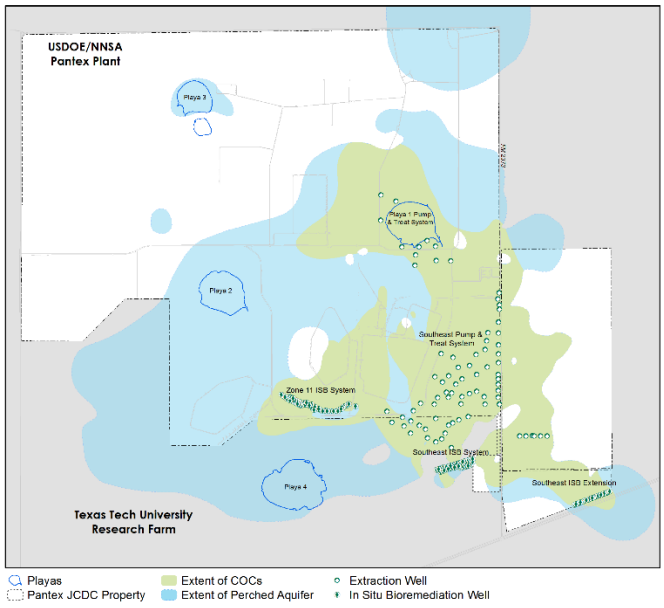
PANTEX ENVIRONMENTAL RESTORATION

In Situ Groundwater Bioremediation Systems

The Pantex Groundwater Resource Conservation and Recovery Act Facility Investigation Report identified impacts to perched groundwater that require corrective action. The Pantex Site Wide Human Health Risk Assessment found that perched groundwater underneath the Pantex Plant contains high explosives and other constituents that could migrate over time to the Ogallala Aquifer, the main drinking water source for the area. A Record of Decision (ROD) was issued in 2008 with concurrence of the Environmental Protection Agency (EPA) and Texas Commission on Environmental Quality (TCEQ) to address cleanup of the legacy contamination at the Pantex Plant. The Selected Remedy for perched groundwater is a combination of extraction and treatment in areas with greater than 15 feet of saturation and in situ treatment in the thinner areas.

The area of primary concern for in situ treatment is in the area southeast of the main Plant on the adjacent Texas Tech University property. The fine-grained zone prevents vertical migration in most areas, but becomes thinner and more permeable in the southeast, so migration to the Ogallala Aquifer is more probable there. The area to the southeast also has thin saturated thickness so pump and treat technology is not a viable option in portions of that area. Another area identified for cleanup is located south of Zone 11 on Pantex property and is a concern for migration offsite to the Texas Tech University property. Another area to the southeast was identified after the first Five-Year Review where it was noted that the area was not under control of the pump and treat system and the high explosive plume was continuing to migrate to the southeast.

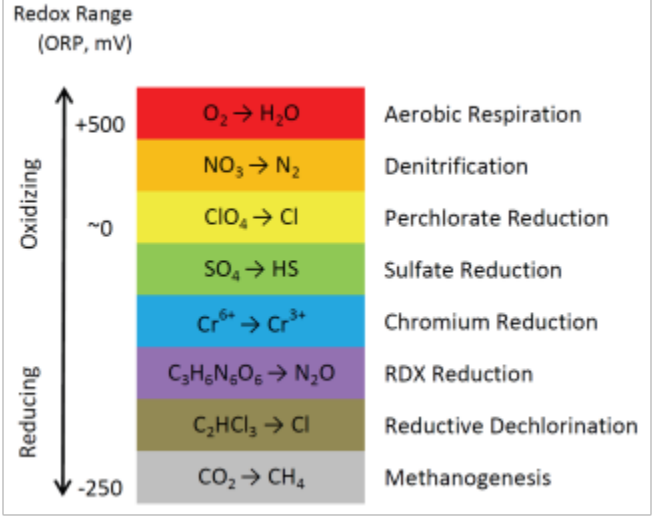
To address the areas of concern, Pantex operates three in situ bioremediation (ISB) systems consisting of 115 active injection wells and 17 downgradient wells to monitor the effectiveness of the treatment zone. The Southeast ISB was installed in the southeast area of the plume on Texas Tech property where the fine-grained zone is more permeable. The Southeast ISB Extension was installed at the southeast property boundary east of FM 2373 to prevent further offsite movement of the perched groundwater plumes. The Zone 11 ISB was installed to intercept contaminants moving towards Texas Tech University property to the south and to address multiple contaminants that are treatable with ISB technology.



Plume Boundary and Groundwater Remedies

October 2018

The objective of the ISB systems is to establish an anaerobic biodegradation treatment zone capable of reducing contaminants to levels that are safe for residential use. This is accomplished by injecting the necessary amendments or nutrients into the treatment zone wells to stimulate resident bacteria. As the naturally occurring bacteria feed and multiply, oxygen is removed from the injected area and deep reducing conditions are established for treatment of the contaminants. The ISB must achieve reducing conditions for perchlorate, chromium, RDX, and reductive dechlorination (TCE). The figure below shows the reducing conditions required to breakdown various contaminants.



Pantex monitors the treatment zone to evaluate the health of the bacteria so injection frequencies and volume of food source can be adjusted. Downgradient wells are also monitored to evaluate the effectiveness of treatment. As long as optimal subsurface reducing conditions and a food source is available, a diverse bacterial community can be sustained which leads to in situ treatment of contaminants.

The Southeast ISB system was installed in 2007 on the Texas Tech University property, as an early action. 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 fine-grained zone layer becomes thinner and more permeable.

Amendment Tanks and Control Buildings at the ISBs

Based on the rate of perched groundwater flow and estimated amendment longevity, injections are necessary about every 18-36 months. Injection frequencies/volumes are expected to change over time at this system as the Pump and Treat Systems continue to operate and remove water that could move south through the Southeast ISB.

The Southeast ISB Extension was installed in 2017 after discovery of the high explosive plume expansion beyond the property boundary. The system was designed to prevent further movement of the groundwater plume offsite in areas that are not captured by the pump and treat system and water is too thin to pump. Based on the rate of perched groundwater flow and estimated amendment longevity, injections are necessary every 12-24 months.

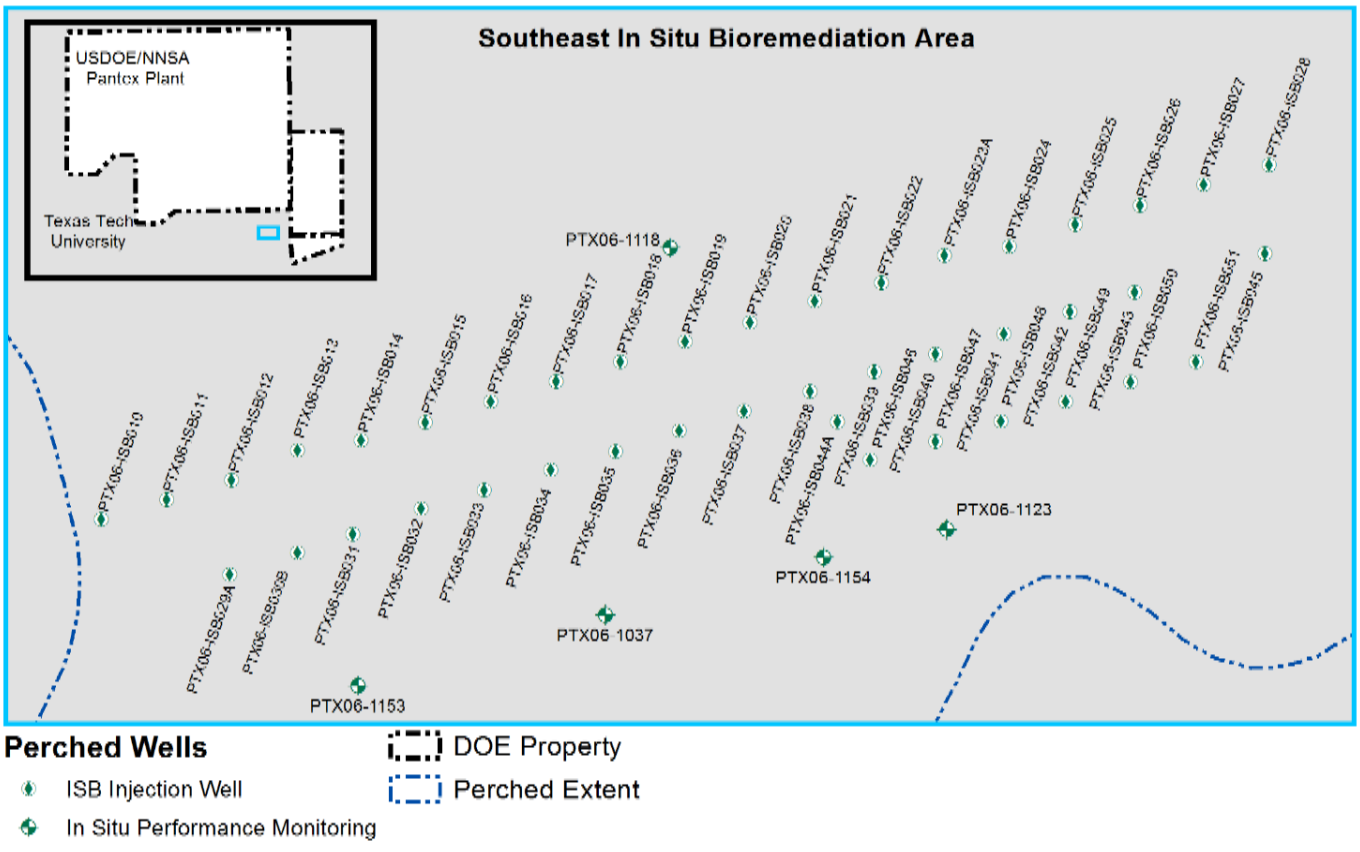
The Zone 11 ISB system was installed in 2009 as part of the final Remedy with an expansion occurring after initial treatment and again in 2014. The injection wells were drilled in a line perpendicular to the hydraulic gradient so water flowing through this zone will be treated before it reaches the area south on Texas Tech property near Playa 4. Based on the rate of perched groundwater flow and estimated amendment longevity, injections are necessary every 12-24 months.

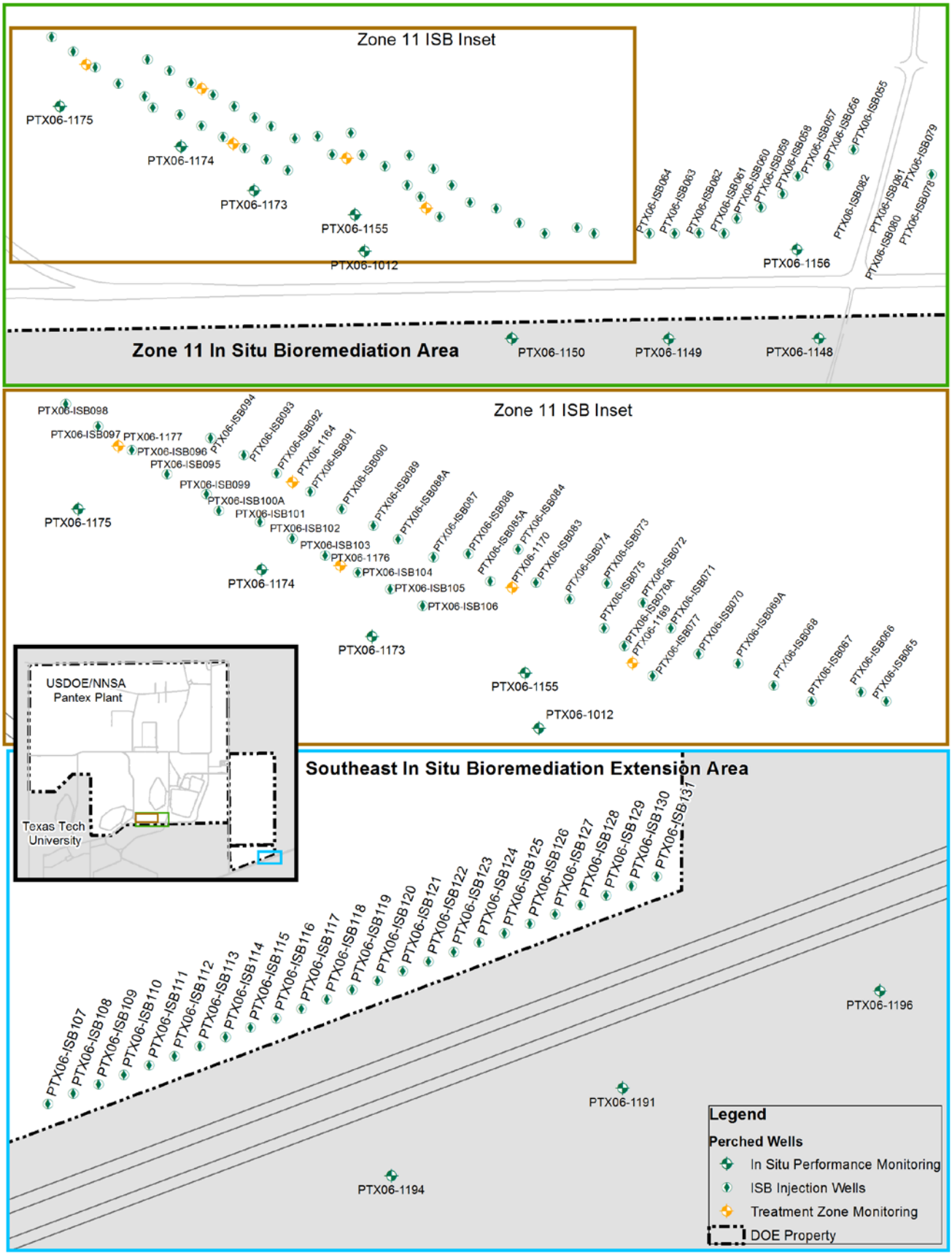
The Southeast ISB primarily treats the high explosive RDX and hexavalent chromium. This system has successfully treated high explosives and hexavalent chromium below safe levels at most downgradient wells. One downgradient well on the southwest end of the system does not demonstrate treatment. Pantex is investigating whether this well is hydraulically connected to the system or if treatment has not been effective in a portion of the system. Treatment options will be evaluated with time as wells are drilled and more information becomes available.

The Southeast ISB Extension primarily treats the high explosive RDX and 4-amino-2,6-dinitrotoluene (a breakdown of the high explosive TNT). The first injection into this system is planned to start in November 2018 and treatment effects are not expected to be observed at downgradient wells for 4-8 years. Treatment effects inside the ISB are typically observed within 6 months after injection.

The Zone 11 ISB primarily treats the organic solvent trichloroethene (TCE) and perchlorate. This system has successfully treated perchlorate to safe levels and TCE has been greatly reduced and is meeting safe levels through most of the ISB. Other areas are expected to meet safe levels in a short time. While TCE levels are declining, the breakdown product of TCE are showing signs of incomplete treatment. Because of this incomplete treatment, bioaugmentation with a necessary bacteria, *Dehalococcoides*, was implemented in 2015. Additionally, the amendment strategy was changed in 2018 to include a higher dosage of a more soluble carbon source to provide better distribution of the amendment throughout the zone. It is expected that the bacteria and change in amendment distribution will completely treat TCE and its breakdown products to safe drinking levels.

It is expected to take several years of treatment to allow the contaminant plumes to move through the treatment zones. Pantex will continue to operate this action and provide results in progress reports that can be found at pantex.energy.gov. This action is one of several positive steps Pantex is taking to protect the public and Ogallala Aquifer.




Zone 11 ISB Inset
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PTX06-1174
PTX06-1173
PTX06-1155
PTX06-1012
PTX06-1156
PTX06-ISB064
PTX06-ISB063
PTX06-ISB062
PTX06-ISB061
PTX06-ISB060
PTX06-ISB059
PTX06-ISB058
PTX06-ISB057
PTX06-ISB056
PTX06-ISB055
PTX06-ISB082
PTX06-ISB081
PTX06-ISB080
PTX06-ISB079
PTX06-ISB078
Zone 11 In Situ Bioremediation Area
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PTX06-1149
PTX06-1148
Zone 11 ISB Inset
PTX06-ISB098
PTX06-ISB097
PTX06-1177
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PTX06-ISB095
PTX06-ISB099
PTX06-ISB100A
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PTX06-1012
USDOE/NNSA
Pantex Plant
Texas Tech
University
Southeast In Situ Bioremediation Extension Area
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PTX06-ISB108
PTX06-ISB109
PTX06-ISB110
PTX06-ISB111
PTX06-ISB112
PTX06-ISB113
PTX06-ISB114
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PTX06-1196
PTX06-1191
PTX06-1194
Legend
Perched Wells
In Situ Performance Monitoring
ISB Injection Wells
Treatment Zone Monitoring
DOE Property