flux indicating that water is continuing to move into the system. Seepage velocities across most of the wells ranged from 20 to 320 feet per year (ft/yr). The three first-row ISB injection wells had the lowest seepage velocities reported. Two wells located to the northwest of the system (PTX06-1166 and PTX06-INJ/BIO-007) had the highest seepage velocities. The two downgradient ISPM wells (PTX06-1153 and PTX06-1154) also indicated low-to-medium seepage velocities. One of those wells, PTX06-1153, which does not demonstrate treatment, does indicate a low seepage velocity so water is continuing to move into the well. One well to the northeast of the system had anomalous data reported, so Pantex is in the process of validating that information.

The PFM results indicate that water is continuing to move toward the Southeast ISB, but at a low rate. Water levels in wells within the system indicate that minimal water is moving in and the areas of greater saturated thickness represent residual water that will continue to move downgradient through the treatment zone. Wells to the northwest of the ISB indicate that water is moving at a higher rate. Pantex will continue to evaluate the dry area to the west of the Southeast ISB to evaluate whether water from the northwest has impacted or will continue to impact the ISB. Residual water continues to move through the ISB and is moving into the downgradient wells indicating that PTX06-1153 is not in a stagnant area. As expected, COCs continue to move with the groundwater.

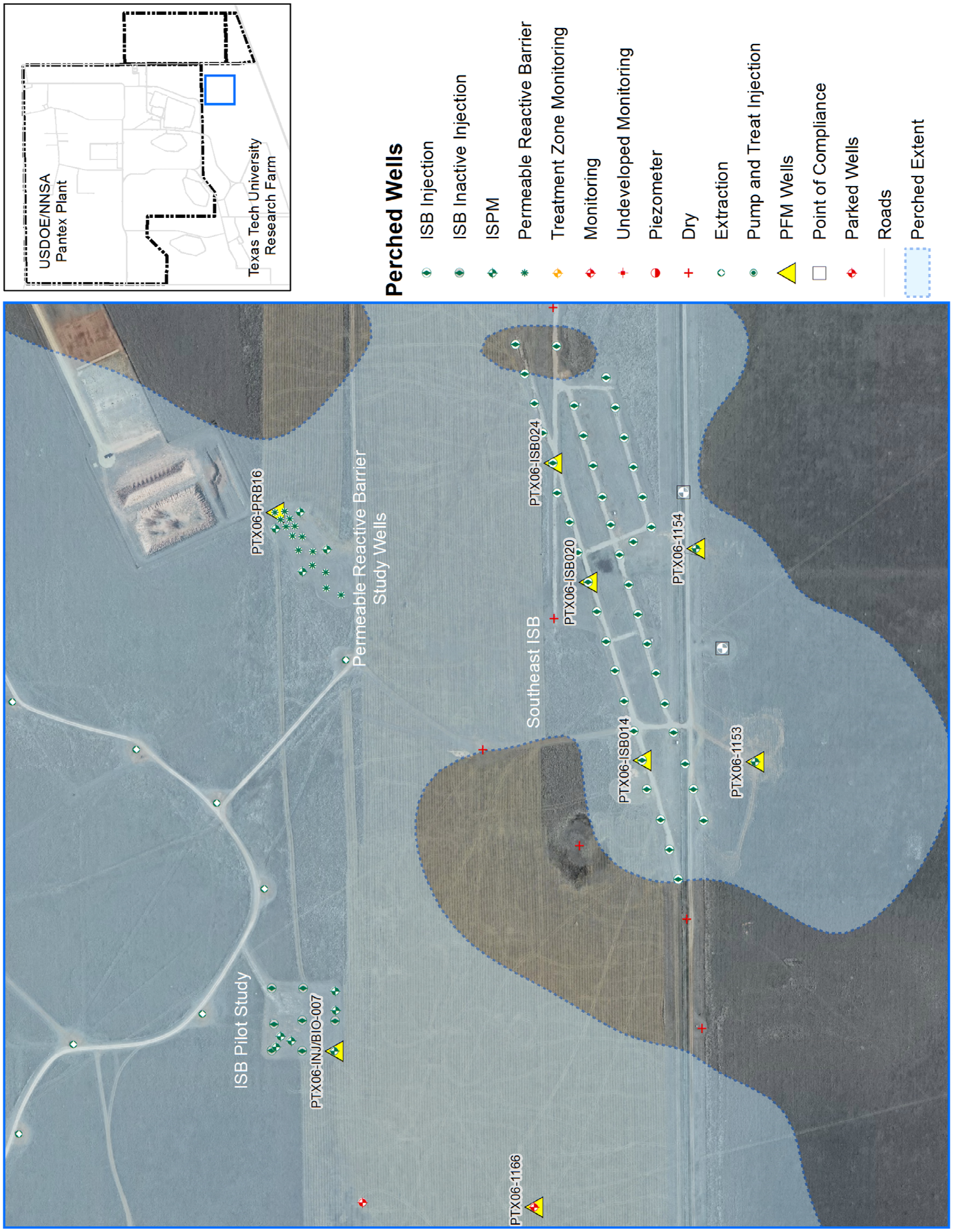


Figure 2-21. Passive Flux Meter Well Locations

2.2.2.4 Recommendations for Southeast ISB Operation

The Southeast ISB has been injected at an 18-month frequency. Similar to the Zone 11 ISB, the wells have become difficult to inject, likely because of accumulation of amendment in the pore spaces. Organic carbon data collected before the latest injection indicated that additional amendment was not necessary to sustain treatment. Data from the Pilot Study also indicate that a longer period between injections is achievable once reducing conditions are adequately established. The *Design Basis* indicates that less frequent injections would be appropriate in later years. While Pilot Study results indicate that as long as five years could be achievable, Pantex plans to reinject the Southeast ISB in three years (2019). The timing or need for further injections will be evaluated after the next injection because predicted water levels in six years based on current trends indicate that very few ISB injection wells will have significant saturated thickness.

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 1.2.1). The O&M of the soil remedies are discussed in these sections.

2.3.1 Burning Ground SVE

The Burning Ground 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 address the remediation of VOCs present in the shallow and intermediate depth vadose zone at the Burning Ground (SWMUs 47 and 38). The system was designed to remediate soil gas in the areas beneath the solvent evaporation pit/chemical burn pit (SEP/CBP) and the Landfills north of the SEP/CBP. From the RCRA Facility Investigations, original VOC concentrations at the Burning Ground were as high as 962 parts per million by volume (ppmv) in the shallow zone (20-90 ft 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 (95-275 bgs) were as high as 1845 ppmv (Stoller, 2002). The remedial goal was to reduce the mass of VOC contaminants in soil gas significantly, thus mitigating impacts to the underlying groundwater. That goal has been 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 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 single soil gas well (SVE-S-20), where soil gas concentrations continue 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 allow installation of a small-scale CatOx system that continues to focus remediation on SVE-S-20. The new system is more cost efficient and will effectively treat all detected COCs at the Burning Ground. System construction and installation began in February 2012. System startup and testing began on April 5, with normal operations commencing on April 19, 2012.

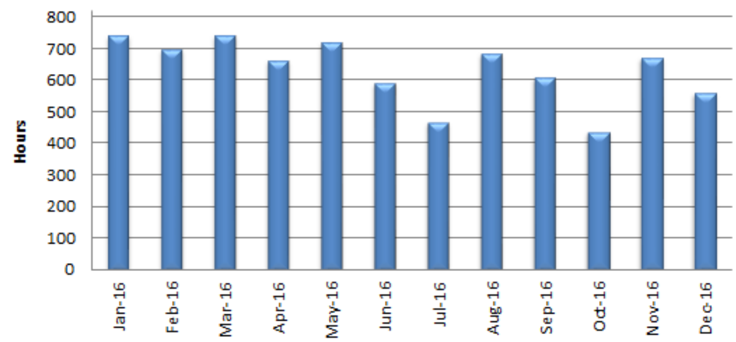


Figure 2-22. SVE System Operation

Figure 2-22 depicts the SVE system operation for 2016. The system was intermittently operated with shutdowns for maintenance, repairs, extreme temperatures, and power outages. Ambient temperature and shutdown for inspection affected the system in July and October. Maintenance and repairs occurred infrequently throughout the other months. The system was operating each month with most monthly operational rates above 80%.

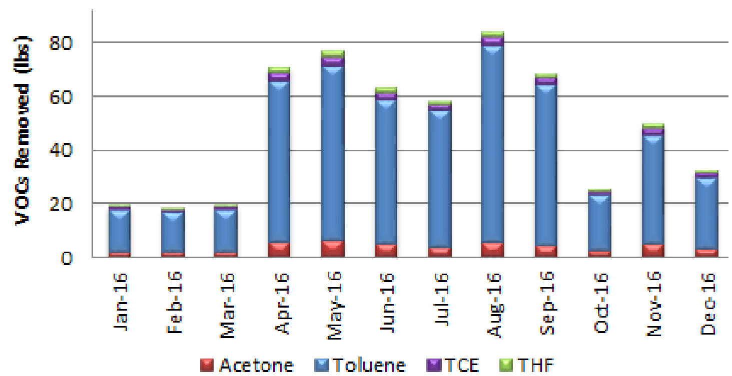


Figure 2-23. Burning Ground SVE Mass Removal

Calculated mass removal for 2016 is presented in Figure 2-23. Mass removal was estimated based on concentrations reported from analytical sampling, system operation time, and system flow rates. VOC constituents contributing more than 1% of the total VOC concentration were included in the calculation. Mass removal has been impacted by the shutdowns for inspection, maintenance and repairs, with the greatest impact occurring from the low influent concentrations. Trends of 2016 data indicate that most COCs demonstrated a decreasing trend. See Section 4 for a discussion of trends.

The SVE system has been effective at removing VOCs from soils. The system removed about 664 lbs of VOCs during 2016. Since inception, the SVE system has removed over 18,800 lbs of VOCs.

As reported in the monthly Air Quality Monitoring Reports to the Regional TCEQ office, all 2016 effluent PID readings for the new system indicate that destruction efficiency was 98% or greater, exceeding the permit-by-rule limit of 90%.

2.3.1.1 Soil Remedial Action Inspections

During 2016, Pantex conducted quarterly inspections of landfills as well as after rainfall events of greater than ½ inch. Inspections were also conducted for the ditch liner and SWMU signs and postings at various times during 2016. The FS-5 fence was installed during 2009, and the fencing is inspected quarterly. Key findings of the landfill inspections and resulting actions are included in Table 2-7.

2.3.2 Engineered and Institutional Controls

The soil remedial actions at Pantex are discussed in Chapter 1. The SVE system is the only active soil remedy; 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 Interim Remedial Action Report (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 to prevent spread of contaminated soils. Pantex also regularly inspects and maintains soil covers on landfills to prevent infiltration of water into the landfill contents and migration of impacted water to groundwater. Pantex installed, inspects, and maintains a fence around FS-5 to control access and use of an area that is impacted by depleted uranium. 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 rain water from infiltrating into soils. Pantex regularly inspects this ditch liner. Maintenance is either contracted, as necessary, or work orders are placed with the onsite Maintenance Department.

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 small holes/voids from wildlife. In the past, these smaller issues were addressed using Pantex personnel and equipment. However, to ensure long-term 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 such as those identified during the 2015 and 2016 inspections (e.g., Landfill 3 erosion) have been contracted separately for design and construction. Each contracting effort will be followed-up with inspections to evaluate the effectiveness of the actions. The key findings from soil inspections is included in Table 2-7.

Table 2-7. 2016 Key Findings and Corrective Actions for Soil SWMUs

Findings	Corrective Actions
SWMU 57 Landfill 6 has large holes and areas that require reseeding	Will be addressed through new landfill maintenance contract. Seeding will also be conducted after filling of holes.
SWMU 60 and 61 (Landfill 9 and 10, respectively) had low areas where ponding and infiltration could occur.	Will be addressed through new landfill maintenance contract. Seeding will also be conducted after filling of low areas.
SWMU 66 (Landfill 15) has holes and depressions.	Landfill addressed in late 2016 through new landfill maintenance contract.
Unassigned Zone 10 Landfills had holes and depressions.	Landfills addressed in early 2017 through new landfill maintenance contract.
SVS 7a/7b numerous small landfills with holes and depressions.	Will be addressed through new landfill maintenance contract. Seeding will also be conducted after filling of holes.
SVS 8 Abandoned Zone 10 Landfill has holes	Holes were addressed by Pantex personnel in 2016.
SWMU 54, Landfill 3 has extensive erosion in areas along the nearby ditch. Heavy rainfall in 2015 caused erosion of those areas. Erosion of areas near parking areas and culverts also need to be addressed.	Pantex has started contracting for design and construction of a remedy for the erosion and to address improvement of the cover where needed.
SWMU 63 Landfill 12 has depressions	Landfill addressed in early 2017 through new landfill maintenance contract.
SWMU 68c, SWMU 54, SWMU 64, SWMUs 37-44, and SVS 6 landfills (Landfills 2, 3, 13, Burning Ground, and Zone 7, respectively) had low spots and distressed vegetation when inspected for the First Five-Year Review. Review of the landfills during 2015 indicated that the landfills had a few holes that need to be filled. The vegetation is still sparse in the reseeded areas. Side slope erosion was noted on Landfill 3. Landfill 13 has holes/voids on the north and southwest edges of the landfill.	These areas were identified during the Five-Year Review as needing erosion control. The work was contracted and low areas were backfilled, seed applied per the landfill reseeding plan, and erosion control mats were applied on sloped areas in 2013. Pantex continues to evaluate the effectiveness of the maintenance. Based on the 2015 review, most of the landfill vegetation has recovered due to heavy rainfall that occurred during 2015. A long-term maintenance contract was issued in 2016 to address remaining small areas that needed seeding and periodic repair of holes and depressions in the surface of the landfill covers. In late 2016/early 2017 Pantex addressed SWMU 68c with the installation of Closure Turf and SWMU 64 was addressed through the new landfill maintenance contract. Landfill 3 (SWMU 54) is being contracted separately and will be addressed by 2018.
SWMUs 5-05 and 2 – Ditches. The liner in the ditches has pulled away from the top trench anchoring and has a few small tears.	The liner was replaced in early 2017.

During 2016, Pantex conducted inspections to evaluate the effectiveness of seeding conducted in accordance with recommendations from the *First Five-Year Review* (Pantex, 2013d). The bare ground/stressed vegetation at the landfills was noted during the inspection for the Five-Year Review. Drought conditions in the Texas Panhandle from 2011 through 2013 caused considerable loss of vegetation on the covers. As part of the recommendations from the *Draft Final Five-Year Review*, Pantex developed and implemented a plan to control erosion on the landfill. The plan was detailed in the *2012 Annual Progress Report* (Pantex, 2013b). The reseeding of the landfills was complete in October 2013, with the recommendation to review the landfills in 2014. However, no rainfall occurred after seeding, so significant changes were not expected. Pantex applied the seed at double the recommended minimum rate and the seed is viable for two to three years. Therefore, Pantex requested that the evaluation of reseeded landfill covers continue annually through 2016. These landfills have been scheduled for final seeding and filling of holes through the new landfill maintenance contract. Most of these areas were addressed in late 2016 or early 2017. SWMU 54 and SVS 6 are scheduled to be addressed by 2018. The five-year issue is considered closed out through the contracting. Old issues as well as any newly identified problems are being addressed.

The rainfall that occurred in 2015 and 2016 significantly improved vegetative cover at all landfills. However, the heavy rainfall also caused erosion in some areas, with the largest problems identified at Landfill 3. Pantex has contracted for design of improvements to address the erosion at Landfill 3. Construction of the upgrades is expected to occur by 2018.

To provide long-term erosion and infiltration control at the landfills, Pantex received additional funding to install Closure Turf® on landfills that were good candidates for the cover. Landfill 2, SWMU 68c, was identified for installation of the Closure Turf®. The construction was completed in April 2017.

Pantex will continue to evaluate the landfills annually and report the findings of the review and any plans that are developed to address holes, depressions, or bare areas. Problems identified will be addressed annually through the landfill maintenance contract and larger issues, such as erosion, will be addressed through separate contracts. The active landfill area at Pantex is continually maintained by the Waste Operations Department and old landfills in that area will be addressed by onsite Waste Operations personnel.

Pantex also noted during inspection that the ditch liner in Zone 12 was degrading, pulling away from the top anchor trenching, and had a few small tears. Because the liner was near the end of its life cycle, Pantex contracted to replace the liner in 2017, with installation completed in March. The new liner is more resistant to UV light and is heavier, providing a longer life cycle for the liner.

2.3.2.1 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 execution of the work. Older listed projects from the completed project areas were inspected after completion of work to ensure 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 2-8 provides information on projects that were not complete by the last annual report as well as new SWMU interference projects from 2016. Ten new permits were issued in 2016 with four completed in 2016.

Table 2-8. SWMU Interference Log

Log #	State Approval Date	SWMU #	Explanation of Work
Current Projects			
SIN 16-001	Reissue	SWMU 108, 109	12-68: Replaced domestic water valve 12NV2, and to remove domestic water valves 12NV3A, and 12EV1. Status: Complete 2016
SIN 16-002	03.02.16	SWMU 5-04b	Two Locations to be excavated 6-8 ft to repair water lines: South of 12-R-034, and west of 12-073, and then 50 yards south of that. Soils were returned to SWMU. Status: Complete 2016
SIN16-003	03.28.16	SWMU 5/13a	12-130: Repair of domestic water leak on a water line that feeds Building 12-130. Hydro-excavation or back-hoe was used as needed to repair the water leak to restore water to 12-130. Soil was returned to the original SWMU area. Status: Complete 2017
SIN16-004	06.17.16	SWMU 55	Infrastructure group must excavate to repair post indicator and PIV valve. Backhoe, loader, CAT Excavator and other equipment will be used. Status: Active
SIN16-005		SWMU 56	The yard group will excavate a ditch area that is intended to drain water away from the 12-44 ramp to the SWMU 56 Ditch. Equipment to be used includes: Hydro-excavator, shovels, and a Bob Cat Skid Loader. The work includes removing the top 6 inches of soil as the ditch, and making it 7 feet wide to tie into the SWMU 56 Ditch. A small soil berm will be leveled across the area. All soils were evenly distributed within the SWMU area. Status: Complete 2016
SIN16-006	08.01.16	AOC 13	A temporary generator will be added on a new pad to 12-108. A new road will also be installed along with an underground duct bank. In addition to this, a new ATS system will be installed to accompany the existing system to help support the load of the new generator. The underground duct bank trench is estimated to be 150 feet long and 6 feet deep. All soils are going to be returned to their original area. The portion of the trench that is within a SWMU will require soils to be kept separate from what is not within a SWMU. Status: Pending
SIN16-007	07.29.16	SWMU 137	Repair or replace existing PIV 12SP367 valve near Building 12-47 and 12-42 to restore regular water flow to the HPFL line. The Yard group will be excavating the area using a hydro-excavator. They will hydro-excavate approximately 10 feet below grade, exposing at least 2 feet of the leaking system. Status: Pending
SIN16-008	11.15.16		Excavation for all utilities within SWMU's and SWMU extents for the new Administrative Support Complex. Status: Active

Log #	State Approval Date	SWMU #	Explanation of Work
SIN16-009	10.07.16	SWMU 13	Installing a new concrete pad for a transformer on the East side of 11-51A. Area will be leveled and the excavation area will consist of approximately 45 square feet with a maximum depth of 4 feet. Status: Active
SIN16-010	10.17.16	SWMU 05/13	12-86: Removal of existing asphalt, excavate existing base and some soil to level road grade, lay new base, and re-lay new asphalt. All soils were evenly distributed within the road area within the SWMU. Status: Complete.

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, 2013c) was completed in October 2013 and was 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. Significant components of the plan include:

- Assigning 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).
- Assigning a maintenance frequency of two years for all wells with stainless steel screens that have documented well corrosion and elevated chromium concentrations.
- Assigning a default inspection frequency of five years for all perched aquifer LTM wells to comply with total depth measurement requirements 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 the field technicians. Water levels are measured at each sampling event and twice annually and total well depths are only measured when dedicated equipment is not present in the well.

The 2016 maintenance log for groundwater wells is included in Appendix C. This log 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. The disposition of the purge water from well activities is also provided.

Pantex has identified, through well videos, evidence of bacteria in many of the stainless steel wells. This condition is common in monitor wells, especially in wells with lower groundwater velocity. 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 (chromium, manganese, molybdenum, and nickel) that become elevated in wells. Well videos recorded during routine well inspections indicate that a large percentage of wells have some biofouling. Pantex continues to evaluate rehabilitation methods for the biofouling. Pantex plans to implement a chemical rehabilitation program in 2017 to address the perched wells as the growth has completely blocked portions of the screens in some wells. New perched wells are now installed with PVC materials, rather than stainless steel, to avoid corrosion issues associated with well materials; however, pumps still consist of stainless steel that is subject to corrosion.

Pantex has redeveloped wells, including brushing, bailing, and pumping, as necessary, when screens were impacted by biofouling, calcium deposits, or sedimentation, or elevated chromium levels were observed. Based on well videos and total depth measurements, some wells were observed to have sediment in the sump, with a few wells having sediment built up into the bottom of the screen. One well was noted as possibly having more than 20% of the effective (saturated) screen silted in. Well evaluation and maintenance has been ordered for the well. Most well maintenance efforts were focused on cleaning wells that exhibited issues with silting or bacteria in the screen. Pantex also focused on completing high volume purges on wells that were sampled for the five-year review.

Pantex performed the following well maintenance activities in 2016:

- Performed 67 well videos to evaluate the condition of wells and determine if re-development or other maintenance was required.
- Performed pump service (removal/installation of pump and tubing bundles) to prepare for well videos, re-development, special sampling, measurement of pump and tubing bundle length, lengthen sampling depths due to declining water levels, install diverters, and replace pumps.
- Re-developed 35 wells to reduce silting and clean the well screens.

2.4.2 Well Casing Elevations

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

Pantex resurveyed all wells in 2010 using Pantex's real-time kinetic GPS system that is calibrated to the National Geodetic Survey. This system will be consistently used for surveying wells in the future. Those well elevations were included in the *2010 Annual Progress Report* (Pantex, 2011a).

The surveyed well elevations for new wells and resurveyed wells are included in Table 2-9. During 2016 Pantex installed two long-term monitoring wells and five extraction wells. Several wells within or near the Zone 11 ISB were resurveyed to validate the original information due to anomalies noted in water table mapping for the Zone 11 ISB. Pantex plans to use the new survey data where significant differences are noted.

Table 2-9. Well Elevations

Well	Northing	Easting	Ground Surface Elevation (amsl)	TOC Elevation (amsl)
Wells Installed in 2016				
PTX06-1182	3751088.49	647140.17	3515.30	3517.32
PTX06-1183	3753350.43	639765.77	3532.36	3534.32
PTX06-EW-82	3753953.55	644481.36	3528.58	3530.65
PTX06-EW-83	3753953.69	644782.02	3528.32	3530.15
PTX06-EW-84	3753954.16	645082.73	3528.18	3530.01
PTX06-EW-87	3753953.71	645782.09	3527.71	3529.71
PTX06-EW-88	3753954.30	646083.180	3527.46	3529.42
Wells Surveyed in 2016				
PTX06-1148	3754719.97	636466.58	3524.17	3526.24
PTX06-1155	3755215.62	634603.92	3539.89	3541.92
PTX06-1170	3755442.76	634569.72	3540.98	3543.18
PTX06-ISB075	3755335.13	634812.70	3539.57	3542.14
PTX06-ISB077	3755206.28	634942.45	3538.09	3540.24
PTX06-ISB069A	3755239.82	635169.70	3536.28	3538.34
PTX06-ISB071	3755333.00	634990.90	3538.83	3540.90
PTX06-ISB082	3755139.31	636598.04	3528.82	3530.58
PTX06-1156	3755076.46	636379.03	3527.27	3529.42
PTX06-1012	3755069.41	634640.47	3539.06	3541.08
PTX06-1031	3753347.88	644674.49	3527.17	3529.41

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 is to 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 for mapping of 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

All 2016 purged contaminated groundwater exceeding GWPS from sampling events and maintenance activities was containerized, then the volume of water was logged and the water treated through SEPTS in accordance with Provision XI.B.8 of the HW-50284, with a few exceptions. Purge water from one designated perched monitor well and all ISB system wells was containerized and disposed of by the Pantex Plant Waste Operations Department due to the water being characteristically hazardous or the water contained contaminants that were not treatable by the pump and treat systems. Most Ogallala Aquifer wells are unaffected and are not required to be managed or volumes tabulated so the water is released to nearby ditches. Because Ogallala well PTX06-1056 had low-level detections of HEs (below GWPS) in 2016, Pantex containerized the purge water from sampling events, and then the water was logged and treated through SEPTS.

In accordance with Provision XI.B.8 of HW-50284, all recovered perched groundwater from extraction wells is treated through the P1PTS or SEPTS. All treated water from the P1PTS and the majority of the SEPTS treated water is sent through subsurface lines to the WWTF storage lagoon. The lagoon water is then sent through the WWTF filter building and subsequently released to the Plant's subsurface irrigation system, as needed. Pantex Plant has been authorized by permit (TLAP #04397, issued April 2012) to release treated wastewater for irrigation of crops. Provisions were added in the latest permit renewal allowing treated water to be used in other ways, such as for construction projects, as long as the treated water meets GWPS and criteria specified by the State of Texas. Pantex has completed construction of a bulk water station at SEPTS for delivery of treated water for beneficial use at Pantex. Pantex has set up procedures and record keeping for the bulk water station. The station became operational by July 2016.

As authorized by the Underground Injection Control, Authorization No. 5X2600215, Pantex injects treated water into select wells at Pantex. Portions of the SEPTS treated water is injected through injection wells PTX06-INJ-10 and PTX06-INJ-11 when needed. Portions of the SEPTS treated water are used for the Southeast ISB and Zone 11 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 is provided in Section 2.1.

3.0 Groundwater Remedial Action Effectiveness

In this section, the groundwater remedial action is evaluated for overall effectiveness during 2016 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/early detection
4. Natural attenuation

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

3.1 Plume Stability

Plume stability is evaluated through 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) also support this analysis.

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

In order 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, 2014a). Therefore, a comparison of observed versus expected conditions was conducted as part of the evaluation process. Appendix E includes the LTM expected conditions as well as current conditions based on 2016 analytical and water level data.

3.1.1 COC Concentration Trending

COC concentration trends were calculated using both the non-parametric Mann-Kendall and parametric linear regression statistical methods adapted from the AFCEE Monitoring and Remediation Optimization System (MAROS) Software. Trends were calculated for the entire dataset for each LTM network well (long-term), data from the four most recent sampling events (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 remedial actions began for RDX, TCE, perchlorate, and hexavalent chromium are depicted in Figure 3-1, Figure 3-2, Figure 3-3, and Figure 3-4, 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, etc.) and can be used with data sets which 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 LTM System Design Report* (Pantex, 2014a).

3.1.1.1 RDX Trends

Evaluation of concentration trends for RDX indicates that RDX is decreasing, stable, or does not demonstrate a trend at all monitoring points near source areas (Playa 1 and the ditch along the eastern side of Zone 12). This condition is expected as 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). The SEPTS has had some effect on the plume as 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 as concentrations in downgradient wells are stable or declining, with the exception of PTX06-1153. 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 3-1.

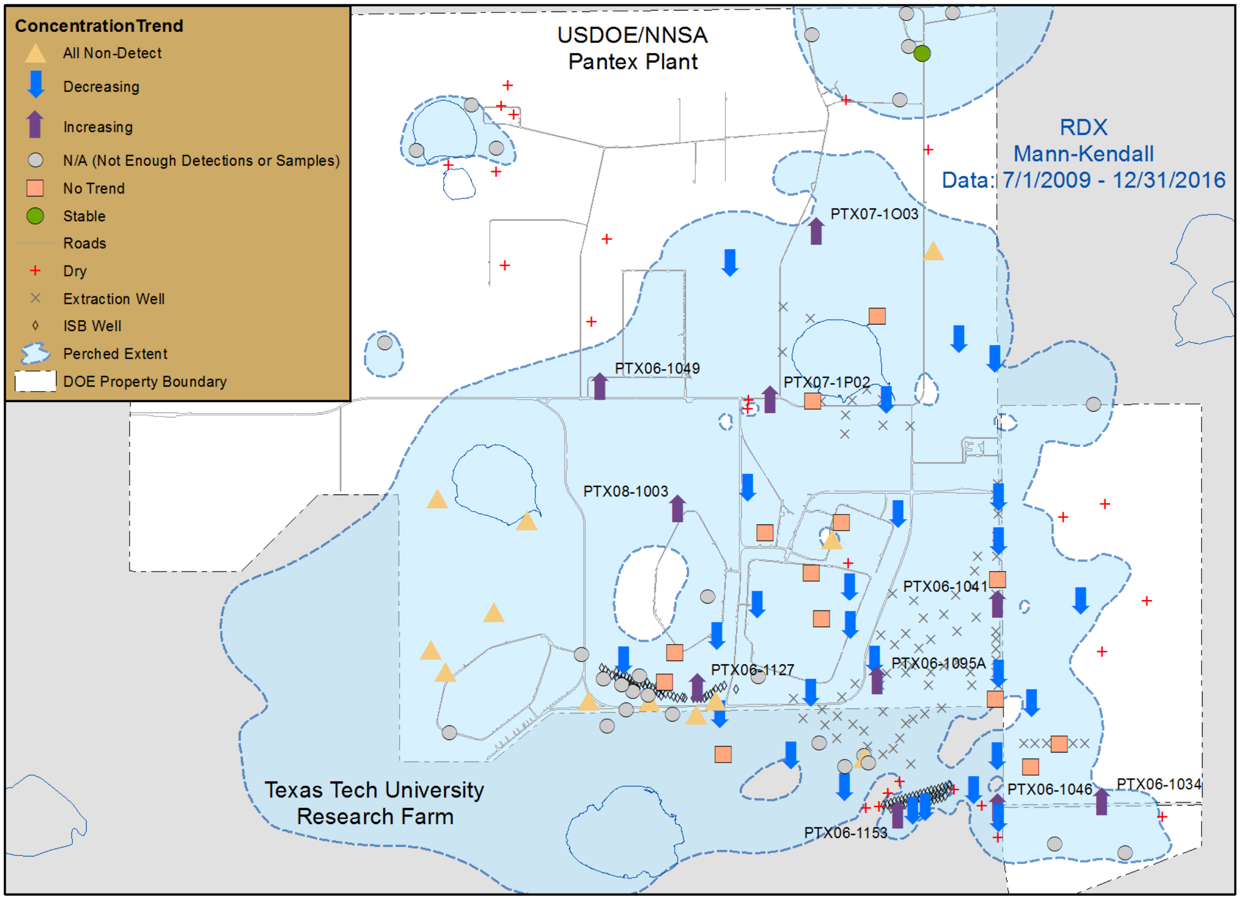


Figure 3-1. RDX Trends in the Perched Aquifer

Overall, 10 monitoring wells exhibited increasing trends in RDX using data since the start of remedial actions, as depicted in Figure 3-1.

- RDX was first observed at low concentrations in PTX06-1049 in 2011, then steadily increased until 2014, and have since declined to levels below the GWPS in 2016. This well is located in the far western side of the perched aquifer which is outside the influence of a remedial action and these trends are likely due to groundwater flow from the Playa 1 vicinity.
- PTX07-1O03, located north of Playa 1, is exhibiting an increasing trend in RDX. However, this well exhibited higher historic RDX concentrations and exhibits a decreasing trend considering all data. In addition, concentrations have been stable for the last three years. The increasing trend may be due to P1PTS effects as system operations have dramatically affected water levels and gradients in this region of perched groundwater.
- PTX06-1127, located south of Zone 11 outside the effects of a remedial action, is exhibiting an increasing RDX trend and exceeded the GWPS for the first time in 2016.

This well is located upgradient of the Zone 11 ISB system, and based on the data collected in the Southeast ISB system, RDX will be effectively treated in the system.

- Two wells located in the far southeast lobe of perched groundwater (PTX06-1034 and PTX06-1046) are exhibiting increasing trends in RDX, likely due to plume movement into these wells. This area has been identified as a region that is not currently under the effect of a remedial action.
- PTX06-1041, installed along the eastern edge of the extraction well field, is exhibiting an increasing trend in RDX, but is under the direct influence of nearby extraction wells. Both long-term and short-term trends do not indicate increasing concentrations and the variable trend may result from affected water from the east being pulled back into the well field or other pumping effects.
- PTX06-1095A is within the influence of the SEPTS well field, but is also located less than 50 feet downgradient of the Permeable Reactive Barrier Pilot Study wells PTX06-PRB01A and PTX06-PRB02. The increasing trend is likely due to the PRB losing treatment effectiveness and concentrations returning to baseline conditions.
- PTX06-1153, which is a downgradient ISPM well for the Southeast ISB system, is exhibiting an increasing but highly variable trend in RDX. This well is discussed in detail in Section 3.2.3.2.
- PTX07-1P02, located southwest of Playa 1, is exhibiting a slight increasing trend just above the GWPS, but concentrations remain far below historical levels for this well. The increasing trend may be due to P1PTS effects as system operations have dramatically affected water levels and gradients in this region of perched groundwater.
- PTX08-1003, is exhibiting an increasing trend, but all values are near the PQL and well below the GWPS.

A comparison of current trends to expected conditions for specific wells in the LTM network is included in Section 3.1.2.

3.1.1.2 TCE Trends

As depicted in Figure 3-2, 16 monitoring wells are exhibiting increasing trends in TCE concentration since the start of remedial actions:

- The apparent increasing TCE trend in PTX06-1005 is likely caused by the return of unaffected conditions in this area following the cessation of injection of treated water at SEPTS injection well PTX06-INJ-12A, which is located approximately 200-feet to the east. Almost 70 million gallons 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 into this well was ceased because of failure of the well.

- Slightly increasing trends were identified for PTX06-1010 in the eastern part of Zone 12. TCE concentrations in PTX06-1010 have been below the GWPS since 2009.

- Increasing trends were identified for PTX06-1031 and PTX06-1046 in the extreme southeastern portion of perched groundwater. All sample results in both wells have been below the sample PQLs. The identified increasing trends are the result of low-level detections and use of one-half the detection limit in the trending and do not indicate actual increasing concentrations in this area.

- PTX06-1035, PTX06-1134, PTX06-1148, PTX06-1150, and PTX06-1159 which are downgradient of the Zone 11 ISB, are exhibiting increasing trends in TCE concentration due to general plume movement downgradient. However, 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 and PTX06-1148 remain below the GWPS.

- TCE is exhibiting an increasing trend in PTX06-1049, located west of Playa 1 which is not historically nor expected to be under the effect of a remedial action. TCE was first detected in this well in 2006 and has been slowly increasing at levels below the GWPS, although declining concentrations were observed in 2016. This trend is likely due to groundwater flow from the Playa 1 vicinity.

- PTX06-1095A is within the influence of the SEPTS well field, but is also located less than 50 feet downgradient of the PRB pilot study wells PTX06-PRB01A and PTX06-PRB02. The increasing trend is likely due to the PRB losing treatment effectiveness and concentrations returning to baseline conditions.

- An apparent increasing trend was identified for PTX06-1098, located on the upgradient side of the ISB pilot system, based on samples collected in 2015 and 2016. Similar to PTX06-1101, these results correspond to a decrease in *cis*-1,2-DCE and may indicate a reduction in the treatment provided by the ISB pilot system.

- An apparent increasing trend was identified for PTX06-1101 based on the last two samples which indicate a sudden increase from low-level detections near the PQL to TCE levels exceeding the GWPS. This well is located on the downgradient side of the Southeast ISB pilot study well field, and these results correspond to a decrease in *cis*-1,2-DCE to below the PQL. Therefore, the increase in TCE may indicate a reduction in the treatment provided by the ISB pilot system.

- PTX07-1O02, located north of Playa 1, has exhibited variable low-level TCE concentrations since 1996. However, no concentrations have exceeded GWPS. As discussed in Section 3.1.1.1, the area north of Playa 1 is affected by P1PTS operations.
- 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.
- 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 use of one-half the detection limit in the trending and does not indicate actual increasing concentrations in this area.

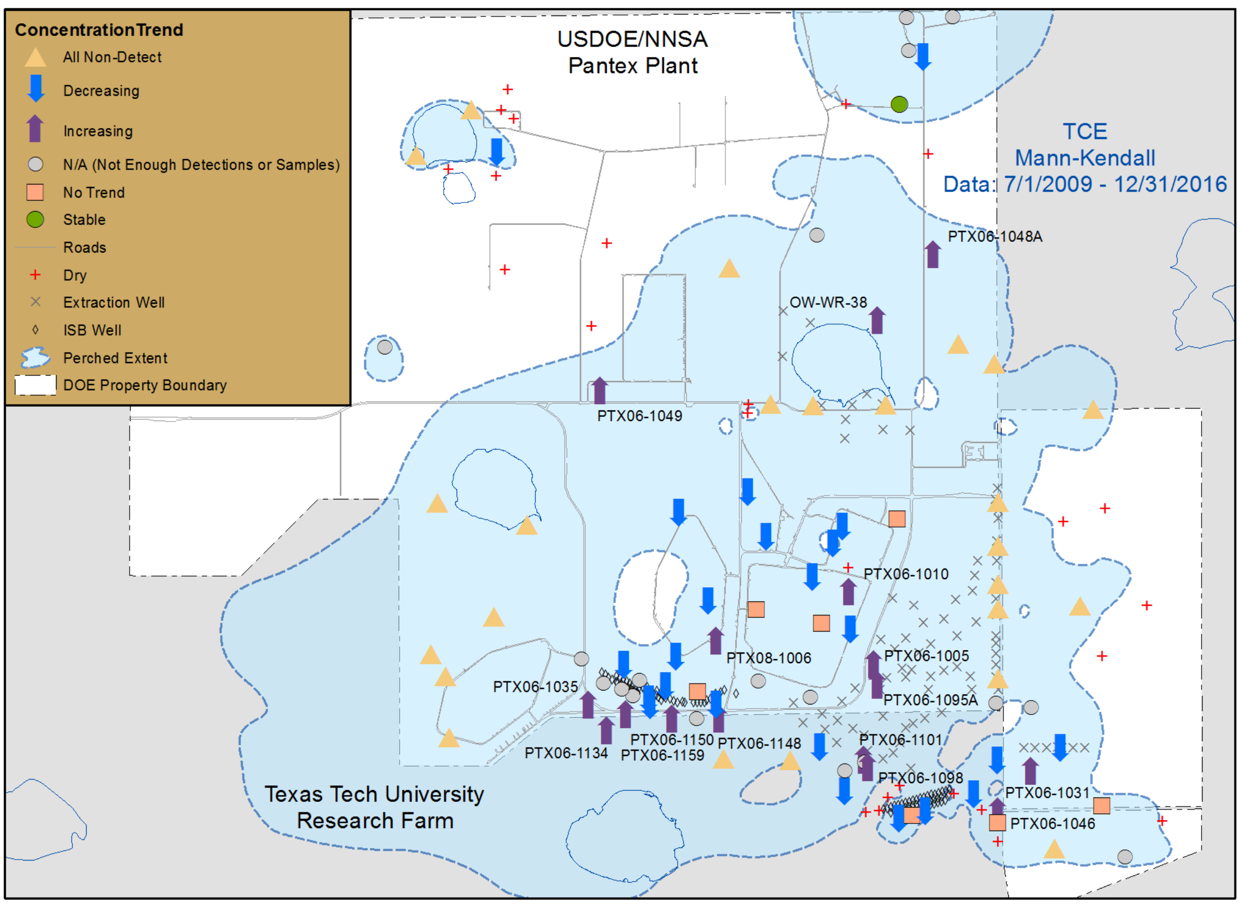


Figure 3-2. TCE Trends in the Perched Aquifer

3.1.1.3 Perchlorate Trends

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

- 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. While these wells are located downgradient of the current Zone 11 ISB system, treated water is not expected to reach these wells for many years.

- PTX06-1007 was exhibiting a slight decreasing trend in perchlorate from the time it was installed in 2000 until 2008, then began exhibiting increasing trends; Mann-Kendall analysis indicates a probably increasing trend based on data collected since the start of remedial actions in 2009. However, the last two samples indicate a substantial decrease in perchlorate to levels observed in 2010 and 2011. 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 historic injection and the resulting return to unaffected perchlorate 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 PTX06-1007.

- 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 slow increasing trend. 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 captured by the SEPTS.

- An apparent probably increasing trend was identified for PTX06-1077A. However, samples collected in the past three years have been non-detect, and the apparent trend is caused by using one-half the sample detection limit in the trend analysis.

- Perchlorate continues to increase in PTX08-1008 since the increasing trend was observed following the November 2014 sampling event. The observed increase in perchlorate in this well may be due to general plume movement to the southeast in this area, which may also be influenced by SEPTS operations.

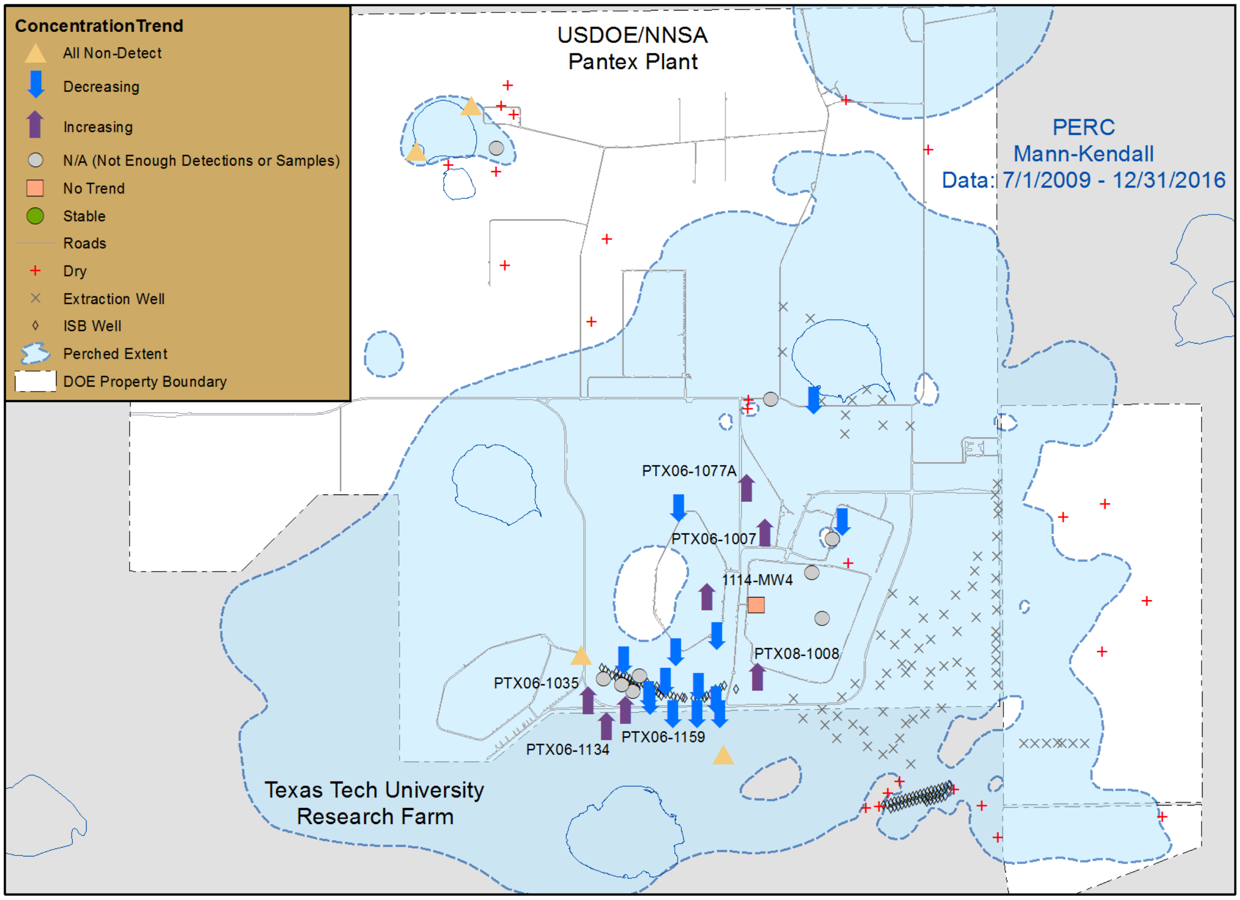


Figure 3-3. Perchlorate Trends in the Perched Aquifer

3.1.1.4 Hexavalent Chromium Trends

As depicted in Figure 3-4, five perched aquifer wells are exhibiting increasing trends in hexavalent chromium since remedial actions began:

- An apparent increasing trend was identified for PTX06-1015; however, samples collected during the past three years have fluctuated above and below the sample PQL. 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 casing of the well.

- An apparent increasing trend was identified for PTX06-1146; however, samples collected during the past three years have been below the sample PQL with the exception of the most recent sample from August 2016, although this value was not confirmed by the total chromium analysis. 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 casing of the well.

- PTX06-1153, which is a downgradient ISPM well for the Southeast ISB system, is exhibiting an increasing trend in hexavalent chromium based on data collected since the start of remedial actions in 2009. However, data collected over the last two years indicate concentrations are decreasing. This well is discussed in detail in Section 3.2.3.2.

- A probably increasing trend was identified for PTX06-1166. 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 PTX08-1009 with the last three sample results indicating relatively stable concentrations below the GWPS, although data collected over the last two years indicate relatively stable concentrations. This well is located along the northern edge of the hexavalent chromium plume and historically exhibited very high concentrations. The recent detections may indicate general plume movement to the southeast and the influence of the SEPTS well field.

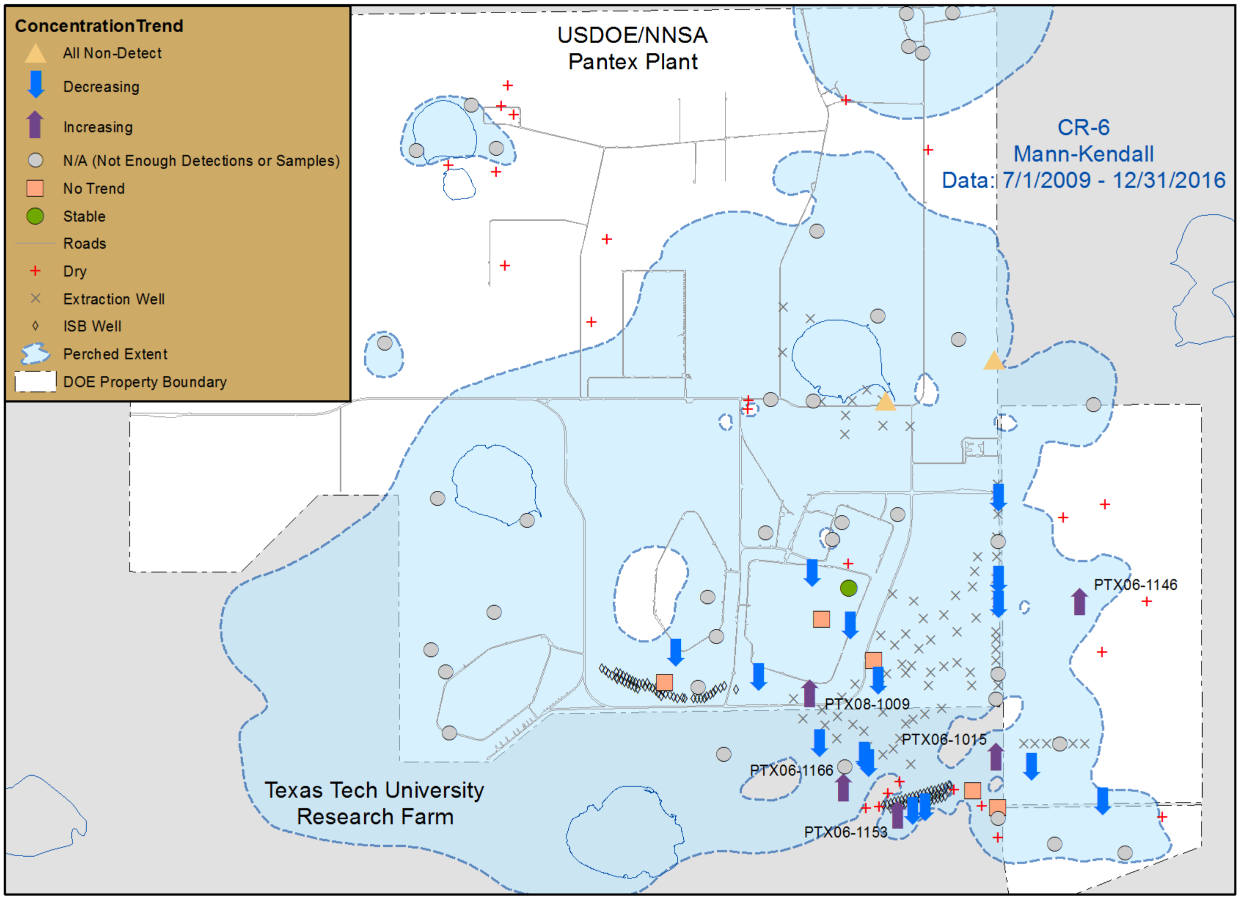


Figure 3-4. Hexavalent Chromium Trends in the Perched Aquifer

3.1.2 Concentration Trends Compared To Expected Conditions

Of the 103 monitor wells with expected COC concentration conditions defined in the LTM Design Report, 27 wells did not exhibit trends (since the start of remedial actions) consistent with the expected conditions. Thirteen wells (1114-MW4, OW-WR-38, PTX06-1010, PTX06-1015, PTX06-1031, PTX06-1041, PTX06-1048A, PTX06-1077A, PTX07-1O02, PTX07-1O03, PTX07-1P02, PTX08-1003, and PTX08-1009) had expected conditions of long-term stable or decreasing trends in concentration, but indicated increasing trends since the start of remedial actions. However, their long-term trends were decreasing or stable, so the expected conditions are met and the trends in these wells are not discussed further. Currently, the smaller size of the comparative dataset (covering approximately 6 ½ years since remedial actions began) limits its effectiveness to represent long-term trends. It is expected that, as remedial actions continue to operate and the dataset continues to grow, these trends will become more representative of long-term conditions in the perched aquifer.

The following 14 monitoring wells (depicted in Figure 3-5), PTX06-1005, PTX06-1007, PTX06-1034, PTX06-1035, PTX06-1046, PTX06-1049, PTX06-1095A, PTX06-1127, PTX06-1134, PTX06-1146, PTX06-1159, PTX06-1166, PTX08-1006, and PTX08-1008, exhibited trends that were not consistent with the expected conditions and were previously discussed in Section 3.1.1. Additional detail on all LTM wells is located in Table E-1 in Appendix E.

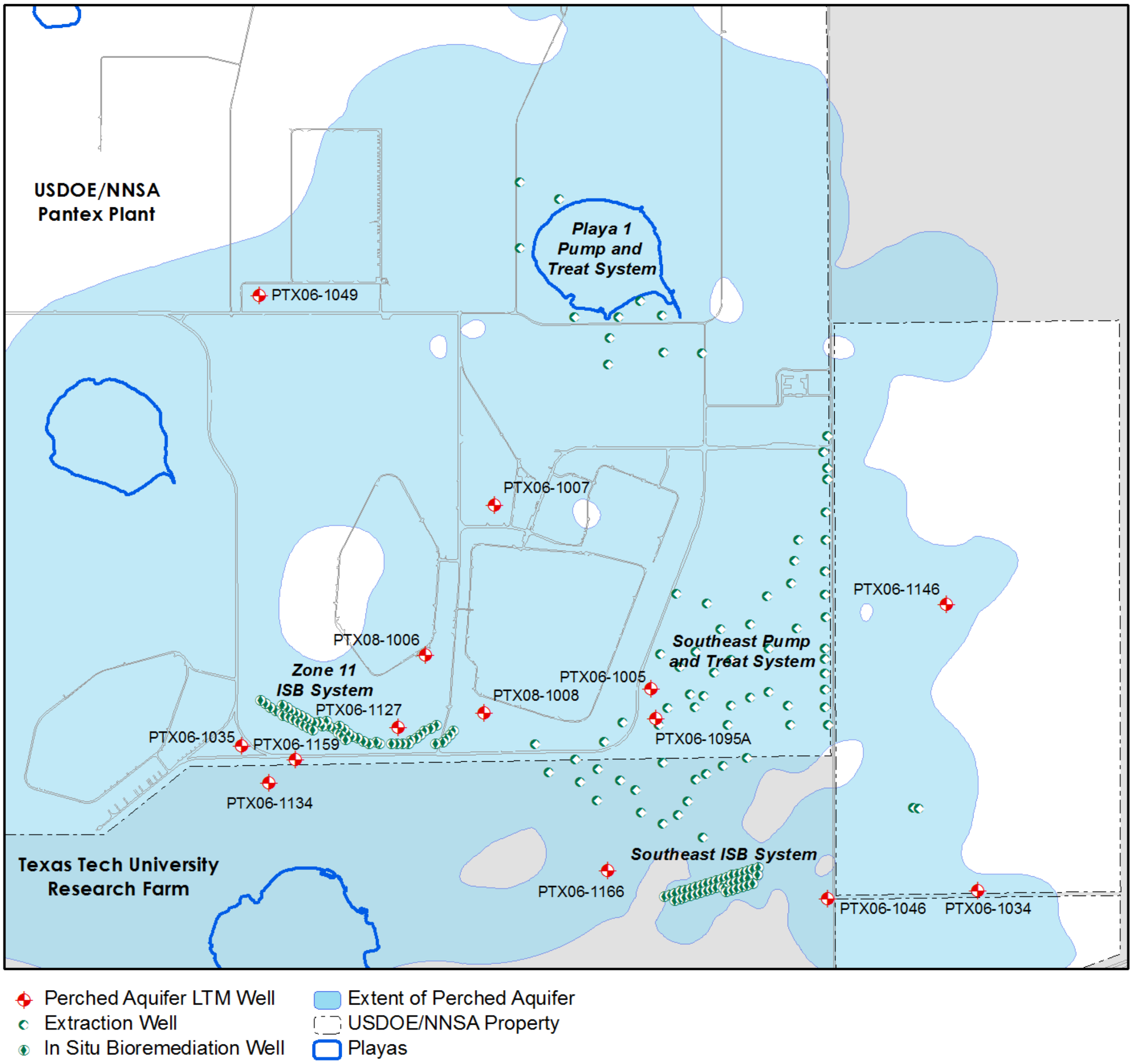


Figure 3-5. Perched Wells with Unexpected COC Trends

3.1.3 Water Level Trending

MAROS linear regression methodology outlined in the LTM Design Report was used to trend water levels at each well. Trends were calculated for the entire dataset of water levels for each well, in addition to the most recent two years of data at each well. The recent trends are expected to give a more accurate measurement of the effectiveness of the two pump and treat systems as the P1PTS began operating in late 2008 and the SEPTS began operating near full capacity by April 2009. Figure 3-6 depicts the water level trends in all LTM perched aquifer wells. Well hydrographs are included in Appendix F.

Trending results are showing positive effects of the remedial actions as all wells currently recognized to be under the influence of the SEPTS are exhibiting short-term decreasing trends in water levels. Above normal precipitation during the spring and summer of 2016 filled the playas, and a resulting increase in water levels was observed in several wells near Playa 1. The apparent recharge through the playa was much greater than the volume extracted by the P1PTS causing short-term increasing trends to be observed in these wells. Similar short-term increases have been observed in these wells in the past, and decreasing trends are expected to resume with a return to normal precipitation. Away from Playa 1, comparison of the short-term and long-term trends for wells located in Zone 11 and Zone 12 shows that many wells in this region have begun to exhibit short-term decreasing trends in water level. These trends could be an indication of expansion of the zone of influence of the pump and treat systems as the perched aquifer saturated thickness below Playa 1 is reduced.

A discussion of the remedial action effectiveness is included in a later section.

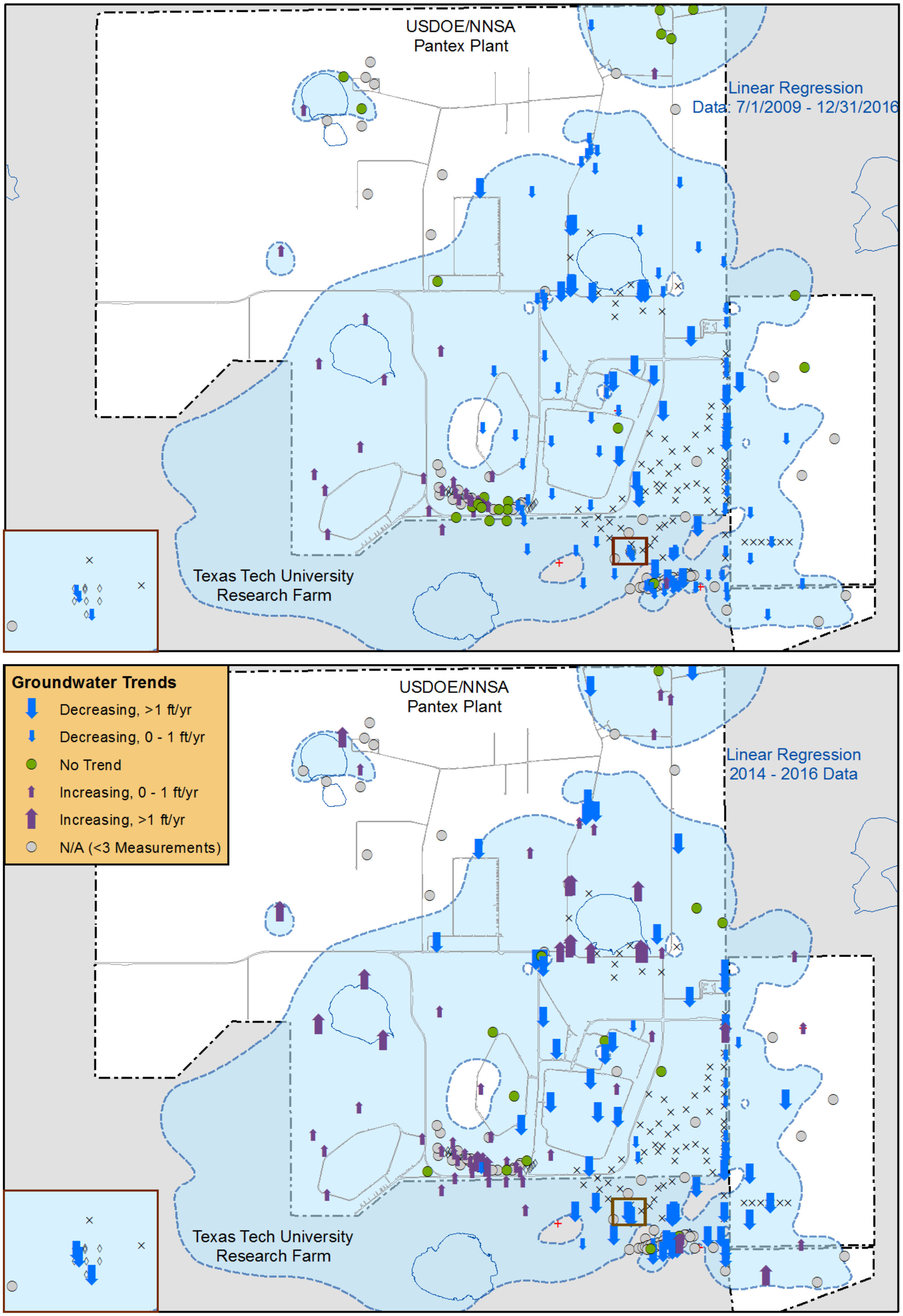


Figure 3-6. Water Level Trends in the Perched Aquifer

3.1.4 Water Level Trends Compared To Expected Conditions

Overall, calculated groundwater level trends are consistent with expected conditions defined in the LTM Design Report summarized in Appendix E. Of the 43 monitor wells with expected decreasing water level trends defined in the *Update to the LTM System Design Report* (Pantex, 2014a) only seven wells (depicted in Figure 3-7) exhibited conditions inconsistent with the current expected conditions or trends. Water levels rose up to several feet in three wells around Playa 1, OW-WR-38, PTX08-1001, and PTX08-1002, in the latter half of 2015 and into 2016 in response to above normal precipitation during 2015 and 2016.

Recent water level data for two wells east of Playa 1, PTX06-1013 and PTX06-1023, indicate no trend, although long-term water levels have declined in both wells over the last 15 years. Both wells have less than 10 feet of saturated thickness, and recent trends are flat. These wells are beyond the influence of a remediation system, and it is expected that water levels will continue to decline at slow rates.

Water levels in PTX06-1002A began increasing in late 2015 after declining since 2001. This well is located south of Playa 1 adjacent the main ditch from Zone 12; the reversal in trend may be associated with the above normal precipitation during 2015 and 2016 and increased recharge through these features.

An apparent increasing trend was identified for PTX08-1008 although inspection of the hydrograph shows that water levels are nearly constant since 2015 and have declined since 2009. The increasing trend is the result of an anomalous low water level measured in 2015, and data since then indicate a slight decreasing trend.

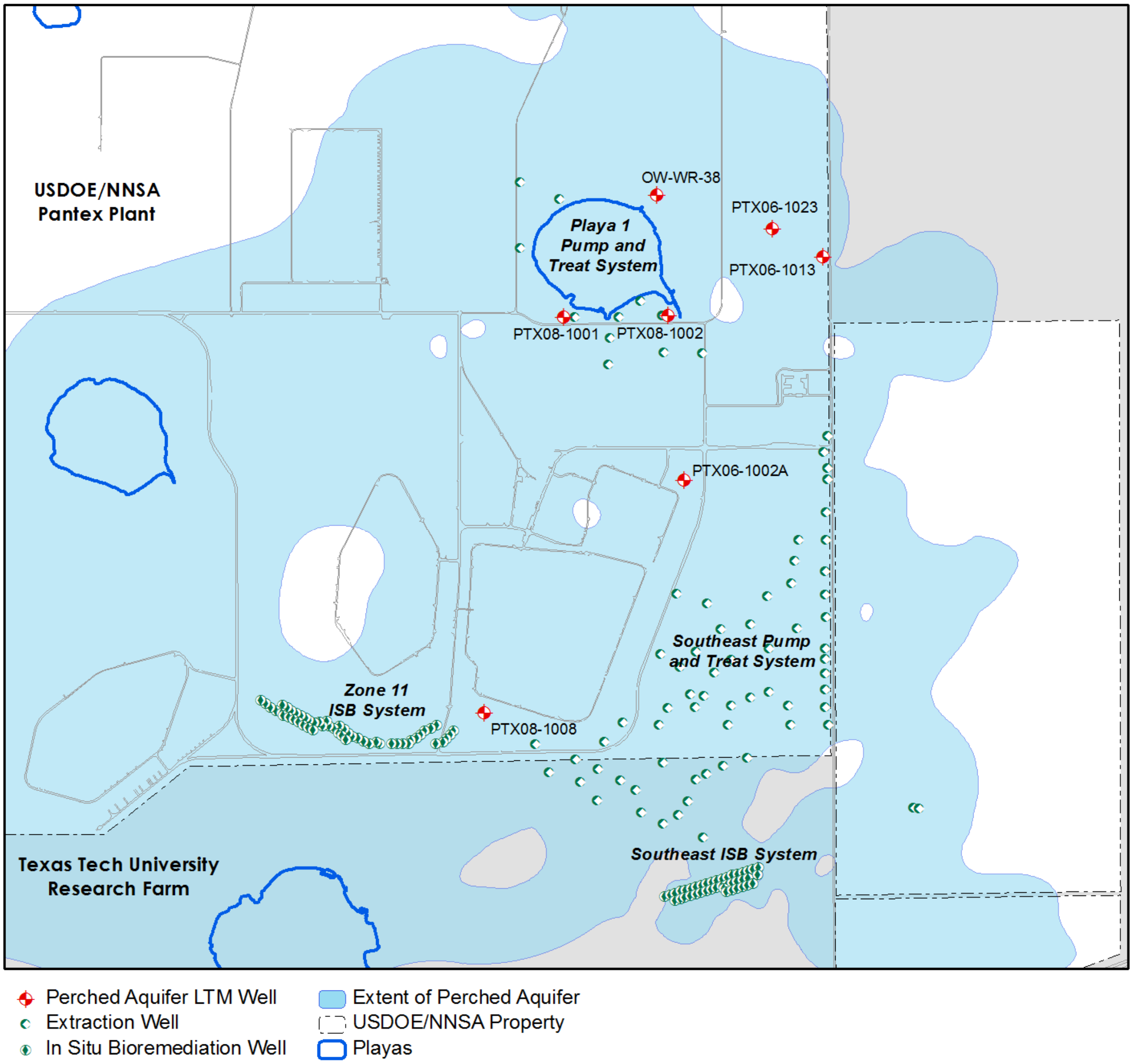


Figure 3-7. Perched Wells with Unexpected Water Level Trends

3.1.5 Water Level Mapping

Groundwater beneath the Pantex 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, as perched groundwater overlying a fine-grained zone.

Presented in this section are water table maps of the Ogallala Aquifer and the primary perched aquifer underlying Pantex Plant. Water level measurements used to create these maps were collected primarily during December 2016 from Pantex Ogallala and perched aquifer investigative wells. These data were supplemented with recent water level measurements in the Ogallala Aquifer collected by other agencies and published by the Texas Water Development Board (TWDB). Figure 3-8 presents the Ogallala Aquifer water levels. Figure 3-9 and Figure 3-10 present perched aquifer water levels.

3.1.5.1 Ogallala Aquifer

As shown in Figure 3-8, flow in the Ogallala Aquifer underlying Pantex Plant is to the northeast. The northeast hydraulic gradient results from agricultural pumping as well as from the City of Amarillo well field to the north and from the Pantex water supply wells in the northeastern part of the Plant. The Amarillo well field produces approximately 12.7 million gallons per day from the Ogallala Aquifer, based on 2013 City of Amarillo data. The hydraulic gradient in the Ogallala Aquifer underlying the northern part of Pantex Plant is approximately 0.006 ft/ft.

3.1.5.2 Perched Aquifer

As shown in Figure 3-9 and Figure 3-10, perched groundwater occurs as a number of separate flow systems beneath Pantex 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 about 2.5 miles northeast of the Plant property boundary, but this body of groundwater is not hydraulically connected to the perched aquifer underlying the Pantex Plant.

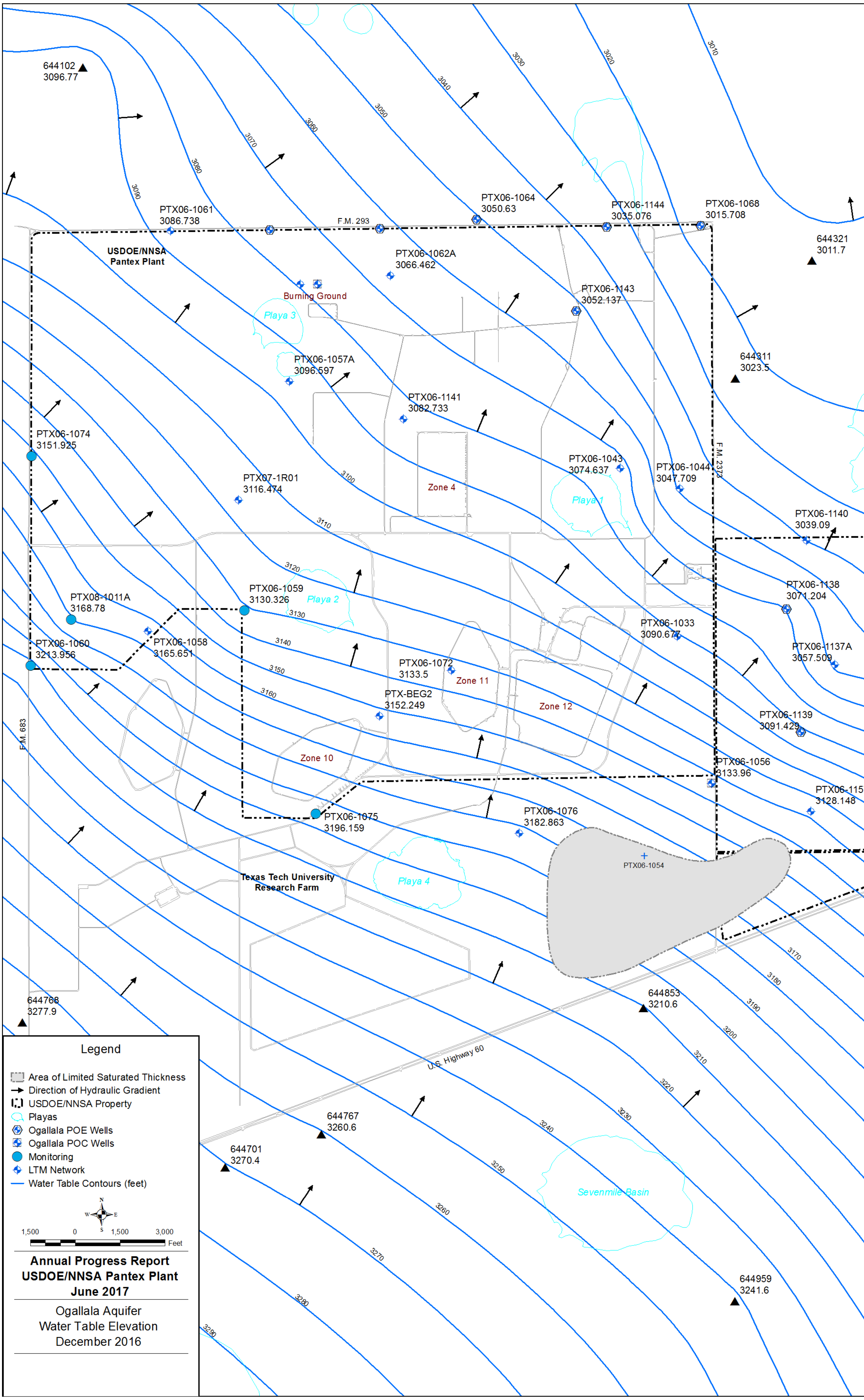


Figure 3-8. Ogallala Aquifer Water Levels

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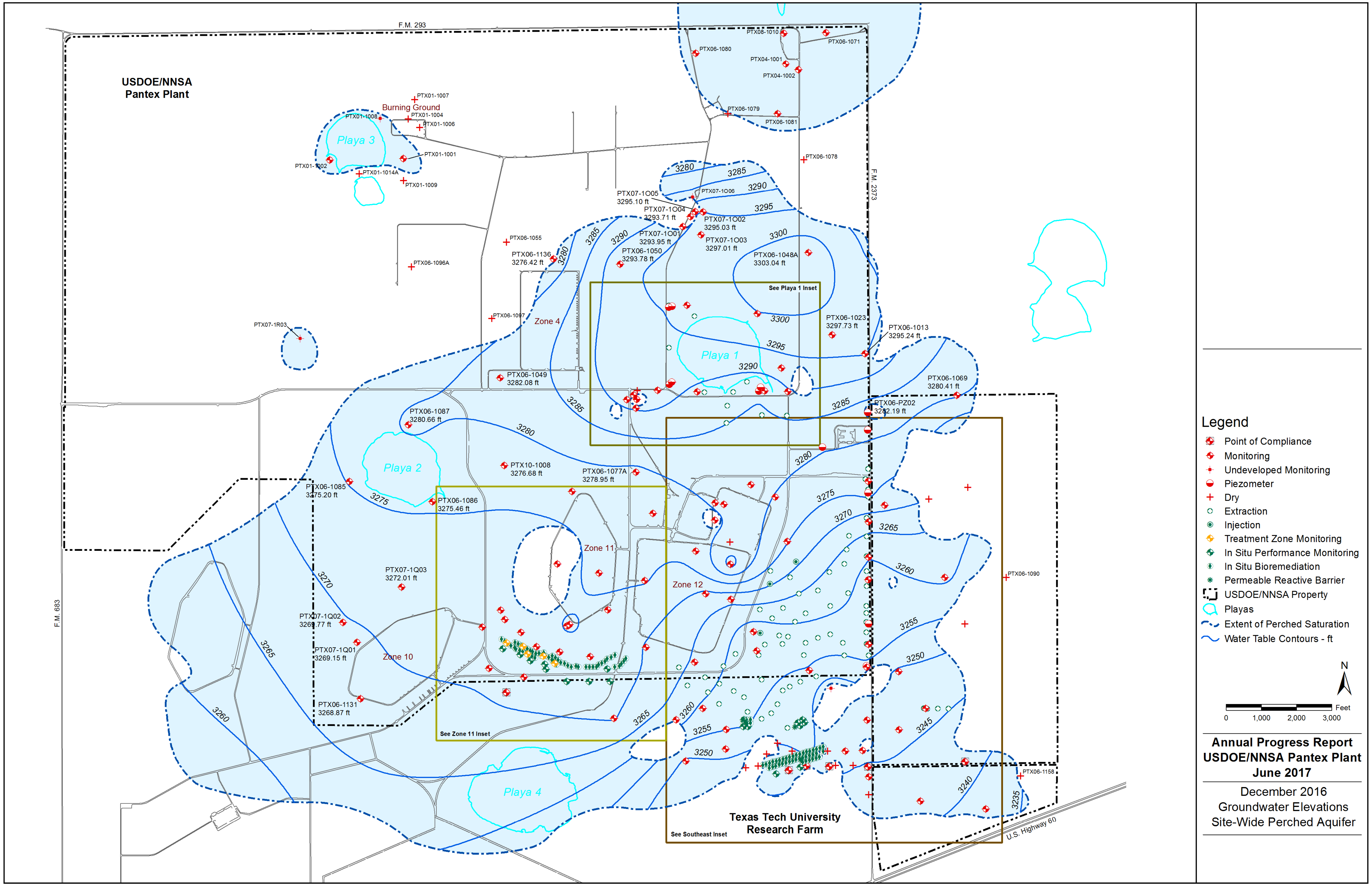

Figure 3-9. Perched Aquifer Water Levels

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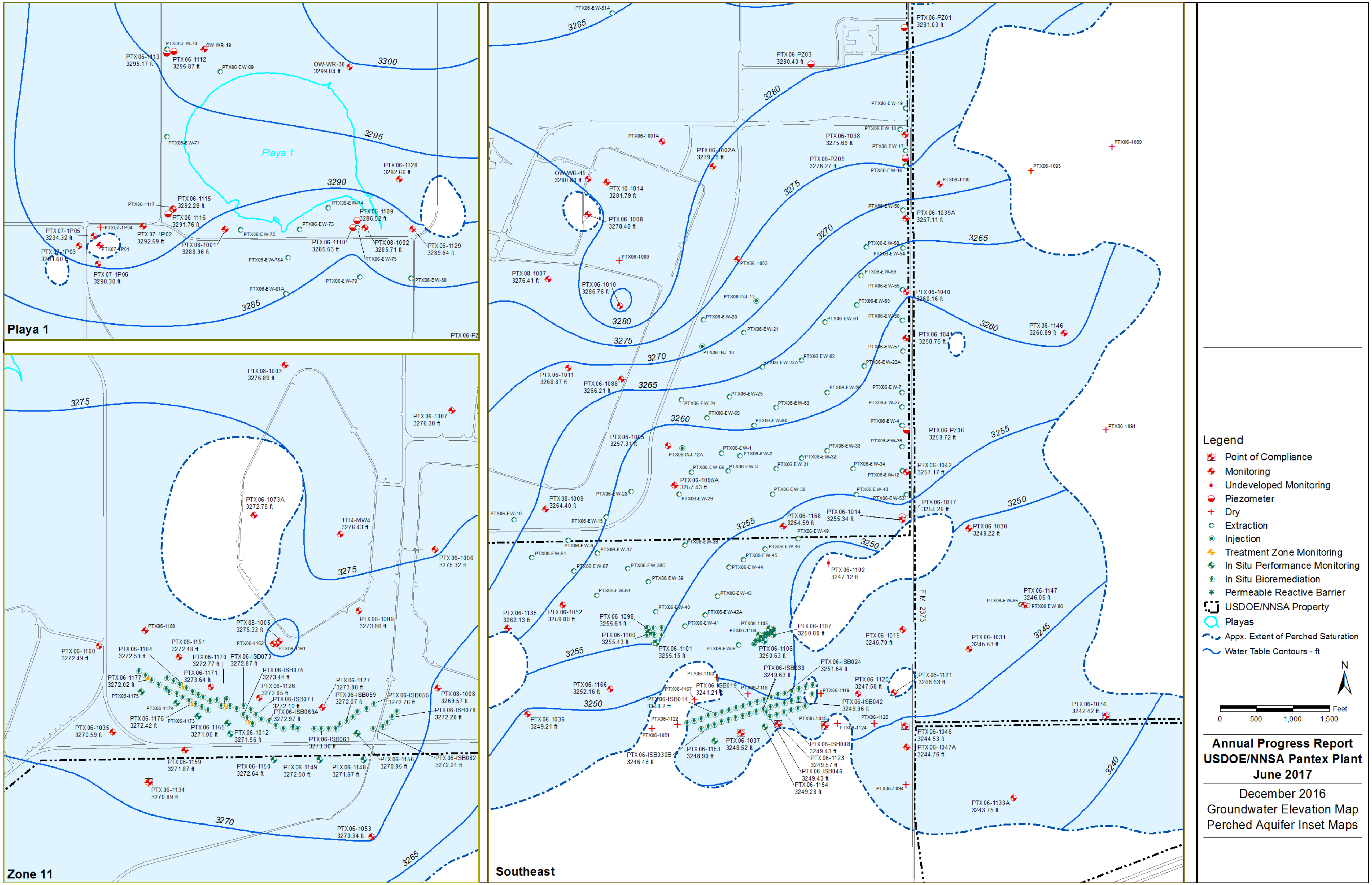

Figure 3-10. Perched Aquifer Water Levels, Inset Maps

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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 0.004 ft/ft near Playa 1, 0.002 ft/ft near Playa 2, 0.004 ft/ft downgradient of Zone 12, and 0.002 ft/ft south of Zone 11.

3.1.6 Plume Mapping

Isoconcentration maps of indicator constituents (COCs and breakdown products of RDX and TCE) in the perched aquifer are presented in this section. Perched aquifer indicator parameters were proposed in the SAP*.* Isoconcentration maps for this annual report were produced from groundwater data collected in 2016. Each isoconcentration map presents the highest detected concentration for each constituent using validated analytical data from January to December 2016. The COC plumes were delineated to the approved GWPS as was done for the 2014 Annual Progress Report. 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 in generating the isoconcentration contours, but the analytical concentration data from these wells may differ from 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.

Figure 3-31 and Figure 3-32 present total chromium isoconcentrations for the perched aquifer. Well locations shown surrounded by an orange circle were constructed with a stainless steel well screen and casing. Extraction wells, ISB injection wells, and dry wells were not depicted with these symbols. Several of these wells have been shown by video observation to be corroded and/or have bacterial growth present, and statistical analysis of the concentrations of chromium and other components of stainless steel (manganese, molybdenum, and nickel) shows 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. Therefore, the chromium concentrations for these wells were not included in the kriging of the isoconcentration lines unless the well is associated with the hexavalent chromium plume. The maximum observed concentration for the year is posted on the map for each of these wells.

Constituent concentrations for samples from the Southeast ISB injection wells were generally used in generating 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 now indicating treatment effects of the ISB treatment zone, as well as 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, these results were not included in the contouring process. The estimated downgradient areas under the influence of the ISB systems are now 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 in generating 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 3-11 through Figure 3-40 are isoconcentration maps for RDX, MNX, DNX, TNX, TNT, 2-amino-4,6-dinitrotoluene, 4-amino-2,6-dinitrotoluene, 1,3,5-trinitrobenzene, perchlorate, hexavalent chromium, chromium, TCE, 1,4-dioxane, *cis*-1,2-dichloroethene, and 1,2-dichloroethane.

Table 3-1. Perched Aquifer Indicator Parameters

HEs	Metals	Inorganics	Volatile Organics
RDX	Boron	Perchlorate	1,2-Dichloroethane
HMX	Chromium		1,4-Dioxane
MNX	Hexavalent Chromium		*cis*-1,2-Dichloroethene
DNX			*trans*-1,2-Dichloroethene
TNX			PCE
TNT			TCE
1,3-Dinitrobenzene			Chloroform
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 the other indicator constituents (HMX, 1,3- dinitrobenzene, 2,4-dinitrotoluene, 2,6-dinitrotoluene, boron, *trans*-1,2-dichloroethene, PCE, chloroform, and vinyl chloride) 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 sections provide specific information detailing the reasons maps were not prepared for these constituents.

Boron

Boron did not exceed the GWPS of 7,300 ug/L in any perched aquifer well sampled in 2016. Therefore, an isoconcentration map was not prepared for this compound.

HMX

HMX was detected above the GWPS of 360 ug/L in three perched aquifer well sampled in 2016. These isolated exceedances could not be used to map a distinct plume. 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 2016. Therefore, an isoconcentration map was not prepared for this compound.

2,4-Dinitrotoluene

2,4-Dinitrotoluene did not exceed the GWPS of 1 ug/L in any perched aquifer well sampled in 2016. 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 three perched aquifer wells sampled in 2016. These isolated exceedances 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 2016. Therefore, an isoconcentration map was not prepared for this compound.

PCE

PCE was detected above the GWPS of 5 ug/L in only one perched aquifer well sampled in 2016. This isolated exceedance could not be used to map a distinct plume. Therefore, an isoconcentration map was not prepared for this compound.

Chloroform

Chloroform did not exceed the GWPS of 80 ug/L in any perched aquifer well sampled in 2016. Therefore, an isoconcentration map was not prepared for this compound.

Vinyl Chloride

Vinyl chloride was detected at or below the PQL of 1 ug/L in two perched aquifer wells in 2016. All vinyl chloride detections were below the GWPS. Both wells are under the influence of the Zone 11 ISB system where low-level vinyl chloride is expected. Therefore an isoconcentration map was not developed for this compound.

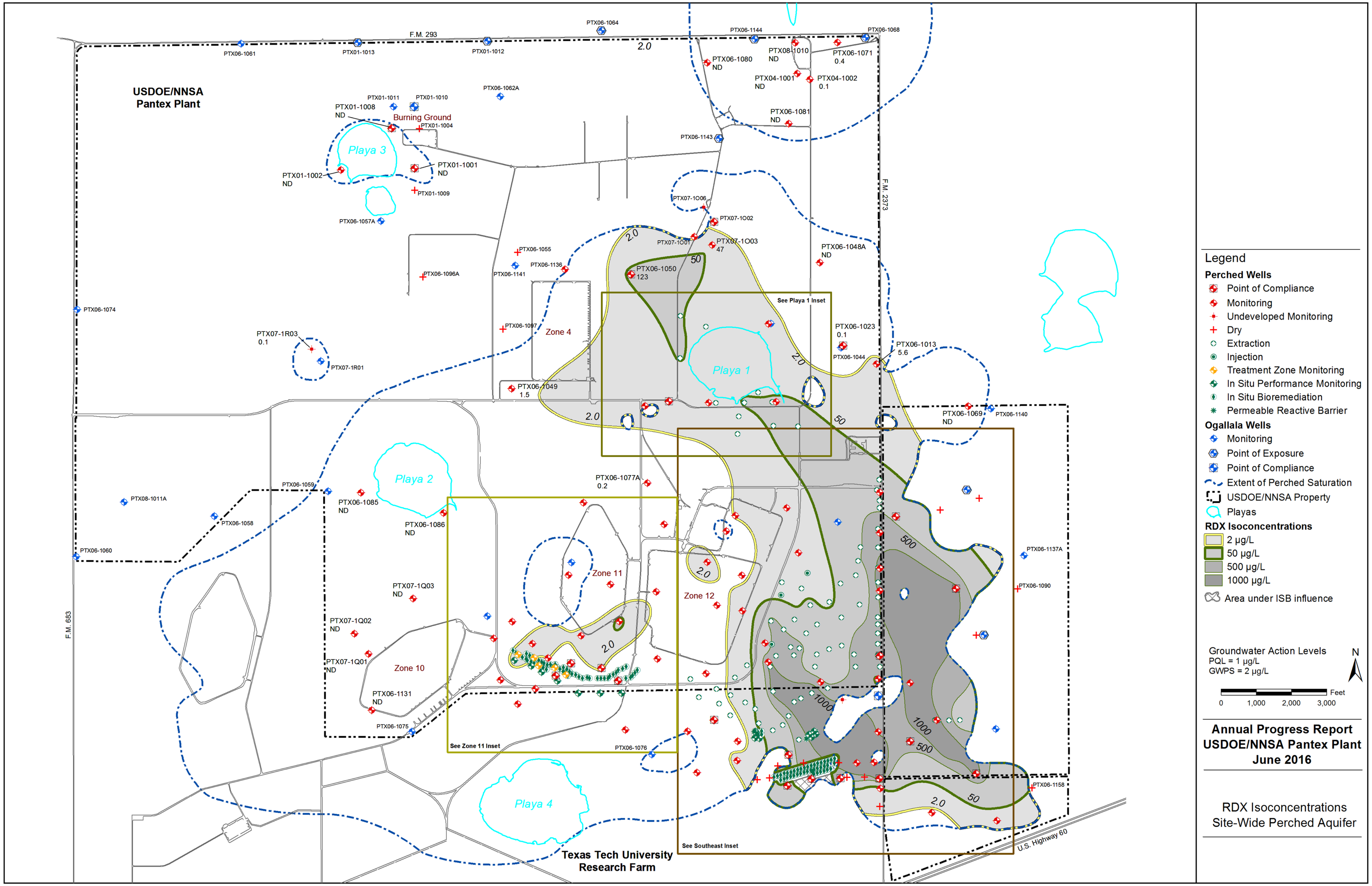

Figure 3-11. RDX Isoconcentration Map

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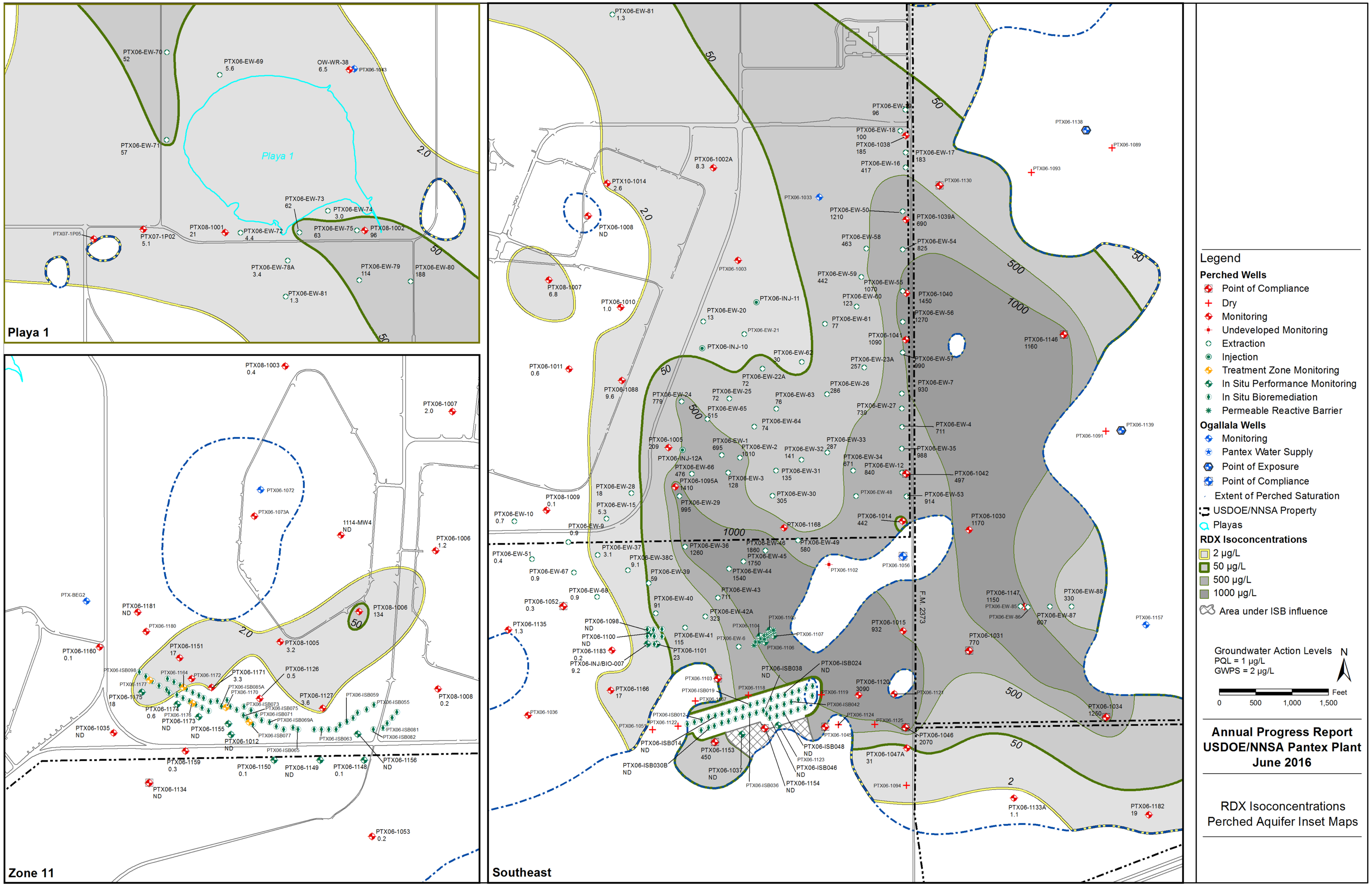

Figure 3-12. RDX Isoconcentration Inset Map

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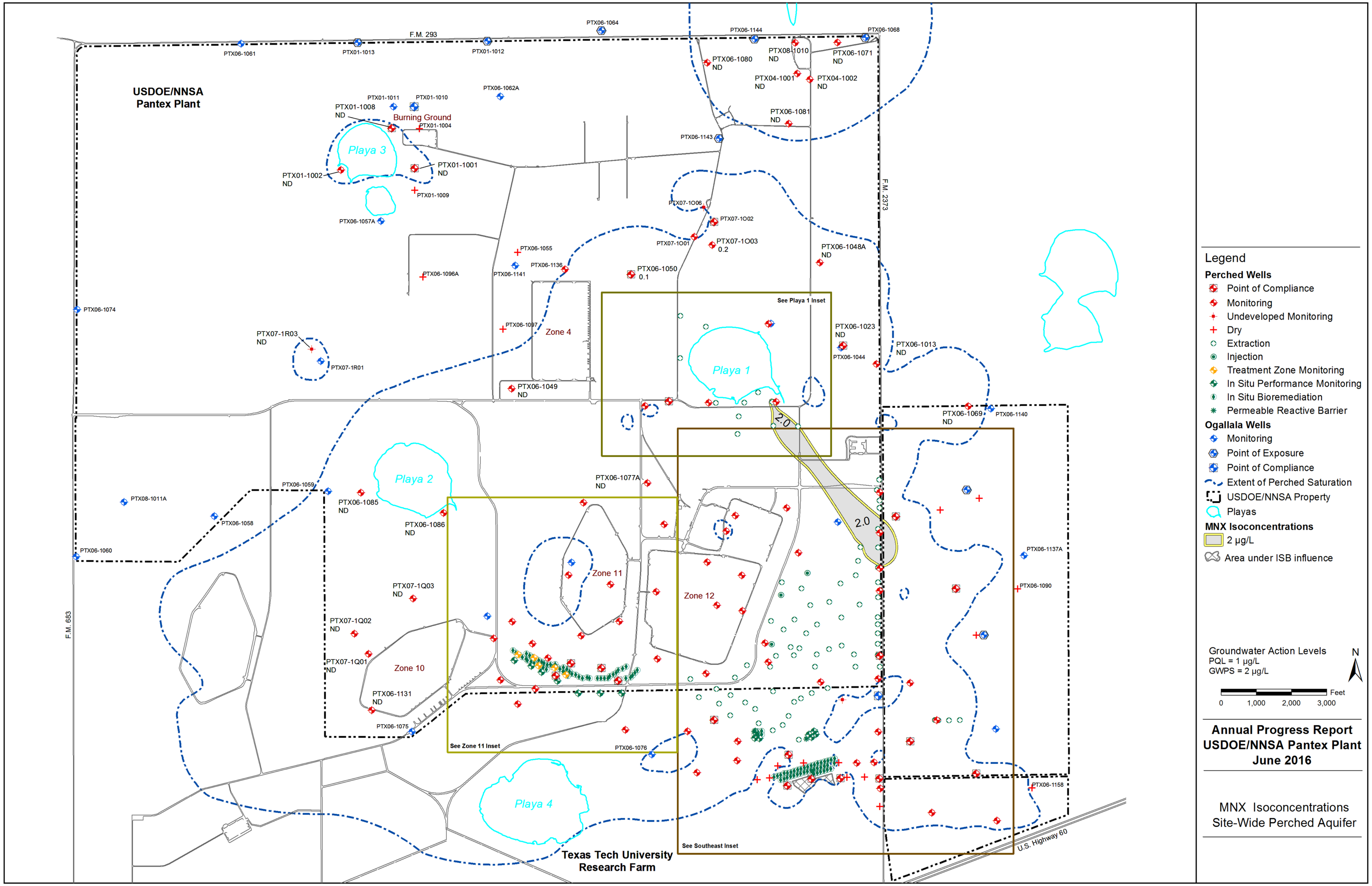

Figure 3-13. MNX Isoconcentration Map

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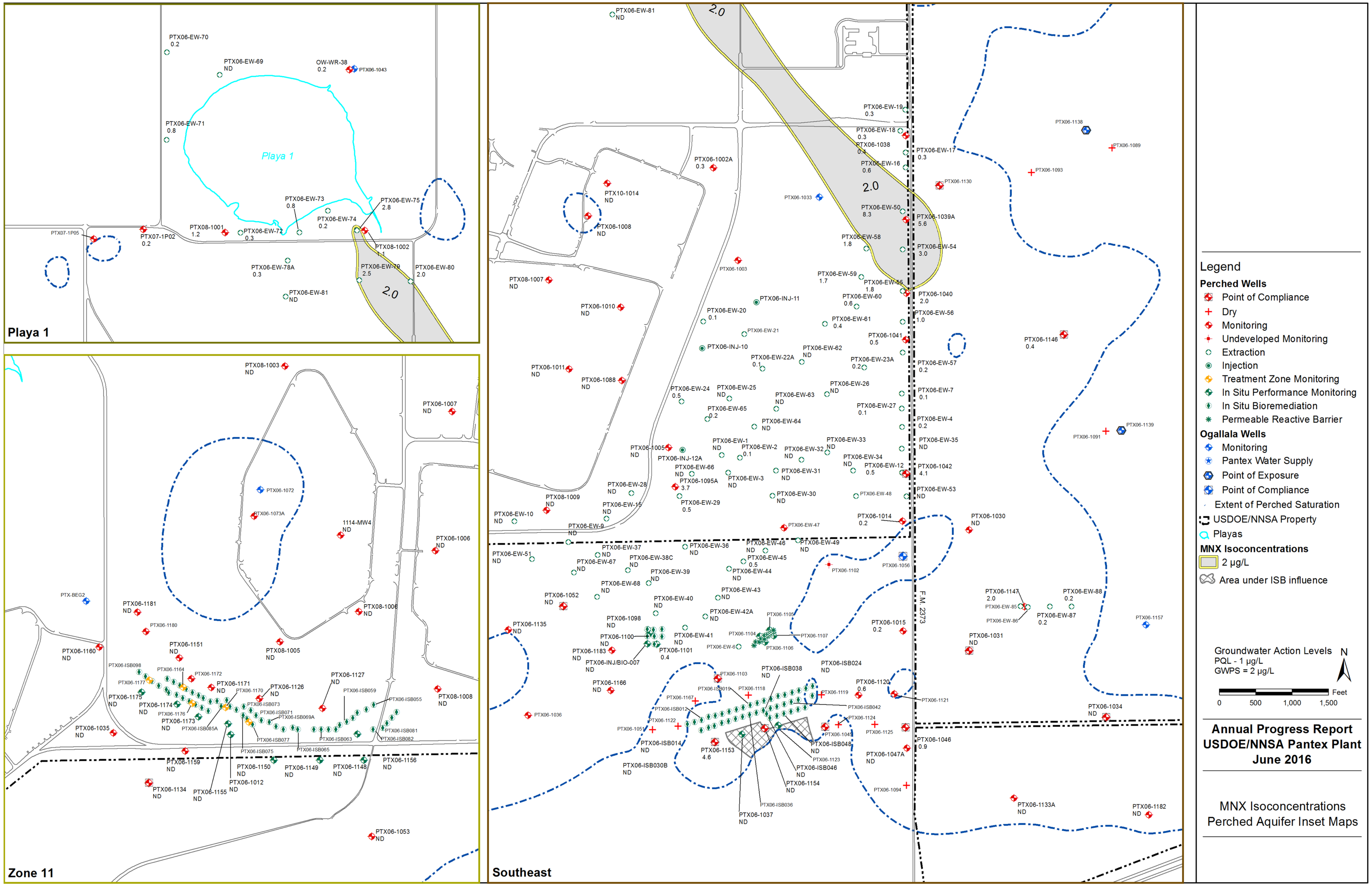

Figure 3-14. MNX Isoconcentration Inset Map

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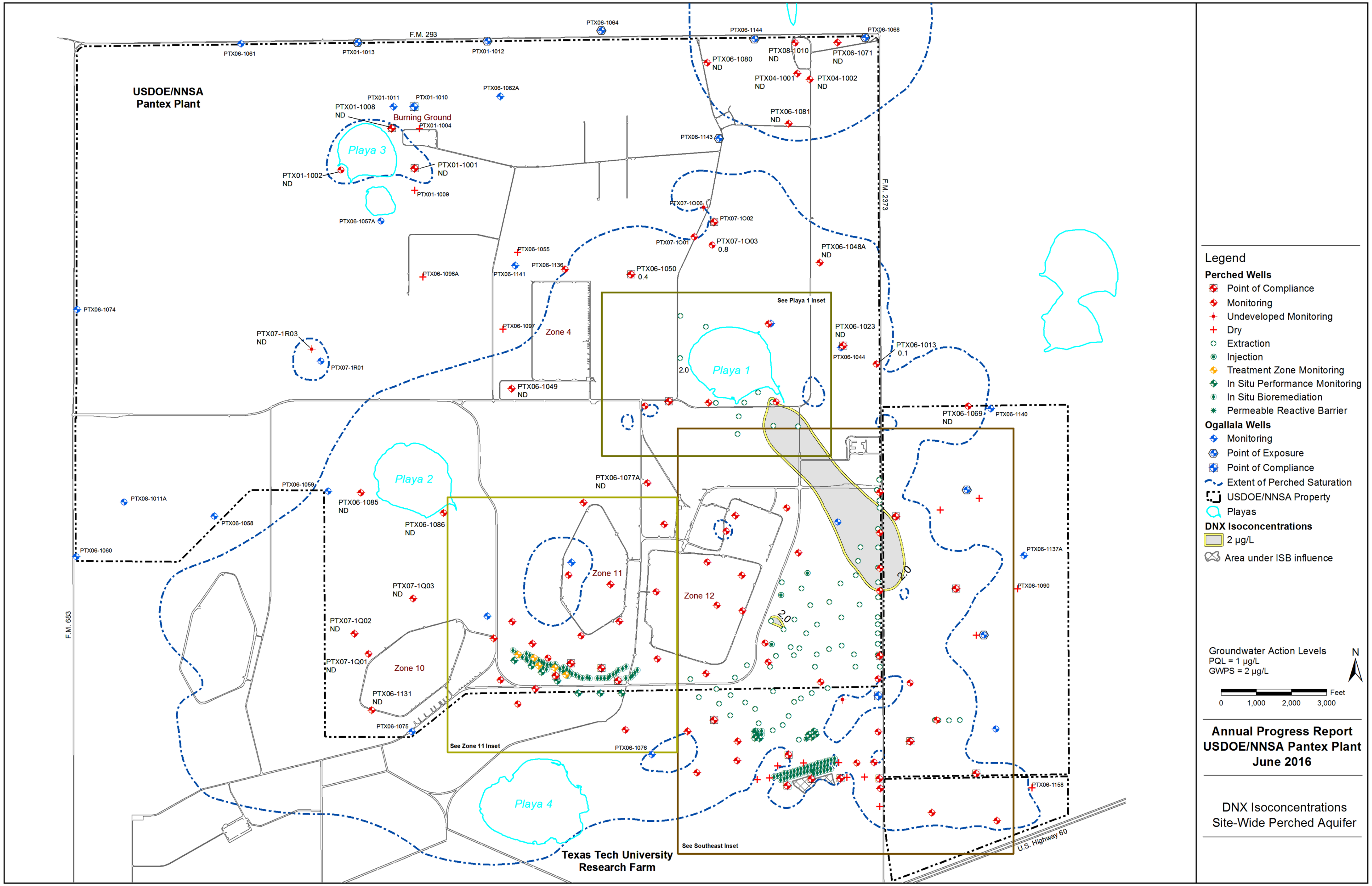

Figure 3-15. DNX Isoconcentration Map

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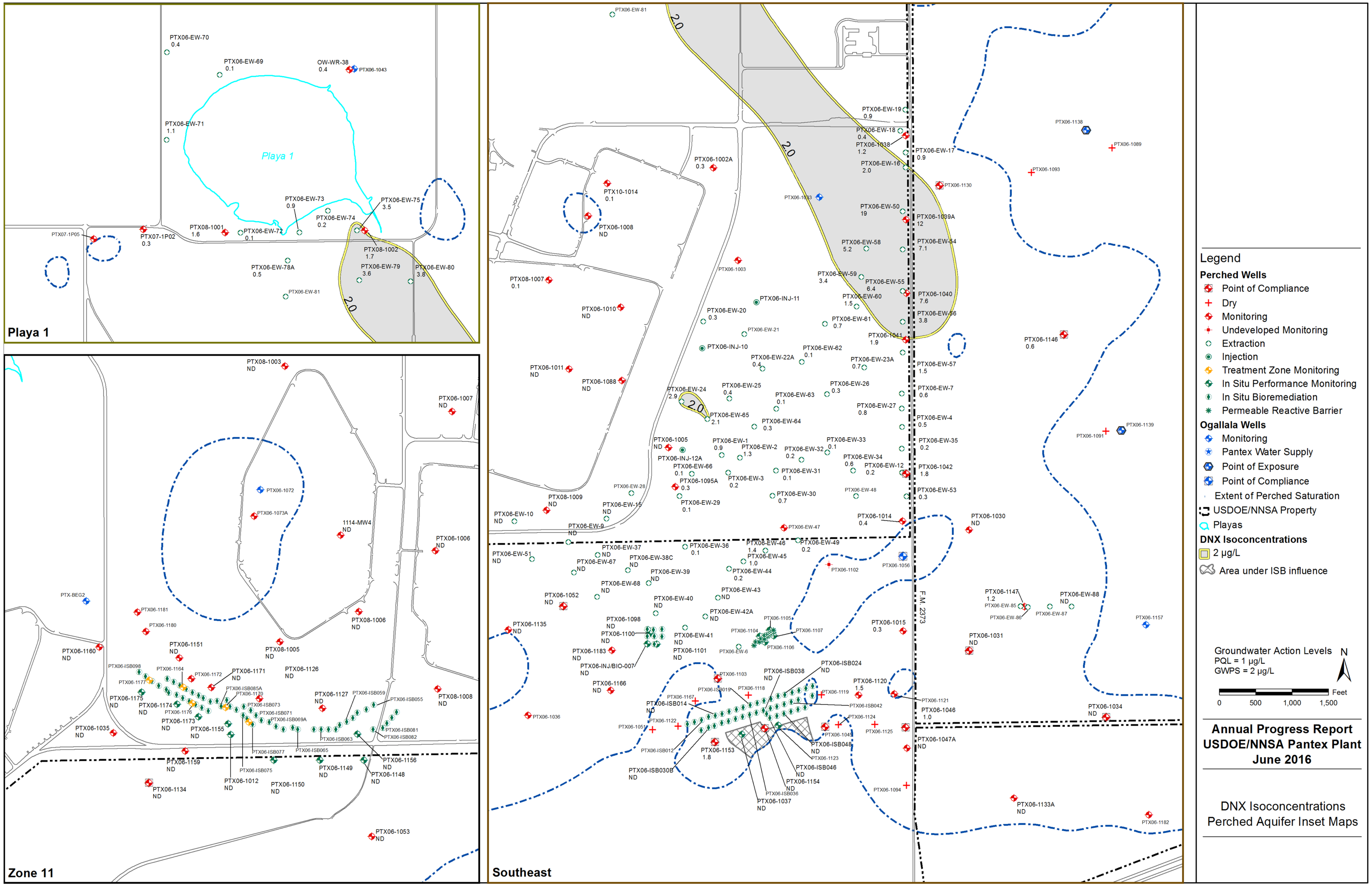

Figure 3-16. DNX Isoconcentration Inset Map

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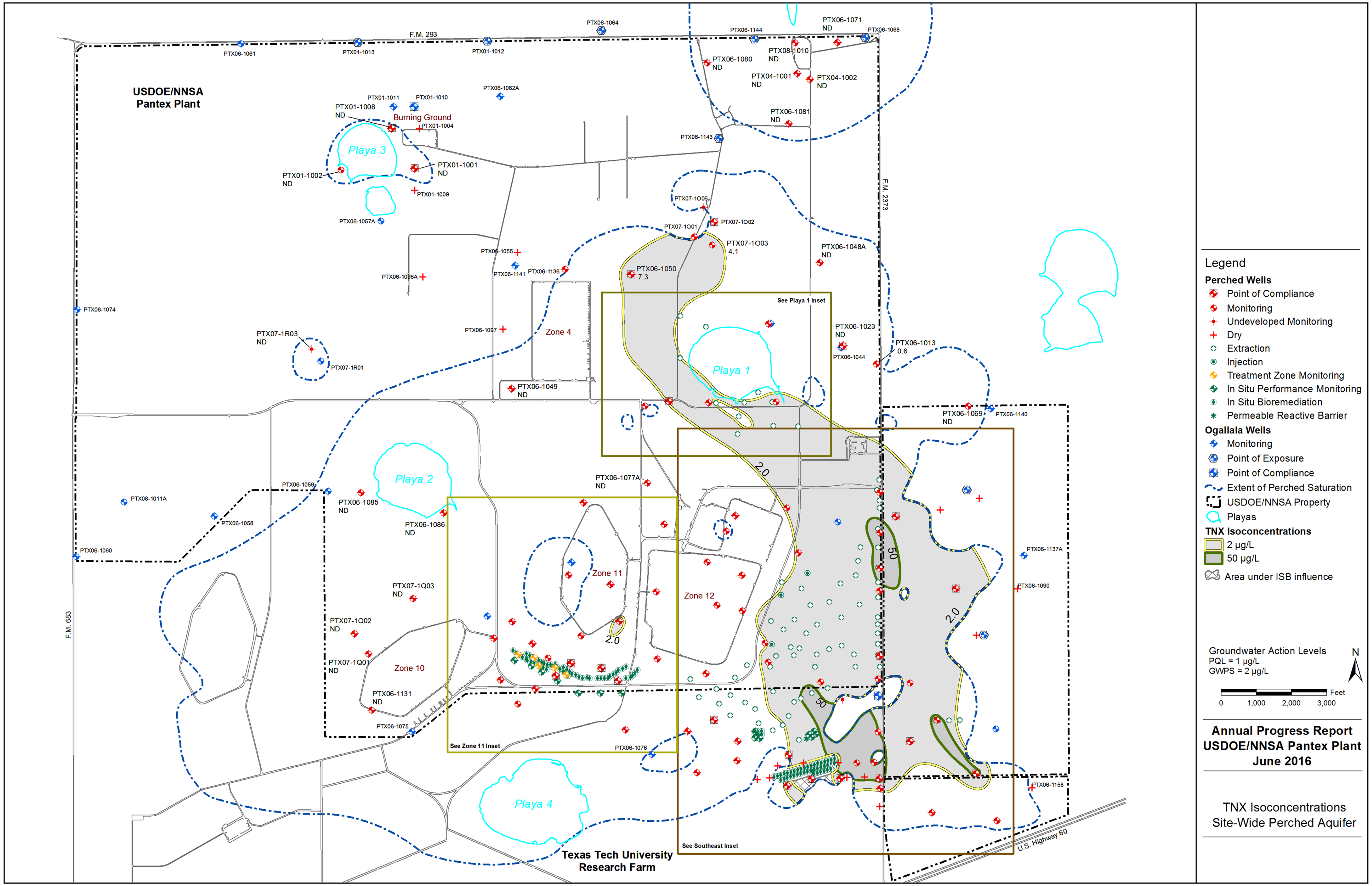

Figure 3-17. TNX Isoconcentration Map

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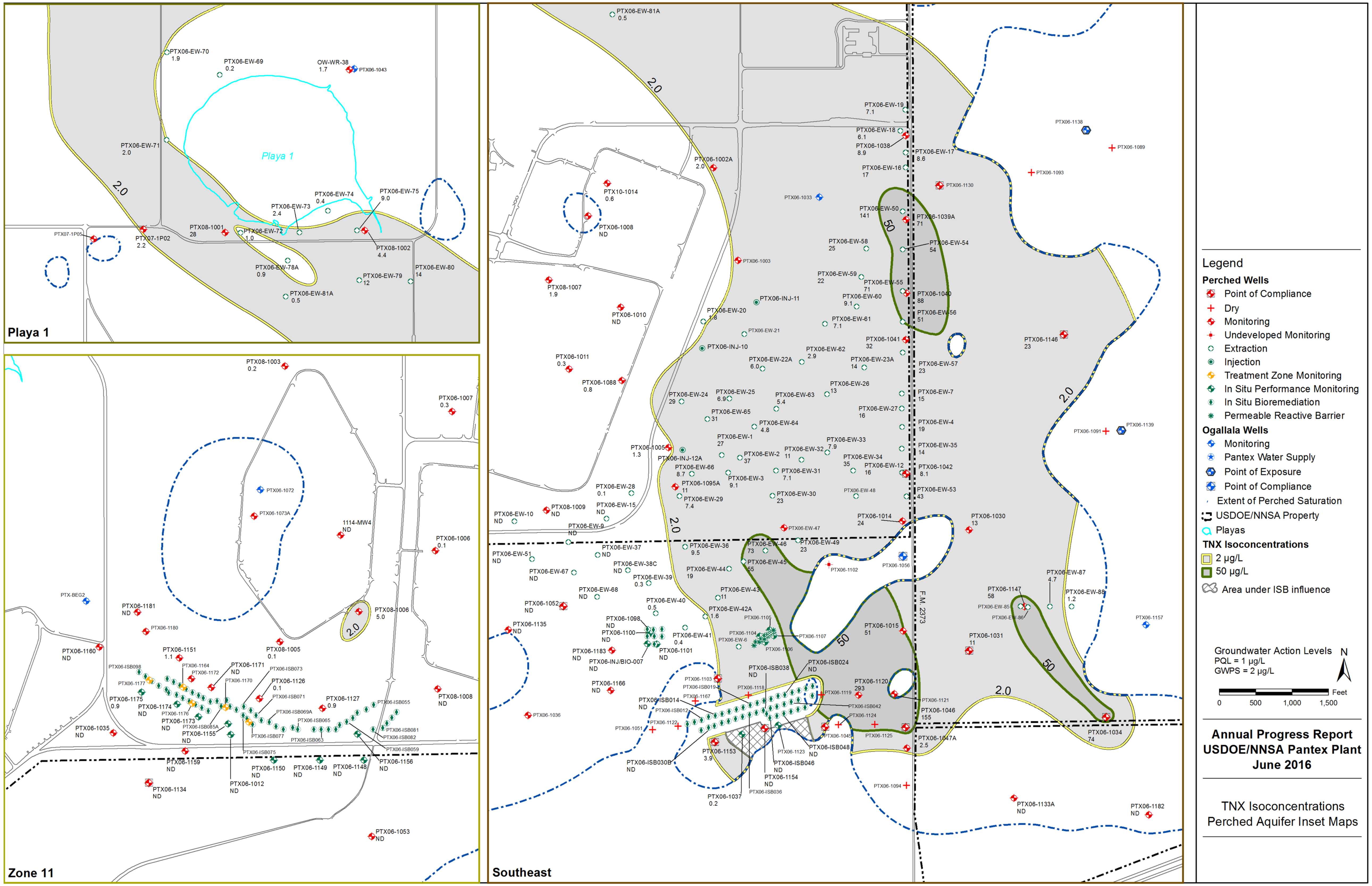

Figure 3-18. TNX Isoconcentration Inset Map

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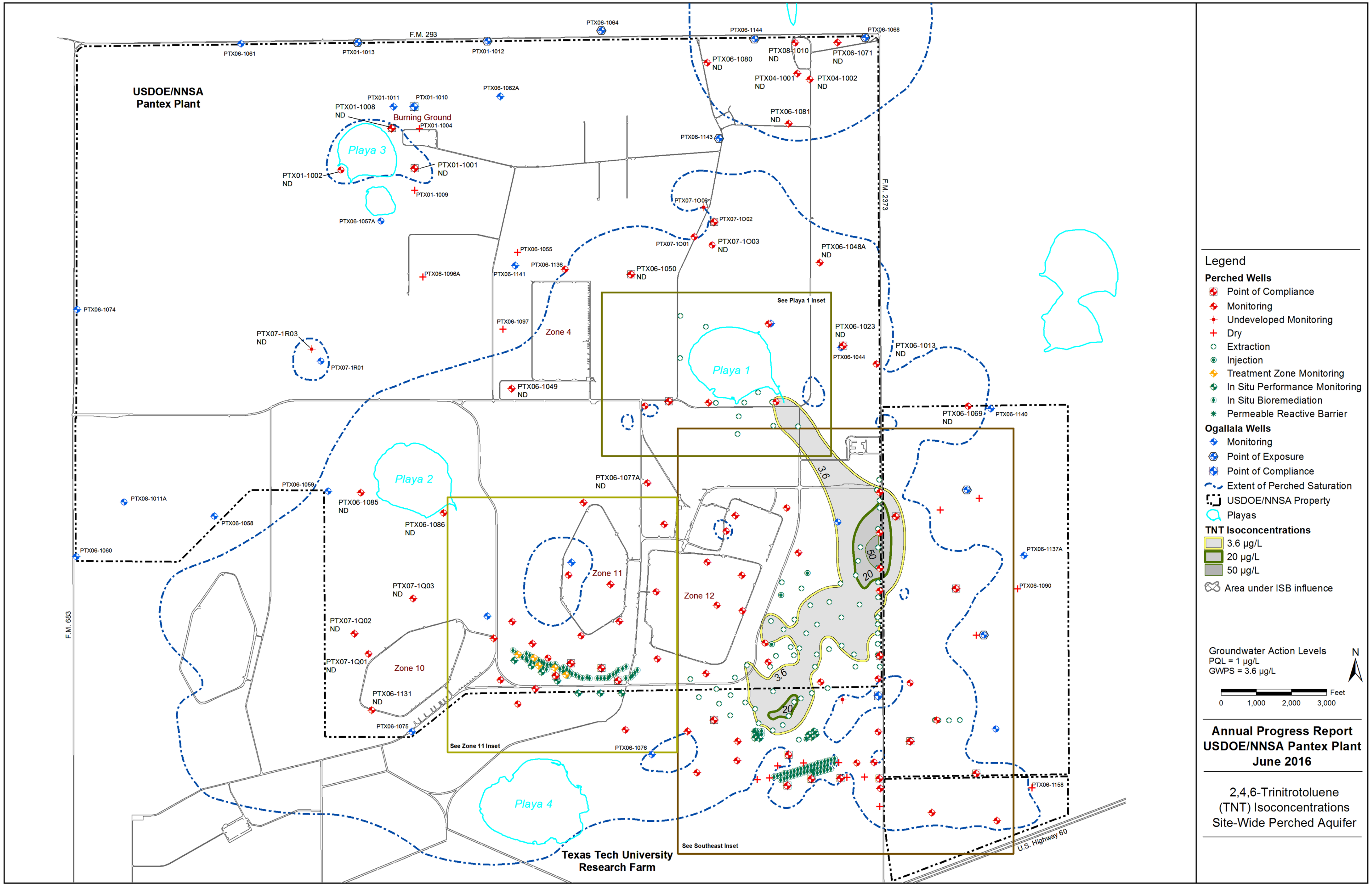

Figure 3-19. TNT Isoconcentration Map

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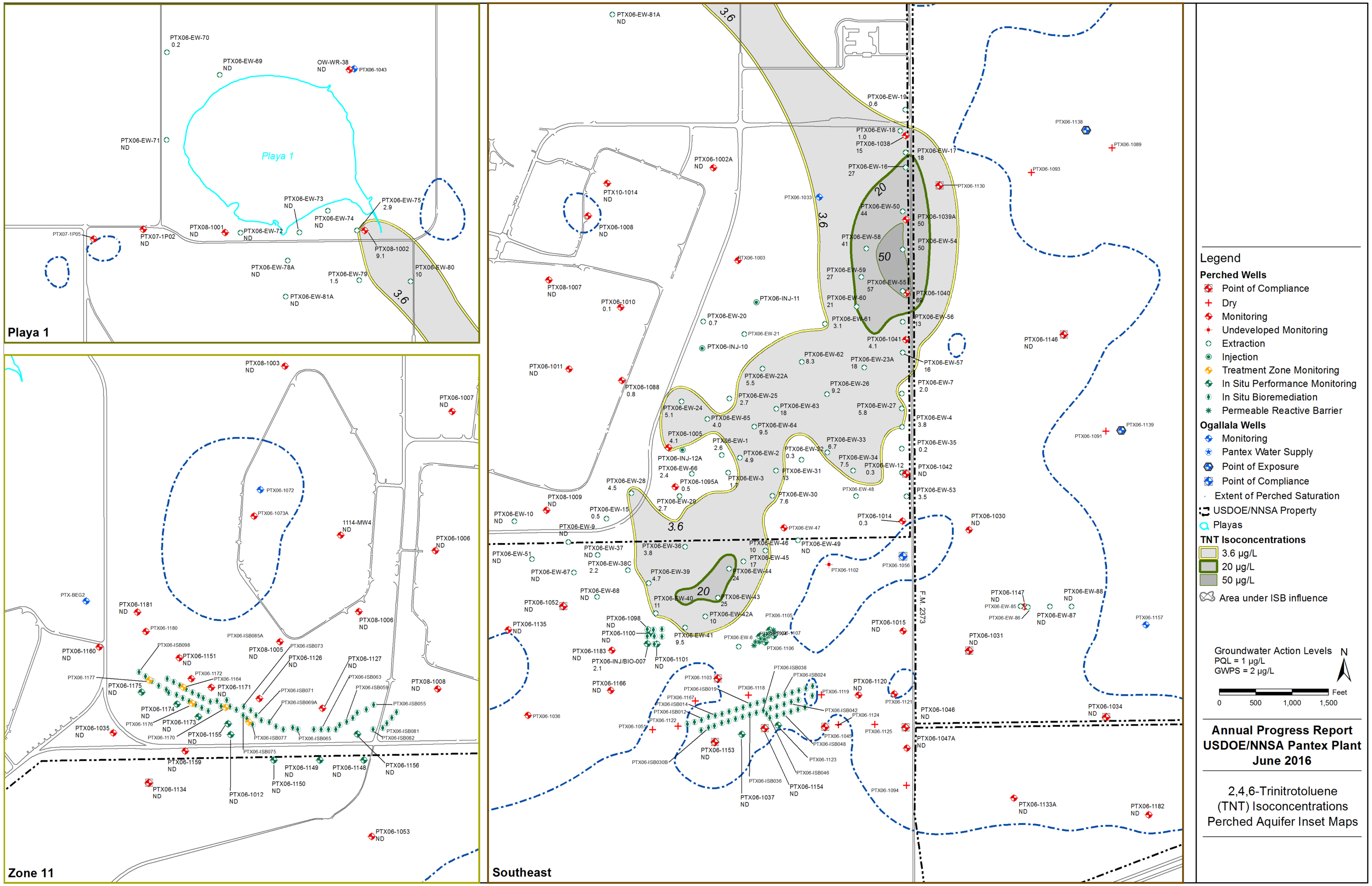

Figure 3-20. TNT Isoconcentration Inset Map

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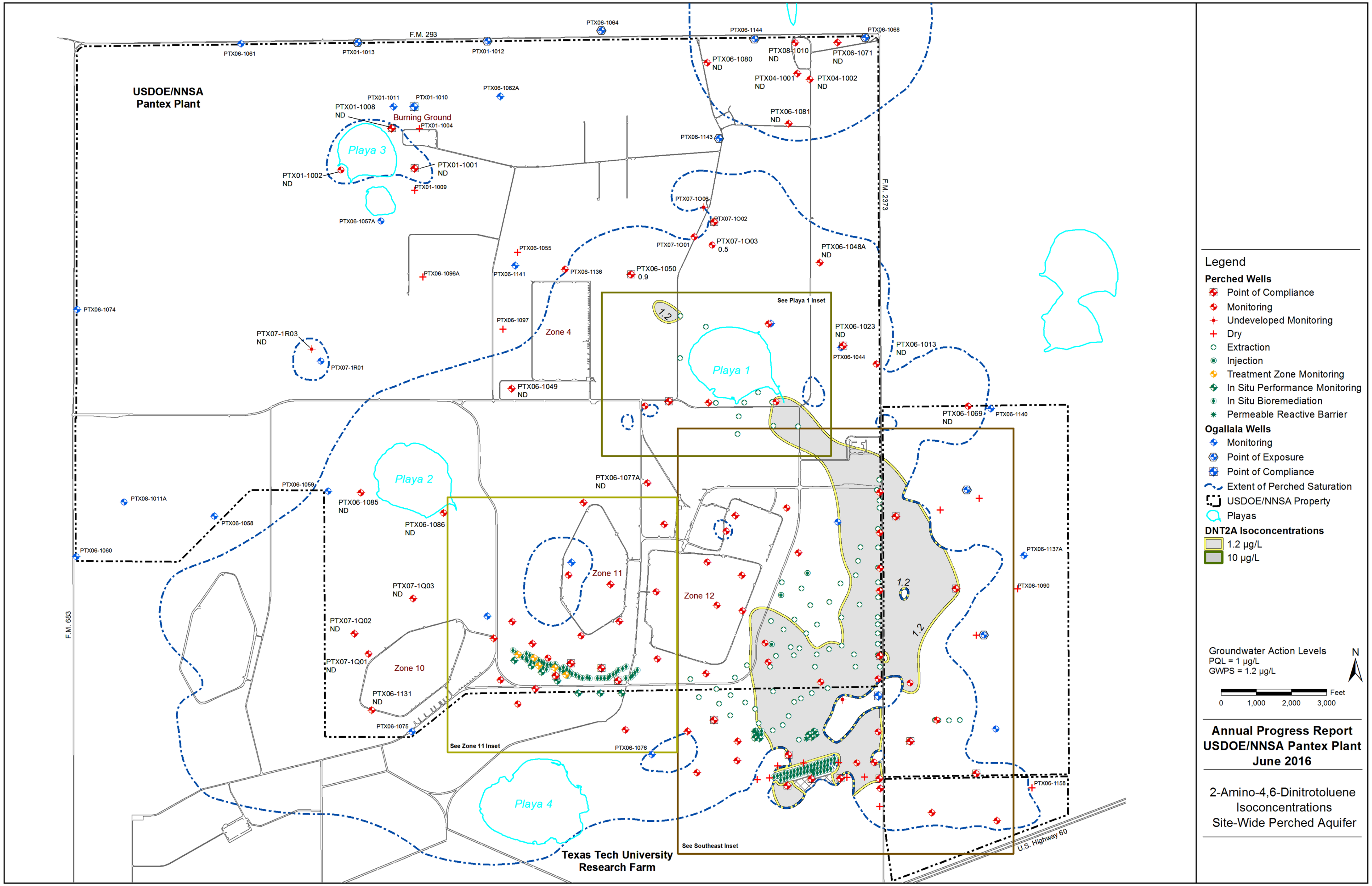

Figure 3-21. DNT-2A Isoconcentration Map

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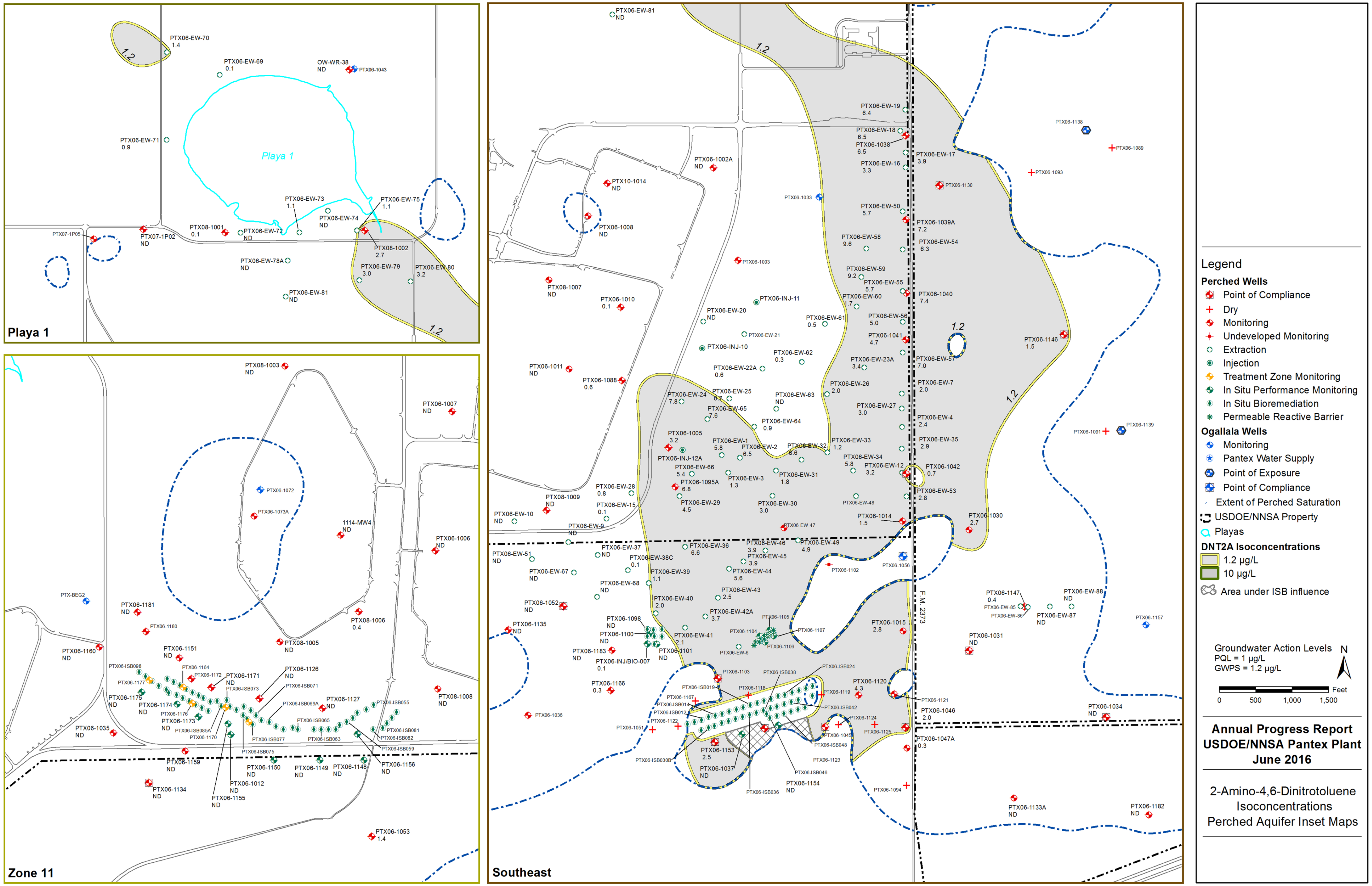

Figure 3-22. DNT-2A Isoconcentration Inset Map

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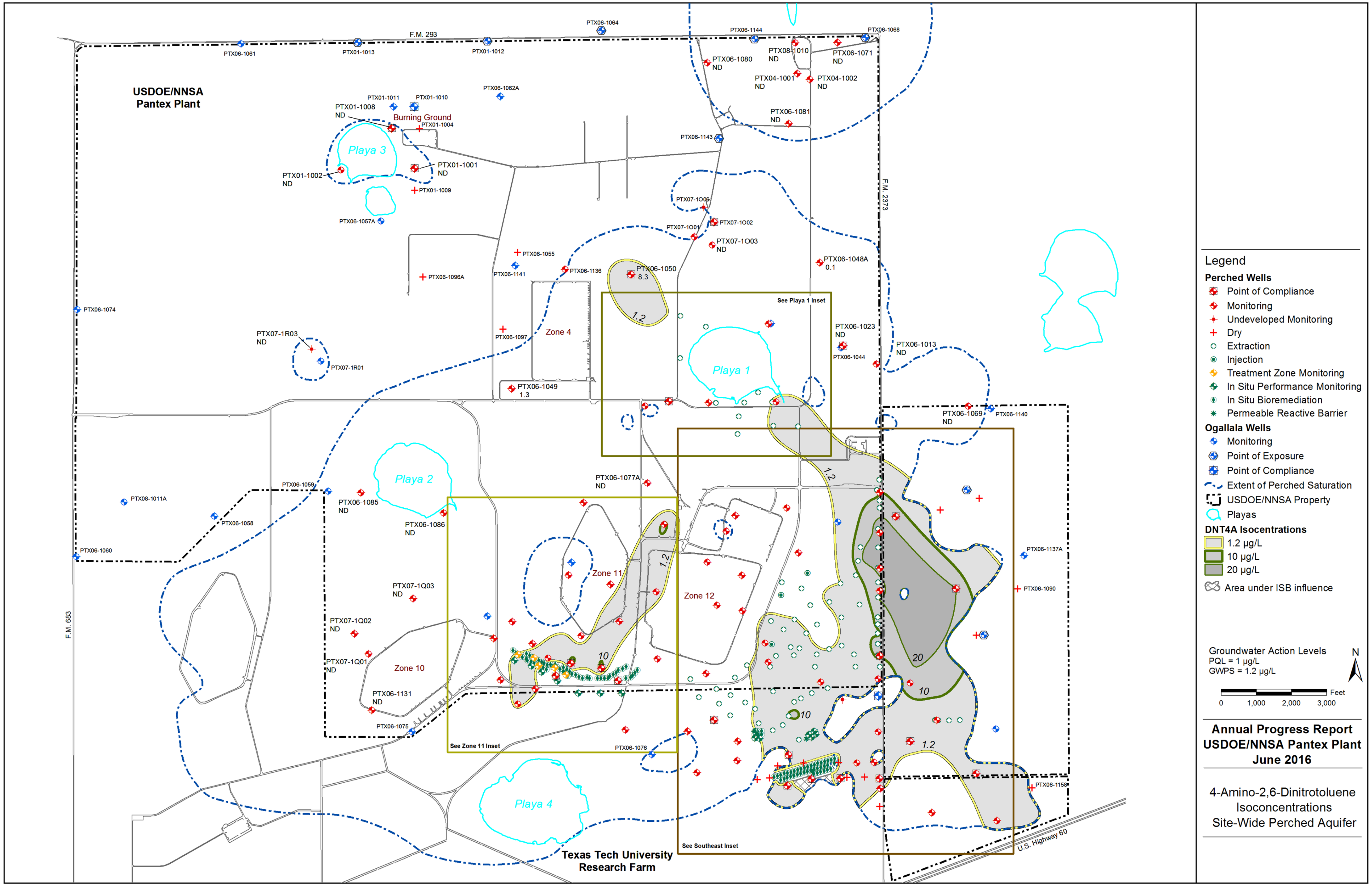

Figure 3-23. DNT-4A Isoconcentration Map

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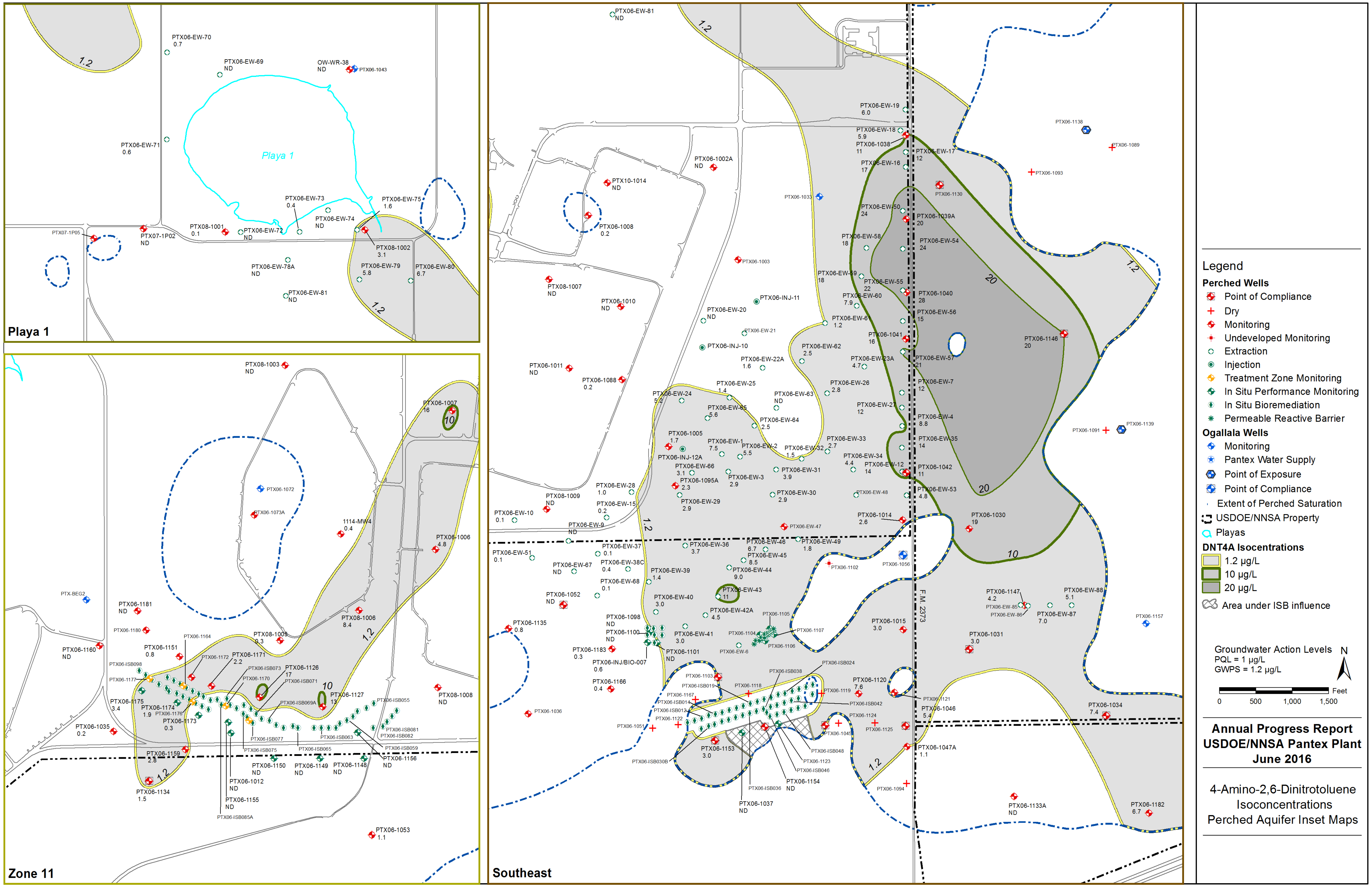

Figure 3-24. DNT-4A Isoconcentration Inset Map

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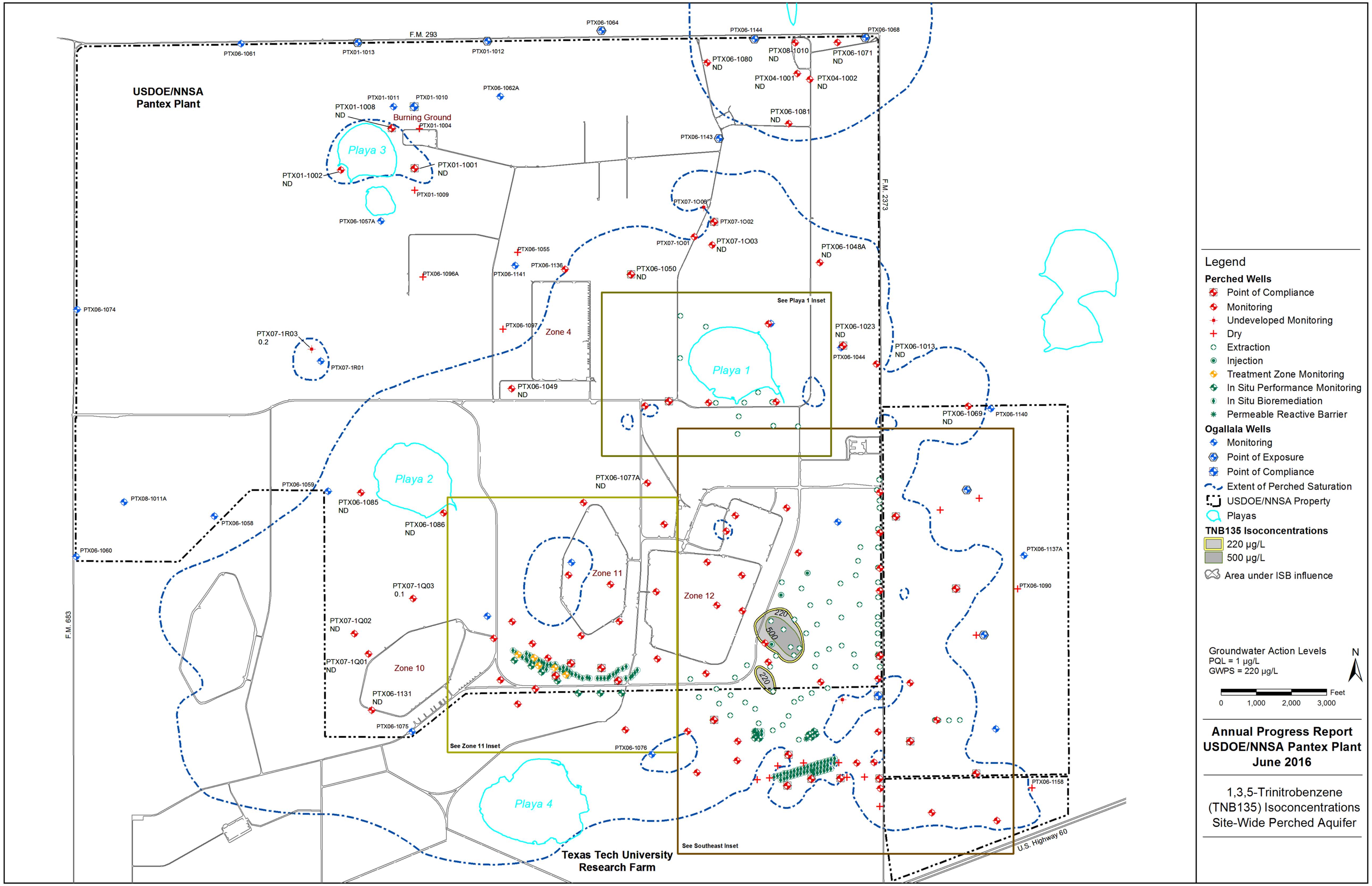

Figure 3-25. 1,3,5 - Trinitrobenzene Isoconcentration Map

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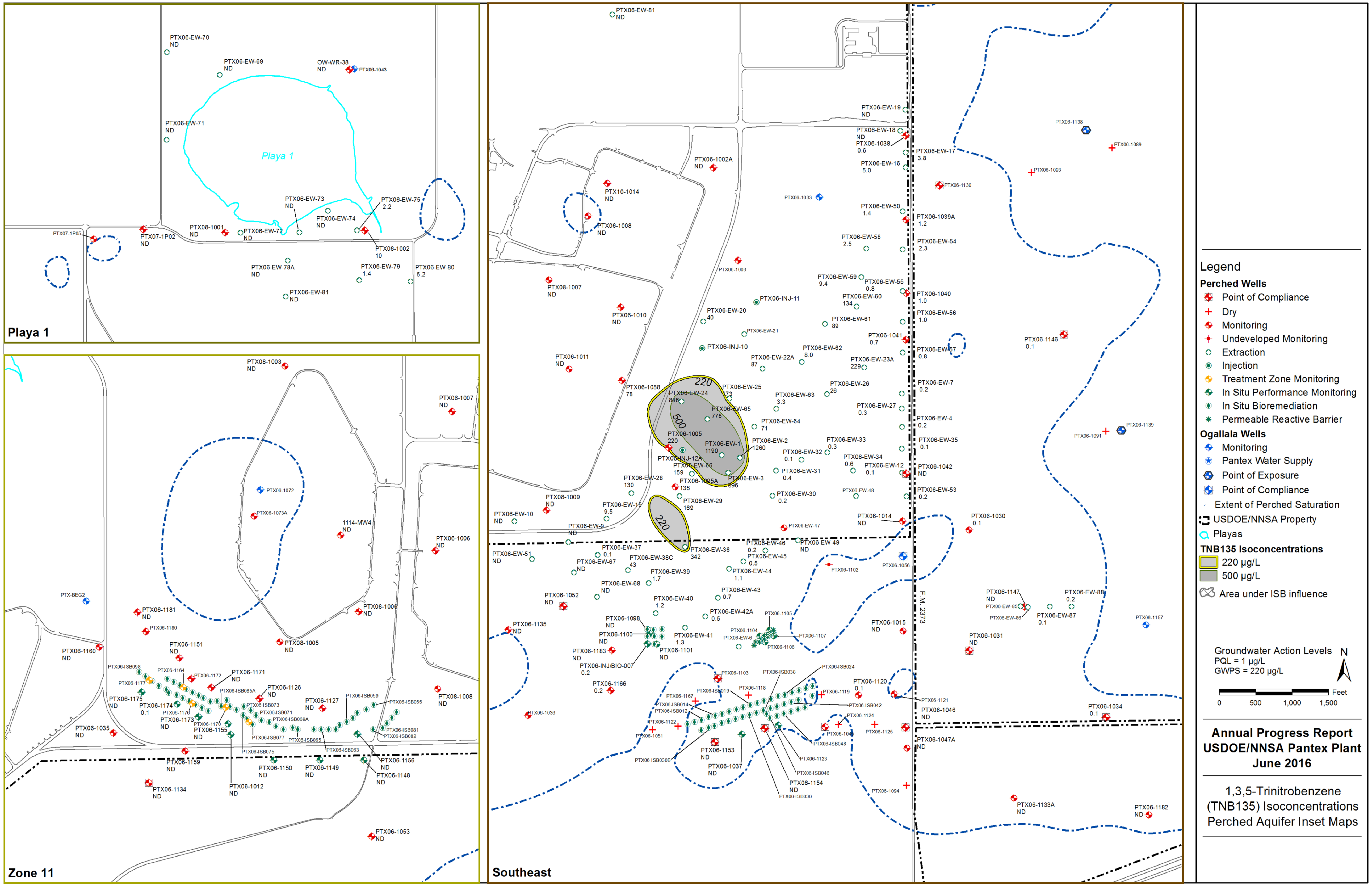

Figure 3-26. 1,3,5 - Trinitrobenzene Isoconcentration Inset Map

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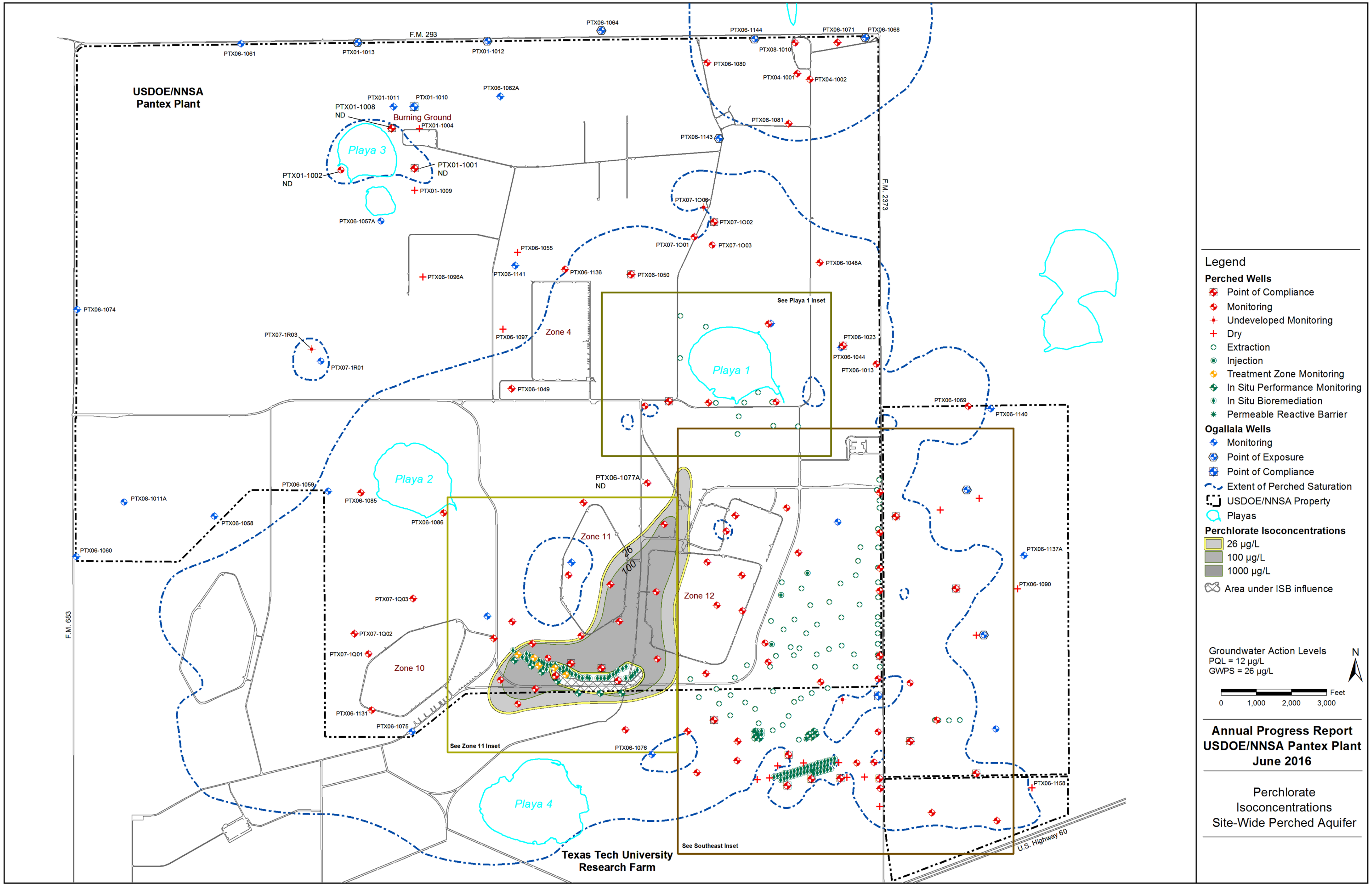

Figure 3-27. Perchlorate Isoconcentration Map

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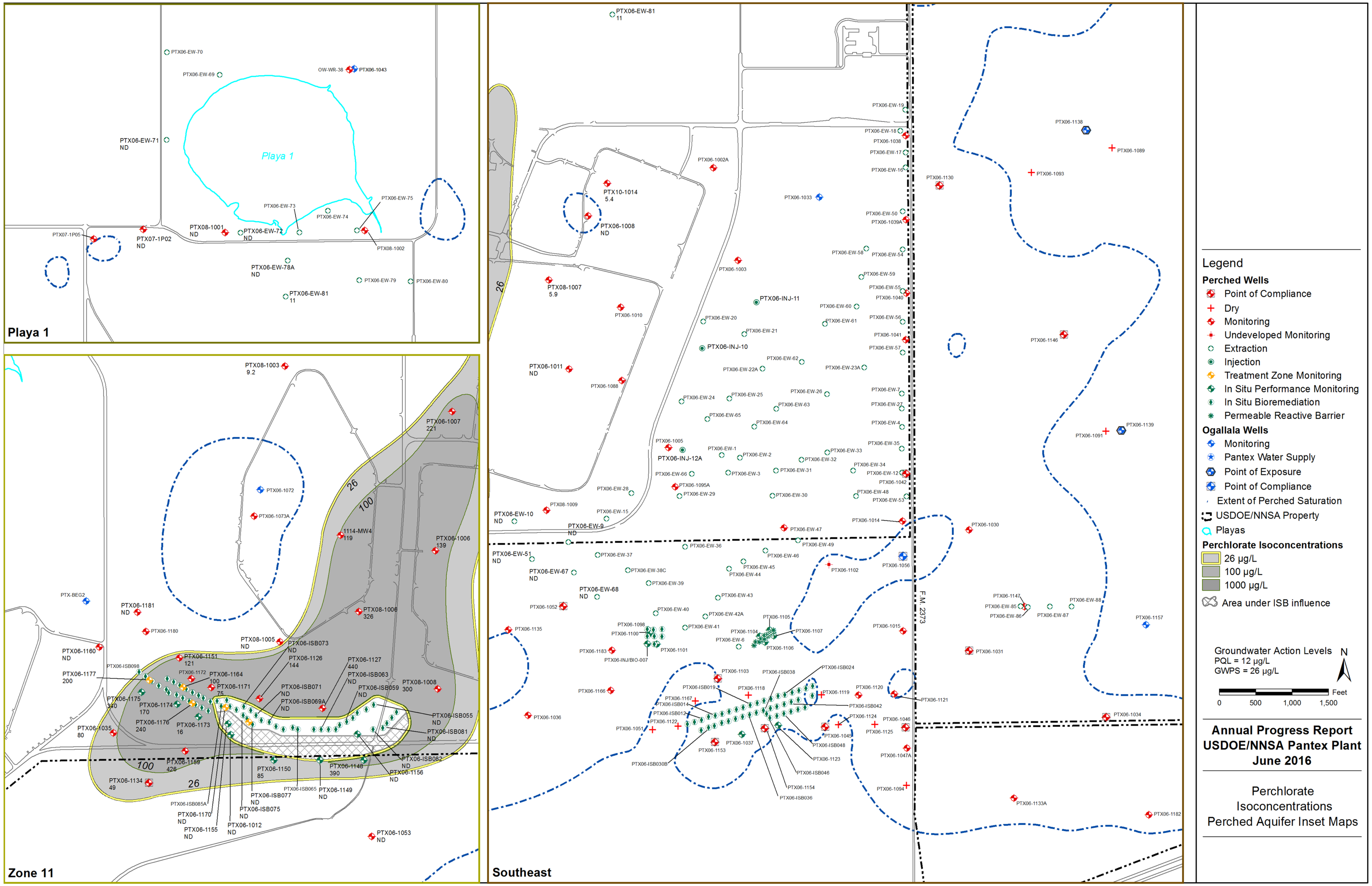

Figure 3-28. Perchlorate Isoconcentration Inset Map

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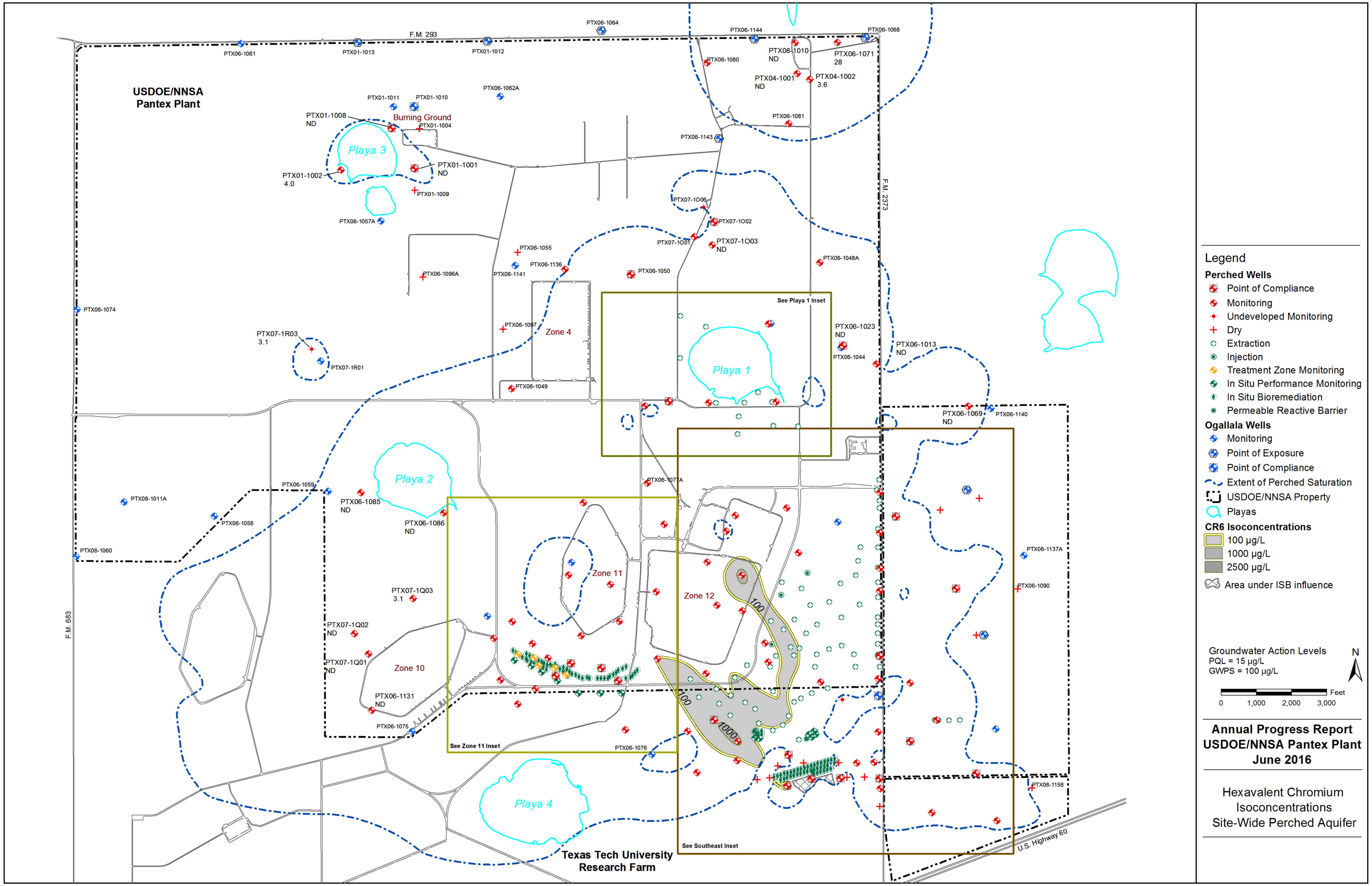

Figure 3-29. Hexavalent Chromium Isoconcentration Map

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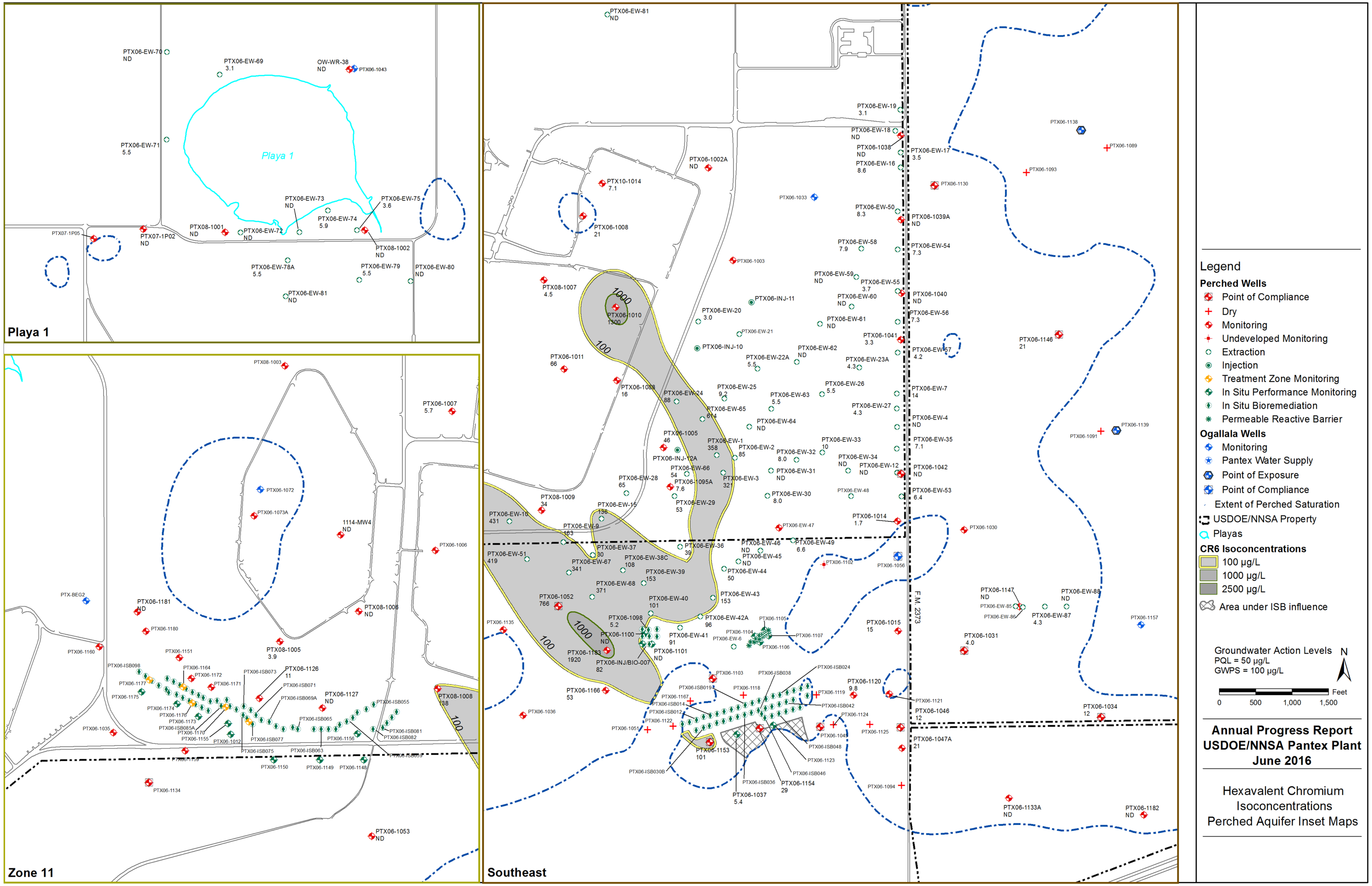

Figure 3-30. Hexavalent Chromium Isoconcentration Inset Map

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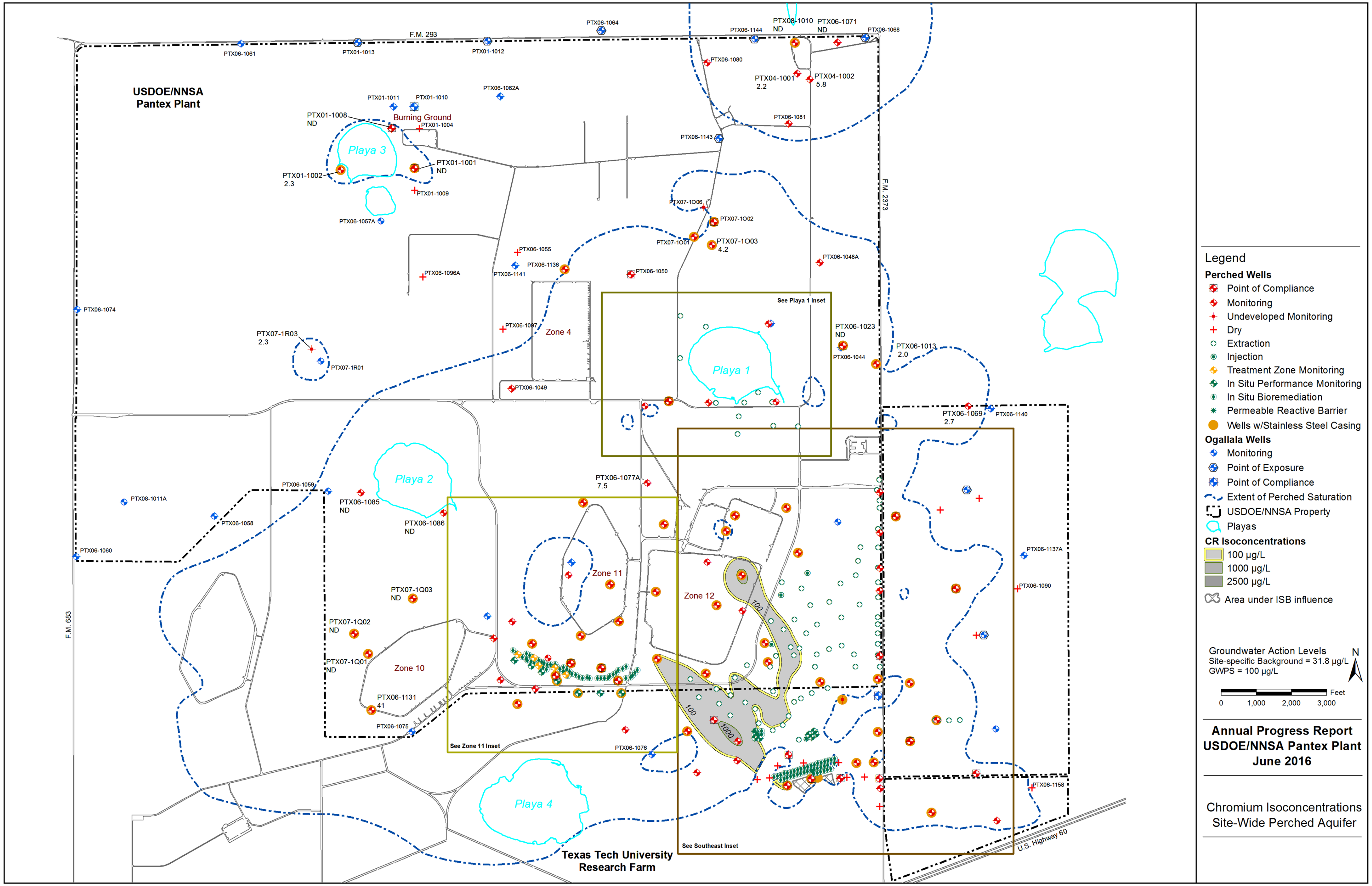

Figure 3-31. Chromium Isoconcentration Map

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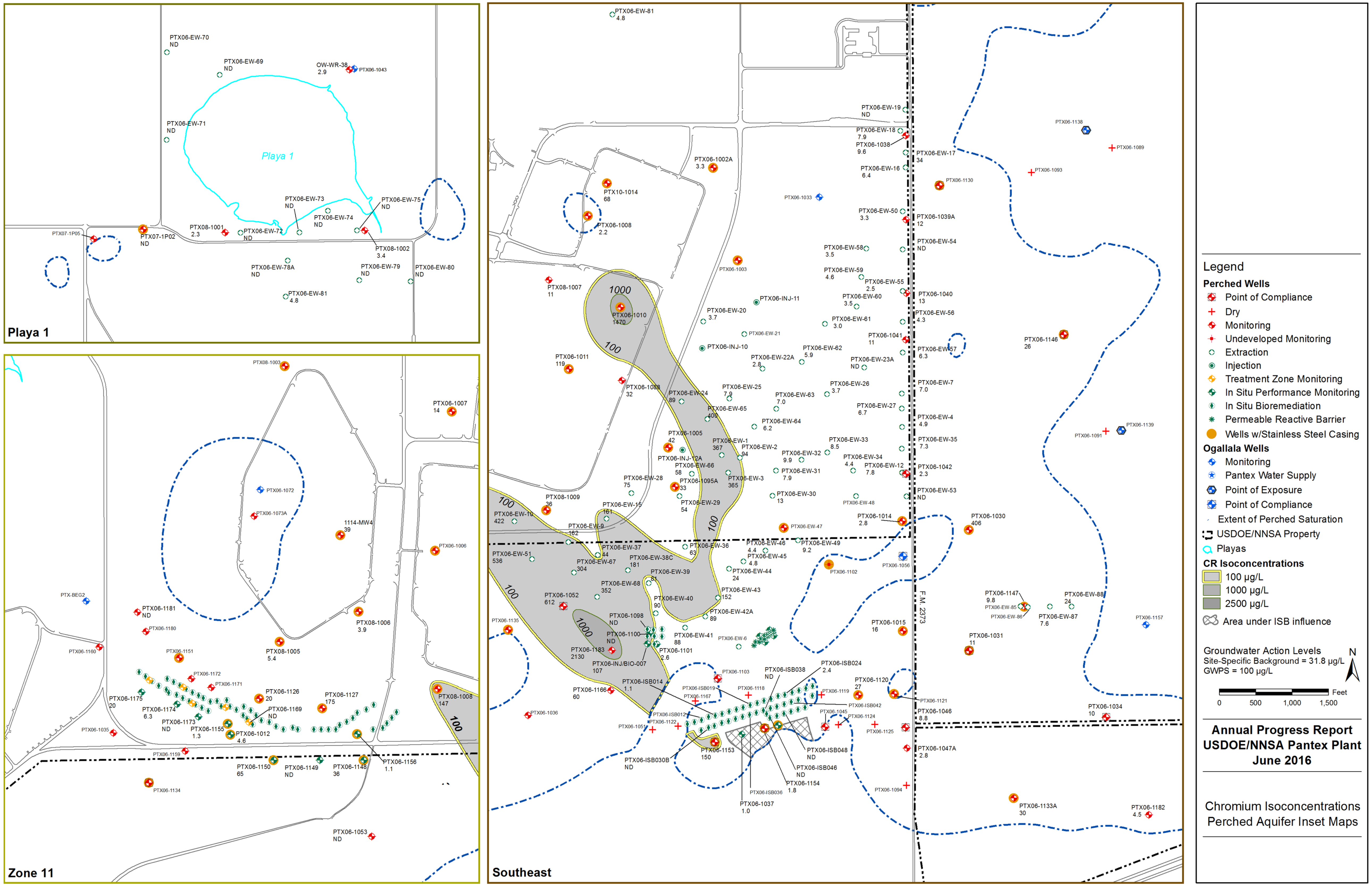

Figure 3-32. Chromium Isoconcentration Inset Map

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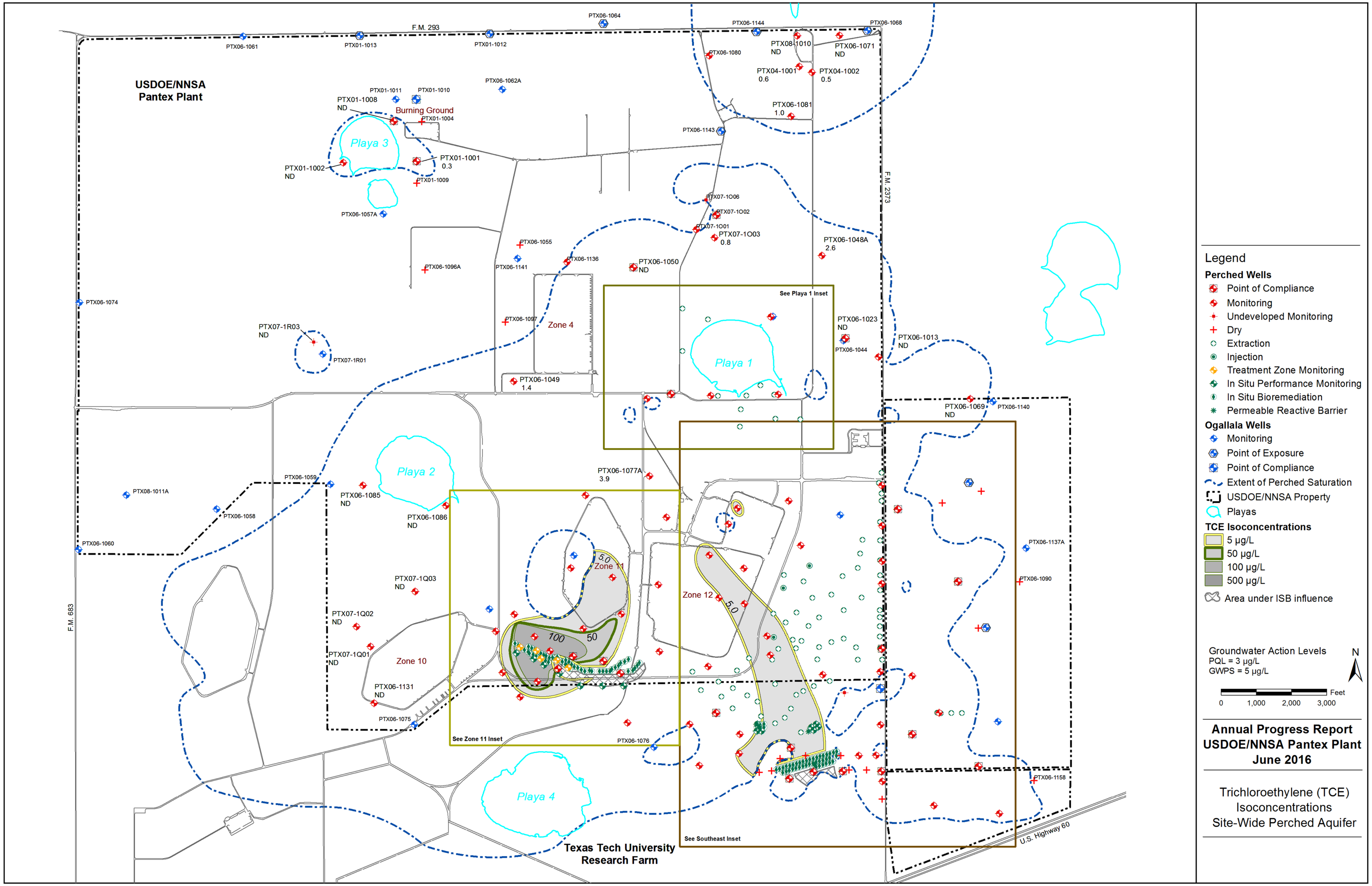

Figure 3-33. TCE Isoconcentration Map

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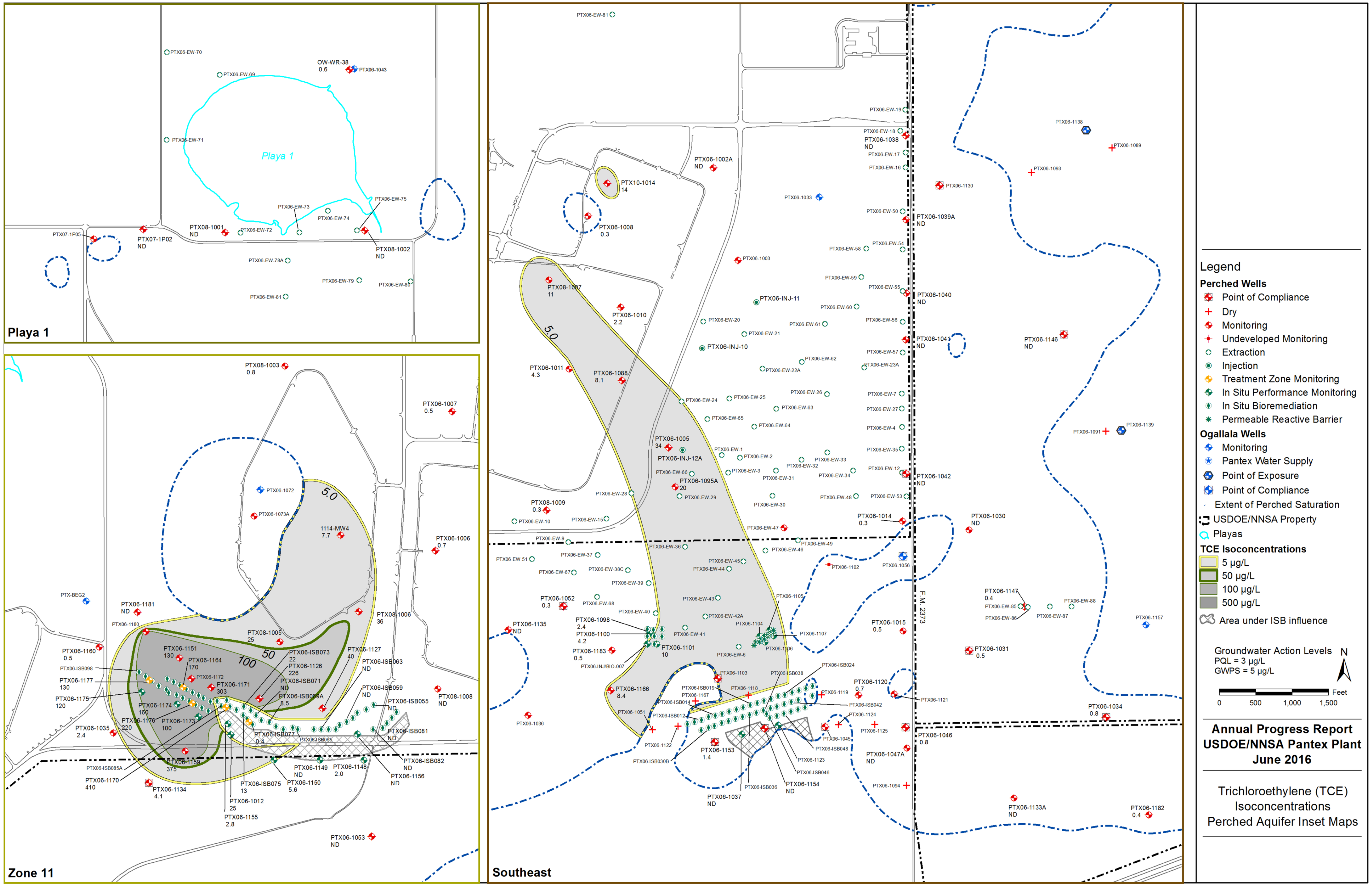

Figure 3-34. TCE Isoconcentration Inset Map

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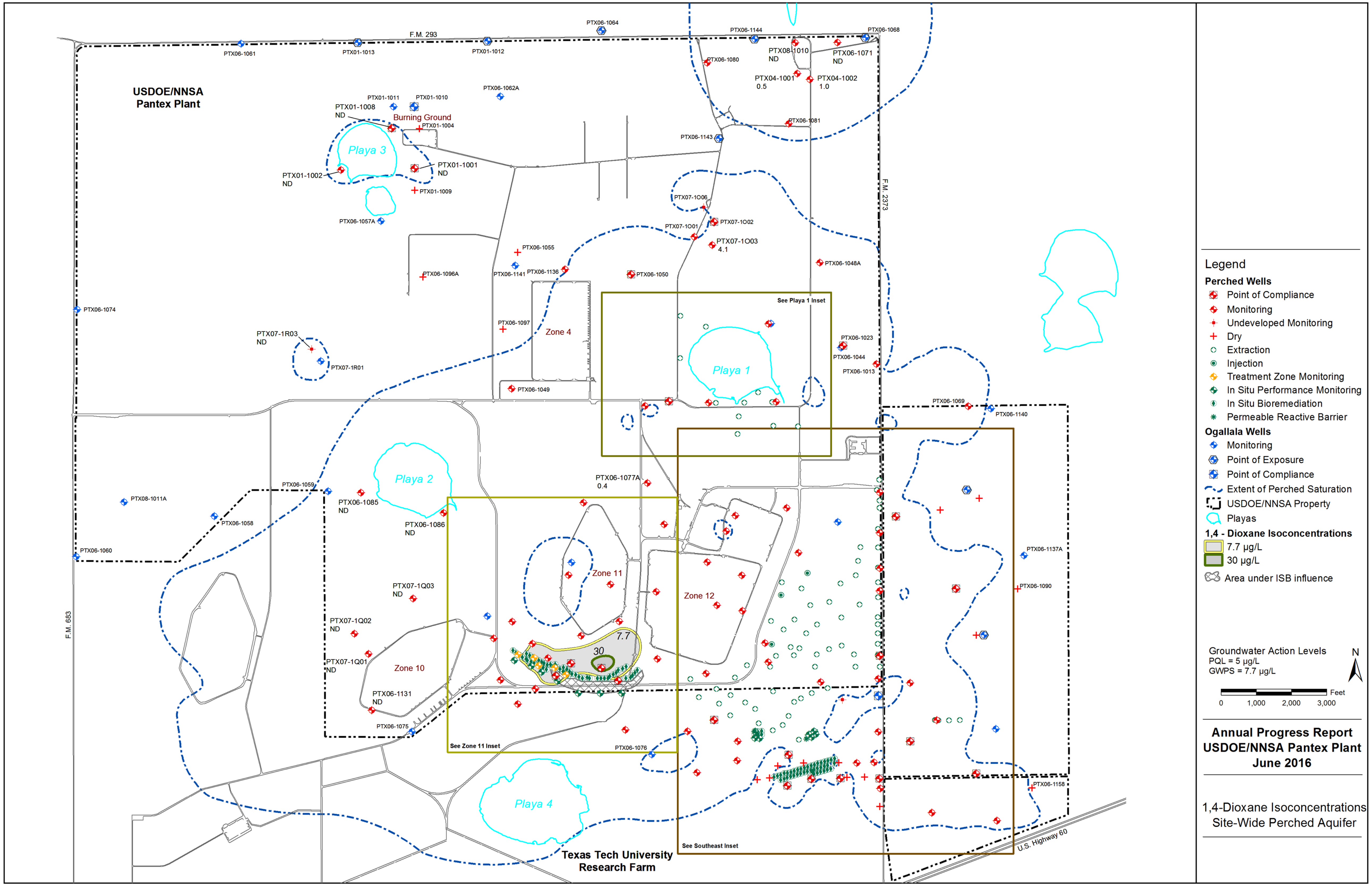

Figure 3-35. 1,4-Dioxane Isoconcentration Map

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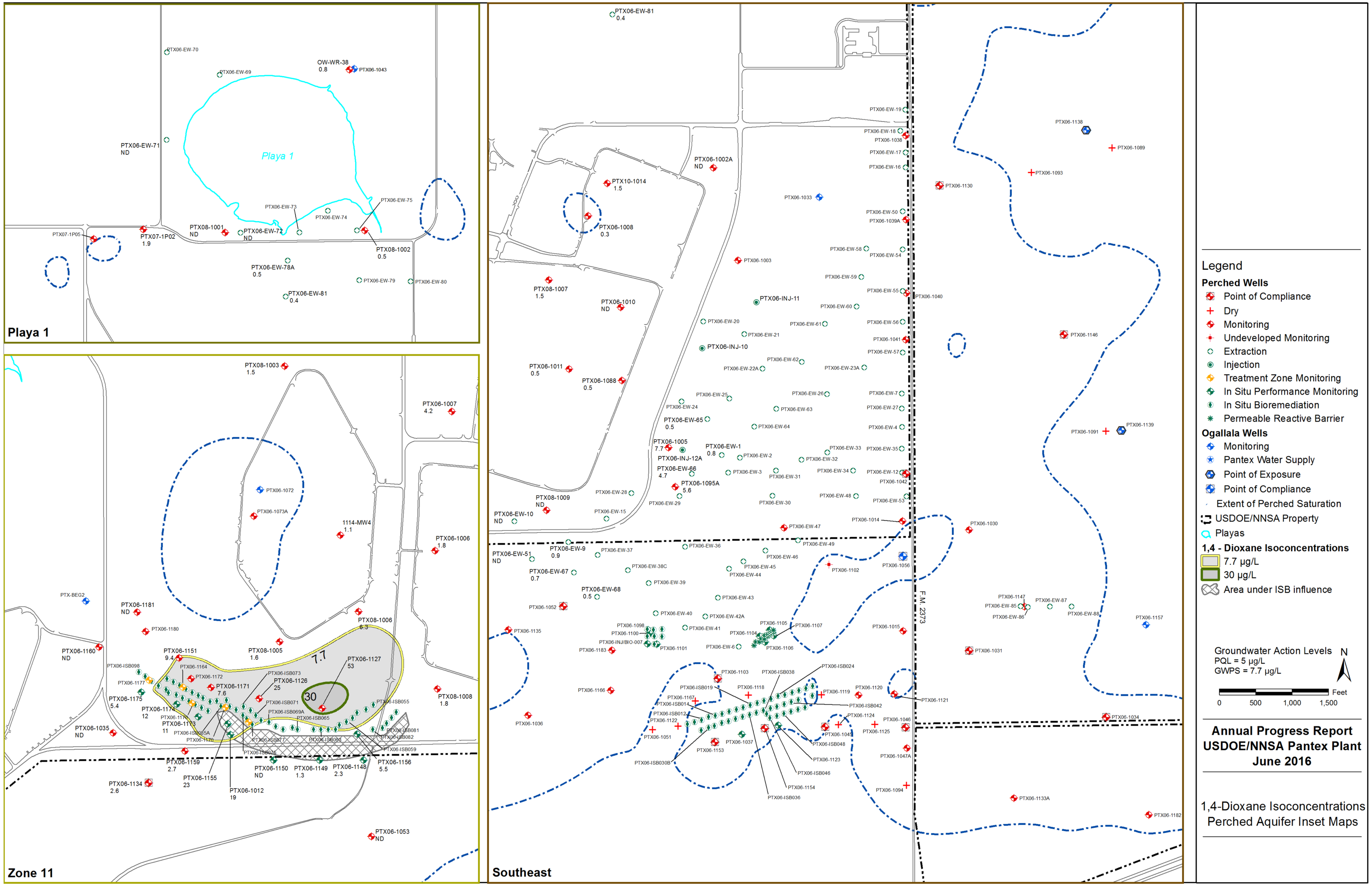

Figure 3-36. 1,4-Dioxane Isoconcentration Inset Map

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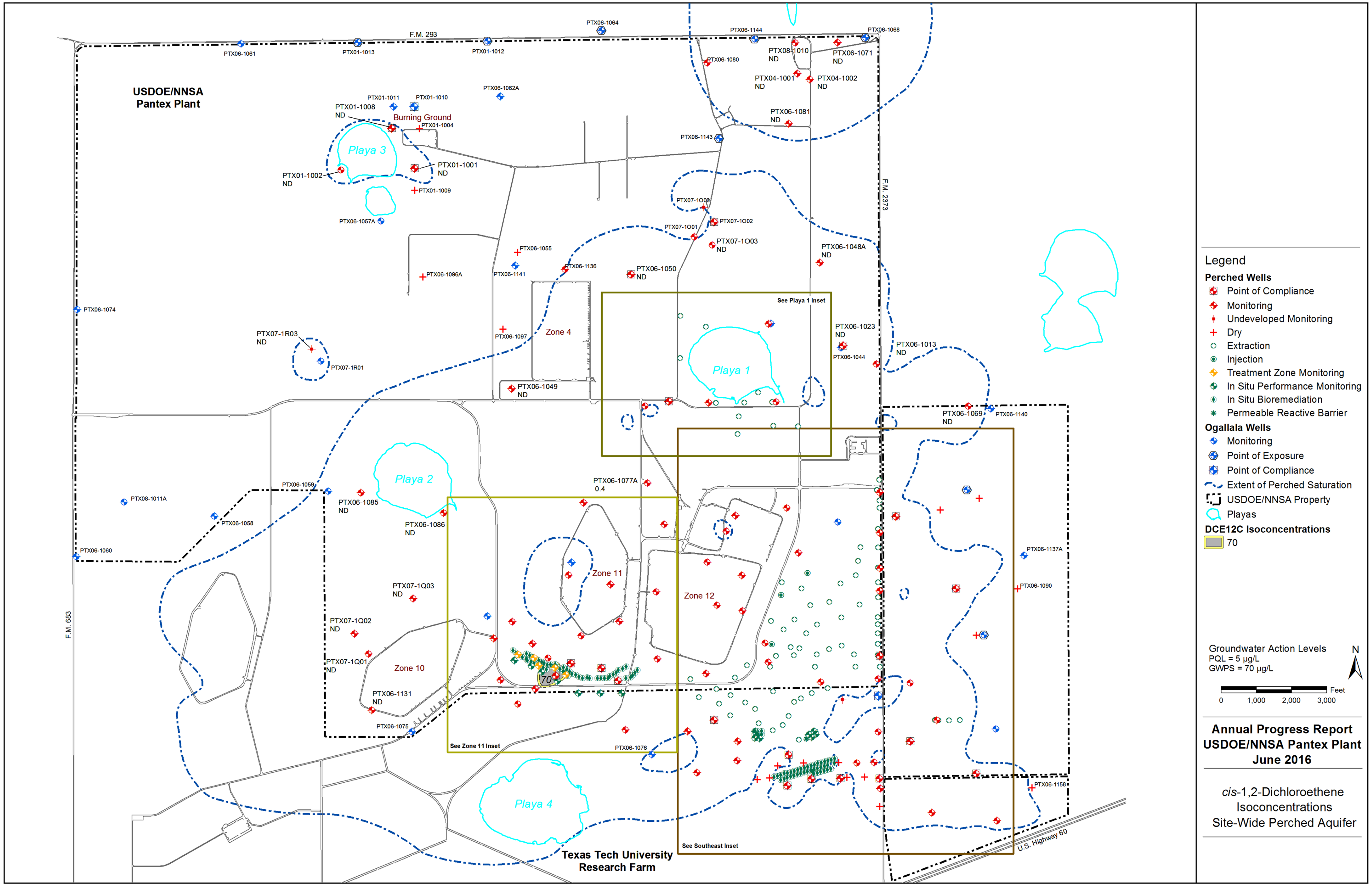

Figure 3-37. ***cis*-1,2-DCE Isoconcentration Map**

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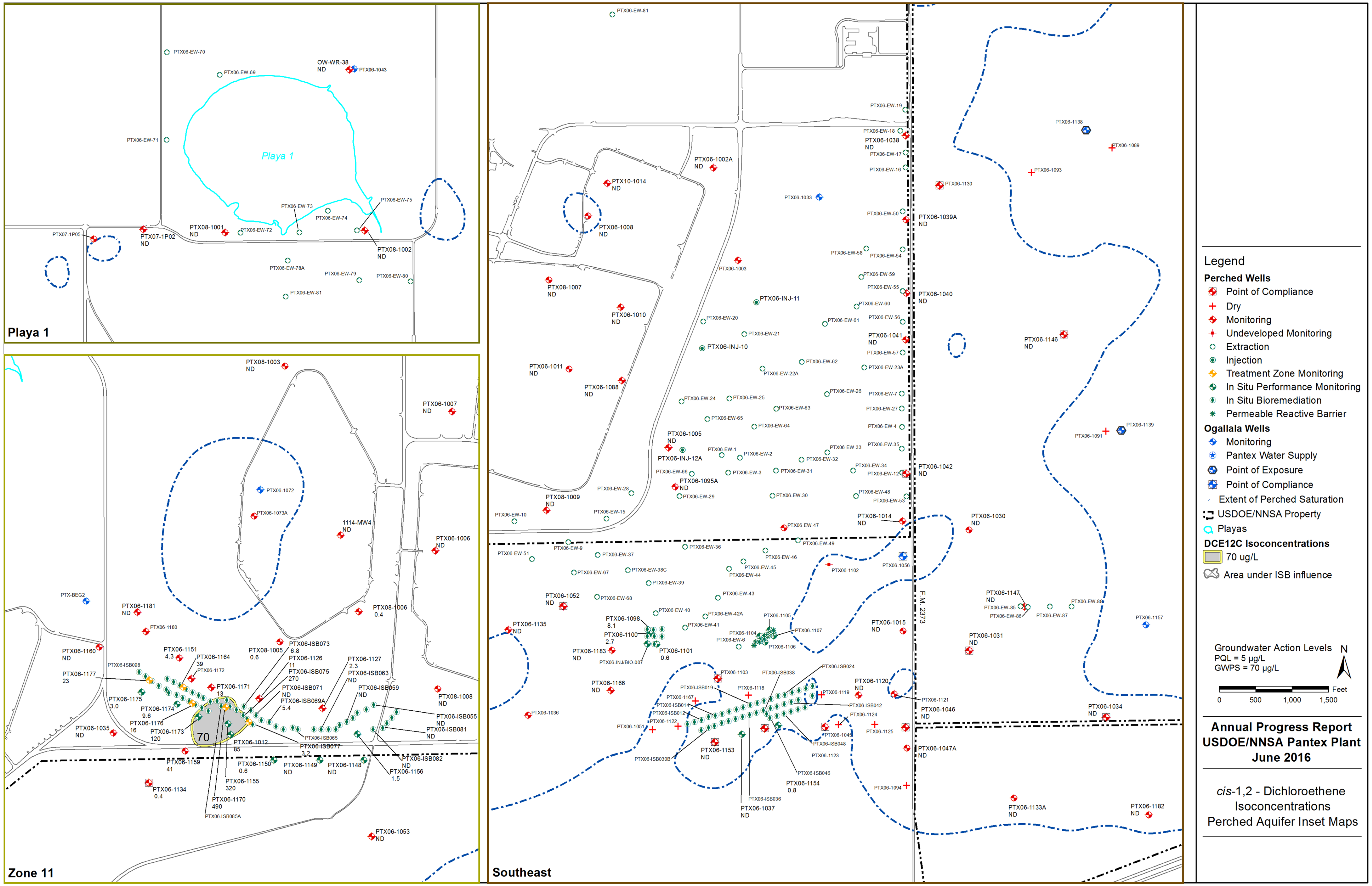

Figure 3-38. ***cis*-1,2-DCE Isoconcentration Inset Map**

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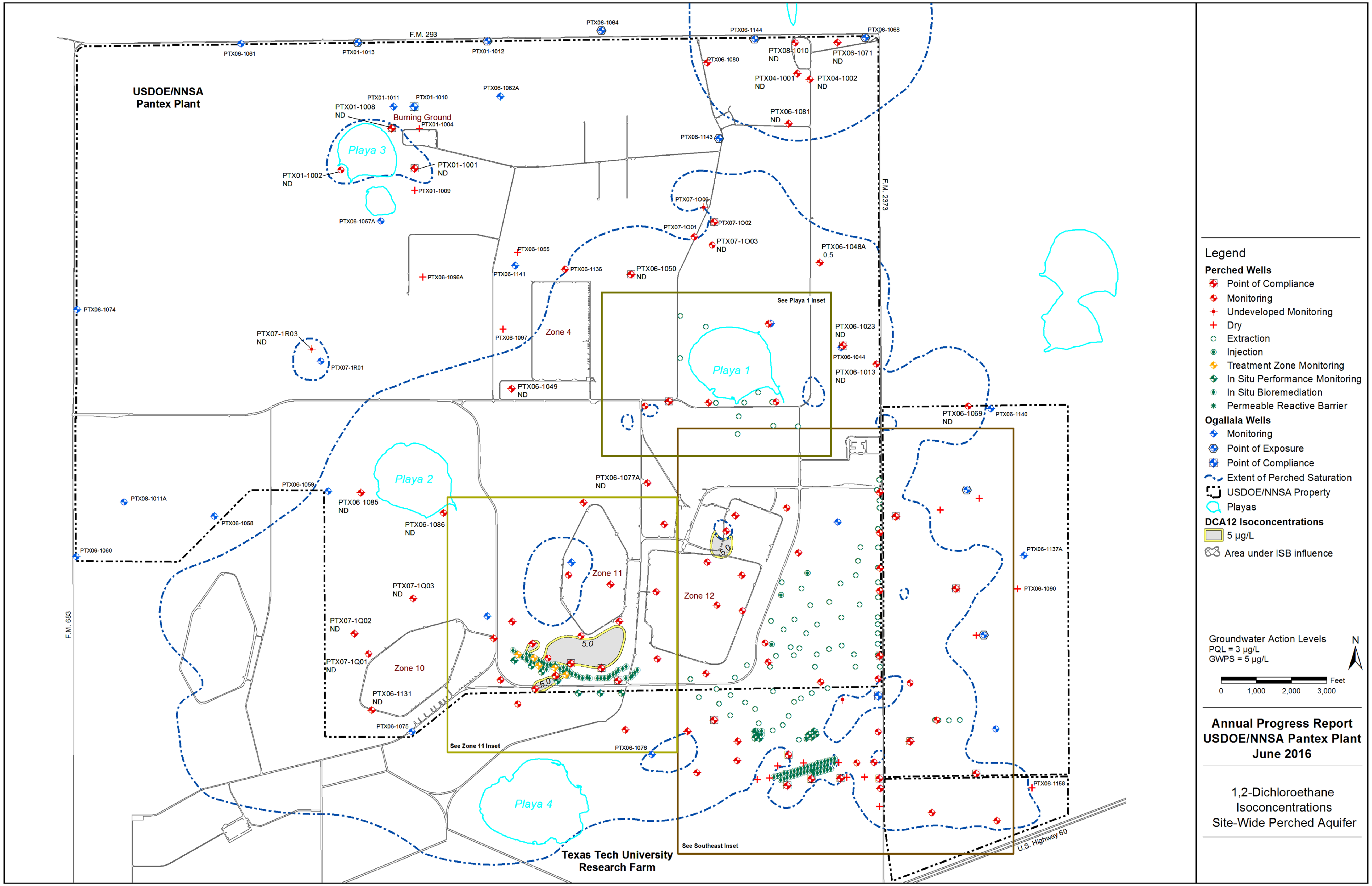

Figure 3-39. 1,2 - DCA Isoconcentration Map

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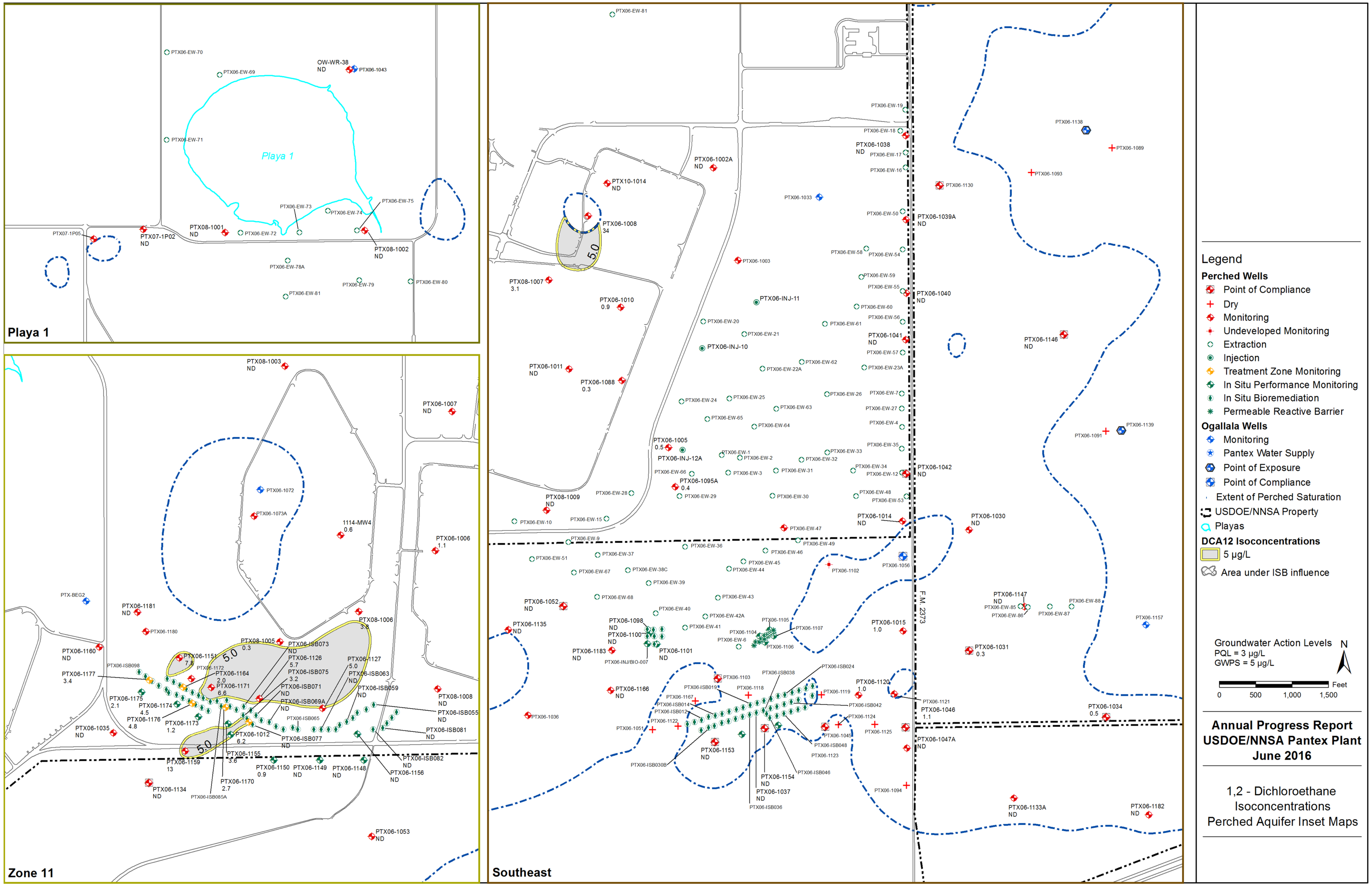

Figure 3-40. 1,2 - DCA Isoconcentration Inset Map

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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 for estimating the rate of migration of groundwater contaminants. Unlike a typical contaminant plume in a regional aquifer, the HE plume associated with Pantex (Figure 3-11) 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, 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 located 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 2009–2016 is included in the following sections. 2016 plume boundaries and/or select contours were compared with the 2009 isocontour maps available. 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 as shown in Figure 3-11 through Figure 3-26. 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. Trending of historic analytical data for this plume indicates source areas along the ditches continue to leach HEs into perched groundwater, but at much lower concentrations than occurred historically. This plume is being actively remediated by the SEPTS that 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 may be associated with water infiltrating from the playa. Wells installed near Landfills 1 and 2 and PTX06-1050 are exhibiting some increasing trends in HEs. However, these trends are believed to be due to the reduction of saturated thickness and shifting gradients in the northern perched groundwater due to P1PTS operations rather than sourcing from the landfills. Trends will continue to be monitored at these locations.

When compared to the 2009 HE plume estimates, the shapes are generally similar, with some small differences that are primarily due to slight variations in the data and low values defining the boundaries. Breakdown product plumes are variable and will likely continue to be variable as natural attenuation and remedial actions continue in the perched aquifer.

In order to attempt to evaluate HE plume movement from 2009–2016, 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 the plume 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 (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 3-41, 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 SEPTS operations and general plume movement in areas that are not under the SEPTS influence. For 2016, the RDX contour has extended into the far southeastern lobe of perched groundwater. This shift is the result of an increase in RDX to above 1,000 ug/L for the first time in 2016 at PTX06-1034 coupled with an increase in RDX to above 1,000 ug/L in 2016 at PTX06-1147. RDX in PTX06-1034 has been trending upward since 2008, while RDX in PTX06-1147 had previously been observed at levels above 1,000 ug/L starting in 2011, but had dropped below 1,000 ug/L in 2014.

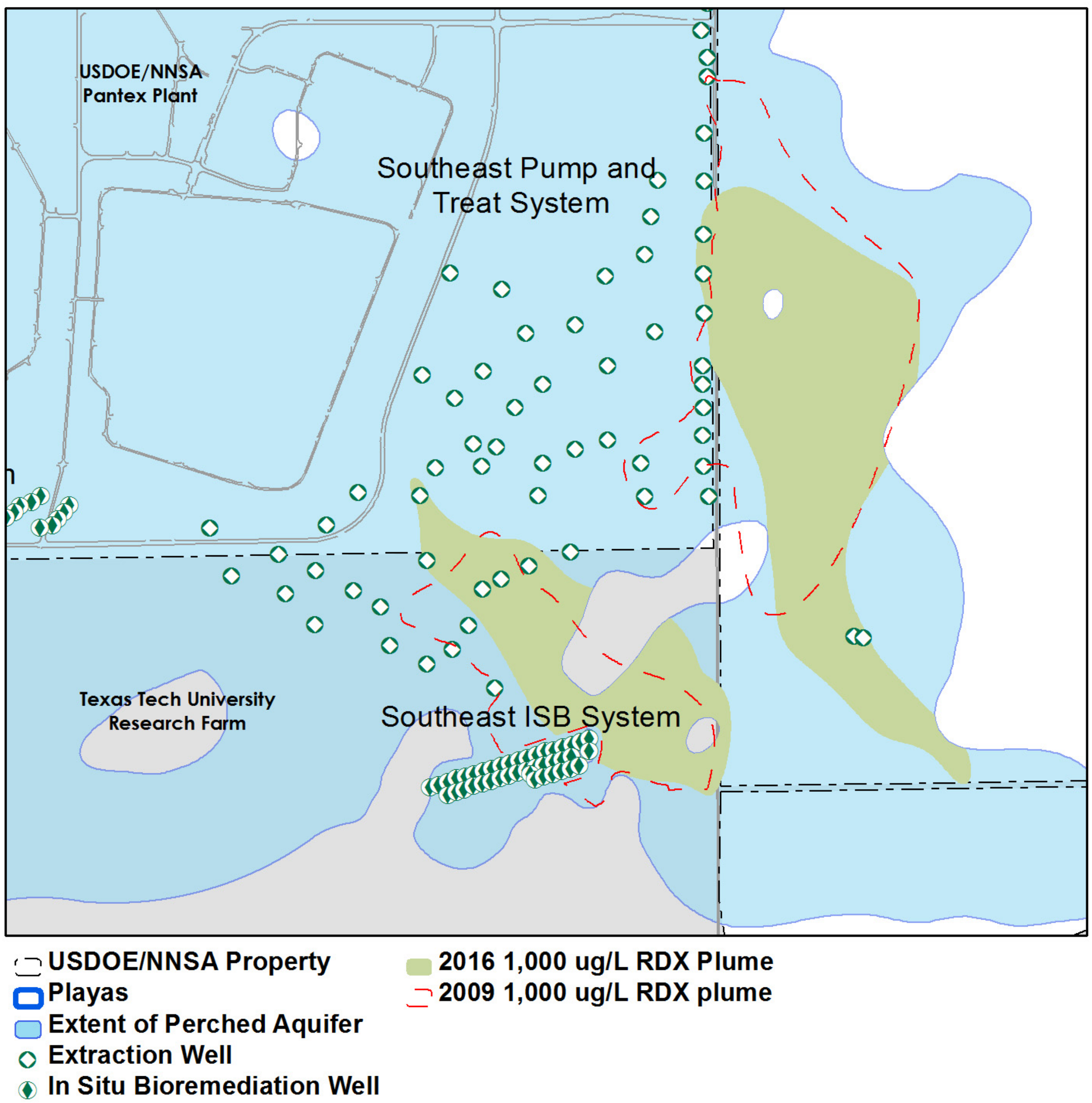

Figure 3-41. RDX Plume Movement, 2009-2016

3.1.7.2 Hexavalent Chromium Plumes

Hexavalent chromium is present in the perched aquifer in two commingled plumes originating in Zone 12 as shown in Figure 3-29 and Figure 3-30. Both of these plumes are being actively remediated by the SEPTS. The highest concentrations are associated with a source in WMG 5 outside the southwestern corner of Zone 12. Concentrations near the source area are decreasing indicating 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 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 (Figure 3-42), 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 SEPTS extraction well pumping and reduction of injection in the area.
- The southern portion of the plume has apparently shifted west due to data collected at monitoring well PTX06-1166, which has better defined the plume boundary in this area, and decreased concentrations in extraction wells north of the ISB system.

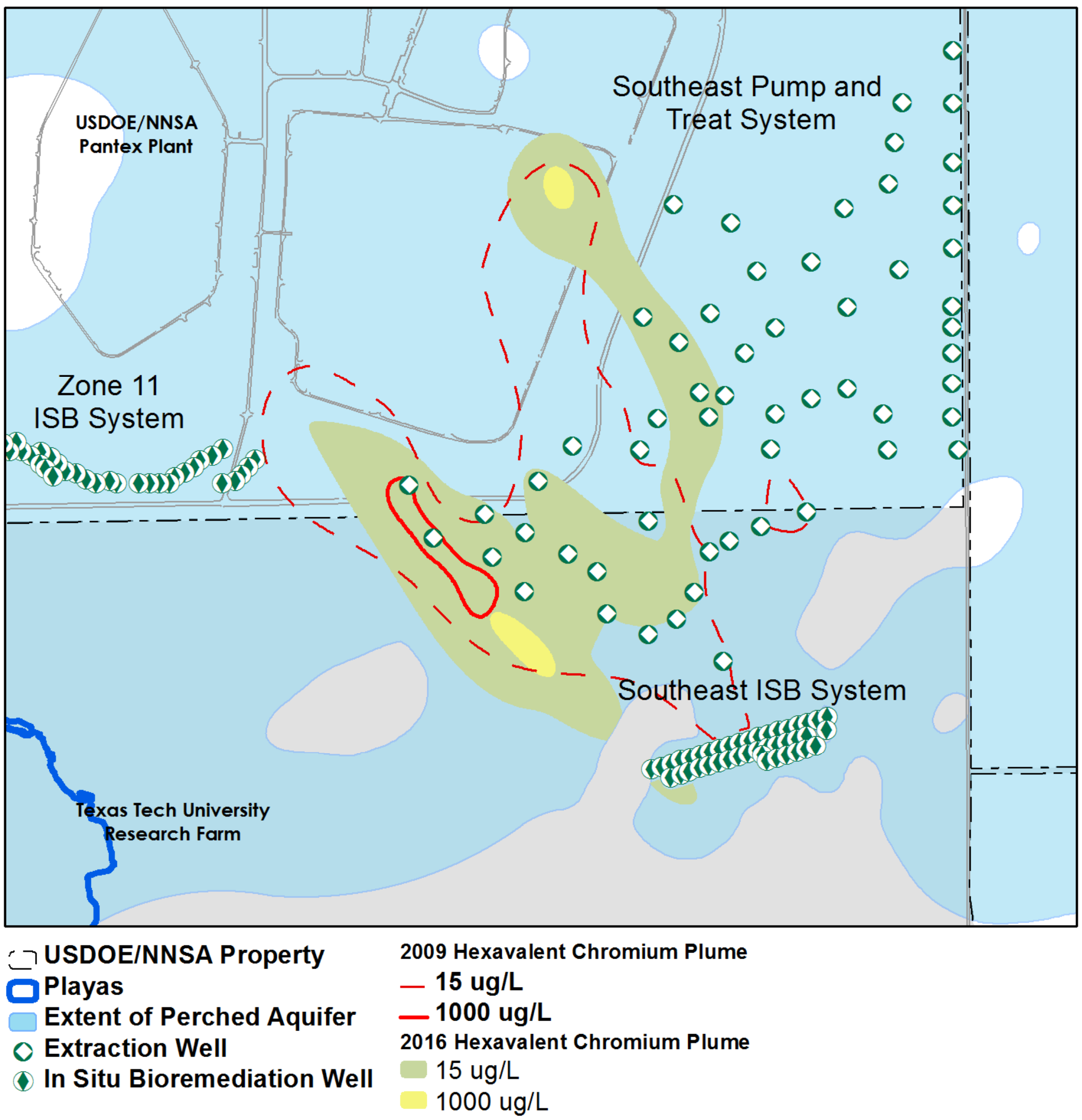

Figure 3-42. Hexavalent Chromium Plume Movement, 2009–2016

3.1.7.3 Trichloroethene Plumes

Several TCE plumes are present in the perched aquifer as shown in Figure 3-33 and Figure 3-34. The largest plume originates in the north (WMG 10) and east (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 leaching of TCE-contaminated process water associated with legacy discharges to 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 which resulted in industrial wastewater that infiltrated into the subsurface and TCE in soil gas originating from several areas within the zone. Concentrations in this plume are decreasing at all wells beneath Zone 11, except PTX08-1006 where concentrations are increasing indicating continuing migration of TCE into perched groundwater. This plume is migrating southward, and observed concentrations at the TTU property boundary are increasing. This plume is being actively remediated by the Zone 11 ISB System as discussed in Section 3.2.3.1.

As depicted in Figure 3-43, the 2009 and 2016 TCE plume shapes are similar, with the following notable exceptions.

- The plume originating from Zone 12 has contracted near the Zone 12 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 Southeast ISB ISPM wells.
- The plume originating from Zone 11 has shifted to the southwest due to general gradient in the area and a newly installed well to the west.

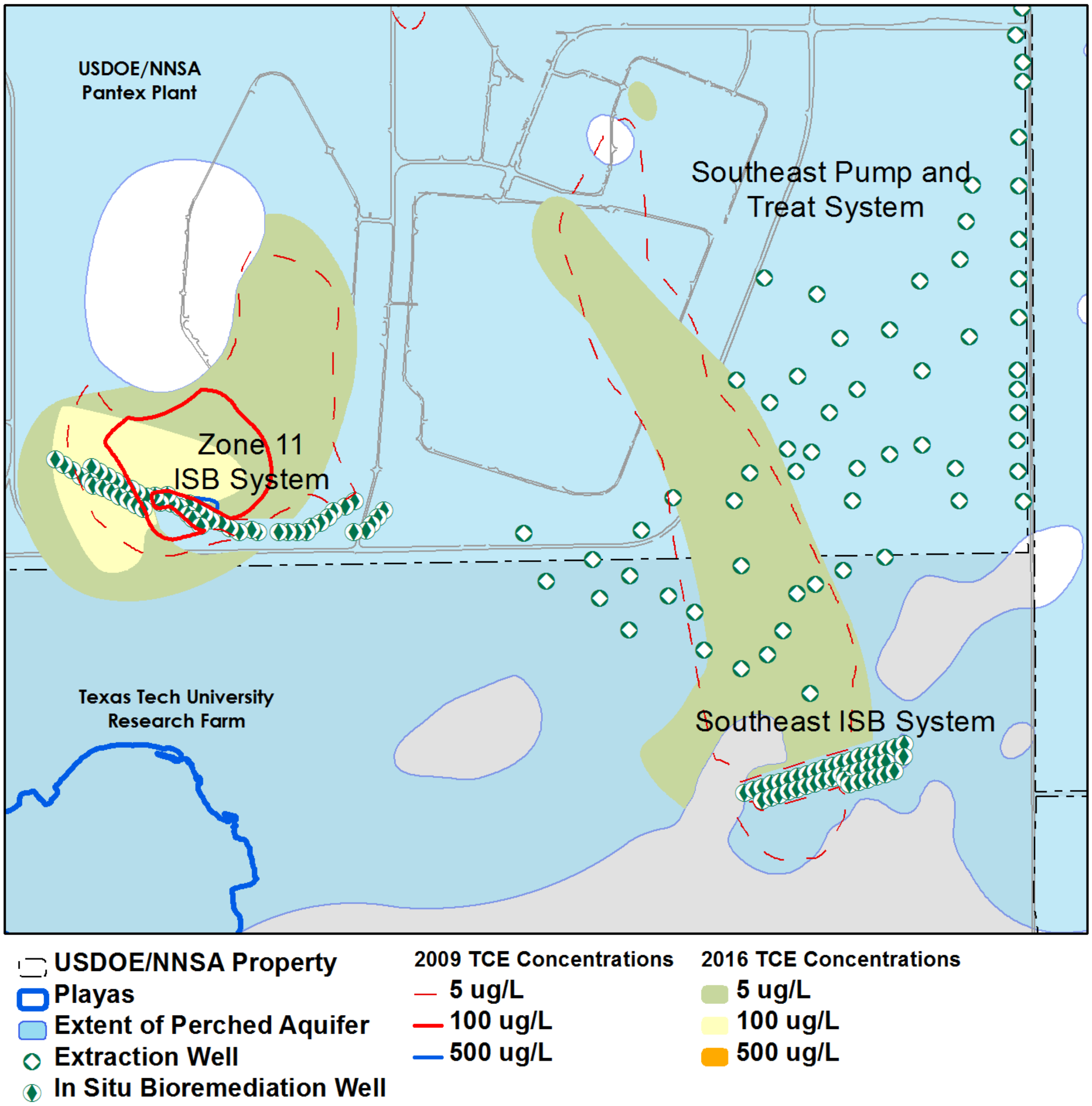

Figure 3-43. TCE Plume Movement, 2009-2016

3.1.7.4 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 TTU property as shown in Figure 3-27 and Figure 3-28. 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 decreasing, but remain steady or are increasing near the ditch to Playa 1. Perchlorate concentrations near the southern boundary of Pantex Plant continue to generally increase. This plume is being actively remediated by the Zone 11 ISB System.

As depicted in Figure 3-44, 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 monitor wells.
- The southeastern boundary of the plume has shifted east because of the increase of perchlorate in PTX08-1008 first observed in 2008. The hydraulic gradient in this area has shifted more eastward and a portion of the perchlorate plume in this area should be captured by SEPTS extraction wells.

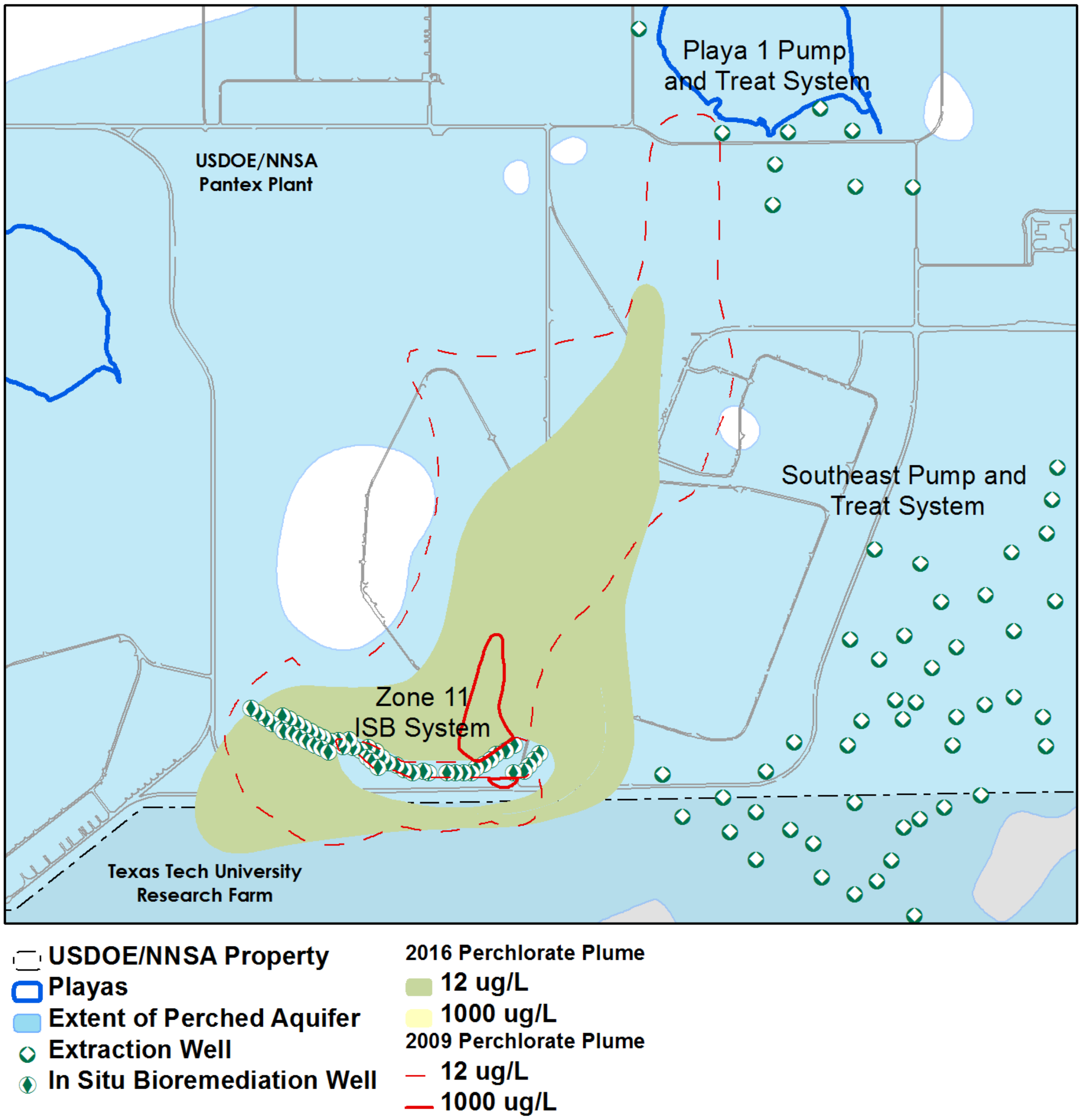

Figure 3-44. Perchlorate Plume Movement, 2009-2016

3.2 Remedial Action Effectiveness

3.2.1 Southeast Pump and Treat System

The objective of the SEPTS (Figure 3-45) 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 in order to achieve two important goals:

- A gradual reduction of the volume of perched groundwater (and contamination) moving downgradient toward the extent of saturation, and

- A reduction in the head (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. The P1PTS appears to be influencing local water levels and hydraulic gradient in the area near Playa 1. Figure 3-46 illustrates the influence of these two systems. Water levels measured at 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 formation of an extensive cone of depression throughout the system is limited by the thin saturated thickness of the aquifer.

The water table map indicates groundwater is still flowing southward across the USDOE/NNSA property boundary onto TTU property. However, extraction wells located on TTU property limit the further migration of perched groundwater contaminants to the south.

Water table contours along FM 2373 indicate groundwater is flowing to the south and southeast 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 System Operations in 2016

The SEPTS treated nearly 130 million gallons of extracted water during 2016. This system released about 98% of the treated water to the WWTF for use in the irrigation system, and the remainder was beneficially used for construction use and injection of amendment in the ISB systems. None of the treated water was injected into the perched zone in 2016.

Figure 3-45. SEPTS Extraction Wells and Conveyance Lines

The system removed about 79 lbs of hexavalent chromium, 380 lbs of RDX, and 240 lbs of all other HEs during 2016. The average removal rate of hexavalent chromium was 0.6 lbs/Mgal of water, and the average removal rate for HEs was 4.8 lbs/Mgal of water. This system has treated approximately 11,500 lbs of HEs and 1,500 lbs of hexavalent chromium since beginning operation. Evaluation of effluent data indicates the system continues to treat the recovered groundwater to concentrations below the PQL and the GWPS.

3.2.1.2 Hydrodynamic Control

Hydrodynamic control limits the horizontal migration of contaminants by using extraction wells to alter the hydraulic gradient. Because of the limited saturated thickness of the perched aquifer, complete hydraulic containment of the contaminant plume is not possible. However, the SEPTS has been effective at altering 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. The approximate radius of influence of the groundwater treatment systems and the directions of perched groundwater flow gradients outside the radius of influence are shown on Figure 3-46. Capture zones, shown in Figure 3-46 for the extraction wells, were calculated using a single-layer groundwater flow model of the perched aquifer. Average 2016 extraction flow rates for each well were used in the calculations.

3.2.1.3 System Effectiveness

Considering 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 included in Section 3.1 can be used to determine the effectiveness of these systems. To this end, the pump and treat systems have been very effective in 2016. When comparing the 2016 conditions to LTM Design expected conditions, the majority of monitor wells are meeting expected conditions in the sixth 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 SEPTS secondary goal of mass removal, the system continued to remove both HEs and hexavalent chromium and treated nearly 130 million gallons of extracted water to concentrations below the PQL and the GWPS. While the SEPTS did not consistently meet all throughput goals during 2016 due to system upgrades, reduced flow to the WWTF and irrigation system, and maintenance activities, Pantex continues to optimize the system operation.

Table 3-2. LTM Wells Not Meeting Expected Conditions for Water Levels

Well	Water Level Trend
OW-WR-38	Increasing
PTX06-1002A	Increasing
PTX06-1013	No Trend
PTX06-1023	No Trend
PTX08-1001	Increasing
PTX08-1002	Increasing
PTX08-1008	Increasing

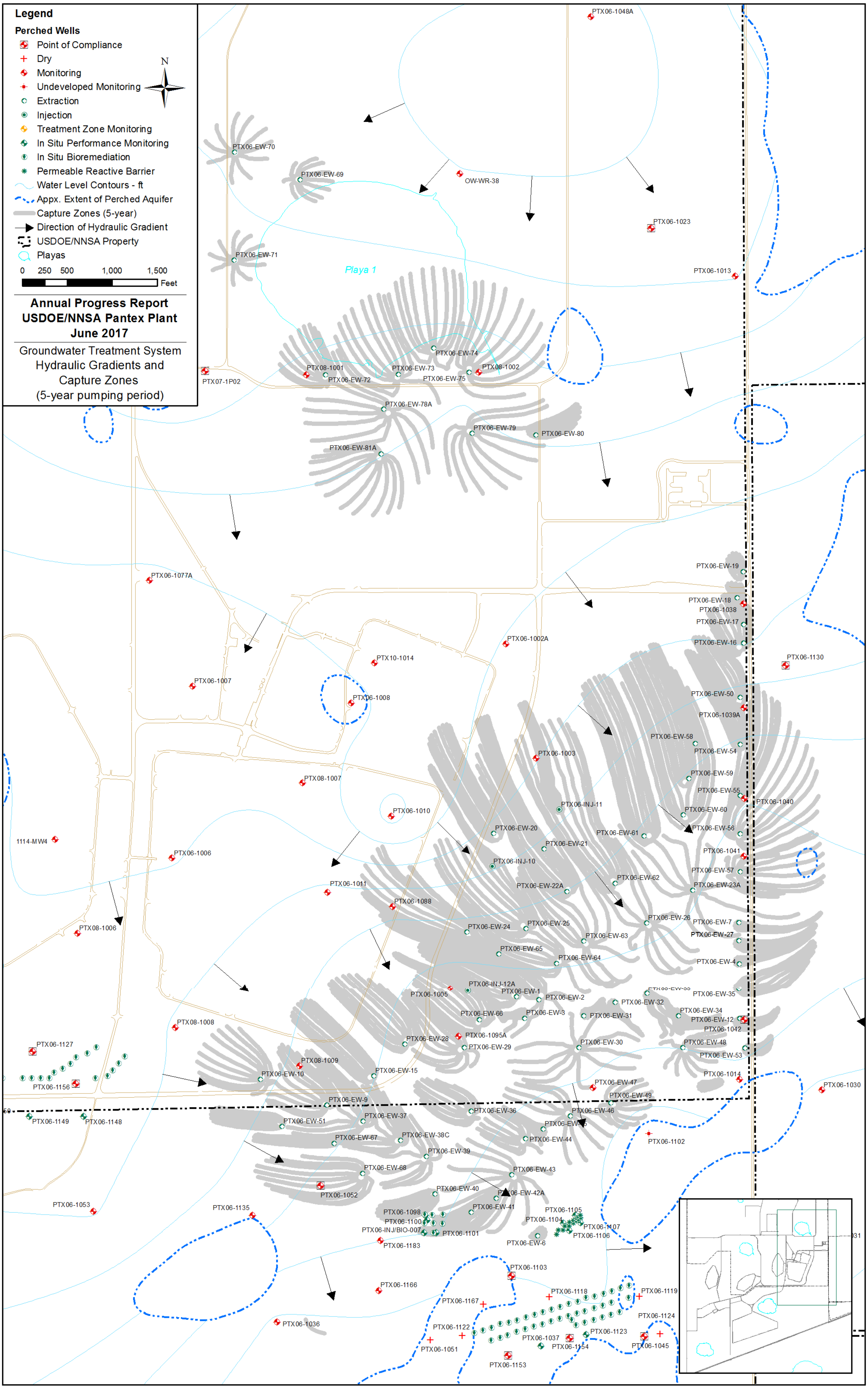

Figure 3-46. Pump and Treat System Capture Zones

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3.2.2 Playa 1 Pump and Treat System

The P1PTS was completed during 2008 with operations starting in September 2008. This system extracts water from 10 wells near Playa 1 (see Figure 3-47) 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 reduce the mound of perched groundwater associated with Playa 1, affecting the movement of the southeast plume by reducing the hydraulic head, as well as achieving mass removal.

P1PTS appears to be influencing local water levels and hydraulic gradient in the Playa 1 area. Figure 3-46 illustrates the influence of both groundwater pump and treat systems. Water levels measured at extraction wells were not used in the interpretation of water table contours so that cones of depression would not be overestimated. Due to the thicker saturated interval near Playa 1 and more consistent pump operation, cones of depression are established around the extraction wells.

The water table map indicates the mound of groundwater beneath Playa 1 has been reduced as the groundwater high in the perched aquifer is now to the northeast. Groundwater is still generally flowing away from the Playa 1 region, then to the south/southeast across the USDOE/NNSA property boundary onto TTU property. As the perched aquifer saturated thickness continues to be reduced in this region, this flow should decrease and the driving head will be reduced. In addition, SEPTS extraction wells limit the further migration of perched groundwater contaminants to the south.

The hydraulic gradient has begun to be 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 Operations in 2016

The system treated approximately 68 million gallons during 2016. Operational performance was below goals for portions of the year because flow was restricted to the WWTF/irrigation system. As recommended in the first *Five-Year Review Report* (Pantex, 2013d), Pantex has installed one additional P1PTS extraction well (PTX06-EW81A) to ensure operational goals can be consistently met regardless of individual well repair issues. That well was connected to the system in May 2016 and became operational by November after troubleshooting and repair of communication issues. However, it should be recogized the majority of the system downtime in 2016 was due to WWTF or irrigation system issues, which cannot be addressed by P1PTS optimization or improvements.

3.2.2.2 System Effectiveness

Considering 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 included in Section 3.1 can be used to determine the effectiveness of these systems. To this end, the pump and treat systems have been very effective in 2016. When comparing the 2016 conditions to LTM Design expected conditions, most wells are meeting expected conditions.

During 2016, the system removed a total of 21 lbs of RDX and 9 lbs of all other HEs. The average removal rate of HEs was 0.4 lbs/Mgal of treated water. Evaluation of effluent data indicates the system treated the recovered groundwater to concentrations below the PQL and the GWPS.

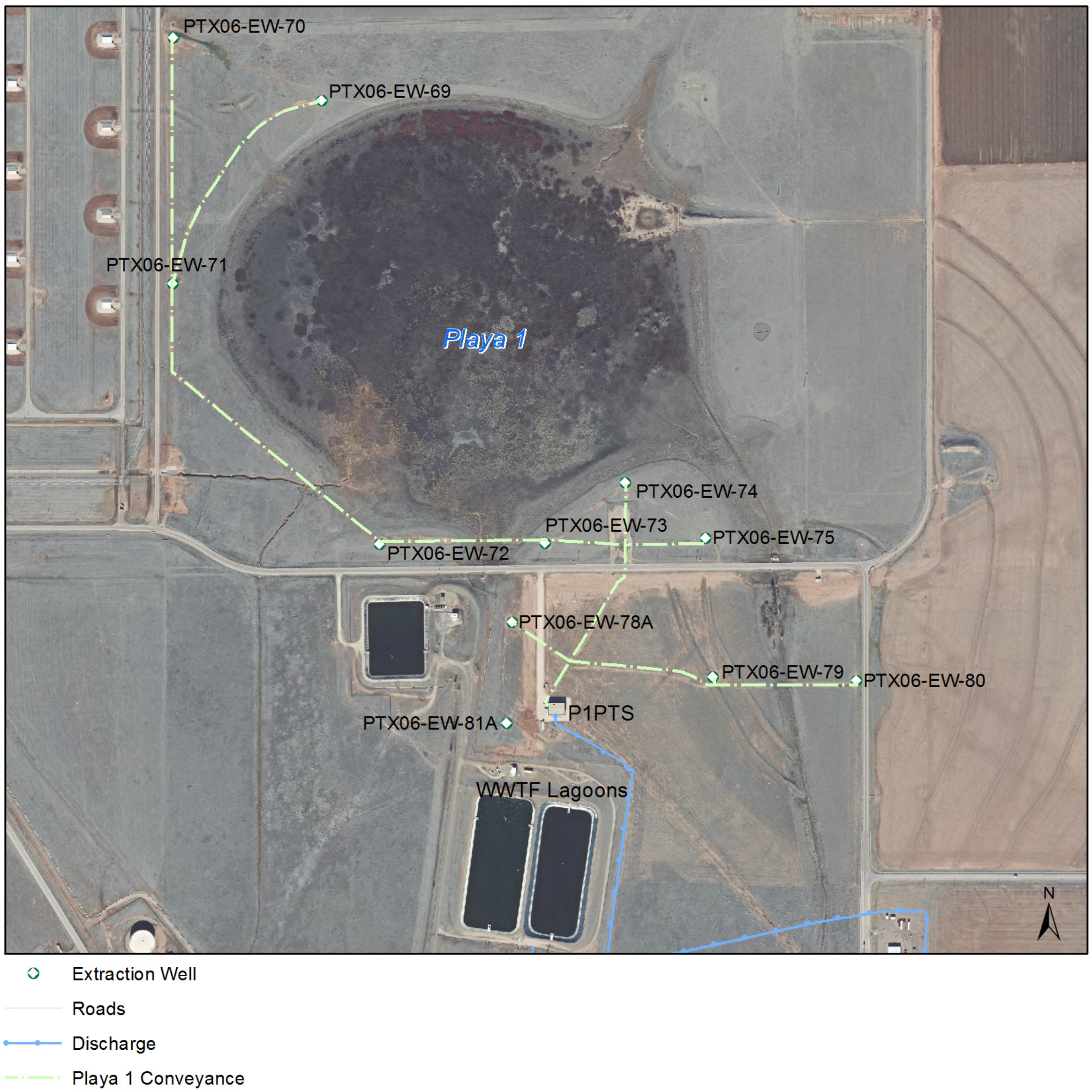


Figure 3-47. P1PTS Extraction Wells and Conveyance Lines

3.2.3 ISB Systems

Pantex has installed and operates two ISB systems. One system is southeast of Pantex Plant on TTU property and one is south of Zone 11. The ISB systems consist of 90 active treatment zone wells and 15 active ISPM wells.

The objective of the ISB systems is to establish an anaerobic biodegradation treatment zone 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 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, indicators of geochemical conditions and amendment longevity are used to determine if conditions are within an acceptable range for oxidation-reduction (redox) potential, electron acceptor concentrations (i.e., dissolved oxygen [DO], nitrate, and sulfate), and nutrient supply (total organic carbon and prevalent volatile fatty acids [VFAs]). These parameters are important because reducing conditions and adequate nutrients must be present to treat the COCs.

The bioremediation amendment, or carbon source, selected for the ISB systems is an emulsion of sodium lactate and soybean oil called Newman Zone™. The formulation provides both a rapidly-utilized electron donor (sodium lactate) and a slow-release long-term electron donor (soybean oil). As illustrated in Figure 3-48, the complex carbon source slowly ferments releasing lighter weight organic compounds, such as VFAs, which are further used for microbial energy and growth. Many steps of the fermentation process produce hydrogen, which is utilized by some microbes to directly metabolize COCs. As long as optimal subsurface reducing conditions and VFAs are available, a diverse microbial community can be sustained which leads to in situ treatment of COCs. Total VFAs are evaluated at the ISBs and serve as a good indicator that fermentation is occurring. TOC was selected as an indicator that an adequate carbon source remains available for continued ISB treatment. Pantex monitors for a wide range of VFAs and those results are included in Appendix D.

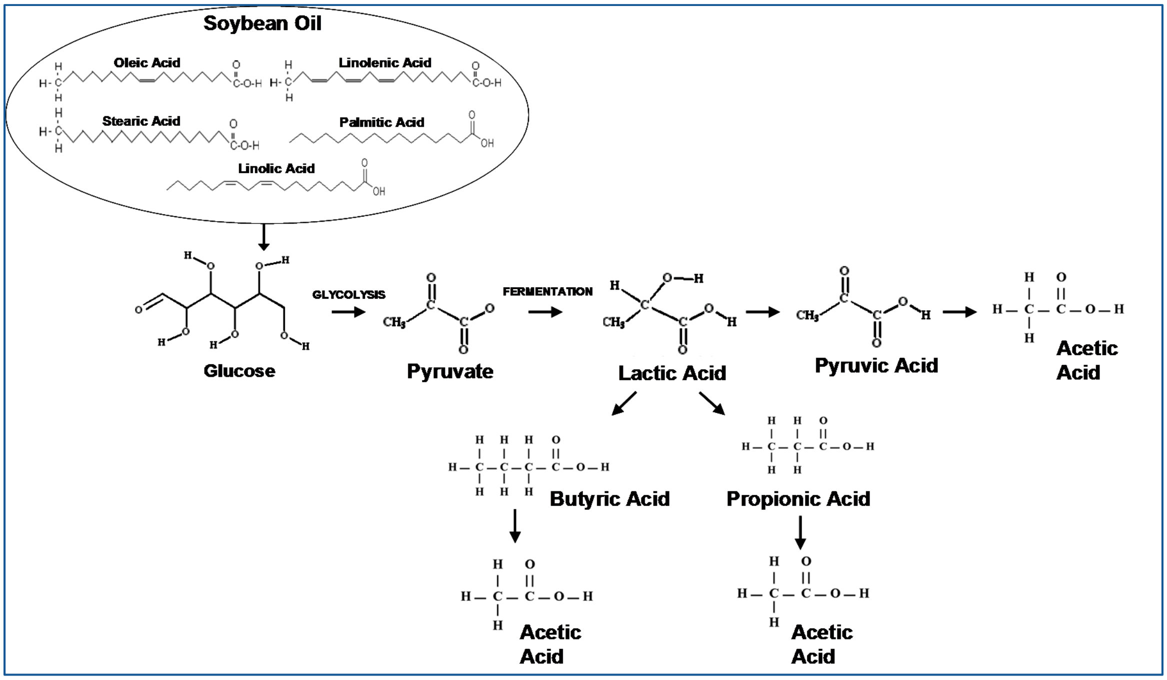


Figure 3-48. Soybean Oil Fermentation Pathways

In addition, geochemical conditions can be evaluated to determine if adequate reducing conditions exist to achieve reduction. Figure 3-49 presents the redox ranges for 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 the most widespread and that have the potential to affect human health if the water were to be used for residential purposes, even though 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.

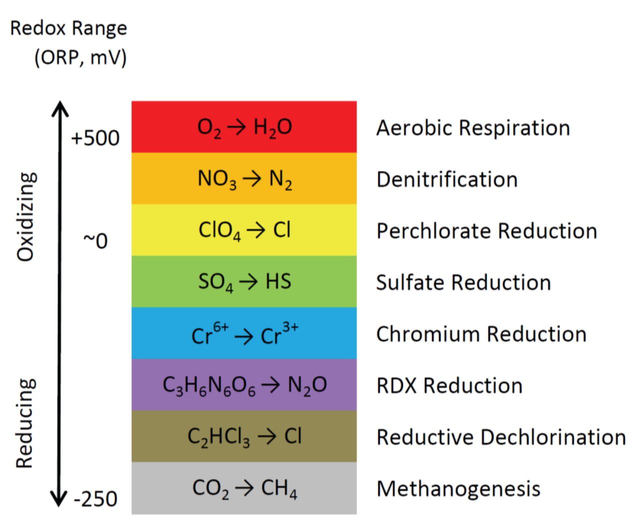


Figure 3-49. Typical Geochemical Redox Ranges

In addition to specific indicators to help determine if additional injections are required, Pantex monitors for a wide range of VFAs, metals, and general chemistry parameters. The VFAs help determine if fermentation is occurring and also help determine the fermentation pathways. Specific metals are monitored in downstream performance monitoring 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 the naturally occurring metals in the formation soils. However, as the water moves away from the reducing conditions, the metals are expected to precipitate out into 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 is on Pantex Property, south of Zone 11 (see Figure 3-50). The system, as operated in 2016, consists of 48 injection wells installed in a zone of saturated thickness of approximately 15–20 ft. Four treatment zone wells, eleven ISB injection wells, and nine downgradient wells are used to monitor characteristics indicative of the health of the microorganisms and the overall performance of the remedial system.

The Zone 11 ISB system was installed in 2009 with injection completed in 32 wells. Pantex expanded the system to the west in late 2014 to include an additional 20 injection wells, along with treatment zone and performance monitoring wells, targeted at the TCE plume on the western side of the ISB system. Four second row wells on the perchlorate (eastern) side of the system were removed from active injection in 2016. The expansion area has only received two injections, so reducing conditions are just being established at the injection wells. As summarized in Table 3-3, an eighth injection event, described in Section 2.2.1, was completed in 2016. The seventh injection event included bioaugmentation of the western side of the Zone 11 ISB where reducing conditions are established. To avoid loss of reducing conditions that could affect the DHC, Pantex injected anaerobic makeup water mixed with amendment in the areas where bioaugmentation previously occurred. Pantex will collect more samples in 2017 to continue to evaluate the effectiveness of the bioaugmentation.

Table 3-3. Zone 11 ISB Injection Dates

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
6	July 2014
7	November 2015
8	August 2016

During 2016, Pantex monitored five treatment zone monitoring wells, ten injection wells, and nine downgradient performance monitoring wells to evaluate the Zone 11 ISB (see Figure 3-50). Pantex also monitors three treatment zone wells in the second row to better evaluate conditions in higher concentration and/or flow areas. The 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. Based on the current rate of perched groundwater flow, estimated amendment longevity, and data collected in the treatment zone, Pantex has recommended moving to a 2-year injection frequency as discussed in Section 2.2.1.4.

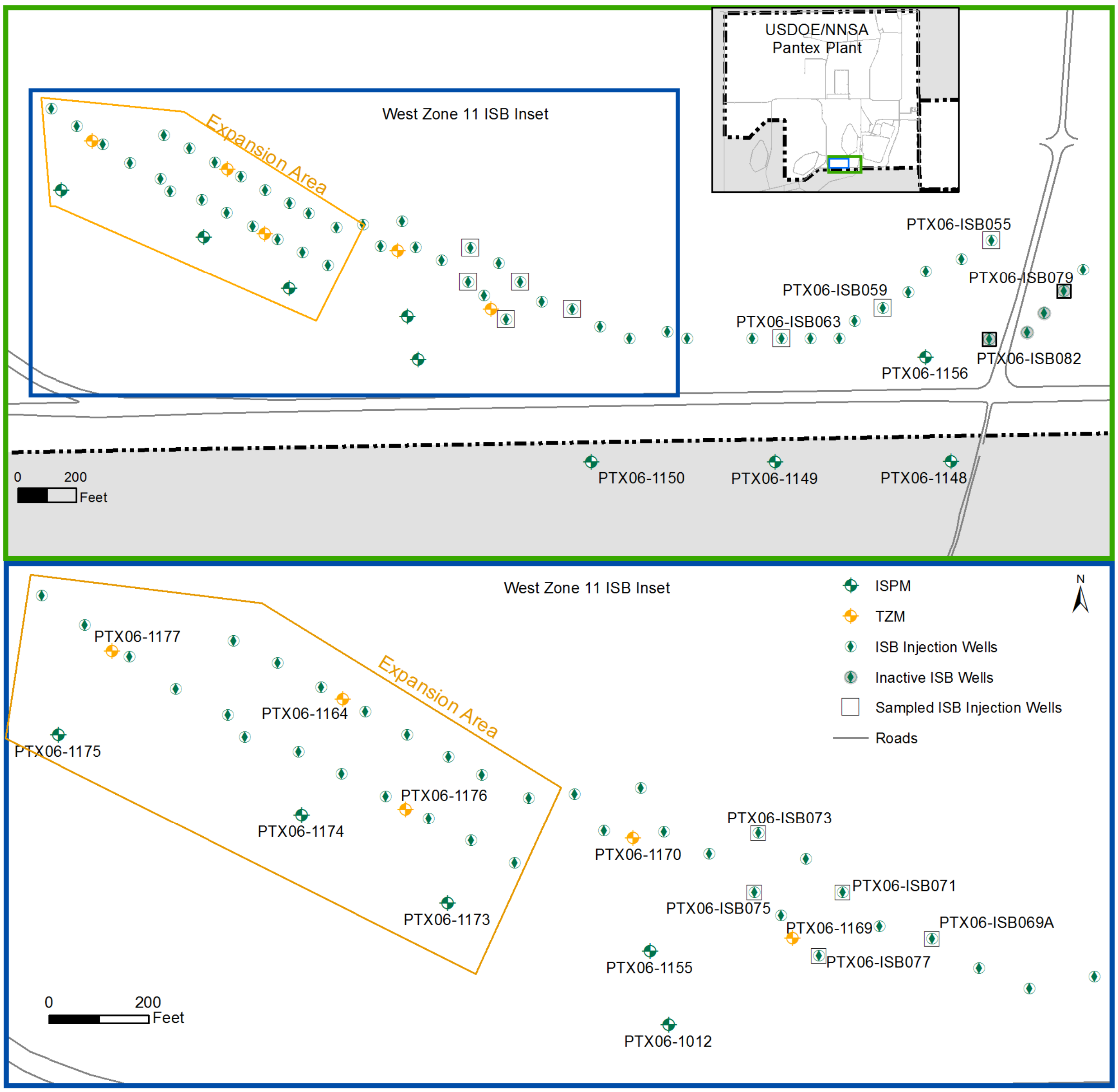


Figure 3-50. Zone 11 ISB System Wells and Sampling Locations

COCs targeted for treatment by this system are perchlorate and TCE. Indicator constituents evaluated for trends at downgradient performance monitoring wells include TCE and its degradation products (*cis*-1,2-DCE and vinyl chloride) and perchlorate. Expected conditions are that the indicator constituent concentrations will begin to decline at 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, total organic carbon, and total VFAs are evaluated in the ISB treatment zone performance wells to determine if the treatment zone is rebounding to baseline conditions, thus requiring amendment injection. The expected conditions for the treatment zone wells are that redox potential and electron acceptor (DO, nitrate, and sulfate) concentrations will decline after injection. As shown in Figure 3-49, strongly reducing conditions must be achieved for reductive dechlorination of TCE to occur. The redox potential should decline from baseline and be below -50 mV for the reduction of TCE and near 0 mV for the reduction of perchlorate. Concentrations of total organic carbon and acetic acid should increase after injection, but decline over time as the amendment is consumed.

Prior to the 3rd quarter 2016 injection, the TOC remained high in the majority of the injection wells, but VFAs had decreased in all but one of the monitored injection wells. After injection, the TOC and VFA concentrations responded variably across the treatment zone wells, with most indicating stable TOC and increased VFAs. The TOC data indicates that a fair to good food source is available at the wells to allow continued biological activity and remediation of the COCs.

The discussion in this paragraph of continued treatment of TCE and perchlorate applies only to the original portion of the system because the expansion area is not yet demonstrating reducing conditions at the monitored wells. Data indicate mild to deep reducing conditions on the perchlorate (eastern) side of the Zone 11 ISB. Reducing conditions across the TCE side ranged from very mild (ORP > 0 and sulfate rebounding in some wells) to mild. The low ORP values, combined with low food source, indicate that some of the wells may have been affected by the chase water used after the amendment injection. However, monitored conditions indicate that all but two treatment zone wells had nitrate and sulfate reduced, indicating that deeper reducing conditions at treated wells are present for the reduction of TCE. Replacement well PTX06-ISB075 and PTX06-1170 treatment zone well, which are not injected, both had nitrate reduced, but sulfate is rebounding to background conditions. These two wells indicate that conditions 25 to 50 ft from injection wells may be mild and may not be conducive to reduction of TCE. However, methane concentrations were high in all but one treatment zone well following the 2016 injection event indicating that deep reducing conditions continue to occur in some areas. TCE continues to be reduced to *cis*-1,2-DCE, with TCE concentrations near or below GWPS in the injected wells. The presence of TCE and *cis*-1,2-DCE continues to indicate partial treatment 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. Ethene and vinyl chloride are currently not detected, indicating that the *Dehalococcoides spp*. (DHC) are not fully degrading the TCE in measurable amounts.

Table 3-4 summarizes the current and maximum COC concentrations in each ISB, TZM, and ISPM well. The five TZM wells are located on the western side of the ISB. Three of these wells are located within the expansion zone; only PTX06-1169 and PTX06-1170 are located within the established treatment zone.

PTX06-1012 and PTX06-1155 are on the western side of the ISB where TCE is the primary COC, although baseline concentrations of perchlorate also exceeded the GWPS in that area. PTX06-1156 is on the eastern side of the Zone 11 ISB where perchlorate is the primary COC. PTX06-1148, 1149, and 1150, which are located further downgradient from the ISB treatment zone, were converted to ISPM wells in 2014. Monitoring data from these three wells to date suggest that affected water has reached PTX06-1149 but not PTX06-1148 or PTX06-1150. However, due to their distance from the treatment zone, effects are not expected for another few years. PTX06-1173, 1174, and 1175 are downgradient of the expansion zone and do not yet indicate any effects of treatment. Wells downgradient of the expansion area are not expected to demonstrate treatment until up to two years following the second injection.

Table 3-4. Summary of 2016 Zone 11 ISB Monitoring Well Data for TCE and Perchlorate

	Perchlorate					Trichloroethene				
Well ID	Max[a]	1Q	2Q	3Q	4Q	Max[a]	1Q	2Q	3Q	4Q
In Situ Bioremediation Wells										
PTX06-ISB055	3000	<24	<12	--	<12UJ	16	<3	<3	--	<3
PTX06-ISB059	970	<24	<12	--	<12UJ	<3	<3	<3	--	<3
PTX06-ISB063	39	<24	<12	--	<12UJ	0.75J	<3	<3	--	<3
PTX06-ISB069A	880	<24	<12	--	<240UJ	62	<3	<3	--	8.5J+
PTX06-ISB071	400	--	--	--	<12UJ	1500	--	--	--	<3
PTX06-ISB073	380	<24	<24	--	<240UJ	560	<3	<3	--	22J+
PTX06-ISB075[b]	97	<12	<12	<12UJ	<12UJ	440	13	0.39	1.9J	8.4
PTX06-ISB077	840	<24	<24	--	<12UJ	310	0.41	<3UJ	--	<3
PTX06-ISB079	<24	--	<24	--	<12UJ	<3	--	<3	--	<3
PTX06-ISB082[a]	3090	<24	<24	<12UJ	<12UJ	9.6	<3UJ	<3	<3UJ	<3
In Situ Treatment Zone Monitoring Wells										
PTX06-1164	130	84	100	<120	86J-	170	160	170	82	130
PTX06-1169	<12	<12	--	--	--	13	13	--	--	--
PTX06-1170	<120	<12	<12	<120UJ	<12UJ	500	180	14J	170J	410
PTX06-1176	240	240	180	190J	76J-	220J	180	220J	190J	110J+
PTX06-1177	210	200	150	140	<12UJ	130	120	120	130	26
In Situ Performance Monitoring Wells										
PTX06-1012	341	<12	<12	<120UJ	<12	580	25	13	5.6J	1.2
PTX06-1155	487	<12	<12	<120UJ	<12	660	0.8	2.8	1.4J	<3
PTX06-1156	2140	<12	<12	<120UJ	<12	7.4	<3	<3	<3UJ	<3
PTX06-1148	1290	210	200	390J	360	3.63	1.4J	1.7	2.0J	1.9
PTX06-1149	684	<12	<12	<120UJ	<12	0.39J	<3UJ	<3	<3UJ	<3
PTX06-1150	235	85	76	58J	49	5.6J	4J	4.8	5.6J	5.2
PTX06-1173	16J	--	16J	--	--	100J	--	100J	--	--
PTX06-1174	170J	--	170J	--	--	160J	--	160J	--	--
PTX06-1175	340J	--	340J	--	--	120J	--	120J	--	--

Concentrations provided in ug/L.

Highlighted cells indicate concentrations less than the GWPS.
The "--" symbol indicates no samples were collected.
When COC was not detected, a "less than" with the detection limit is provided.
Elevated detection limits for perchlorate in third quarter were due to corrections that occurred from the lab after the data were reported to Pantex. Archived samples were past the holding time, so data were not reanalyzed. Elevated perchlorate detection limits in fourth quarter were caused by interference from the sample matrix that required dilution.
[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]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.
UJ – The material was analyzed for but was not detected. The sample quantitation limit is an estimated quantity.

Perchlorate concentrations were non-detect in four of the nine downgradient ISPM wells during 2016. Perchlorate is exhibiting a decreasing trend in PTX06-1150, and has been decreasing in PTX06-1148 although an increase was observed during 2016 in this well. TCE concentrations were non-detect or below GWPS in four of the nine downgradient ISPM wells during 2016 and were decreasing in PTX06-1012 with the last sample below GWPS. TCE concentrations in PTX06-1150 were slightly increasing. The remaining three wells are downgradient of the expansion area and are not expected to exhibit decreasing trends for several years.

TCE breakdown products *cis*-1,2-DCE and vinyl chloride continue to be detected in downgradient wells. *Cis*-1,2-dichloroethane is exhibiting a stable trend at or above the GWPS of 70 ug/L in PTX06-1012 and a decreasing trend above the GWPS in PTX06-1155 in 2016. *Cis*-1,2-DCE was detected at low levels below the PQL in three quarters in PTX06-1156. *Cis*-1,2-DCE was also detected in the single baseline sample collected from all three of the new ISPM wells downgradient of the expansion area. Vinyl chloride was consistently measured in PTX06-1155 below the PQL, but was not detected in PTX06-1012 in 2016. This condition of high concentrations of *cis*-1,2-DCE with little or no vinyl chloride continues to indicate that TCE is only partially breaking down. Pantex previously recognized in the 2013 Annual Progress Report that complete TCE treatment may be constrained by a lack of DHC that are necessary for complete dechlorination of TCE and began working on a Bioaugmentation Plan in 2014. The seventh injection event, completed in 2015, included bioaugmentation of the western side of the Zone 11 ISB where reducing conditions are established and where the heart of the TCE plume is treated.

Pantex is monitoring the impact of the bioaugmentation through the use of qPCR and compound specific isotope analysis (CSIA) sampling which began in February 2016. The qPCR and CSIA data, combined with other monitoring data from the Zone 11 ISB area, indicate that complete dechlorination is not likely occurring at this time due to low counts of DHC and mild reducing conditions in many areas of the Zone 11 ISB where bioaugmentation has occurred. Additional sampling for CSIA and census DNA for DHC and 1,4-dioxane will be conducted at the Zone 11 ISB during 2017. These analyses will be used to determine the effectiveness of bioaugmentation and to evaluate other potential processes that may be helping break down TCE and 1,4-dioxane through cometabolic processes. Bioaugmentation in the expanded treatment zone described in Section 2.2.1 will not occur until the weight of evidence suggests the proper reducing conditions exist for DHC survival and growth.

Metals concentrations are increasing in all downgradient performance monitoring wells since the start of remedial actions and some are exceeding GWPS. For example, arsenic concentrations in PTX06-1149, PTX06-1155, and PTX06-1156 and barium concentrations in PTX06-1156 exceeded GWPS in 2016. However, 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. This can be seen in recent metals trends in the downgradient wells as arsenic and manganese were previously increasing but are now decreasing or exhibit no trend in PTX06-1012 and PTX06-1149.

3.2.3.2 Southeast ISB

The Southeast ISB System is on TTU property south of Pantex. The system was installed in 2007 as an early action and consists of 42 injection wells within the treatment zone and six performance monitoring wells (see Figure 3-51). 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. Pantex has recommended the Southeast ISB for injections approximately every three years (see Section 2.2.2.4) to avoid depletion of food source and possible loss of reducing conditions.

Table 3-5 summarizes the six injection events completed to date at the Southeast ISB system.

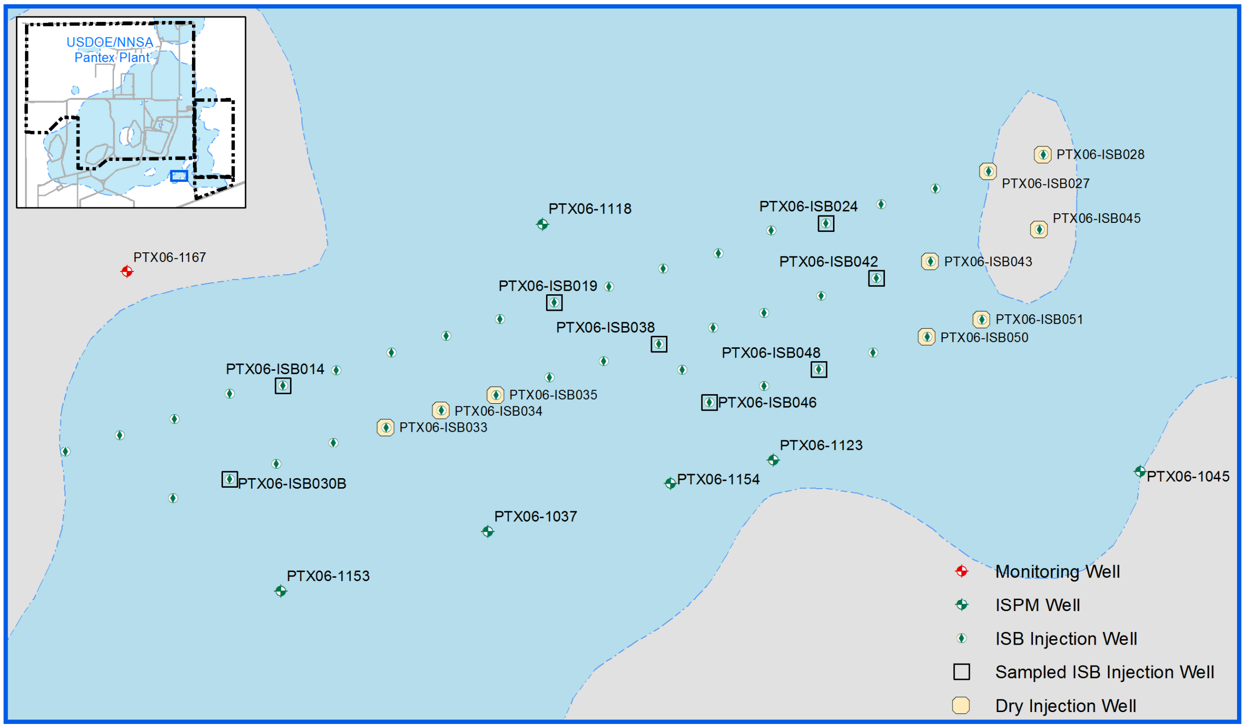


Figure 3-51. Southeast ISB System Wells and Sampling Locations

Table 3-5. Southeast ISB Injection Dates

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

Constituents targeted for treatment by this system are RDX, other HE constituents of concern (DNTs and 1,3,5-TNB), and hexavalent chromium. Indicator constituents evaluated for trends at downgradient performance monitoring wells include RDX and its degradation products (DNX, MNX, and TNX) and total and hexavalent chromium. Expected conditions at downgradient performance monitoring wells are that concentrations of indicator constituents will decline over time and that all degradation products of RDX will not be detected or will be present in low concentrations indicating complete breakdown is occurring. Dissolved oxygen, redox potential, nitrate, sulfate, total organic carbon, and volatile fatty acids are also evaluated at the ISB treatment zone performance wells.

The expected conditions for the treatment zone wells are that redox potential and electron acceptor (dissolved oxygen, nitrate, and sulfate) concentrations will decline after injection. Redox potential should be less than 0 mV for reduction of RDX and hexavalent chromium. Dissolved oxygen may continue to be observed because oxygen is replenished from the atmosphere when equipment is introduced into the well during sampling, injection, or well rehabilitation or development and the saturated thickness in the treatment zone is very thin. Concentrations of total organic carbon and total VFAs should increase after injection but decline over time as the amendment is consumed.

Graphs of the amendment indicators and COCs for the eight ISB injection wells sampled, as well as concentrations for target indicators at the six performance monitoring wells for this system are included in Appendix E. Five of the performance monitoring wells are downgradient of the system; one (PTX06-1118) is upgradient of the system. The conditions in the treatment zone and performance monitoring wells are discussed below.

Evaluation of data in treatment zone wells indicates adequate reducing conditions for the treatment of RDX and hexavalent chromium. RDX was not detected above GWPS in any treatment zone wells in 2016.

Pantex monitors eight treatment zone wells and six performance monitoring wells (see Figure 3-51 for wells that are sampled). Table 3-6 summarizes the current and maximum COC concentrations in each ISB and ISPM well. The closest downgradient monitoring wells for the Southeast ISB demonstrate that reduction of RDX, HE degradation products, and hexavalent chromium has occurred resulting in concentrations below the GWPS, with most not detected. PTX06-1153 continues to exhibit RDX concentrations above 200 ug/L and variable hexavalent chromium concentrations near the GWPS. Pantex continues to monitor this well and other new wells installed nearby to determine if treated water is slow to reach it, or if this well may not be hydraulically connected to the Southeast ISB.

Table 3-6. Summary of 2016 Southeast ISB Monitoring Well Data for RDX and Hexavalent Chromium

Well ID	Hexavalent Chromium Max[a]	1Q	2Q	3Q	4Q	RDX Max[a]	1Q	2Q	3Q	4Q
In Situ Bioremediation Wells										
PTX06-ISB014	NE	NE	NE	NE	NE	217	<4UJ	<0.263	<0.26	--
PTX06-ISB019[b]	NE	NE	NE	NE	NE	143	--	--	--	--
PTX06-ISB024	NE	NE	NE	NE	NE	3860	<4UJ	<0.26UJ	<0.26UJ	--
PTX06-ISB030B[b]	NE	NE	NE	NE	NE	2.7	<4UJ	<0.26	<0.263UJ	--
PTX06-ISB038	NE	NE	NE	NE	NE	421	<4UJ	<0.253	<0.258UJ	--
PTX06-ISB042	NE	NE	NE	NE	NE	2920	--	--	--	--
PTX06-ISB046	NE	NE	NE	NE	NE	4350	<4	<0.26	<0.26UJ	--
PTX06-ISB048	NE	NE	NE	NE	NE	--	<4UJ	<0.255	<0.26UJ	--
In Situ Performance Monitoring Wells										
PTX06-1037	108.5	4.75J	<10	5.38	<10	2800	<0.2	<0.26	<0.263	<0.258
PTX06-1123	10	--	--	--	--	4300	--	--	--	--
PTX06-1153	159	85.5	101	82.1	81.2	450J	450J	278	180	263
PTX06-1154	29.2	17	<40	29.2	6.32	630	<0.2UJ	<0.258	<0.26	<0.255

Concentrations provided in ug/L.
[*] NE – Hexavalent chromium was not evaluated in the ISB treatment zone due to interference from the amendment.
Highlighted cells indicate non-detect or concentrations less than the GWPS.
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-ISB019 and PTX06-ISB42 were either dry or had limited water and could not be sampled for all or part of 2016.
Data from ISPM Wells PTX06-1045 and PTX06-1118 were 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. In addition, this well went dry in the second half of 2011. PTX06-1118 is upgradient to the ISB system and is used to monitor the influent COC concentrations and has been dry since late 2009.

Some of the injection and performance monitoring wells are indicating variable water conditions at the Southeast ISB. Two Southeast ISB performance monitoring wells (one upgradient, one farther downgradient) remain dry and cannot be sampled. PTX06-1123, a downgradient performance monitoring well, has not been sampled since August 2015 due to low water conditions. Injection was completed at only 50 percent of the injection wells during the 2016 injection event because of dry or low water (<1 ft) conditions in the wells (see Figure 3-51 for indication of the dry wells). The inability to sample or inject into these wells is expected to continue as the result of effects from injection biofouling and upgradient pump and treat operations that are decreasing the saturated thickness across the area.

The ISB system has been effective in treating HEs and hexavalent chromium at three of the closest downgradient ISPM wells (PTX06-1037 and 1154, plus historically at PTX06-1123) for the SE 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 ORP is negative, nitrate and sulfate concentrations are reduced, and TOC is present in all three wells.

RDX concentrations in PTX06-1153 tend to fluctuate, but are much lower than initial concentrations in the upgradient treatment zone and are currently exhibiting a decreasing trend. In 2016, the highest RDX concentration (450 ug/L) was observed since the well was installed in 2009, but then declined to an average of 240 ug/L for the remaining three quarters. Concentrations have historically ranged from approximately 100 – 450 ug/L in this well. The concentrations of the degradation products (MNX, DNX, and TNX, in sequence) are either near or below the cleanup value of 2 ug/L. The combination of high RDX and low concentrations of degradation products indicates background conditions rather than enhanced treatment at this well. Hexavalent chromium concentrations in this well have been variable, with most concentrations just below GWPS (100 ug/L) in 2016, but a decreasing trend is evident in recent data.

Pantex is continuing to investigate the cause of the unexpected results in PTX06-1153. As discussed in the 2013 Annual Progress Report, the conditions could be due to any number of hydrologic issues and it may be difficult to prove (or disprove) if any of these are occurring. Several confounding issues complicate the investigation efforts in the area, including significant heterogeneity in the fine-grained zone, potential changes in formation properties due to biologic growth or other injection effects, and potential reduction of saturated thickness upgradient due to pump and treat operations.

Passive flux meters (PFMs) were deployed in fall 2016 to assess the impact of dewatering within and around the Southeast ISB on groundwater flow and to support long-term decisions regarding Southeast ISB injection. A primary objective of the PFM testing was to evaluate the hypothesis that contaminant concentrations have persisted in PTX06-1153 because groundwater in the vicinity of this well is stagnant. Results of the PFM testing show that measureable groundwater flux was observed in PTX06-1153, although PFM-measured groundwater flux values are generally higher than values calculated using transport times or Darcy's Law for all wells tested. However, this result indicates that PTX06-1153 is not located in a stagnant groundwater zone. The reduced seepage velocity calculated for PTX06-1153 does suggest that flow to the well may be inhibited. Given the location of PTX06-1153, apparent groundwater flux through the well may indicate a groundwater-flow pathway around the western end of the Southeast ISB. Complete results for the PFM testing are presented in the *Updated Conceptual Site Model Report* included in Appendix D.

Metals concentrations have increased in all downgradient performance monitoring wells and some are exceeding GWPS. Arsenic and barium concentrations exceeded the GWPS in PTX06-1037 and PTX06-1154 during 2016. Total organic carbon data suggest the treatment zone has expanded into these wells and the reduced conditions continue to mobilize the 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 complete breakdown is occurring. Monitoring results for the system indicate that RDX and breakdown products (MNX, DNX, and TNX) are present in downgradient performance monitoring wells. TNX, the final degradation product, is the best indicator of degradation because the other intermediate products (MNX, DNX) degrade rapidly and do not accumulate in the environment. 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 was non-detect at PTX06-1037 throughout 2016, while TNX was non-detect in one quarter and detected below the PQL in the other quarters. At PTX06-1154, RDX and TNX were non-detect throughout 2016, although this well was not sampled in the first quarter sample. These results indicate near complete treatment occurring during most of the year. High RDX concentrations and low TNX concentrations at PTX06-1153 continue to indicate little to no treatment at this location.

3.3 Natural Attenuation

Natural attenuation is the result of processes that naturally lower concentrations of contaminants over time. This process is monitored at Pantex to help determine where natural attenuation is occurring, under what conditions it is occurring, and to possibly determine 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. Because the right microbes for biodegradation are present in the perched sediments, Pantex is interested in monitoring for breakdown products of RDX. Pantex started monitoring for degradation products of RDX in all monitoring wells by July 2009, after testing analytical methods to ensure they can reliably detect and quantify those products. Since analytical methods are

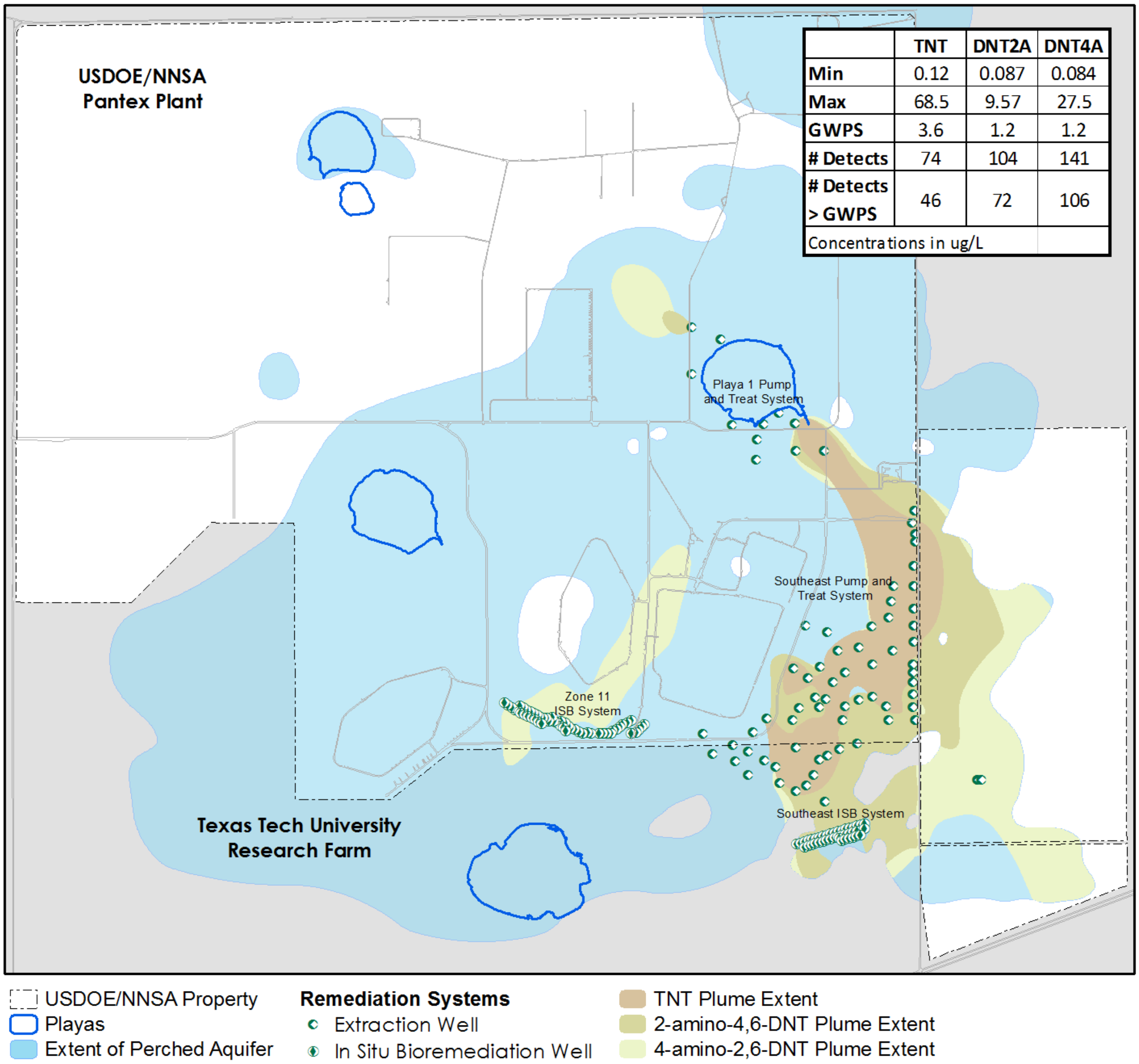
> ***Natural Attenuation Processes***
>
> - Biodegradation – soil microbes can cause the contaminants to break down to less harmful products
> - Sorption – the contaminants are bound to soil particles so that movement through groundwater is stopped or is slower allowing time for other processes to work
> - Dispersion – the contaminants are dispersed through the groundwater as they move away from the source so that concentrations are diluted

readily available, Pantex has monitored for degradation products of TNT and TCE in the past and continues to monitor for those in key areas.

Other groundwater conditions that may impact 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 best reduction under anaerobic conditions. As more data are collected, trending and statistical analysis 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 (2-amino-4,6-DNT and 4-amino-2,6-DNT), TNT has naturally attenuated over time (see Figure 3-52). TNT has been manufactured at Pantex since the 1950s, yet is only present in the central portion of the overall southeastern plume - within the SEPTS well field and near Playa 1. Its first breakdown product, 2-amino-4,6-DNT, occurs near the TNT plume and extends slightly beyond. The final monitored breakdown product, 4-amino-2,6-DNT, 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 GWPS, but most wells with detections are recently showing a decreasing or stable trend. A table of natural concentration ranges for wells outside the influence of the ISB systems is included in Figure 3-52.

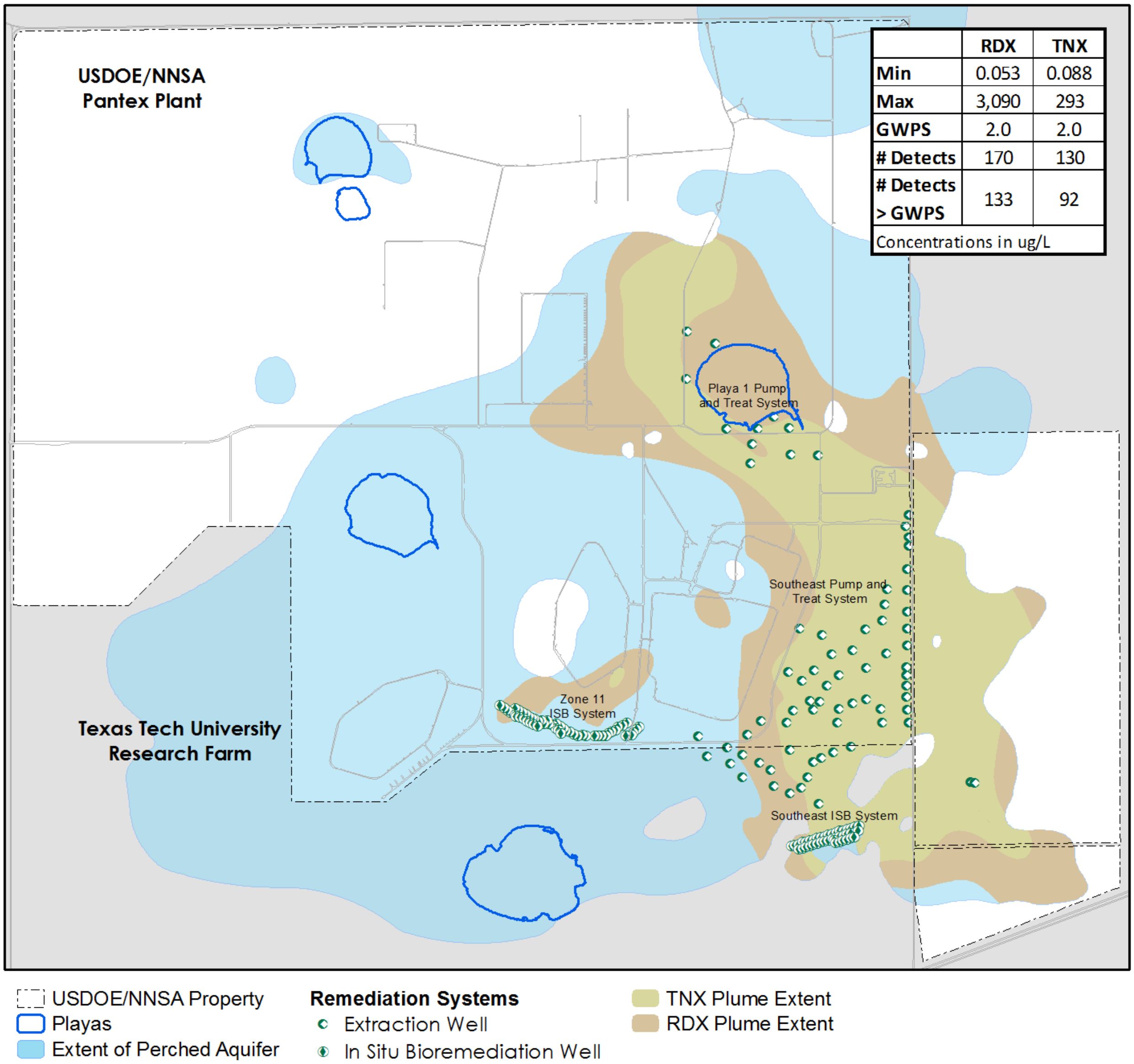


	TNT	DNT2A	DNT4A
Min	0.12	0.087	0.084
Max	68.5	9.57	27.5
GWPS	3.6	1.2	1.2
# Detects	74	104	141
# Detects > GWPS	46	72	106
Concentrations in ug/L			

Figure 3-52. TNT and Degradation Product Plumes

Perched aquifer sampling results for RDX and breakdown products (MNX, DNX, and TNX) indicate that the breakdown products are present throughout most of the RDX plume, with TNX being the most widespread. TNX, the final degradation product, is a better indicator of degradation because the other intermediate products (MNX, DNX) degrade rapidly and do not accumulate in the environment (SERDP, 2004). If complete biodegradation of RDX is occurring, RDX and all breakdown products would be expected to decrease over time. Figure 3-53 depicts the overall RDX and TNX plume. A table of concentration ranges for wells outside the influence of the ISB systems is included in the figure. More data will be required over time to determine trends and rates of attenuation.

A recent SERDP study (2014) provided evidence that aerobic degradation is occurring in the Pantex RDX plume. Strong evidence of aerobic degradation was found in two monitoring wells, one near the SEPTS extraction wells, and one near the southeast edge of the plume. One other well near the source (Playa 1), indicated that degradation is occurring, but no aerobic breakdown products were found. Prior to this study, Pantex had been unable to determine what type of degradation is occurring (biotic/abiotic and anaerobic/aerobic) across the plume. Because different types of degradation may be occurring near the source areas and changing to aerobic degradation as the plume moves away, the rate of attenuation is difficult to quantify because it will vary across the plume. This study provided new methods for evaluating RDX degradation including carbon and nitrogen fractionation (CSIA) approaches. These approaches, along with the ability to quantify NDAB, an aerobic degradation product, allows Pantex to better evaluate the degradation of RDX. Pantex has contracted with leading researchers for further study at the Pantex Plant to apply the CSIA and other new analytical techniques to determine where and what type of degradation is occurring across the RDX plume. Groundwater samples for this study have been collected, and the study is expected to be completed by the end of 2017. If data support quantification of attenuation rates in the future, rates will be calculated.



	RDX	TNX
Min	0.053	0.088
Max	3,090	293
GWPS	2.0	2.0
# Detects	170	130
# Detects > GWPS	133	92
Concentrations in ug/L		

Figure 3-53. RDX and Degradation Product Plumes

Pantex has monitored for breakdown products of TCE for many years and a strong indication of natural attenuation of TCE has not been observed in the perched aquifer. 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 the ISB treatment zones.

3.4 Uncertainty Management/Early Detection

The purpose of uncertainty management wells in perched and Ogallala groundwater is to confirm expected conditions identified in the RCRA Facility Investigations and ensure there are not any deviations, fill potential data gaps, and fulfill long-term monitoring requirements for soil units evaluated in a baseline risk assessment. The purpose of early detection wells is to monitor for breakthrough of constituents to the Ogallala Aquifer from the overlying perched aquifer, if present, or from potential source areas in the unsaturated zone before potential points of exposure have been impacted. These wells were proposed in the LTM design for purposes of evaluating the effectiveness of the soil and groundwater remedial actions. Additionally, the perched aquifer data were evaluated with respect to field observations. In 2016, no evidence of NAPL was observed in sampled perched aquifer wells.

This report focuses on subsets of the uncertainty management/early detection wells as depicted in Figure 3-54. The wells are evaluated with respect to:

Group 1 — 47 locations (designated by boxes on Figure 3-54) where contamination has not been detected or confirmed, or in previous plume locations where concentrations have fallen below GWPS, background, or PQL (e.g., Burning Ground and Old Sewage Treatment Plant areas). These are typically Ogallala Aquifer wells, although some perched aquifer wells are located in areas where there are no active groundwater remedial actions. These wells were evaluated in the quarterly reports.

Group 2 — 30 uncertainty management wells (all other wells in Figure 3-54) near groundwater contamination source areas. This is 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 frequency of sampling, all available data for the UM/ED wells are used in this evaluation.

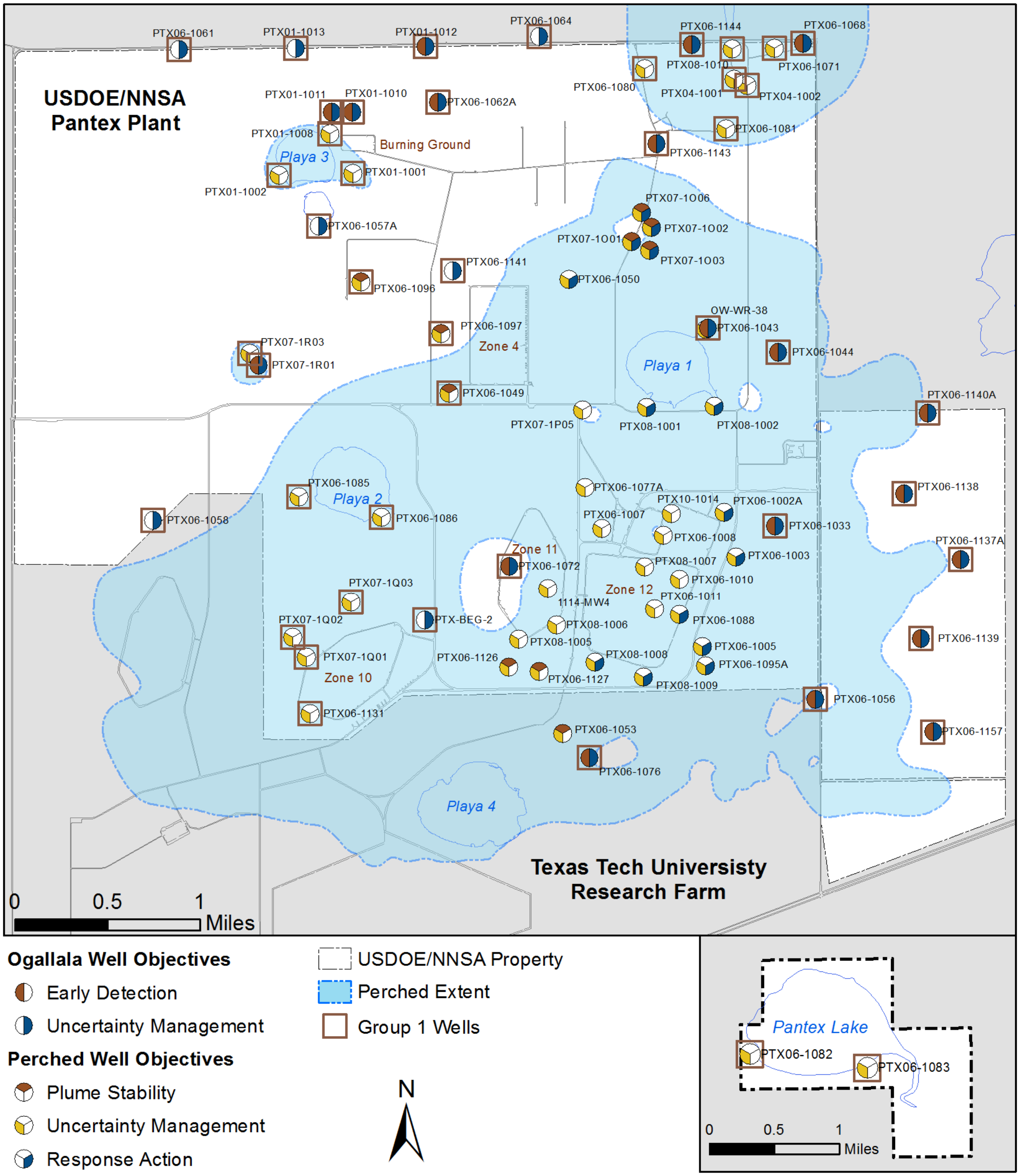


Figure 3-54. Uncertainty Management and Early Detection Wells

3.4.1 Group 1 Wells

Table 3-7 provides a summary of all 2016 Group 1 perched aquifer well indicator COC detections and comparisons of the detections to naturally occurring background concentrations, the laboratory PQL, and the GWPS provided in the approved SAP (Pantex, 2014b). Explanations are also provided in the table. The wells with unexpected conditions are discussed below.

3.4.1.1 Perched Aquifer Wells

As depicted in Table 3-7, no Group 1 perched aquifer wells had unexpected conditions in 2016.

3.4.1.2 Ogallala Aquifer Wells

As depicted in Table 3-8, 15 Ogallala wells had detected results (above background for those metals with site-specific background concentrations). This table does not include boron detections as these data are summarized in Table 3-9.

Manganese was detected above the background value in two wells in 2016 (PTX06-1033 and PTX06-1141). No GWPS has been established for manganese. Manganese has been identified as an indicator for stainless steel corrosion; nickel was also detected above background in PTX06-1033, the remaining corrosion indicators did not demonstrate increasing concentrations in these wells. Pantex will continue to monitor these wells for manganese to determine if concentrations increase or persist. Low-level detections of nickel exceeding site-specific background occurred in PTX06-1033. This well has had confirmed screen corrosion as documented by increasing concentrations of metals and confirmed by well video. This well was rehabilitated in March 2013 and metals concentrations subsequently decreased to values below their respective site-specific backgrounds. However, nickel increased to a level above background the next sampling event and continued to increase during 2015. The well was again rehabilitated in 2015, but nickel dropped only slightly in the next sample event then increased in the most recent sample. The increasing trend in nickel concentration is likely due to continued slight well screen corrosion. This well was assigned a maintenance frequency of two years in the Well Maintenance Plan.

Hexavalent chromium was detected in eleven wells (PTX06-1043, PTX06-1061, PTX06-1062A, PTX06-1068, PTX06-1072, PTX06-1138, PTX06-1139, PTX06-1140, PTX06-1141, PTX06-1144, and PTX06-1157) in 2016 below the GWPS of 100 ug/L. The detections in all but two of the wells were below the laboratory PQL of 10 ug/L. As discussed in the 2013 Annual Progress Report, these detections are likely a result of one or more of the following:

- Low-level background of hexavalent chromium in the Ogallala aquifer as suggested in a study by Texas Tech University completed in 2014. Pantex worked with the Texas Tech University Water Resources Center to investigate the occurrence, distribution, and speciation of chromium in the Ogallala Aquifer system in the Texas Panhandle. In this study, 19 wells distributed across the Texas Panhandle were sampled and analyzed for total chromium and hexavalent chromium using an ultra-high resolution method (PQL = 0.015 ug/L). Low-level hexavalent chromium (approximately 0.5 – 5 ug/L) was detected in all 19 wells sampled. Furthermore, when both total and hexavalent chromium were detected in the same sample (total chromium was analyzed using a standard resolution method with a PQL of 10 ug/L), the ratio of hexavalent to total chromium ranged from approximately 0.5 to 1, with an average of 0.74. These results suggest that the oxidized conditions in the Ogallala Aquifer are converting the naturally occurring chromium to the hexavalent oxidation state, creating a low-level hexavalent chromium background in the aquifer.

- Lower detection limits for Method SW-7196 based on improvements to the method. MDLs dropped from 5 ug/L to 3.3 ug/L and the PQL dropped from 15 ug/L to 10 ug/L in June 2013. The revised detection limits allow low-level background concentrations to be estimated above the new MDL and below the PQL.
- Corrosion of stainless steel screen/casing. Specific wells at Pantex have documented evidence of corrosion and conversion of total chromium to hexavalent chromium is possible due to oxidized conditions in the Ogallala Aquifer.
- False positive detections near the MDL due to the colorimetric analytical method. Typically, these detections are not confirmed by total chromium results.

It is likely that most of these sporadic detections are related to the lower detection limits and the ability to quantify low-level background detections. For example, hexavalent chromium was not detected in seven of the eleven wells in 2015, while four wells that had detections in 2015 did not have detections in 2016.

PTX06-1056 continues to demonstrate detections of 4-amino-2,6-DNT, a breakdown product of the high explosive TNT, first detected in April 2014 and the VOC 1,2-dichloroethane, detected for the first time in August 2015. 4-Amino-2,6-DNT was detected in all four quarterly samples in 2016 at values up to 0.304 ug/L, slightly above the PQL of 0.27 ug/L, but below the GWPS. Two of those detections were below the PQL. 1,2-Dichloroethane was detected in three of four quarterly samples in 2016; all detections were below the PQL and GWPS. Pantex has fully implemented the conditions specified in the *Pantex Plant Ogallala Aquifer and Perched Groundwater Contingency Plan* (Pantex, 2009d) and will continue quarterly sampling for HEs and VOCs at this well.

Pantex has proactively evaluated potential sources for the contamination. 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 contamination, 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 contamination to reach the Ogallala Aquifer.

Pantex also contracted with Daniel B. Stephens & Associates, Inc. for outside review of PTX06-1056 and the area data to determine further steps for source determination. The outside review included the evaluation of water samples, previous risk assessment fate and transport modeling, laboratory hydraulic parameter data, soil grain size and hydraulic data, well construction logs, actions taken to date, the current monitoring approach, and the contingency actions described in the *Groundwater Contingency Plan*. A new multiphase transport simulation was also conducted to evaluate the potential for cross-contamination from the soils near PTX06-1056 and for preferential migration due to PTX06-1108 penetrating too deeply into the FGZ.

The study concluded that previous fate and transport modeling conducted for the risk assessment did identify potential migration pathways through the soils beneath Texas Tech property. The predicted concentrations from the early modeling do not match the current detected results; therefore, a new fate and transport simulation was conducted using HYDRUS 1-D to evaluate the natural migration in soils near PTX06-1056 and PTX06-1108, migration of contamination from the shorter route through the FGZ created by PTX06-1108 drilling, and to address contingency actions to identify the source area for the detected contaminants. The outside review concluded that results of the additional transport modeling are not entirely conclusive for identifying the pathway for contaminant migration to the Ogallala at PTX06-1056 with certainty. However, the weight of evidence from the transport simulations suggests that transport to the Ogallala is most likely to have occurred along the preferential pathway through PTX06-1108. Recommendations from the report include the following:

- Continue quarterly sampling for HEs and VOCs to more clearly establish whether or not trends are increasing.
- Continue current semiannual sampling schedule for other contaminants of concern.
- Consider additional high-volume purge sampling if contaminant concentrations begin to exhibit a consistent increasing trend.
- Obtain a cement bond log in PTX06-1056. If the integrity of the annular seal can be confirmed, this will eliminate the possibility that the annulus of PTX06-1056 could be a preferential pathway for contaminant migration to the Ogallala Aquifer.
- As an early measure to potentially mitigate the observed detections, Pantex has already plugged and abandoned PTX06-1108 due to its penetration depth.

- o If the quarterly sampling results show the contaminant concentrations stabilizing or declining at levels significantly lower than the GWPS, that would support the premise that elimination of the preferential pathway at PTX06-1108 by its abandonment was successful. Resumption of normal semiannual monitoring would be justified going forward after that.
- o If trends increase to levels exceeding the GWPS, then the contingent action process should be revisited and additional activities considered at that time, including: additional monitoring, delineation of extent, and additional characterization of site-specific hydraulic properties to support more focused transport simulations.

The review also provided further information to answer questions for the contingent action process. As part of the review of the contingent action process, it was noted that contaminant extent has not been defined based on our current monitoring well network. As recognized by the review, there are risks associated with installing Ogallala monitor wells through the contaminated regions of perched groundwater, and it is premature to consider such intensive efforts at this time because current contaminant levels are well below the GWPS.

Pantex has evaluated statistical trends at PTX06-1056. The Mann-Kendall tests indicate increasing trends for 4-amino-2,6-DNT and 1,2-dichloroethane considering all data. Mann-Kendall trends for the last four samples indicate no trend for 4-amino-2,6-DNT and an increasing trend for 1,2-dichloroethane. However, these trends are based on low-level data that have changed very little over time and include non-detects. Additionally, variability in laboratory data can also be a confounding factor in these trends of low-level detections because Pantex changed methods for the analysis of HEs in March 2016 (from 8321A to 8330B consistent with EPA requirements). Based on a study performed on Pantex wells, the methods were comparable, but overall the 8330B results were slightly higher in concentration than the 8321A results, and a larger percentage of the results exceeded the PQL when concentrations were low. Concentrations remain below the GWPS for both detected constituents; therefore, Pantex plans to continue the current monitoring to determine if further actions are necessary.

As presented in Table 3-9, boron was detected at concentrations slightly above the background value of 194 ug/L in ten Ogallala wells in 2016, including PTX01-1012, PTX06-1033, PTX06-1043, PTX06-1044, PTX06-1056, PTX06-1062A, PTX06-1137A, PTX06-1139, PTX06-1140, and PTX06-1157. Because the boron concentrations at these wells are very close to background and observed boron concentrations tend to be considerably variable, it appears that these concentrations also represent background. Evaluation of historic boron data in these wells results in variable trends. Only six of these ten wells had a boron detection above background in 2015. Additionally, all ten wells were sampled two times in 2016, and the boron concentration in the other sample for each well was below the background in six of those wells. At PTX06-1140 and PTX06-1157, samples were collected from multiple depths and boron was detected above background in only some of the depths sampled. At PTX06-1140, boron was detected above background in the normal sample but was below background in the duplicate sample. The measured concentrations are well below the GWPS of 7,300 ug/L. Pantex will continue to monitor these wells according to the *SAP*.

RDX was detected below the PQL in samples collected from three wells in August and October 2016. These low-level detections are suspected to be the result of laboratory contamination because the detections occurred at multiple wells within a similar period of time. The wells will continue to be monitored and trended over time.

Table 3-7. Detected Results in Group 1 Perched Aquifer Uncertainty Management/Early Detection Wells

Well ID	Sample ID	Sample Date	Sample Type	Analyte	Measured Value (ug/L)	Detection Limit (ug/L)	Lab Qualifier	PTX Qualifier	Background (ug/L)	> Background?	PQL (ug/L)	>PQL?	GWPS (ug/L)	>GWPS?	Expected Condition?	Explanation
PTX01-1001	20160621M00146	6/21/2016	N	Trichloroethene	0.33	1	J			NA	1	N	5	N	Y	This well was previously affected by TCE. However, the concentrations have declined below the GWPS and PQL.
PTX01-1002	20160728M00210	7/28/2016	N	Chromium, Hexavalent	4.04	10	J			NA	10	N	100	N	Y	This well has historic low-level intermittent detections of CR-6 below the PQL. This well will continue to be monitored and trended for CR-6.
PTX04-1001	20160425M00079	4/25/2016	N	1,4-Dioxane	0.54	1	J	J		NA	1	N	7.7	N	Y	This well has historic low-level detections of DIOXANE14. This well will continue to be monitored and trended for DIOXANE14.
PTX04-1001	20160425M00079	4/25/2016	N	Trichloroethene	0.61	1	J			NA	1	N	5	N	Y	This well has historic low-level TCE detections. This well will continue to be monitored and trended for TCE.
PTX04-1002	20160425M00078	4/25/2016	N	HMX (Octahydro-1,3,5,7-Tetranitro-1,3,5,7-Tetrazocine)	0.742	0.258				NA	0.258	Y	360	N	Y	This well has historic low-level intermittent HE and VOC detections. This well will continue to be monitored and trended for HE and VOC.
PTX04-1002	20160425M00078	4/25/2016	N	RDX	0.143	0.258	J			NA	0.258	N	2	N	Y	This well has historic low-level intermittent HE and VOC detections. This well will continue to be monitored and trended for HE and VOC.
PTX04-1002	20160425M00078	4/25/2016	N	Chromium, Hexavalent	3.61	10	J			NA	10	N	100	N	Y	This well has historic low-level intermittent detections of CR-6. This well will continue to be monitored and trended for CR-6.
PTX04-1002	20160425M00078	4/25/2016	N	1,4-Dioxane	0.953	1	J	J		NA	1	N	7.7	N	Y	This well has historic low-level intermittent HE and VOC detections. This well will continue to be monitored and trended for HE and VOC.
PTX04-1002	20160425M00078	4/25/2016	N	Trichloroethene	0.54	1	J			NA	1	N	5	N	Y	This well has historic low-level intermittent HE and VOC detections. This well will continue to be monitored and trended for HE and VOC.
PTX04-1002	20160425M00078	4/25/2016	N	Chloroform	0.33	1	J			NA	1	N	80	N	Y	This well has historic low-level intermittent HE and VOC detections. This well will continue to be monitored and trended for HE and VOC.
PTX06-1049	20160620M00136	6/20/2016	N	4-Amino-2,6-Dinitrotoluene	1.33	0.26				NA	0.26	Y	1.2	Y	Y	DNT4A was detected in this well at levels > GWPS in 2011. This may indicate that the contamination is slowly moving into this well from Playa 1 or the contributing ditches. This well will continue to be monitored and trended over time.
PTX06-1049	20160620M00136	6/20/2016	N	RDX	1.42	0.26				NA	0.26	Y	2	N	Y	RDX was first detected in this well in 2011. This may indicate that the contamination is slowly moving into this well from Playa 1 or the contributing ditches. This well will continue to be monitored and trended over time.
PTX06-1049	20160620M00136	6/20/2016	N	Trichloroethene	1.36	1				NA	1	Y	5	N	Y	TCE has been detected in this well since 2009. This may indicate that the contamination is slowly moving into this well from Playa 1 or the contributing ditches. This well will continue to be monitored and trended over time.

Well ID	Sample ID	Sample Date	Sample Type	Analyte	Measured Value (ug/L)	Detection Limit (ug/L)	Lab Qualifier	PTX Qualifier	Background (ug/L)	> Background?	PQL (ug/L)	>PQL?	GWPS (ug/L)	>GWPS?	Expected Condition?	Explanation
PTX06-1049	20161026M00311	10/26/2016	N	4-Amino-2,6-Dinitrotoluene	1.27	0.255				NA	0.255	Y	1.2	Y	Y	DNT4A was detected in this well at levels > GWPS in 2011. This may indicate that the contamination is slowly moving into this well from Playa 1 or the contributing ditches. This well will continue to be monitored and trended over time.
PTX06-1049	20161026M00311	10/26/2016	N	RDX	1.49	0.255				NA	0.255	Y	2	N	Y	RDX was first detected in this well in 2011. This may indicate that the contamination is slowly moving into this well from Playa 1 or the contributing ditches. This well will continue to be monitored and trended over time.
PTX06-1049	20161026M00311	10/26/2016	N	Trichloroethene	1.23	1				NA	1	Y	5	N	Y	TCE has been detected in this well since 2009. This may indicate that the contamination is slowly moving into this well from Playa 1 or the contributing ditches. This well will continue to be monitored and trended over time.
PTX06-1071	20161130M00343	11/30/2016	N	RDX	0.424	0.256				NA	0.256	Y	2	N	Y	RDX has historically been detected at low levels in the area near this well. This well will continue to be monitored and trended over time.
PTX06-1071	20161130M00343	11/30/2016	N	Chromium, Hexavalent	27.6	10		J+		NA	10	Y	100	N	Y	This analysis was conducted using the colorimetric method which is not reliable, and this detection was not confirmed by the Total Chromium result which was non-detect below 10 ug/L. This well will continue to be monitored and trended over time.
PTX06-1081	20160725M00200	7/25/2016	N	Trichloroethene	1.02	1				NA	1	Y	5	N	Y	This well has historic low-level TCE detections. This well will continue to be monitored and trended for TCE.
PTX06-1131	20160413M00074	4/13/2016	N	Chromium, Total	40.7	10			31.8	Y	10	NA	100	N	Y	This well has historic CR detections below the GWPS. This well will continue to be monitored and trended for CR.
PTX07-1Q03	20160727M00208	7/27/2016	N	1,3,5-Trinitrobenzene	0.0947	0.266	J			NA	0.266	N	220	N	Y	Suspected laboratory contamination; low level detections below the PQL occurred at other wells sampled within the same time frame. This well will continue to be monitored and trended over time.
PTX07-1Q03	20160727M00208	7/27/2016	N	Chromium, Hexavalent	3.14	10	J			NA	10	N	100	N	Y	This well has historic low-level intermittent detections of CR-6 below the PQL. This well will continue to be monitored and trended for CR-6.
PTX07-1R03	20160727M00207	7/27/2016	N	RDX	0.0883	0.266	J			NA	0.266	N	2	N	Y	This well has historic low-level intermittent HE detections. This well will continue to be monitored and trended for HE.
PTX07-1R03	20160727M00207	7/27/2016	N	1,3,5-Trinitrobenzene	0.153	0.266	J			NA	0.266	N	220	N	Y	This well has historic low-level intermittent HE detections. This well will continue to be monitored and trended for HE.
PTX07-1R03	20160727M00207	7/27/2016	N	Chromium, Hexavalent	3.14	10	J			NA	10	N	100	N	Y	This well has historic low-level intermittent detections of CR-6. This well will continue to be monitored and trended for CR-6.

Table 3-8. Detected Results in Group 1 Ogallala Aquifer Uncertainty Management/Early Detection Wells

Well ID	Sample ID	Sample Date	Sample Type	Analyte	Measured Value (ug/L)	Detection Limit (ug/L)	Lab Qualifier	PTX Qualifier	Background (ug/L)	> Background?	PQL (ug/L)	> PQL?	GWPS (ug/L)	> GWPS?	Expected Condition?	Explanation
PTX01-1011	20160803M00223	8/3/2016	N	RDX	0.131	0.26	J			NA	0.26	N	2	N	N	Suspected laboratory contamination; low level detections below the PQL occurred at other wells sampled within the same time frame. This well will continue to be monitored and trended over time.
PTX06-1033	20160510M00098	5/10/2016	N	Nickel	45.3	2			15	Y	2	NA	730	N	Y	Possible corrosion.
PTX06-1033	20161011M00294	10/11/2016	N	Manganese	23.1	5			16	Y	5	NA	1715.5	N	Y	Possible corrosion.
PTX06-1033	20161011M00294	10/11/2016	N	Nickel	56.4	2			15	Y	2	NA	730	N	Y	Possible corrosion.
PTX06-1043	20160816M00254	8/16/2016	N	Chromium, Hexavalent	10.1	10		J		NA	10	Y	100	N	Y	Possible low-level background.
PTX06-1056	20160119M00005	1/19/2016	N	4-Amino-2,6-Dinitrotoluene	0.261	0.27	J			NA	0.27	N	1.2	N	N	Unexpected condition.
PTX06-1056	20160119M00005	1/19/2016	N	1,2-Dichloroethane	0.41	1	J			NA	1	N	5	N	N	Unexpected condition.
PTX06-1056	20160412M00071	4/12/2016	N	4-Amino-2,6-Dinitrotoluene	0.286	0.266				NA	0.266	Y	1.2	N	N	Unexpected condition.
PTX06-1056	20160412M00071	4/12/2016	N	1,2-Dichloroethane	0.41	1	J			NA	1	N	5	N	N	Unexpected condition.
PTX06-1056	20160719M00191	7/19/2016	N	4-Amino-2,6-Dinitrotoluene	0.255	0.266	J			NA	0.266	N	1.2	N	N	Unexpected condition.
PTX06-1056	20161011M00295	10/11/2016	N	4-Amino-2,6-Dinitrotoluene	0.304	0.269				NA	0.269	Y	1.2	N	N	Unexpected condition.
PTX06-1056	20161011M00295	10/11/2016	N	1,2-Dichloroethane	0.53	1	J			NA	1	N	5	N	N	Unexpected condition.
PTX06-1061	20160920M00275	9/20/2016	N	Chromium, Hexavalent	1.2	0.1		J		NA	0.1	Y	100	N	Y	Possible low-level background.
PTX06-1061	20160920M00276	9/20/2016	N	Chromium, Hexavalent	1.2401	0.02		J		NA	0.02	Y	100	N	Y	Possible low-level background.
PTX06-1062A	20160803M00224	8/3/2016	N	RDX	0.1	0.263	J			NA	0.263	N	2	N	N	Suspected laboratory contamination; low level detections below the PQL occurred at other wells sampled within the same time frame. This well will continue to be monitored and trended over time.
PTX06-1062A	20160803M00224	8/3/2016	N	Chromium, Hexavalent	6.5	10	J			NA	10	N	100	N	Y	Possible low-level background.
PTX06-1068	20160622M00155	6/22/2016	N	Chromium, Hexavalent	3.6	10	J	J		NA	10	N	100	N	Y	Possible low-level background.
PTX06-1072	20160803M00225	8/3/2016	N	Chromium, Hexavalent	3.66	10	J			NA	10	N	100	N	Y	Possible low-level background.
PTX06-1137A	20161025M00305	10/25/2016	N	RDX	0.0837	0.255	J			NA	0.255	N	2	N	N	Suspected laboratory contamination; low level detections below the PQL occurred at other wells sampled within the same time frame. This well will continue to be monitored and trended over time.
PTX06-1138	20160613M00133	6/13/2016	N	Chromium, Hexavalent	9.98	10	J	J		NA	10	N	100	N	Y	Possible low-level background.
PTX06-1139	20160817M00259	8/17/2016	N	Chromium, Hexavalent	8.94	10	J	J		NA	10	N	100	N	Y	Possible low-level background.
PTX06-1140	20160613M00134	6/13/2016	N	Chromium, Hexavalent	4.46	10	J	J		NA	10	N	100	N	Y	Possible low-level background.
PTX06-1140	20160920M00272	9/20/2016	N	Chromium, Hexavalent	6.72	10	J	J		NA	10	N	100	N	Y	Possible low-level background.
PTX06-1140	20160920M00273	9/20/2016	N	Chromium, Hexavalent	2.4	0.1		J		NA	0.1	Y	100	N	Y	Possible low-level background.

Well ID	Sample ID	Sample Date	Sample Type	Analyte	Measured Value (ug/L)	Detection Limit (ug/L)	Lab Qualifier	PTX Qualifier	Background (ug/L)	> Background?	PQL (ug/L)	> PQL?	GWPS (ug/L)	> GWPS?	Expected Condition?	Explanation
PTX06-1140	20160920M00274	9/20/2016	N	Chromium, Hexavalent	1.8447	0.02		J		NA	0.02	Y	100	N	Y	Possible low-level background.
PTX06-1141	20161031M00316	10/31/2016	N	Chromium, Hexavalent	5.18	10	J			NA	10	N	100	N	Y	Possible low-level background.
PTX06-1141-2	20160705M00177	7/5/2016	N	Manganese	16.4	5			16	Y	5	NA	1715.5	N	Y	Possible corrosion.
PTX06-1144	20160920M00269	9/20/2016	N	Chromium, Hexavalent	16.4	10		J		NA	10	Y	100	N	Y	Possible low-level background.
PTX06-1144	20160920M00270	9/20/2016	N	Chromium, Hexavalent	1.6	0.1		J		NA	0.1	Y	100	N	Y	Possible low-level background.
PTX06-1144	20160920M00271	9/20/2016	N	Chromium, Hexavalent	1.7189	0.02		J		NA	0.02	Y	100	N	Y	Possible low-level background.
PTX06-1157-2	20160621M00150	6/21/2016	N	Chromium, Hexavalent	6.6	10	J	J		NA	10	N	100	N	Y	Possible low-level background.

Table 3-9. Detected Boron Results in Group 1 Ogallala Aquifer Wells

Well ID	Sample ID	Sample Date	Sample Type	Measured Value (ug/L)	Detection Limit (ug/L)	Lab Qualifier	PTX Qualifier	>Background? (193.9 ug/L)	PQL (ug/L)	>PQL?	GWPS (ug/L)	>GWPS?	Expected Condition?	Mann-Kendall Trends		Explanation
														LT	ST	
PTX01-1012	20160125M00012	1/25/2016	N	196	75			Y	75	NA	7300	N	Y	No Trend	No Trend	This concentration likely represents natural variability in background.
PTX06-1033	20160510M00098	5/10/2016	N	201	30			Y	30	NA	7300	N	Y	No Trend	Decreasing	This concentration likely represents natural variability in background.
PTX06-1033	20161011M00294	10/11/2016	N	194	150			Y	150	NA	7300	N	Y	No Trend	Decreasing	This concentration likely represents natural variability in background.
PTX06-1043	20160125M00013	1/25/2016	N	196	75			Y	75	NA	7300	N	Y	Probably Increasing	No Trend	This concentration likely represents natural variability in background.
PTX06-1043	20160816M00254	8/16/2016	N	202	75			Y	75	NA	7300	N	Y	Probably Increasing	No Trend	This concentration likely represents natural variability in background.
PTX06-1044	20161012M00299	10/12/2016	N	198	15			Y	15	NA	7300	N	Y	No Trend	Decreasing	This concentration likely represents natural variability in background.
PTX06-1056	20160119M00005	1/19/2016	N	240	75			Y	75	NA	7300	N	Y	Decreasing	Decreasing	This concentration likely represents natural variability in background.
PTX06-1056	20160719M00191	7/19/2016	N	198	75			Y	75	NA	7300	N	Y	Decreasing	Decreasing	This concentration likely represents natural variability in background.
PTX06-1062A	20160803M00224	8/3/2016	N	196	15			Y	15	NA	7300	N	Y	Decreasing	Decreasing	This concentration likely represents natural variability in background.
PTX06-1137A	20160412M00070	4/12/2016	N	197	15			Y	15	NA	7300	N	Y	No Trend	No Trend	This concentration likely represents natural variability in background.
PTX06-1137A	20161025M00305	10/25/2016	N	195	15			Y	15	NA	7300	N	Y	No Trend	No Trend	This concentration likely represents natural variability in background.
PTX06-1139	20160201M00027	2/1/2016	N	211	75			Y	75	NA	7300	N	Y	No Trend	No Trend	This concentration likely represents natural variability in background.
PTX06-1139	20160817M00259	8/17/2016	N	212	75			Y	75	NA	7300	N	Y	No Trend	No Trend	This concentration likely represents natural variability in background.
PTX06-1140	20160920M00272	9/20/2016	N	211	75			Y	75	NA	7300	N	Y	Increasing	Increasing	This concentration likely represents natural variability in background.
PTX06-1140-2	20160629M00170	6/29/2016	N	196	75			Y	75	NA	7300	N	Y	Increasing	Increasing	This concentration likely represents natural variability in background.
PTX06-1157-2	20160621M00150	6/21/2016	N	217	75			Y	75	NA	7300	N	Y	No Trend	No Trend	This concentration likely represents natural variability in background.
PTX06-1157-3	20160622M00157	6/22/2016	N	248	75			Y	75	NA	7300	N	Y	No Trend	No Trend	This concentration likely represents natural variability in background.

LT – Long-Term Trend (all data)
ST – Short-Term Trend (last 4 samples)

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

The Mann-Kendall trending results, summarized in Table 3-10, indicate that across all data, 11 wells are indicating increasing or probably increasing trends.

Eight wells indicate an increasing or probably increasing trend in chromium. However, the detections were below background in all of these wells except for PTX06-1033. These chromium trends may also be related to the stainless steel casings and the confirmed presence of bacterial growth that has been found in many wells (perched and Ogallala aquifers) at Pantex. Typically, chromium levels drop in these wells after brushing and bailing of the well. Detections of manganese and nickel in PTX06-1033, discussed previously, along with the chromium, indicate that corrosion of the stainless steel well screen is affecting this well.

PTX06-1033 and PTX06-1068 exhibited increasing trends in hexavalent chromium. Hexavalent chromium was not detected in PTX06-1033 in 2016, and the increasing trend is associated with use of non-detect data in the trend analysis. As discussed in the 2012 Annual Progress Report, the increasing trend at PTX06-1068 is likely due to several 2012 detections associated with the corrosion of the stainless steel sampling pump. All other detections have been below the PQL, and more detections in 2015 and 2016 likely represent naturally occurring background concentrations.

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

Table 3-10. Increasing Trends in Group 1 Ogallala Aquifer Wells

Well	COC	Concentration Trend
PTX06-1033	CR	Increasing
PTX06-1033	CR-6	Increasing
PTX06-1043	B	Probably Increasing
PTX06-1043	CR	Increasing
PTX06-1056	DNT4A	Increasing
PTX06-1062A	CR	Increasing
PTX06-1064	CR	Probably Increasing
PTX06-1068	CR	Increasing
PTX06-1068	CR-6	Increasing
PTX06-1072	CR	Increasing
PTX06-1076	CR	Increasing
PTX06-1140	B	Increasing
PTX07-1R01	B	Probably Increasing
PTX07-1R01	CR	Probably Increasing

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. It is an expected condition that the ditches and playas would continue to contribute contamination to the perched aquifer for a long period of time (20 years or more), but at much lower concentrations than in the past (Pantex, 2006). For many of these wells, it is expected that concentrations will stabilize with an eventual long-term decreasing trend below the GWPS. Table 3-11 presents the evaluation of 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 3-11:

- HE breakdown products (MNX; TNX; DNX; 1,3-DNB; 2-amino-4,6-DNT; and 4-amino-2,6-DNT) were not included since increasing trends are not an indicator of continued sourcing.
- TCE breakdown products (*cis*-1,2-DCE; trans-1,2-DCE; and vinyl chloride) were not included since increasing trends are not an indicator of continued sourcing.
- Total Chromium was not included in lieu of hexavalent chromium.

Many wells that have detections of COCs already meet expected conditions at the well. Several wells have increasing or probably increasing historical COC trends. PTX06-1095A, PTX06-1005, and PTX08-1002 are exhibiting increasing trends in multiple COCs, but these three 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.

PTX06-1126, PTX06-1127, PTX07-1O02, and PTX07-1O03, while classified as Group 2 wells, are far away from the identified source areas, so these trends are not representative of the current mass flux near the source areas.

The remaining 12 wells that are exhibiting increasing trends when the expected condition is a decreasing or stable trend are discussed below.

- 1114-MW4, located in central Zone 11, is exhibiting an increasing trend in perchlorate, possibly due to increased mass flux and plume movement downgradient away from the source (Hypalon pond and nearby ditches).
- OW-WR-38, located northeast of Playa 1, is exhibiting a probably increasing trend in TCE; however, detections have been sporadic at levels below the PQL and GWPS. The trend is due to the use of one-half the sample detection limit as a surrogate for trend identification.
- PTX06-1007 is exhibiting a probably increasing trend in perchlorate while the expected condition is a long-term decreasing trend. As discussed in Section 3.1.1.3, this trend could be caused by changes in mass flux from the perchlorate source area or possible effects of injection.
- PTX06-1010 is exhibiting increasing trends in TCE and chloroform and a stable trend in hexavalent chromium while the expected condition is a long-term decreasing trend. These trends may be due to increased mass flux at the source area (WMG 10) or possible downgradient plume movement from the source.
- PTX06-1077A is exhibiting an apparent increasing trend in perchlorate; however, all samples in 2016 were non-detect and the trend is due to the use of one-half the sample detection limit as a surrogate for trend identification.
- PTX06-1088 is exhibiting an increasing trend in PCE since the start of remedial actions. PCE concentrations in PTX06-1088 are only slightly increasing, are currently lower than observed in recent years, and reflect general movement of the plume in this area.
- PTX07-1P02 is exhibiting an increasing trend in RDX since the start of remedial actions while the expected condition is a stable or decreasing trend below GWPS. However, the long-term trend is decreasing, and RDX concentrations are variable near the GWPS.

- PTX08-1005 is exhibiting a stable trend in PCE while the expected condition is a long-term decreasing trend; however, concentrations have sharply declined since 2014 and all samples in 2016 were non-detect. This well is located on the south end of Zone 11, further away from the Zone 11 VOC source areas.

- PTX08-1006 is exhibiting an increasing trend in TCE, while the expected condition is a long-term decreasing trend. This well is located in southeast Zone 11 and the trends are likely due to plume movement away from upgradient sources.

- PTX08-1007 is exhibiting a slight increasing trend in 1,4-dioxane below the GWPS since the start of remedial actions while the expected condition is a long-term decreasing trend. Although the trend was identified as increasing, little actual change in concentration has been observed over the past five years.

- PTX08-1008 is exhibiting increasing trends in perchlorate and chloroform while 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 may also be influenced by SEPTS operations. The long-term trend for chloroform is decreasing, and recent detections have been below the PQL and below the GWPS.

- PTX08-1009 is exhibiting a slight increasing trend in hexavalent chromium below the GWPS since the start of remedial actions while the expected condition is a long-term stabilization of concentrations. Although the trend was identified as increasing, little actual change in concentration has been observed over the past two years, the trend analysis was affected by the use of one-half the sample detection limit as a surrogate for non-detects, and the long-term trend is decreasing.

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

Table 3-12 summarizes all detections of analytes above the PQL and site-specific background, if calculated, that are not considered to be indicator parameters, but were either analyzed in 2011 as part of the five-year review or are considered to be corrosion indicators. Because a longer analyte list was used for some samples collected in 2016 as part of the Five-Year Review, other analytes were also excluded from this comparison including common water quality indicators (e.g., total dissolved solids, alkalinity) and compounds considered to not be of concern for protection of human health as determined by TCEQ, including essential elements (e.g., calcium, chloride, iron, magnesium, sulfate, etc.). The remaining detected analytes included acetone, bromide, bromoform, carbon tetrachloride, dibromochloromethane, 1,1-dichloroethane, 1,1-dichloroethene, fluoride, manganese, methylene chloride, nickel, nitrate, nitrite, 1,1,2-trichloroethane, trichlorofluoromethane, and uranium. Additional discussion on these detections is presented below.

- Several wells had concentrations of nickel and manganese exceeding background concentrations. However, both of these are indicators of corrosion of stainless steel screens, and all of these wells had stainless steel screens at the time of sampling.
- Acetone was detected in two wells, PTX07-1P02 and PTX08-1002, below the laboratory PQL in 2016. Both detections were qualified as UJ by the Pantex data review indicating that the material was analyzed for but was not detected. The sample quantitation limit is an estimated quantity.
- Bromide was detected at 24 wells at values ranging from 86 to 650 ug/L, but most of the detections were above the laboratory PQL of 200 ug/L. No GWPS has been established for bromide. These detections will be evaluated during the upcoming five-year review.
- Bromoform was detected in two wells, PTX06-1010 and PTX08-1005, at levels slightly above the laboratory PQL in 2016. Both detections were below the GWPS. Bromoform has been sporadically detected in the past at PTX08-1005 in samples collected in 1996 and 2005, but was not detected in 14 other samples collected since 1995. The detection in PTX08-1005 was the first detection at this well. This detection will be evaluated in the upcoming five-year review.
- Carbon tetrachloride was detected in two wells, PTX06-1005, PTX06-1010, below the laboratory PQL of 1 ug/L, and slightly above the PQL in a third well, PTX06-1088. This chemical has been historically detected at similar concentrations in these wells, so these detections are is not unexpected conditions.
- Dibromochloromethane was detected in three wells, PTX06-1010, PTX08-1005, and PTX08-1007, in 2016 at levels below the GWPS of 10 ug/L. These detections will be evaluated during the upcoming five-year review.
- 1,1-Dichloroethane, a potential breakdown product of TCE, was detected at PTX06-1126 below the laboratory PQL. 1,1-Dichloroethene has been previously detected in this well. This detection is several orders of magnitude lower than the GWPS of 3650 ug/L.
- 1,1-Dichloroethene, a potential breakdown product of TCE, was detected at two wells, PTX06-1005 and PTX06-1126, slightly above the laboratory PQL. 1,1-Dichloroethene has been historically detected at low concentrations (<3 ug/L) in the perched aquifer,

and was previously detected in both wells (above the GWPS of 7 ug/L in PTX06-1126). These detections will be evaluated during the upcoming five-year review.

- Fluoride was detected at 24 wells at values ranging from 320 to 1660 ug/L; all detections were below the GWPS of 4000 ug/L. These detections will be evaluated during the upcoming five-year review.
- Methylene chloride was detected in three wells, PTX06-1011, PTX08-1001, and PTX08-1007, in 2016 at levels below the laboratory PQL and GWPS of 5 ug/L. Methylene chloride has been sporadically detected at two of these wells in the past. These detections will be evaluated during the upcoming five-year review.
- Nitrate was detected in 23 wells in 2016 below the GWPS of 10,000 ug/L. Nitrate is commonly found in aquifers of the High Plains associated with infiltration of agricultural runoff and may be associated with explosive compound residues found in perched groundwater; therefore, these detections are not unexpected conditions.
- Nitrite was detected in two wells, PTX06-1095A and PTX08-1006, below the laboratory PQL of 70 ug/L. Nitrite is an unstable intermediate compound in the transformation of ammonium to nitrate or nitrate to nitrogen gas; therefore, these detections are not unexpected conditions.
- 1,1,2-Trichloroethane was detected in three wells, PTX06-1126, PTX06-1127, and PTX08-1006, in 2016 at levels below the GWPS of 5 ug/L. 1,1,2-Trichloroethane was previously detected in two of these wells. These detections will be evaluated during the upcoming five-year review.
- Trichlorofluoromethane was detected in six wells in 2016 above the laboratory PQL. All detections are several orders of magnitude below the GWPS of 10,950 ug/L. These detections will be evaluated during the upcoming five-year review.
- Uranium isotopes uranium-233/234 and uranium-238 were detected in two wells, PTX08-1007 and PTX10-1014, above their respective background levels. Based on an initial review of the radiological data, these detections are believed to be associated with natural variations in background and are not indicative of depleted uranium. Considering a minimum uncertainty of 10% and the measured error counts in each of the radiological results, the uncertainty range includes background values. Additionally, the uranium-235/236 isotope is below background at both wells. A more detailed evaluation of the radiological data will be conducted as part of the five-year review.

Table 3-11. COC Trends vs. Expected Conditions, Group 2 Wells

Well ID	COC Expected Condition – LTM Design	COC >GWPS	Historic Mann-Kendall Trends										
			RDX	TNT	DNT24	DNT26	TNB135	PERC	TCE	PCE	CR(VI)	1,4-Dioxane	TCLME
1114-MW4	Long-term decreasing trend	PERC, TCE	N/A	ND	ND	ND	ND	Increasing	Decreasing	Decreasing	NT	No Trend	Decreasing
OW-WR-38	Long-term stabilization of concentrations	RDX, HMX	No Trend	ND	ND	ND	ND	NT	Probably Increasing	ND	NT	NT	ND
PTX06-1002A	Long-term stabilization of concentrations	RDX, TNX, HMX	Decreasing	ND	ND	ND	N/A	NT	No Trend	N/A	N/A	NT	ND
PTX06-1003[1]	Long-term stabilization of concentrations	RDX, TNX	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
PTX06-1005	Long-term stabilization of concentrations	DNT24, DNT2A, DNT4A, RDX, TNB135, TNX, TCE	Decreasing	Increasing	Decreasing	Increasing	Decreasing	NT	Increasing	Increasing	No Trend	NT	No Trend
PTX06-1007	Long-term decreasing trend	PERC	No Trend	ND	ND	Decreasing	ND	Probably Increasing	Decreasing	ND	NT	No Trend	ND
PTX06-1008	Long-term decreasing trend	DCA12, CR	ND	ND	ND	ND	ND	N/A	Decreasing	ND	N/A	N/A	Decreasing
PTX06-1010	Long-term decreasing trend	CR, CR6, RDX	Decreasing	N/A	ND	ND	ND	NT	Increasing	Decreasing	Stable	NT	Increasing
PTX06-1011	Stable or decreasing trend below GWPS	NONE	No Trend	ND	N/A	ND	N/A	N/A	No Trend	Decreasing	No Trend	Decreasing	Stable
PTX06-1050	Long-term stabilization of concentrations	RDX, TNX	Decreasing	ND	ND	ND	ND	NT	ND	ND	NT	NT	ND
PTX06-1053	Stable or decreasing trend below GWPS	NONE	No Trend	ND	ND	ND	ND	ND	ND	ND	N/A	ND	ND
PTX06-1077A	Stable or decreasing trend below GWPS	TCE	Decreasing	ND	ND	ND	ND	Probably Increasing	Decreasing	N/A	NT	N/A	ND
PTX06-1088	Long-term stabilization of concentrations	TNT, TCE, CR, CR-6, RDX, DNT24, DNT2A, DNT4A, TNB135	Decreasing	Decreasing	Decreasing	Decreasing	Decreasing	NT	Decreasing	Increasing	Decreasing	NT	Decreasing
PTX06-1095A	Long-term stabilization of concentrations	RDX, TNX, TCE	Increasing	No Trend	ND	Decreasing	Increasing	NT	Increasing	Increasing	Decreasing	NT	Increasing
PTX06-1126	Long-term decreasing trend	TCE, PERC, DIOXANE14	No Trend	ND	ND	N/A	ND	Decreasing	Decreasing	Increasing	No Trend	No Trend	Increasing
PTX06-1127	Long-term decreasing trend	TCE, PERC, DIOXANE14, DCA12	Increasing	ND	ND	ND	ND	Decreasing	No Trend	Increasing	N/A	No Trend	Increasing
PTX07-1O01	Long-term decreasing trend	RDX	Decreasing	ND	ND	ND	ND	NT	N/A	ND	NT	NT	ND
PTX07-1O02	Long-term decreasing trend	NONE	Decreasing	ND	ND	ND	ND	NT	Increasing	ND	NT	NT	N/A
PTX07-1O03	Long-term decreasing trend	RDX, HMX	Increasing	ND	ND	ND	ND	NT	N/A	ND	NT	NT	ND
PTX07-1O06[1]	Stable or decreasing trend below GWPS	NONE	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
PTX07-1P02	Stable or decreasing trend below GWPS	NONE	Increasing	ND	ND	ND	ND	N/A	ND	ND	NT	Decreasing	ND

Well ID	COC Expected Condition – LTM Design	COC >GWPS	Historic Mann-Kendall Trends										
			RDX	TNT	DNT24	DNT26	TNB135	PERC	TCE	PCE	CR(VI)	1,4-Dioxane	TCLME
PTX07-1P05[1]	Stable or decreasing trend below GWPS	RDX, TNX	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
PTX08-1001	Long-term stabilization of concentrations	RDX, TNX	No Trend	ND	ND	ND	ND	Decreasing	ND	ND	NT	N/A	ND
PTX08-1002	Long-term stabilization of concentrations	RDX, MNX, DNX, TNX, DNT2A	Decreasing	Increasing	Increasing	N/A	Increasing	NT	ND	ND	ND	NT	ND
PTX08-1005	Long-term decreasing trend	TCE, DCA12, DIOXANE14, PERC	No Trend	ND	ND	ND	ND	Decreasing	Decreasing	Stable	Decreasing	Decreasing	Decreasing
PTX08-1006	Long-term decreasing trend	RDX, TNX, PERC, DNT4A, TCE, PCE, DIOXANE14, DCA12	Decreasing	ND	ND	Decreasing	N/A	Decreasing	Increasing	Decreasing	NT	Decreasing	Decreasing
PTX08-1007	Long-term decreasing trend	TCE, RDX, CR, CR-6	No Trend	ND	ND	ND	ND	N/A	Decreasing	Decreasing	Decreasing	Increasing	No Trend
PTX08-1008	Long-term stabilization of concentrations	CR, CR-6	N/A	ND	ND	ND	ND	Increasing	N/A	ND	Decreasing	N/A	Increasing
PTX08-1009	Long-term stabilization of concentrations	NONE	Decreasing	ND	ND	ND	ND	NT	N/A	ND	Increasing	NT	Decreasing
PTX10-1014	Long-term decreasing trend	TCE	No Trend	ND	ND	ND	ND	Decreasing	Decreasing	Decreasing	N/A	N/A	Decreasing

CR = Chromium, total; CR+6 = Chromium, hexavalent; DCA12 = 1,2-dichloroethane; DNT2A = 2-amino-4,6-dinitrotoluene; DNT4A = 4-amino-2,6-dinitrotoluene
DNT24 = 2,4-dinitroluene; DIOXANE14 = 1,4-dioxane; PCE = tetrachloroethene; PERC = perchlorate; TCE = trichloroethene
TCLME = chloroform; TNB135 = 1,3,5-trinitrobenzene; N/A = not enough detections; ND = non-detect; NT = not tested

[1] – PTX06-1003, PTX07-1O06, and PTX07-1P05 were not able to be sampled in 2015 due to either dry conditions or insufficient water to sample.

Table 3-12. Group 2 Well Detections of non-Indicator Parameters

Well ID	Sample ID	Sample Date	Sample Type	Analyte	Measured Value (ug or pCi/L)	Detection Limit (ug or pCi/L)	Lab Qualifier	PTX Qualifier	Rad Error Count	Background (ug/L)	>Background?	PQL (ug or pCi/L)	>PQL?	GWPS (mg or pCi/L)	>GWPS ?	Expected Condition?	Explanation
1114-MW4	20160524M00114	5/24/2016	N	Bromide	366	200					NA	200	Y		NCE	N	Naturally occurring; no background established
1114-MW4	20160524M00114	5/24/2016	N	Fluoride	1390	100					NA	100	Y	4000	N	N	Naturally occurring; no background established
1114-MW4	20160524M00114	5/24/2016	N	Nitrate As N	2364.3	70					NA	70	Y	10000	N	N	Widespread, common contaminant; below GWPS
1114-MW4	20161115M00334	11/15/2016	N	Nickel	33.2	2				15	Y	2	NA	730	N	N	Likely screen corrosion
1114-MW4	20161115M00334	11/15/2016	N	Trichloro-fluoromethane	13.1	1					NA	1	Y	10950	N	N	Previously detected at higher concentrations
OW-WR-38	20160427M00087	4/27/2016	N	Bromide	142	200	J				NA	200	N		NCE	N	Naturally occurring; no background established
OW-WR-38	20160427M00087	4/27/2016	N	Fluoride	559	100					NA	100	Y	4000	N	N	Naturally occurring; no background established
OW-WR-38	20160427M00087	4/27/2016	N	Nitrate As N	1820.5						NA		NCE	10000	N	N	Widespread, common contaminant; below GWPS
PTX06-1002A	20160118M00003	1/18/2016	N	Bromide	264	200					NA	200	Y		NCE	N	Naturally occurring; no background established
PTX06-1002A	20160118M00003	1/18/2016	N	Fluoride	318	100					NA	100	Y	4000	N	N	Naturally occurring; no background established
PTX06-1002A	20160118M00003	1/18/2016	N	Nitrate As N	149.1	70		J			NA	70	Y	10000	N	N	Widespread, common contaminant; below GWPS
PTX06-1005	20160118M00002	1/18/2016	N	Bromide	502	200					NA	200	Y		NCE	N	Naturally occurring; no background established
PTX06-1005	20160118M00002	1/18/2016	N	Fluoride	1390	100					NA	100	Y	4000	N	N	Naturally occurring; no background established
PTX06-1005	20160118M00002	1/18/2016	N	Nitrate As N	4276.7	70		J			NA	70	Y	10000	N	N	Widespread, common contaminant; below GWPS
PTX06-1005	20160811M00243	8/11/2016	N	Carbon Tetrachloride	0.59	1	J				NA	1	N	5	N	N	Previously detected at similar concentrations
PTX06-1005	20160811M00243	8/11/2016	N	1,1-Dichloroethene	1.29	1					NA	1	Y	7	N	Y	Previously detected at similar concentrations
PTX06-1005	20160811M00243	8/11/2016	N	Trichloro-fluoromethane	9.27	1					NA	1	Y	10950	N	Y	Previously detected at similar concentrations
PTX06-1007	20160613M00130	6/13/2016	N	Nickel	27	2				15	Y	2	NA	730	N	N	Likely screen corrosion
PTX06-1007	20160613M00130	6/13/2016	N	Bromide	236	200					NA	200	Y		NCE	N	Naturally occurring; no background established
PTX06-1007	20160613M00130	6/13/2016	N	Fluoride	922	100					NA	100	Y	4000	N	N	Naturally occurring; no background established
PTX06-1007	20160613M00130	6/13/2016	N	Nitrate As N	1883.2	70		J-			NA	70	Y	10000	N	N	Widespread, common contaminant; below GWPS
PTX06-1008	20160627M00160	6/27/2016	N	Bromide	353	200					NA	200	Y		NCE	N	Naturally occurring; no background established

Well ID	Sample ID	Sample Date	Sample Type	Analyte	Measured Value (ug or pCi/L)	Detection Limit (ug or pCi/L)	Lab Qualifier	PTX Qualifier	Rad Error Count	Background (ug/L)	>Background?	PQL (ug or pCi/L)	>PQL?	GWPS (mg or pCi/L)	>GWPS ?	Expected Condition?	Explanation
PTX06-1008	20160627M00160	6/27/2016	N	Fluoride	1290	100					NA	100	Y	4000	N	N	Naturally occurring; no background established
PTX06-1008	20160627M00160	6/27/2016	N	Nitrate As N	6244.4	70					NA	70	Y	10000	N	N	Widespread, common contaminant; below GWPS
PTX06-1010	20160622M00152	6/22/2016	N	Bromide	85.9	200	J				NA	200	N		NCE	N	Naturally occurring; no background established
PTX06-1010	20160622M00152	6/22/2016	N	Fluoride	1660	100					NA	100	Y	4000	N	N	Naturally occurring; no background established
PTX06-1010	20160921M00282	9/21/2016	N	Carbon Tetrachloride	0.32	1	J				NA	1	N	5	N	N	Previously detected at higher concentrations
PTX06-1010	20160921M00282	9/21/2016	N	Dibromo-chloromethane	3.04	1					NA	1	Y	10.1	N	Y	Previously detected at similar concentrations
PTX06-1010	20160921M00282	9/21/2016	N	Bromoform	1.98	1					NA	1	Y	10.8	N	Y	Previously detected at higher concentrations
PTX06-1011	20160608M00127	6/8/2016	N	Bromide	380	200					NA	200	Y		NCE	N	Naturally occurring; no background established
PTX06-1011	20160608M00127	6/8/2016	N	Fluoride	1340	100					NA	100	Y	4000	N	N	Naturally occurring; no background established
PTX06-1011	20160608M00127	6/8/2016	N	Nitrate As N	3225.6	70		J-			NA	70	Y	10000	N	N	Widespread, common contaminant; below GWPS
PTX06-1011	20160608M00127	6/8/2016	N	Trichloro-fluoromethane	3.33	1					NA	1	Y	10950	N	N	Previously detected at higher concentrations
PTX06-1011	20160608M00127	6/8/2016	N	Methylene Chloride	1.36	5	J	U			NA	5	N	5	N	N	Previously detected at similar concentrations
PTX06-1050	20160427M00085	4/27/2016	N	Bromide	184	200	J				NA	200	N		NCE	N	Naturally occurring; no background established
PTX06-1050	20160427M00085	4/27/2016	N	Fluoride	401	100					NA	100	Y	4000	N	N	Naturally occurring; no background established
PTX06-1050	20160427M00085	4/27/2016	N	Nitrate As N	1203.7						NA		NCE	10000	N	N	Widespread, common contaminant; below GWPS
PTX06-1053	20160509M00093	5/9/2016	N	Bromide	193	200	J				NA	200	N		NCE	N	Naturally occurring; no background established
PTX06-1053	20160509M00093	5/9/2016	N	Fluoride	727	100					NA	100	Y	4000	N	N	Naturally occurring; no background established
PTX06-1053	20160509M00093	5/9/2016	N	Nitrate As N	5191.7	70		J			NA	70	Y	10000	N	N	Widespread, common contaminant; below GWPS
PTX06-1088	20160608M00126	6/8/2016	N	Bromide	475	200					NA	200	Y		NCE	N	Naturally occurring; no background established
PTX06-1088	20160608M00126	6/8/2016	N	Fluoride	960	100					NA	100	Y	4000	N	N	Naturally occurring; no background established
PTX06-1088	20160608M00126	6/8/2016	N	Nitrate As N	3355.8	70		J-			NA	70	Y	10000	N	N	Widespread, common contaminant; below GWPS
PTX06-1088	20160921M00285	9/21/2016	N	Carbon Tetrachloride	1.34	1					NA	1	Y	5	N	N	Previously detected at higher concentrations
PTX06-1088	20160921M00285	9/21/2016	N	Trichloro-fluoromethane	22.2	1					NA	1	Y	10950	N	Y	Previously detected at lower concentrations

Well ID	Sample ID	Sample Date	Sample Type	Analyte	Measured Value (ug or pCi/L)	Detection Limit (ug or pCi/L)	Lab Qualifier	PTX Qualifier	Rad Error Count	Background (ug/L)	>Background?	PQL (ug or pCi/L)	>PQL?	GWPS (mg or pCi/L)	>GWPS ?	Expected Condition?	Explanation
PTX06-1095A	20160211M00056	2/11/2016	N	Manganese	32.7	5				16	Y	5	NA	1715.5	N	N	Likely screen corrosion
PTX06-1095A	20160211M00056	2/11/2016	N	Nickel	38.7	2				15	Y	2	NA	730	N	N	Likely screen corrosion
PTX06-1095A	20160211M00056	2/11/2016	N	Bromide	648	200					NA	200	Y		NCE	N	Naturally occurring; no background established
PTX06-1095A	20160211M00056	2/11/2016	N	Fluoride	943	100					NA	100	Y	4000	N	N	Naturally occurring; no background established
PTX06-1095A	20160211M00056	2/11/2016	N	Nitrate As N	3402.1	70					NA	70	Y	10000	N	N	Widespread, common contaminant; below GWPS
PTX06-1095A	20160211M00056	2/11/2016	N	Nitrite As N	49.4	70	J				NA	70	N	1000	N	N	Unstable intermediate compound; below GWPS
PTX06-1095A	20160802M00220	8/2/2016	N	Manganese	36.1	5				16	Y	5	NA	1715.5	N	N	Likely screen corrosion
PTX06-1095A	20160802M00220	8/2/2016	N	Nickel	19.3	2				15	Y	2	NA	730	N	N	Likely screen corrosion
PTX06-1126	20160511M00104	5/11/2016	N	Bromide	220	200					NA	200	Y		NCE	N	Naturally occurring; no background established
PTX06-1126	20160511M00104	5/11/2016	N	Fluoride	1380	100					NA	100	Y	4000	N	N	Naturally occurring; no background established
PTX06-1126	20160511M00104	5/11/2016	N	Nitrate As N	1581	70					NA	70	Y	10000	N	N	Widespread, common contaminant; below GWPS
PTX06-1126	20161103M00327	11/3/2016	N	1,1-Dichloroethane	0.44	1	J				NA	1	N	3650	N	N	Previously detected at higher concentration
PTX06-1126	20161103M00327	11/3/2016	N	1,1-Dichloroethene	2.6	1					NA	1	Y	7	N	N	Previously detected at higher concentrations
PTX06-1126	20161103M00327	11/3/2016	N	1,1,2-Trichloro-ethane	1.13	1					NA	1	Y	5	N	Y	Previously detected at lower concentration
PTX06-1127	20160511M00103	5/11/2016	N	Bromide	224	200					NA	200	Y		NCE	N	Naturally occurring; no background established
PTX06-1127	20160511M00103	5/11/2016	N	Fluoride	1390	100					NA	100	Y	4000	N	N	Naturally occurring; no background established
PTX06-1127	20160511M00103	5/11/2016	N	Nitrate As N	2893.2	70					NA	70	Y	10000	N	N	Widespread, common contaminant; below GWPS
PTX06-1127	20161103M00326	11/3/2016	N	Nickel	113	2	E			15	Y	2	NA	730	N	N	Likely screen corrosion
PTX06-1127	20161103M00326	11/3/2016	N	1,1,2-Trichloro-ethane	1.71	1					NA	1	Y	5	N	Y	First detection in this well
PTX07-1O03	20160728M00211	7/28/2016	N	Bromide	217	200					NA	200	Y		NCE	N	Naturally occurring; no background established
PTX07-1O03	20160728M00211	7/28/2016	N	Fluoride	399	100					NA	100	Y	4000	N	N	Naturally occurring; no background established
PTX07-1O03	20160728M00211	7/28/2016	N	Nitrate As N	2159.1	70					NA	70	Y	10000	N	N	Widespread, common contaminant; below GWPS
PTX07-1P02	20160607M00123	6/7/2016	N	Bromide	439	200					NA	200	Y		NCE	N	Naturally occurring; no background established

Well ID	Sample ID	Sample Date	Sample Type	Analyte	Measured Value (ug or pCi/L)	Detection Limit (ug or pCi/L)	Lab Qualifier	PTX Qualifier	Rad Error Count	Background (ug/L)	>Background?	PQL (ug or pCi/L)	>PQL?	GWPS (mg or pCi/L)	>GWPS ?	Expected Condition?	Explanation
PTX07-1P02	20160607M00123	6/7/2016	N	Fluoride	453	100					NA	100	Y	4000	N	N	Naturally occurring; no background established
PTX07-1P02	20160607M00123	6/7/2016	N	Nitrate As N	266.5	70					NA	70	Y	10000	N	N	Widespread, common contaminant; below GWPS
PTX07-1P02	20161102M00323	11/2/2016	N	Acetone	3.33	10	J	UJ			NA	10	N	32850	N	N	Detection qualified as UJ; the material was analyzed for but not detected
PTX08-1001	20160524M00112	5/24/2016	N	Bromide	103	200	J				NA	200	N		NCE	N	Naturally occurring; no background established
PTX08-1001	20160524M00112	5/24/2016	N	Fluoride	357	100					NA	100	Y	4000	N	N	Naturally occurring; no background established
PTX08-1001	20160524M00112	5/24/2016	N	Nitrate As N	433.1	70					NA	70	Y	10000	N	N	Widespread, common contaminant; below GWPS
PTX08-1001	20160524M00112	5/24/2016	N	Methylene Chloride	2.71	5	J	U			NA	5	N	5	N	Y	Previously detected at lower concentrations
PTX08-1002	20160524M00113	5/24/2016	N	Bromide	153	200	J				NA	200	N		NCE	N	Naturally occurring; no background established
PTX08-1002	20160524M00113	5/24/2016	N	Fluoride	667	100					NA	100	Y	4000	N	N	Naturally occurring; no background established
PTX08-1002	20160524M00113	5/24/2016	N	Nitrate As N	1788.8	70					NA	70	Y	10000	N	N	Widespread, common contaminant; below GWPS
PTX08-1002	20161102M00324	11/2/2016	N	Acetone	2.79	10	J	UJ			NA	10	N	32850	N	N	Detection qualified as UJ; the material was analyzed for but not detected
PTX08-1005	20160209M00048	2/9/2016	N	Bromide	208	200					NA	200	Y		NCE	N	Naturally occurring; no background established
PTX08-1005	20160209M00048	2/9/2016	N	Fluoride	1640	100					NA	100	Y	4000	N	N	Naturally occurring; no background established
PTX08-1005	20160209M00048	2/9/2016	N	Nitrate As N	1720.9	70					NA	70	Y	10000	N	N	Widespread, common contaminant; below GWPS
PTX08-1005	20160815M00248	8/15/2016	N	Dibromo-chloromethane	6.64	1					NA	1	Y	10.1	N	Y	First time detection
PTX08-1005	20160815M00248	8/15/2016	N	Bromoform	3.91	1					NA	1	Y	10.8	N	Y	First time detection
PTX08-1006	20160209M00049	2/9/2016	N	Bromide	263	200					NA	200	Y		NCE	N	Naturally occurring; no background established
PTX08-1006	20160209M00049	2/9/2016	N	Fluoride	908	100					NA	100	Y	4000	N	N	Naturally occurring; no background established
PTX08-1006	20160209M00049	2/9/2016	N	Nitrate As N	2424.9	70					NA	70	Y	10000	N	N	Widespread, common contaminant; below GWPS
PTX08-1006	20160209M00049	2/9/2016	N	Nitrite As N	51.8	70	J				NA	70	N	1000	N	N	Unstable intermediate compound; below GWPS
PTX08-1006	20160815M00250	8/15/2016	N	Trichloro-fluoromethane	2.87	1					NA	1	Y	10950	N	Y	First time detection in this well
PTX08-1006	20160815M00250	8/15/2016	N	1,1,2-Trichloro-ethane	0.94	1	J				NA	1	N	5	N	N	Previously detected at similar concentrations

Well ID	Sample ID	Sample Date	Sample Type	Analyte	Measured Value (ug or pCi/L)	Detection Limit (ug or pCi/L)	Lab Qualifier	PTX Qualifier	Rad Error Count	Background (ug/L)	>Background?	PQL (ug or pCi/L)	>PQL?	GWPS (mg or pCi/L)	>GWPS ?	Expected Condition?	Explanation
PTX08-1007	20160608M00128	6/8/2016	N	Bromide	372	200					NA	200	Y		NCE	N	Naturally occurring; no background established
PTX08-1007	20160608M00128	6/8/2016	N	Fluoride	651	100					NA	100	Y	4000	N	N	Naturally occurring; no background established
PTX08-1007	20160608M00128	6/8/2016	N	Nitrate As N	1746.6	70		J-			NA	70	Y	10000	N	N	Widespread, common contaminant; below GWPS
PTX08-1007	20160608M00128	6/8/2016	N	Uranium-233/234	6.22				0.633	5.5	Y		NA	30	N	N	Natural variation in background
PTX08-1007	20160608M00128	6/8/2016	N	Uranium-238	3.35				0.361	2.7	Y		NA	30	N	N	Natural variation in background
PTX08-1007	20160608M00128	6/8/2016	N	Dibromo-chloromethane	0.32	1	J				NA	1	N	10.1	N	Y	First time detection
PTX08-1007	20160608M00128	6/8/2016	N	Trichloro-fluoromethane	1.15	1					NA	1	Y	10950	N	N	Previously detected at higher concentrations
PTX08-1007	20160608M00128	6/8/2016	N	Methylene Chloride	1.4	5	J	U			NA	5	N	5	N	N	Previously detected at similar concentrations
PTX08-1008	20160525M00119	5/25/2016	N	Bromide	307	200					NA	200	Y		NCE	N	Naturally occurring; no background established
PTX08-1008	20160525M00119	5/25/2016	N	Fluoride	1260	100					NA	100	Y	4000	N	N	Naturally occurring; no background established
PTX08-1008	20160525M00119	5/25/2016	N	Nitrate As N	2551.3	70					NA	70	Y	10000	N	N	Widespread, common contaminant; below GWPS
PTX08-1009	20160525M00118	5/25/2016	N	Bromide	403	200					NA	200	Y		NCE	N	Naturally occurring; no background established
PTX08-1009	20160525M00118	5/25/2016	N	Fluoride	1470	100					NA	100	Y	4000	N	N	Naturally occurring; no background established
PTX08-1009	20160525M00118	5/25/2016	N	Nitrate As N	3100.4	70					NA	70	Y	10000	N	N	Widespread, common contaminant; below GWPS
PTX10-1014	20160524M00115	5/24/2016	N	Nickel	47.8	2				15	Y	2	NA	730	N	N	Likely screen corrosion
PTX10-1014	20160524M00115	5/24/2016	N	Bromide	383	200					NA	200	Y		NCE	N	Naturally occurring; no background established
PTX10-1014	20160524M00115	5/24/2016	N	Fluoride	667	100					NA	100	Y	4000	N	N	Naturally occurring; no background established
PTX10-1014	20160524M00115	5/24/2016	N	Nitrate As N	2555.6	70					NA	70	Y	10000	N	N	Widespread, common contaminant; below GWPS
PTX10-1014	20160524M00115	5/24/2016	N	Uranium-233/234	6.28				0.671	5.5	Y		NA	30	N	N	Natural variation in background
PTX10-1014	20160524M00115	5/24/2016	N	Uranium-238	3.46				0.393	2.7	Y		NA	30	N	N	Natural variation in background

N – Normal sample D-Duplicate sample F – Filtered Sample

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3.4.3 Other Unexpected Conditions

Two perched groundwater wells demonstrated unexpected conditions in 2016. During the 3rd quarter, one perched groundwater well, PTX06-1005, demonstrated an all-time high detection of 1,4-dioxane that was measured at 7.71 ug/L, slightly above the GWPS of 7.7 ug/L. This concentration was not expected at this location because previous data and upgradient well data did not indicate a plume of 1,4-dioxane with concentrations near or exceeding the GWPS. The well was resampled with two samples sent to two different off-site laboratories and evaluated using two different methods. Results from both samples confirmed the original detection (results of 6.9 and 7.7 ug/L). This well is on the western edge of the SEPTS extraction well field and is of concern because the system may not be able treat 1,4-dioxane using GAC at current flow rates. Additional sampling of nearby wells was discussed in Section 2.1.2. Further actions will be determined based on results of sampling and in accordance with the *Groundwater Contingency Plan*.

Additionally, a new perched groundwater well installed outside the current defined extent of the southeast lobe of the perched aquifer indicates that water and contamination have migrated further to the southeast. PTX06-1182 was installed in 2016 with sampling conducted in early October. Results indicate the presence of the HEs 4-amino-2,6-DNT and RDX at concentrations exceeding the PQL and GWPS (results of 6.73 and 15 ug/L and GWPS of 1.2 and 2 ug/L, respectively). A confirmation sample confirmed the presence of 4-amino-2,6-DNT and RDX at similar concentrations. Pantex plans to install new downgradient wells in 2017 to determine perched groundwater and contaminant extent.

3.5 POC/POE Well Evaluation

As part of the approved changes to HW-50284, Pantex has designated POC and POE wells. As defined by HW-50284, the purpose of these wells is:

1. POC wells demonstrate compliance with the GWPS.
2. 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 14 exceeding 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/POE wells approved in HW-50284 are depicted in Figure 3-55. 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/POE wells were evaluated against the established GWPS. Evaluation of the data indicates that only four perched aquifer POC wells had concentrations below GWPS. This is an expected condition at these wells as the full remedial actions were started in 2009. The COC concentrations above the GWPS are provided in Table 3-13. The Ogallala Aquifer wells were evaluated in the uncertainty management/early detection section to determine if any COCs were detected above background or PQL. All well data, along with comparison to the laboratory PQL, background, and GWPS are provided in Appendix D.

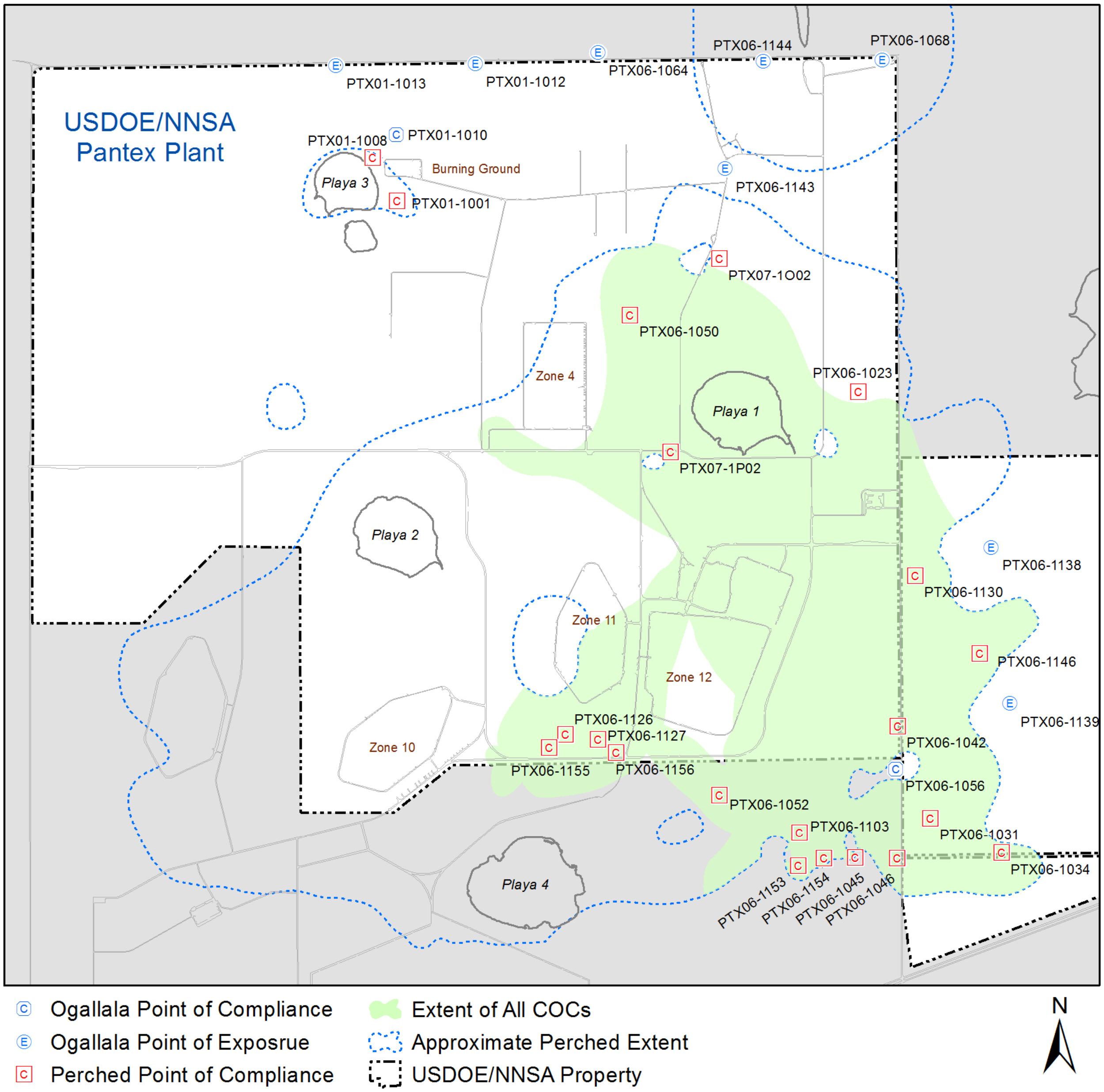

Figure 3-55. POC and POE Wells

Table 3-13. POC Well Detections Above GWPS

Well ID	Sample ID	Analyte	2016 Average Value (ug/L)	Measured Value (ug/L)	Detection Limit (ug/L)	Lab Qualifier	PTX Qualifier	GWPS (ug/L)
PTX06-1031	20160523M00108	4-Amino-2,6-Dinitrotoluene	2.79	2.63	0.263			1.2
PTX06-1031	20160523M00108	RDX	672.5	575	65.8		J	2
PTX06-1031	20160523M00108	TNX	10.95	11	1.32		J	2
PTX06-1031	20161024M00303	4-Amino-2,6-Dinitrotoluene	2.79	2.95	0.255			1.2
PTX06-1031	20161024M00303	RDX	672.5	770	63.8			2
PTX06-1031	20161024M00303	TNX	10.95	10.9	6.38		J+	2
PTX06-1034	20160202M00032	4-Amino-2,6-Dinitrotoluene	6.99	7.36	0.266			1.2
PTX06-1034	20160202M00032	RDX	1116	981	66.5		J	2
PTX06-1034	20160202M00032	TNX	70.7	67.7	2.66		J	2
PTX06-1034	20160817M00256	4-Amino-2,6-Dinitrotoluene	6.99	6.61	0.26			1.2
PTX06-1034	20160817M00256	RDX	1116	1250	65.1		J	2
PTX06-1034	20160817M00256	TNX	70.7	73.7	65.1		J	2
PTX06-1042	20160128M00025	4-Amino-2,6-Dinitrotoluene	9.3	11.2	1.3			1.2
PTX06-1042	20160128M00025	MNX	3.8	3.47	0.259			2
PTX06-1042	20160128M00025	RDX	465.5	497	25.9		J	2
PTX06-1042	20160128M00025	TNX	7.97	7.86	0.259		J	2
PTX06-1042	20160808M00231	4-Amino-2,6-Dinitrotoluene	9.3	7.4	0.26		J-	1.2
PTX06-1042	20160808M00231	MNX	3.8	4.13	1.3		J	2
PTX06-1042	20160808M00231	RDX	465.5	434	13		J	2
PTX06-1042	20160808M00231	TNX	7.97	8.07	1.3		J	2
PTX06-1046	20160127M00019	2-Amino-4,6-Dinitrotoluene	1.85	1.97	0.27			1.2
PTX06-1046	20160127M00019	4-Amino-2,6-Dinitrotoluene	5.2	5.37	0.27			1.2
PTX06-1046	20160127M00019	RDX	1770	1470	67.6		J	2
PTX06-1046	20160127M00019	TNX	137.5	120	13.5		J	2
PTX06-1046	20160810M00237	2-Amino-4,6-Dinitrotoluene	1.85	1.73	0.258		J-	1.2
PTX06-1046	20160810M00237	4-Amino-2,6-Dinitrotoluene	5.2	5.02	0.258		J-	1.2
PTX06-1046	20160810M00237	RDX	1770	2070	64.4		J	2
PTX06-1046	20160810M00237	TNX	137.5	155	64.4		J	2
PTX06-1050	20160427M00085	4-Amino-2,6-Dinitrotoluene	7.23	6.13	0.258			1.2
PTX06-1050	20160427M00085	RDX	120.5	118	6.44		J	2
PTX06-1050	20160427M00085	TNX	7	7.27	0.258			2
PTX06-1050	20161115M00333	4-Amino-2,6-Dinitrotoluene	7.23	8.33	0.255			1.2
PTX06-1050	20161115M00333	RDX	120.5	123	6.38			2
PTX06-1050	20161115M00333	TNX	7	6.72	0.255			2

Well ID	Sample ID	Analyte	2016 Average Value (ug/L)	Measured Value (ug/L)	Detection Limit (ug/L)	Lab Qualifier	PTX Qualifier	GWPS (ug/L)
PTX06-1052	20160208M00043	Chromium, Total	559.5	612	10		J	100
PTX06-1052	20160208M00043	Chromium, Hexavalent	638.5	766	100		J	100
PTX06-1052	20160811M00242	Chromium, Total	559.5	507	10			100
PTX06-1052	20160811M00242	Chromium, Hexavalent	638.5	511	100			100
PTX06-1126	20160511M00104	4-Amino-2,6-Dinitrotoluene	13.01	8.81	0.273		J	1.2
PTX06-1126	20160511M00104	Perchlorate	116.85	144	24			26
PTX06-1126	20160511M00104	1,4-Dioxane	21.45	18.4	3		J	7.7
PTX06-1126	20160511M00104	Trichloroethene	169	112	2			5
PTX06-1126	20161103M00327	4-Amino-2,6-Dinitrotoluene	13.01	17.2	1.3			1.2
PTX06-1126	20161103M00327	Perchlorate	116.85	89.7	12			26
PTX06-1126	20161103M00327	1,2-Dichloroethane	5.65	5.65	1			5
PTX06-1126	20161103M00327	1,4-Dioxane	21.45	24.5	10			7.7
PTX06-1126	20161103M00327	Trichloroethene	169	226	4			5
PTX06-1127	20160511M00103	4-Amino-2,6-Dinitrotoluene	12.8	12.3	0.651		J	1.2
PTX06-1127	20160511M00103	Perchlorate	419.5	399	120			26
PTX06-1127	20160511M00103	1,4-Dioxane	43.5	34.3	4		J	7.7
PTX06-1127	20160511M00103	Trichloroethene	35.3	30.8	1			5
PTX06-1127	20161103M00326	4-Amino-2,6-Dinitrotoluene	12.8	13.3	1.28			1.2
PTX06-1127	20161103M00326	RDX	3.58	3.58	0.255			2
PTX06-1127	20161103M00326	Chromium, Total	175	175	10			100
PTX06-1127	20161103M00326	Perchlorate	419.5	440	120			26
PTX06-1127	20161103M00326	1,2-Dichloroethane	5.03	5.03	1			5
PTX06-1127	20161103M00326	1,4-Dioxane	43.5	52.7	10			7.7
PTX06-1127	20161103M00326	Tetrachloroethene	6.29	6.29	1			5
PTX06-1127	20161103M00326	Trichloroethene	35.3	39.8	1			5
PTX06-1146	20160126M00015	4-Amino-2,6-Dinitrotoluene	19.45	18.9	6.44		J-	1.2
PTX06-1146	20160126M00015	RDX	1155	1150	64.4		J	2
PTX06-1146	20160126M00015	TNX	19.4	15.5	6.44			2
PTX06-1146	20160817M00257	2-Amino-4,6-Dinitrotoluene	1.46	1.46	0.262			1.2
PTX06-1146	20160817M00257	4-Amino-2,6-Dinitrotoluene	19.45	20	1.31			1.2
PTX06-1146	20160817M00257	RDX	1155	1160	65.4		J	2
PTX06-1146	20160817M00257	TNX	19.4	23.3	65.4	J	J	2

Well ID	Sample ID	Analyte	2016 Average Value (ug/L)	Measured Value (ug/L)	Detection Limit (ug/L)	Lab Qualifier	PTX Qualifier	GWPS (ug/L)
PTX06-1153	20160203ISB002	2-Amino-4,6-Dinitrotoluene	2.33	2.4	10	J		1.2
PTX06-1153	20160203ISB002	4-Amino-2,6-Dinitrotoluene	2.04	3	10	J		1.2
PTX06-1153	20160203ISB002	MNX	3.59	4.6	25	J	J	2
PTX06-1153	20160203ISB002	RDX	292.75	450	40	B	J	2
PTX06-1153	20160203ISB002	TNX	3.48	2.5	25	J F1	J-	2
PTX06-1153	20160203ISB002	Chromium, Total	136.67	150	10			100
PTX06-1153	20160510ISB020	2-Amino-4,6-Dinitrotoluene	2.33	2.09	0.258			1.2
PTX06-1153	20160510ISB020	4-Amino-2,6-Dinitrotoluene	2.04	1.78	0.258			1.2
PTX06-1153	20160510ISB020	MNX	3.59	3.18	0.258			2
PTX06-1153	20160510ISB020	RDX	292.75	278	32.2			2
PTX06-1153	20160510ISB020	TNX	3.48	3.74	0.258			2
PTX06-1153	20160510ISB020	Chromium, Total	136.67	150	10			100
PTX06-1153	20160510ISB020	Chromium, Hexavalent	101	101	10			100
PTX06-1153	20160719ISB039	2-Amino-4,6-Dinitrotoluene	2.33	2.29	0.26			1.2
PTX06-1153	20160719ISB039	4-Amino-2,6-Dinitrotoluene	2.04	1.62	0.26			1.2
PTX06-1153	20160719ISB039	MNX	3.59	2.85	0.26		J	2
PTX06-1153	20160719ISB039	RDX	292.75	180	6.51			2
PTX06-1153	20160719ISB039	TNX	3.48	3.79	0.26		J	2
PTX06-1153	20160719ISB039	Chromium, Total	136.67	110	10	B		100
PTX06-1153	20161102ISB062	2-Amino-4,6-Dinitrotoluene	2.33	2.53	0.256			1.2
PTX06-1153	20161102ISB062	4-Amino-2,6-Dinitrotoluene	2.04	1.74	0.256			1.2
PTX06-1153	20161102ISB062	MNX	3.59	3.72	0.256			2
PTX06-1153	20161102ISB062	RDX	292.75	263	32.1			2
PTX06-1153	20161102ISB062	TNX	3.48	3.89	0.256			2
PTX06-1154	20160203ISB003	Arsenic	84.25	110	5			12
PTX06-1154	20160203ISB003	Barium	18500	21000	5	B		2000
PTX06-1154	20160510ISB022	Arsenic	84.25	100	5	B		12
PTX06-1154	20160510ISB022	Barium	18500	20000	5			2000
PTX06-1154	20160719ISB041	Arsenic	84.25	68	5			12
PTX06-1154	20160719ISB041	Barium	18500	21000	5	B ^		2000
PTX06-1154	20161102ISB064	Arsenic	84.25	59	13			12
PTX06-1154	20161102ISB064	Barium	18500	12000	5			2000
PTX06-1155	20160112ZSB008	Arsenic	64.25	54	5			12
PTX06-1155	20160112ZSB008	*cis*-1,2-Dichloroethene	237.5	320	13		J	70
PTX06-1155	20160112ZSB008	1,4-Dioxane	18.25	23	5		J-	7.7

Well ID	Sample ID	Analyte	2016 Average Value (ug/L)	Measured Value (ug/L)	Detection Limit (ug/L)	Lab Qualifier	PTX Qualifier	GWPS (ug/L)
PTX06-1155	20160427ZSB108	Arsenic	64.25	64	5			12
PTX06-1155	20160427ZSB108	*cis*-1,2-Dichloroethene	237.5	300	10			70
PTX06-1155	20160427ZSB108	1,4-Dioxane	18.25	19	5			7.7
PTX06-1155	20160720ZSB126	Arsenic	64.25	58	5			12
PTX06-1155	20160720ZSB126	*cis*-1,2-Dichloroethene	237.5	200	10		J	70
PTX06-1155	20160720ZSB126	1,4-Dioxane	18.25	19	5		J	7.7
PTX06-1155	20161031ZSB191	Arsenic	64.25	81	5			12
PTX06-1155	20161031ZSB191	Manganese	2500	2500	2			1715.5
PTX06-1155	20161031ZSB191	*cis*-1,2-Dichloroethene	237.5	130	5	F1	J-	70
PTX06-1155	20161031ZSB191	1,4-Dioxane	18.25	12	5			7.7
PTX06-1156	20160111ZSB004	Arsenic	59.5	52	5			12
PTX06-1156	20160111ZSB004	Barium	3433	3100	2	B		2000
PTX06-1156	20160427ZSB109	Arsenic	59.5	85	5			12
PTX06-1156	20160720ZSB127	Arsenic	59.5	45	5			12
PTX06-1156	20160720ZSB127	Barium	3433	3400	2	B ^		2000
PTX06-1156	20161031ZSB192	Arsenic	59.5	56	5			12
PTX06-1156	20161031ZSB192	Barium	3433	3800	2			2000
PTX07-1P02	20160607M00123	RDX	4.58	5.12	0.255			2
PTX07-1P02	20160607M00123	TNX	2.19	2.19	0.255		J-	2
PTX07-1P02	20161102M00323	RDX	4.58	4.03	0.259			2

Note: A description of all qualifiers can be found in Appendix D ("Information" tab in the 2016 electronic data file).

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4.0 Soil Remedial Action Effectiveness

Three soil remedial actions were implemented to prevent cross-contamination of soils to groundwater. Those actions include 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 small-scale Burning Ground SVE system operated intermittently during 2016. The small catalytic oxidizer (CatOx)/wet scrubber system installed in 2012 continues to focus on treating residual soil contamination and soil gas at a single soil gas well (SVE-S-20), where soil gas concentrations continue to remain relatively high. The system was down for power outages, freezing temperatures, and maintenance or repairs. The system removed approximately 586 lbs of VOCs during 2016.

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 quarterly influent samples that are sent to a laboratory for analysis. The analytical samples are used to estimate the mass removal for the SVE system. In 2016, four samples were collected for laboratory analysis.

Table 4-1 presents a summary of detected 2016 data and the average concentrations from 2007-2008. The 2016 data were collected at the influent port of the current SVE system. Samples were collected in March, June, September, and November.

The 2016 measured values are typically lower than the 2007-2008 data collected at the system, and similar to 2015 values. Maximum and average values are lower than the baseline concentrations, with the majority of the COC maximum concentrations still within the same order of magnitude. This change in concentration will continue to be analyzed to determine if a long-term trend emerges. Methylene chloride was detected in all four samples in 2016 and has been present since 2010 although it was not detected in baseline data. This COC had been detected prior to 2007 at low concentrations at the large-scale system or in individual soil gas wells. Other COCs may be detected at low levels in the future because detection limits are expected to decrease as the major COC concentrations decrease and dilutions by the laboratory lessen.

Table 4-1. Burning Ground SVE Data Summary

Analyte	2016 Measured Value			2007-2008 Measured Value		
	Ave	Max	Min	Ave	Max	Min
Acetone	31,500	34,000	27,000	82,666	140,000	38,000
Toluene	192,500	260,000	130,000	477,307	990,000	45,000
Methylene chloride	1,790	3,400	660	ND	ND	ND
PCA	3,450	4,500	2,300	3,356	6,300	760
TCE	7,225	8,400	5,400	26,714	41,000	13,000
Tetrahydrofuran (THF)	8,000	10,000	6,600	20,107	26,000	9,500

Measured concentrations in parts per billion by volume (ppbv).
Indicates values greater than the baseline 2007-2008 concentration.

To verify whether concentrations of VOCs are decreasing, a nonparametric trend test, i.e., Mann-Kendall 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 since 2012 and recent data, i.e., last 4 measurements, collected at the influent port to the system. Since the analytical results can be affected by multiple factors, e.g., extraction equipment, sample port location, system conditions, etc., no effort was made to statistically trend the new results with analytical data associated with the old systems. Generally, the concentrations appear to be lower than those collected in the previous large-scale CatOX or GAC system, but it is unknown whether these lower concentrations reflect a true source reduction or are caused by one of the system conditions enumerated above.

Table 4-2 provides a summary of the statistical trending. The results indicate that, for the four main COCs, i.e., acetone, toluene, TCE, and tetrahydrofuran [THF], all four exhibit decreasing trends considering all data collected since 2012. The trends of the recent (last four) concentration measurements for the four main COCs are either decreasing or stable. Trends of other low-level detections of COCs indicate decreasing trends for all data collected since 2012, except for tetrachloroethane, which indicates no trend.

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

COC	Trend-All Data	Recent Trend
Toluene	Decreasing	Stable
TCE	Decreasing	Decreasing
Tetrahydrofuran (THF)	Decreasing	Decreasing
Acetone	Decreasing	Decreasing

The average monthly PID measurements collected at the system influent, summarized in Figure 4-1, are showing some variability, but linear regression results for the dataset, represented by the trend line on the graph, indicate an increasing trend. This increase is likely due to a shutdown period in mid-2015 with concentrations spiking at start up and decreasing over time. Average influent concentrations in 2016 exhibited less variability than in 2015 and ranged from about 330 ppm to about 600 ppm over the year. Continued decreases in PID readings are expected as operations continue.

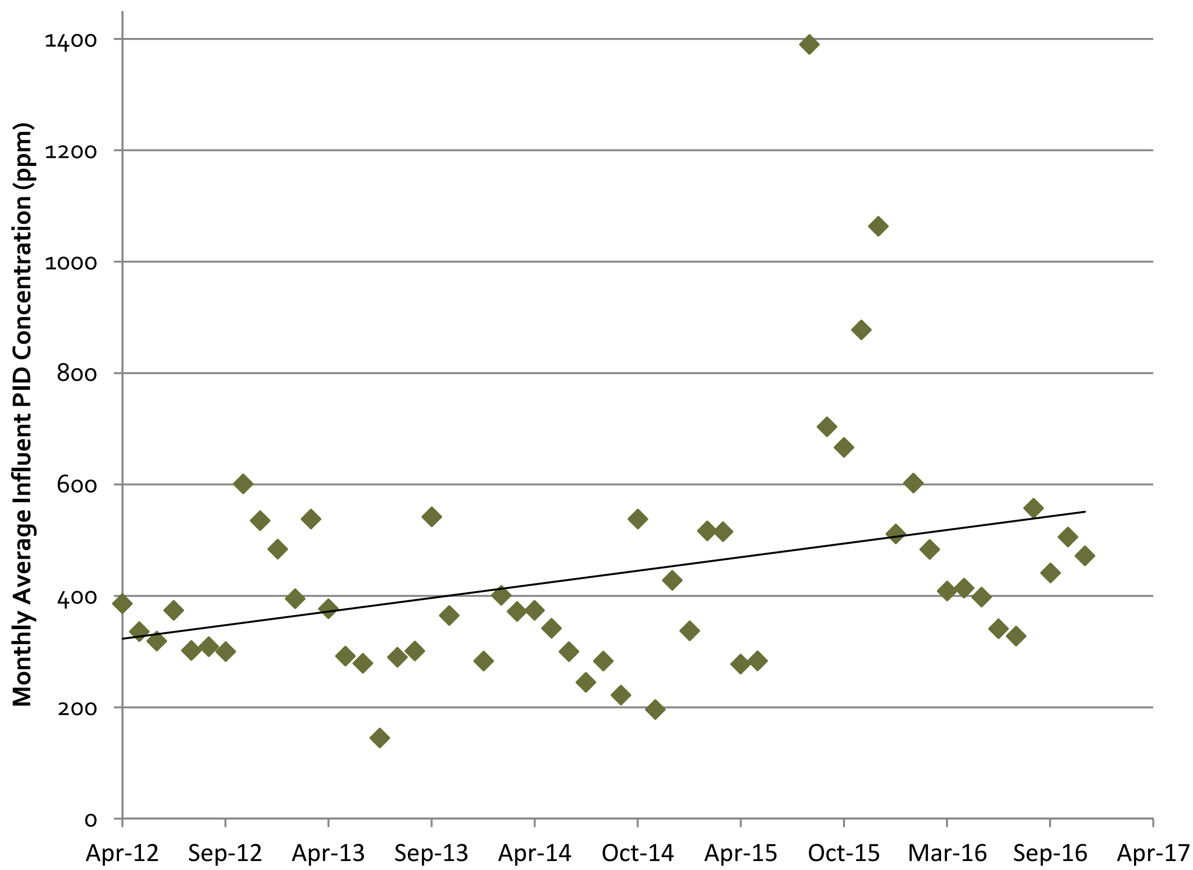

Figure 4-1. Influent Average PID VOC Concentrations vs. Time

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 path toward closure were defined for the SVE system, other than “significant reduction in soil gas VOCs.”

Therefore, in the First FYR, Pantex recommended the development of a Burning Ground SVE Performance Monitoring Plan to define expected conditions of the system performance as well as a clear path toward an end point of active SVE operations. In anticipation of this plan, four rebound tests were attempted in 2014 and 2015 with the expectation of establishing baseline conditions to 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 four attempts at rebound testing over two years it does not appear the SVE performance-based approach will be technically practicable in attaining closure at the solvent evaporation pit/chemical burn pit area of the Burning Ground.

Pantex has evaluated other paths to an end point of active remediation for this system. After evaluation of the influent concentrations and system performance, Pantex has recommended an approach to enhance bioremediation and volatilization and to eventually move to a passive remediation approach. Pantex recommended (Pantex 4th Quarter 2016 Progress Report) that up to seven inactive SVE extraction wells surrounding the active extraction well SVE-S-20 be modified with goose-neck pipes extending above ground with a screen and shut-off valves so that while the system is operating, air flow through the formation can be enhanced by opening the pipes to ambient air. This enhancement will help stimulate naturally occurring aerobic bacteria that will degrade the NAPL source in addition to increasing volatilization. The system flow will be slowly increased to its maximum design capacity to enhance air flow. Pantex will continue to monitor the system for mass reduction in the influent vapor stream and for evidence of bioremediation. Once influent data indicate that COCs are reduced to levels that are no longer practicable for active remediation, Pantex will recommend moving to a passive remediation system.

Pantex will provide further recommendations based on review of influent SVE data over time. The SVE system continues to treat soil gas and residual NAPL in the solvent evaporation pit/chemical burn pit area. This treatment regime mitigates vertical movement of VOCs to groundwater.

4.2 Uncertainty Management

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

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

Pantex analyzes for indicator constituents at all wells according to the SAP. This list of constituents helps determine possible impact at 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.

No Group 1 perched aquifer wells had unexpected conditions in 2016. As discussed in Section 3.4.2, twelve Group 2 perched aquifer wells exhibited increasing long-term trends in COC concentration while the expected condition was decreasing or stable trends below the GWPS. However, only two of these wells, 1114-MW4 and PTX06-1007, exhibit trends that might indicate a new release related to a soil source. Apparent increasing trends for perchlorate were identified for both wells. Historical perchlorate concentrations at 1114-MW4 were much higher than recent levels, and the long-term trend for this well is decreasing. Therefore, the observed perchlorate in this well does not indicate a new release to perched groundwater. Perchlorate concentrations at PTX06-1007 increased from 2010 through 2014, but decreased substantially in 2015 and 2016. This well is not located near the historical source area in Zone 11, so the observed trend is associated with plume movement and does not indicate a new release. These wells will continue to be monitored and evaluated over time to determine if the concentrations decline as expected.

Four Ogallala aquifer uncertainty management wells had unexpected conditions in 2016. Unexpected conditions in three of these wells were estimated RDX detections. As discussed in Section 3.4.1.2, these detections are suspected to result from laboratory contamination or sampling equipment cross-contamination. All three wells were resampled to confirm the original results, and the resampling results were non-detect for RDX for all three wells. Detections of 4-amino-2,6-DNT and 1,2-dichloroethane occurred in samples collected from PTX06-1056 in 2015. In response to these detections, Pantex has fully implemented the conditions specified in the *Pantex Plant Ogallala Aquifer and Perched Groundwater Contingency Plan* (Pantex, 2009d) and will continue quarterly sampling for HEs and VOCs at this well. As discussed in Section 3.4.1.2, Pantex has proactively evaluated potential sources for the contamination. These detections are not likely related to a release from a soil source area.

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5.0 Conclusions and Recommendations

5.1 Conclusions from the 2016 Annual Report

Overall, the groundwater remedial actions have been effective in 2016. The remedial actions continue to operate and meet short-term expectations for cleanup of the perched groundwater in areas under the influence of the remediation systems. Perched water levels are declining, COC mass is being removed or reduced, and institutional controls provide protection for use of impacted groundwater, while the remedial actions continue to operate to meet long-term goals. The influence of both pump and treat systems will continue to expand as the saturated thickness is reduced in the perched aquifer.

One Ogallala Aquifer well had continued COC detections slightly above the laboratory PQL, but below the GWPS, indicating possible migration of perched groundwater to the Ogallala Aquifer. Detections of 4-amino-2,6-DNT and 1,2-dichloroethane below the GWPS occurred in samples collected from PTX06-1056 in 2016. In response to these detections, Pantex has fully implemented the conditions specified in the *Pantex Plant Ogallala Aquifer and Perched Groundwater Contingency Plan* (Pantex, 2009d) and will continue quarterly sampling for HEs and VOCs at this well. Pantex has proactively evaluated potential sources for the contamination. 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 contamination 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 contamination to reach the Ogallala Aquifer.

Low-level detections of hexavalent chromium occurred in several Ogallala Aquifer wells, but these detections are attributed to a combination of lower detection limits and either screen corrosion or background levels rather than breakthrough of perched groundwater.

A new perched groundwater well installed outside the previously defined extent of the southeast lobe of the perched aquifer indicates that water and contamination have migrated further to the southeast. PTX06-1182 was installed in 2016 with sampling conducted in early October. Results indicate the presence of the HEs 4-amino-2,6-DNT and RDX at concentrations exceeding the PQL and GWPS (results of 6.73 and 15 ug/L and GWPS of 1.2 and 2 ug/L, respectively). A confirmation sample confirmed the presence of 4-amino-2,6-DNT and RDX at similar concentrations. Pantex plans to install new downgradient wells in 2017 to determine perched groundwater and contaminant extent.

The pump and treat systems throughput performance consistently achieved close to 90% throughout the year when unaffected by maintenance, power loss, reduced flow to the WWTF, and system upgrades. A new extraction well, PTX06-EW-81A, was drilled in 2015 and brought online in October 2016 to improve P1PTS performance when one or more wells are down for maintenance. In portions of August, September, and December 2016, the WWTF completely, rather than partially, restricted flow, so the operational goals could not be met during that time period. All treated water was beneficially used in 2016, thereby meeting the goal to reduce saturated thickness of the perched aquifer.

Downgradient Zone 11 ISPM wells are exhibiting effects from the treatment zone. TOC and total VFAs have been detected, nitrate and sulfate concentrations have declined, and ORP is negative in all three original downgradient wells suggesting the arrival of affected water. Treatment is also evident in those three wells, with perchlorate not detected and TCE greatly reduced. *Cis*-1,2-dichloroethene continues to be detected at concentrations above the GWPS with little or no detections of vinyl chloride, which continues to indicate that complete treatment of TCE is limited. Three additional wells located further away from the treatment zone were converted to ISB performance monitoring wells in 2014 and one of the three is exhibiting treatment zone effects with perchlorate not detected. Perchlorate is declining in the other two wells.

To address the incomplete treatment of TCE, bioaugmentation for the current treatment zone was completed during the 2015 injection event; bioaugmentation for the expanded treatment zone will not occur until the weight of evidence suggests the proper reducing conditions exist for DHC survival and growth. Pantex is monitoring the impact of the bioaugmentation through the use of qPCR and CSIA sampling which began in February 2016. The qPCR and CSIA data, combined with other monitoring data from the Zone 11 ISB area, indicate that complete dechlorination is limited at this time due to low counts of DHC and mild reducing conditions in many areas of the Zone 11 ISB where bioaugmentation has occurred. Additional sampling for CSIA and census DNA for DHC and 1,4-dioxane will be conducted at the Zone 11 ISB during 2017. These analyses will be used to determine the effectiveness of bioaugmentation and to evaluate other potential processes that may be helping break down TCE and 1,4-dioxane through cometabolic processes.

The Southeast ISB system has been effective in treating HEs and hexavalent chromium at three downgradient ISPM wells (PTX06-1037, 1123, and 1154). RDX concentrations in all three of these wells are below the GWPS of 2 ug/L. Hexavalent chromium is either non-detect or detected at levels below the GWPS in these wells. Data collected from the westernmost ISPM well PTX06-1153 continue to indicate HE and chromium concentrations exceeding GWPS. Pantex continues efforts to determine flow patterns on the west end of the ISB.

Some of the injection and performance monitoring wells are indicating variable water conditions at the Southeast ISB. Two Southeast ISB performance monitoring wells (one upgradient, one farther downgradient) remain dry and cannot be sampled while another downgradient performance monitoring well has not been sampled since August 2015 because of low water conditions. Injection was completed at only 50 percent of the injection wells during the 2016 injection event because of dry or low water (<1 ft) conditions in the wells. The inability to sample or inject into these wells is expected to continue while upgradient pump and treat operations continue to decrease the saturated thickness across the area.

Passive flux meters were deployed in fall 2016 to assess the impact of dewatering within and around the Southeast ISB on groundwater flow and to support long-term decisions regarding Southeast ISB injection. A primary objective of the PFM testing was to evaluate the hypothesis that contaminant concentrations have persisted in PTX06-1153 because groundwater in the vicinity of this well is stagnant. Results of the PFM testing show that measureable groundwater flux was observed in PTX06-1153, although flow to the well is limited. This result indicates that PTX06-1153 is not located in a stagnant groundwater zone. Given the location of PTX06-1153, apparent groundwater flux through the well may indicate a groundwater-flow pathway around the western end of the Southeast ISB. Pantex is installing a new well west of the ISB in 2017 to evaluate the potential for water movement around the western end of the ISB. Pantex will continue to evaluate data collected and develop a path forward for this area as needed.

Soil remedies have been effective at Pantex because 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 are operating as designed and the 2016 rainfall continued to improve vegetative cover on the landfills. Further work is required in a few areas to fully revegetate the covers and will be conducted through the new long-term maintenance contract. Pantex will also address, through contracting, erosion at Landfill 3 caused by heavy rainfall. The ditch liner is maintained and prevents the infiltration of water that would cause migration of HEs in soils to the perched aquifer. Because of the age of the liner and noted degradation in a few areas, Pantex contracted to replace the liner in 2017 with installation completed in March. The new liner will be more resistant to UV light and is heavier to provide a longer life cycle for the liner. 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 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 the active remedies to determine if additional actions are needed to provide permanent long-term protection.

In order to address the identified issue of HE plumes expanding east of FM 2373 and in the southeast lobe of the perched aquifer, Pantex completed a hydrologic evaluation of these areas in 2012. This evaluation is to be updated annually as part of the annual progress reporting process. The 2016 update included the addition of groundwater data collected during 2016. Key findings from the new dataset include:

- Groundwater elevations are suggesting continuing effects of pump and treat operations, resulting in reduced mass flux to the southeast.
- Data suggest continued plume movement from the eastern edge of the perched aquifer extent moving southward. Preliminary aquifer testing data suggest this area is conducive to groundwater extraction, which would reduce the flux of COCs to the south. A total of seven new extraction wells have been installed east of FM 2373 in a line running east-to-west. Data collected from these wells indicates this is an area of greater saturated thickness than found to the north or south.

Based on the information from the aquifer testing and the understanding that water extraction would limit the perched contaminant migration to the southeast lobe and potential downward migration to the Ogallala, Pantex is actively working to tie-in the new extraction wells to the SEPTS to limit further migration of impacted perched water southward along the eastern margin of the perched aquifer.

Pantex has contracted with leading researchers for further study to apply the CSIA and other new analytical techniques to determine where and what type of natural attenuation is occurring across the RDX plume at the Pantex Plant. Groundwater samples for this study have been collected, and the study is expected to be completed by the end of 2017. If data support quantification of attenuation rates, rates will be calculated to support the evaluation of natural attenuation in areas not under the influence of a remedial action.

5.2 Conclusions from the First Five-Year Review

The first Five-Year Review Report for the Pantex Remedial Action was submitted in December 2012 and final approval was received in August 2013. While the recommended changes outlined in the 2012 Annual Report did not change, this section will remain in the Annual Progress Reports in order to track the recommendations and subsequent actions taken to address them.

The conclusions of the Five-Year Review indicate that the overall soil and groundwater remedies are performing as designed and expected. The institutional controls and soil remedies are actively preventing contact with contaminated soil and groundwater while active remedies decrease concentrations of contaminants in soil and groundwater to provide long-term protection of human health and the environment. The groundwater pump and treat systems continue to decrease perched aquifer saturated thickness to reduce the driving force (head) that may cause migration of impacted water to the Ogallala Aquifer.

Some issues were noted that require Pantex to gather additional information to assess the active remedies and the areas that are outside the influence of the remedies and to develop and implement plans to correct noted issues. Deficiencies were also noted in the active remedies so Pantex recommended further actions to optimize remedies or monitoring to ensure continued protection of human health and the environment. The majority of the identified issues and recommendations for optimization have been resolved or the work is ongoing. The status of the remaining issues and recommendation follows:

- Recommendation: If more than one extraction well is not operational for an extended period of time at P1PTS, the system cannot meet throughput goals. Pantex recommended installing 1-2 new extraction wells to increase throughput when more than one well is down.
    - To close out this recommendation, Pantex previously installed PTX06-EW-081A in 2016; the well became operational in October 2016.
- Recommendation: There are no criteria established for ceasing SVE system operations. Pantex recommended completion of an SVE Performance Monitoring Plan.
    - Pantex has conducted multiple rebound tests of the system for use in establishing a path to closure. The rebound tests have been unsuccessful, and based on the continued issues encountered with the rebound tests, Pantex has evaluated other paths to closure or a move to passive remediation for this system.
    - Pantex contracted for outside review of the system in 2016 to assist with determining a path to closure for the system. After evaluation of the influent concentrations and system performance, Pantex has recommended an approach to enhance bioremediation and move to a passive remediation approach. Pantex recommended (Pantex 4th Quarter 2016 Progress Report) that up to seven inactive SVE extraction wells be modified to enhance air flow through the formation by opening the pipes to ambient air. This change will enhance removal of the NAPL source through increased volatilization and bioremediation. The system flow will be slowly increased to its maximum design

capacity to enhance air flow. Pantex will continue to monitor the system for mass reduction in the influent vapor stream and for evidence of bioremediation. Once influent data indicate that COCs are reduced to levels that are no longer practicable for active remediation, Pantex will recommend moving to a passive remediation system.

- Issue: Reduced vegetative cover on specific landfills that were affected by drought. The lack of cover could cause erosion of the covers. Pantex has addressed this by reseeding the landfills that were affected. However, continued drought conditions after the seeding limited growth. Rainfall increased in 2016 and the areas have greatly improved. A few areas will require a second seeding to address bare spots. To close out this action Pantex has completed the following:
    - Contract for long-term maintenance of the landfills. Issues will be identified during the yearly inspections and work will be planned for maintenance each year. Contracting was completed and maintenance activities were started in 2016.
- Issue: Plumes of high explosives (primarily RDX) are expanding east of FM 2373 and in the southeast lobe of the perched aquifer.
    - A new perched groundwater well installed outside the previously defined extent of the southeast lobe of the perched aquifer indicates that water and contamination have migrated further to the southeast. Results indicate the presence of the HEs 4-amino-2,6-DNT and RDX at concentrations exceeding the PQL and GWPS. Pantex plans to install new downgradient wells in 2017 to determine perched groundwater and contaminant extent.
    - Pantex evaluated three wells east of FM 2373 to determine if extending pump and treat to that area is viable. The pump tests indicate that this will be viable and will mitigate the continued southward migration of contaminated water into the southeast lobe. Pantex is actively working to extend SEPTS extraction east of FM 2373 to limit further migration of impacted perched water southward along the eastern margin of the perched aquifer.
    - Pantex has contracted with leading researchers for further study at the Pantex Plant to apply CSIA and other new analytical techniques to determine where and what type of natural attenuation is occurring across the RDX plume. Groundwater samples for this study have been collected, and the study is expected to be completed by the end of 2017. The research will determine where, what type, and the rate of degradation of RDX (if data support the calculation of a rate). This data will be used to evaluate areas where the effects of active remedies are not apparent.

- Issue: Incomplete treatment of contaminants (HEs and hexavalent chromium) downgradient of the west end of the Southeast ISB (at PTX06-1153).
    - Pantex injected amendment into two dry injection wells to attempt to influence PTX06-1153. The wells have received two injections, in 2013 and 2015. The injections do not appear to have influenced PTX06-1153.
    - Passive flux meters were deployed in fall 2016. A primary objective of the PFM testing was to evaluate the hypothesis that contaminant concentrations have persisted in PTX06-1153 because groundwater in the vicinity of this well is stagnant. Results of the PFM testing show that measureable groundwater flux was observed in PTX06-1153, and PTX06-1153 is not located in a stagnant groundwater zone. The reduced seepage velocity calculated for PTX06-1153 does suggest that flow to the well may be inhibited. Given the location of PTX06-1153, apparent groundwater flux through the well may indicate a groundwater-flow pathway around the western end of the Southeast ISB. Pantex plans to install a new well west of the ISB in 2017 to evaluate the potential for movement of water around the western end of the ISB. Pantex will continue to evaluate data collected and develop a path forward for this area as needed.

5.3 Recommendations

Pantex plans to continue the current approved remedial actions. The groundwater remedies are considered protective for the short-term as untreated perched groundwater use is controlled to prevent human contact and Ogallala Aquifer data continues to indicate COC concentrations either non-detect or below GWPS. The systems are proving to be effective in reaching long-term established objectives for cleanup. Soil remedies have been effective at Pantex as 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 vertical movement of VOCs to the Ogallala Aquifer.

Based on issues identified in the Five-Year Review and during completion of this report, several changes are recommended or have been implemented to enhance the effectiveness of the remedies in some areas and to better monitor the effectiveness of the actions. Those recommendations are provided in the following sections.

5.3.1 Recommended Changes to the Pump and Treat Systems

There are no new recommendations for changes to the pump and treat systems based on review of 2016 data.

5.3.2 Recommended Changes to the ISB Systems

5.3.2.1 Southeast ISB

As discussed in Section 2.2.2.4, Pantex plans to reinject the Southeast ISB in three years (2019). Organic carbon data collected before the latest injection indicated that additional amendment was not necessary to sustain treatment while data from the Pilot Study also indicate that a longer period between injections is achievable once reducing conditions are adequately established. The Design Basis indicates that less frequent injections would be appropriate in later years. The timing or need for further injections will be evaluated after the next injection because predicted water levels in six years, based on current trends, indicate that very few ISB injection wells will have significant saturated thickness.

Because no clear cause for the unexpected conditions in PTX06-1153 has been identified, it is recommended to continue monitoring the water level and analytical data collected in and around the Southeast ISB to continue to attempt to discern groundwater flow patterns. Results of the PFM testing show that measureable groundwater flux was observed in PTX06-1153, and PTX06-1153 is not located in a stagnant groundwater zone. The reduced seepage velocity calculated for PTX06-1153 does suggest that flow to the well may be inhibited. Given the location of PTX06-1153, apparent groundwater flux through the well may indicate a groundwater-flow pathway around the western end of the Southeast ISB. Pantex will install a new well west of the Southeast ISB in 2017 and will continue to evaluate data collected and develop a path forward for this area as needed.

5.3.2.2 Zone 11 ISB

As discussed in Section 2.2.1.4, Pantex will change injection frequency to two years within the original portion of the system. The Design Basis Document and the RD/RA Work Plan recognize that the period between injections may be lengthened once the system is fully developed. Pantex will continue to inject annually in the expanded portion of the system and will evaluate the expanded portion of the system to determine the appropriate time to change to a two-year frequency.

5.3.3 Recommended Changes to the Monitoring Network

PTX06-1182 was installed in 2016 in an area that was previously thought to be beyond the extent of perched saturation; the presence of RDX above the GWPS has been confirmed with the most recent sample showing a concentration of 19 ug/L. This well will continue to be monitored and will provide valuable information on the movement of contaminants in this area of the perched groundwater. Pantex plans to install additional wells downgradient in 2017 to determine perched groundwater and contaminant extent in this area.

5.3.4 Recommended Changes to Soil Remedies

Vegetative loss on landfill covers was identified as an issue in the first Five-Year Review Report, primarily caused by drought conditions in the Texas Panhandle. Therefore, Pantex proposed to develop and implement a phased plan to revegetate the landfill covers as outlined in Section 2.3.2. Pantex completed reseeding in 2013 and evaluated the effectiveness of reseeded landfill covers annually through 2016. Based on the 2016 evaluations, the rainfall that occurred in 2015 and 2016 significantly improved vegetative cover at all landfills. Pantex will continue to evaluate the landfills annually and report the findings of the review and any plans that are developed to address holes, depressions, or bare areas. Problems identified will be addressed annually through the landfill maintenance contract and larger issues, such as erosion, will be addressed through separate contracts.

The small-scale SVE system continues to remove VOCs from SVE-S-20 and the VOC source area may be slowly decreasing. As discussed in the Five-Year Review and 2012 Annual Progress Report, no expected conditions or path toward closure were defined for the SVE system, other than "significant reduction in soil gas VOCs". Therefore, Pantex recommended the development of a Burning Ground SVE Performance Monitoring Plan, which will define expected conditions of the system performance as well as a clear path towards an end point of active SVE operations and potential transition to a passive system. To this end, three rebound tests were conducted in 2014 resulting in conflicting or unusable data. Using lessons learned from the 2014 testing, another rebound test was conducted in 2016 but was also unsuccessful, indicating that this approach will not be successful at Pantex. Therefore, Pantex has recommended an approach to enhance bioremediation and move toward passive remediation. Pantex recommended (Pantex 4th Quarter 2016 Progress Report) that up to seven inactive SVE extraction wells be modified to enhance air flow through the formation by opening the pipes to ambient air. This change will enhance removal of the NAPL source through increased volatilization and bioremediation. The system flow will be slowly increased to its maximum design capacity to enhance air flow. Pantex will continue to monitor the system for mass reduction in the influent vapor stream and for evidence of bioremediation. Once influent data indicate that COCs are reduced to levels that are no longer practicable for active remediation, Pantex will recommend moving to a passive remediation system.

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