

IN SITU REMEDIATION PROJECTS

INTRODUCTION TO SERVICES

In situ remediation is a specialty technology, whereby selected chemicals are injected into a targeted subsurface zone to treat a variety of dissolved-phase groundwater contaminants, impacted soils, phase-separated hydrocarbons (PSH), and residual levels of dense non-aqueous phase liquids (DNAPL). The injection treatments are designed to chemically destroy organic-based contaminants or to stabilize and permanently immobilize non-organic contaminants.

When properly applied, in situ remediation can be a highly successful tool to remove and eliminate subsurface contaminants. In situ remediation can be utilized at sites with limited physical access or aggressive completion schedules, thereby eliminating some of the obstacles of traditional remediation. Green Star has closed several remediation projects that would not have gained regulatory closure without the options in situ remediation provided. One of the benefits of in situ remediation technology is that it can be used to treat residual PSH and DNAPL, which may be a continuing source of groundwater contaminants or an obstacle to regulatory closure. Below is a brief list of successfully completed in situ remediation projects.

IN SITU CHEMICAL OXIDATION PROJECTS SUCCESSFULLY COMPLETED

FORMER MAINTENANCE GARAGE, PORTLAND, OR

BRIEF DESCRIPTION OF PROJECT:

Following 18 years of assessment and remediation by previous consultants, Green Star was retained to evaluate site remediation options to expedite closure in a timely manner. The source of the subsurface impacts was two former UST pits. Green Star recommended surfactant-enhanced ISCO of residual onsite impacts. This technology was recommended because it would be the most cost-effective remediation option to meet the client's needs, as well as the landowner's timeframe requirements for completion of the remediation. The remediation was required to allow for site redevelopment. Remaining PSH was present in multiple wells across the site, with a maximum apparent PSH thickness of 4.45 feet.



Treatment of the remaining PSH was the primary goal of remediation activities. In addition, soils in the vadose zone which were saturated with hydrocarbon impacts were targeted in order to treat secondary sources of PSH. Green Star advanced 39 soil borings divided between two distinct treatment areas, approximately 1,500 and 3,800 square feet, respectively. Sixteen of the 39 borings were then converted to permanent injection points. Green Star managed injection of an aqueous solution of a proprietary sequence and mix of surfactant, hydrogen peroxide, and sodium percarbonate solutions applied through the injection points and direct-push borings in three separate week-long events over a six-month period. A total of 22,000 gallons of solution was injected at the site. Due to these efforts, no PSH was detected over six consecutive monthly groundwater gauging events since in situ remediation.

RESULT OF IN SITU REMEDIATION:

Three one-week events of field remediation within a six-month period resulted in achieving all remedial goals. This achievement was sustained as verified by monthly post-remedial monitoring. The Oregon Department of Environmental Quality (ODEQ) issued No Further Action status after a public hearing process.

FORMER FLIGHT TRAINING CENTER, DFW AIRPORT, TEXAS

BRIEF DESCRIPTION OF PROJECT:

This facility was investigated, delineated, and remediated of hydraulic oil PSH and chlorinated solvent constituents within the sub-slab void spaces under a Former Flight Training Center. In addition, dissolved-phase contaminants trichloroethene (TCE), 1,1-dichloroethene (1,1-DCE), and 1,4-dioxane in the groundwater saturated zone and capillary fringe under the source area (building basement) were also remediated. The flight simulators and a hydraulic oil drain system were the primary sources of impacts. Drain lines and tankhold of a former underground storage tank were secondary continuing sources of impacts.



Remediation of the PSH and chemicals of concern within the sub-slab void space was accomplished by inoculating sub-slab ports with a surfactant and hydrogen peroxide aqueous reagent as a surfactant-enhanced in situ chemical oxidation (ISCO). Once remediation of the sub-slab was completed, the groundwater saturated zone and capillary fringe under the source area were remediated utilizing an ISCO treatment train via 33 injection wells. The treatment area covered approximately 15,000 square feet. A total of 66,000 gallons of solution was injected under this area. This project was particularly challenging because the shallow water table consisted primarily of tight clay soils. It was necessary to chemically modify the clay soils to enhance fluid flow prior to initiation of the ISCO injections. The downgradient area outside of the building was remediated as a second phase. The outside treatment area had a thin sand aquifer over an area of 115,000 square feet, which was injected through 36 injection wells, with a total injected volume of 103,000 gallons of treatment solution.

The total timeframe of the project remediation was three years, with the first year used to conduct a bench scale study and field pilot test. The second year was used for installation of the injection wells and implementation of the ISCO injections. The third year was for confirmation monitoring and a polish injection of a small rebound area.

The source area was remediated to below State of Texas default protective concentration levels (PCLs) in groundwater and all primary and secondary sources were removed. The Response Action Completion Report (RACR) was submitted to the Texas Commission on Environmental Quality (TCEQ) in 2014 for the source area with additional information on the remedial results for the downgradient plume area in the First Quarter of 2015. A Certificate of Completion in the Voluntary Cleanup Program for the entire project was issued the Fourth Quarter of 2015 and filed in the real property records.

RESULT OF IN SITU REMEDIATION:

Ten months of field activities implementing in situ remediation resulted in achieving all remedial goals for clean closure (no future restrictions). This achievement was sustained as verified by ample post-remedial monitoring. The site closure was assisted by the TCEQ with the suggestion of using both the Texas Risk Reduction Program and the Petroleum Storage Tank Programs. This assistance to help close the project is a very good example of the willingness of state regulatory agencies to help close sites when properties are cleaned to residential standards as opposed to the more common risk-based closures that leave substantial quantities of contaminants in place under legal controls.



BUS TERMINAL, LAREDO, TX

BRIEF DESCRIPTION OF PROJECT:



Following implementation of traditional remediation techniques including soil vapor extraction and pump and treat technology, Green Star was retained to implement in situ remediation in order to clean the site to the extent practicable due to real estate transaction concerns. At this site, regulatory closure had been obtained with some residual contamination left in place. However, based upon real estate concerns, the client elected to pursue additional remediation in order to fully remove the remaining PSH and avoid future potential transactional issues. The target treatment area was the smear zone just above and below the shallow water table, which was determined to be an ongoing source of remaining PSH at the site. The in situ

treatment option allowed for treatment of this zone without removal of additional groundwater. Following treatment, no remaining PSH was detected and no further action was required at the site.

RESULT OF IN SITU REMEDIATION:

One week of field remediation resulted in achieving and sustaining all remedial goals. No further action was necessary.

FORMER MAINTENANCE GARAGE & TERMINAL, ATLANTA, GA

BRIEF DESCRIPTION OF PROJECT:

To obtain regulatory closure of a large remedial excavation site, remediation was necessary of persistent residual product that migrated from the site to an offsite property. The gasoline and diesel contamination was discovered as a result of former USTs at a former vehicle refueling and maintenance facility. Site investigation activities revealed onsite and offsite soil and groundwater impacts, including the presence of PSH on the water table.



Onsite remediation via excavation of impacted soils was selected to move the site to closure as quickly as possible. However, wells were gauged and data indicated the presence of PSH up to an apparent thickness of 0.22 feet. This PSH was under an offsite parking garage structure and inaccessible for excavation. This offsite PSH would need to be addressed prior to obtaining any regulatory consideration for closure for the entire project. Surfactant-enhanced ISCO remediation was selected as a remedy and developed specifically to address the presence of PSH in this area without the need for excavation.

The targeted treatment area was approximately 2,400 square feet. The targeted vertical interval for treatment was approximately 5 feet to 15 feet below the ground surface. Immediately prior to treatment, PSH thickness of 0.04 feet was measured in the offsite well. An aqueous solution of proprietary reagents was applied through a combination of direct-push Geoprobe® borings and fixed injection wells. Following the in situ remediation, four gauging events were conducted 2 to 6 weeks post treatment. No PSH was detected in any of the wells during any of the four gauging events. However, after a regulatory and legal delay, the well was re-gauged and remaining PSH (up to 0.15 feet) was detected. A second round of in situ treatment was conducted as a polish treatment.

Over the next six months, selected offsite wells were gauged and PSH was not measured at the site. Additionally, no sheen or hydrocarbon odor has been observed since the polish treatment. Following documentation of field activities and gauging results, the Georgia Department of Natural Resources issued a "No Further Action" letter and the site was closed. Without the use of proprietary in situ remediation, persistent product would have kept the entire site from closure.

RESULT OF IN SITU REMEDIATION:

Two week-long periods of field injection resulted in achieving and sustaining all remedial goals. The regulatory agency issued "No Further Action" status on the site.



PROPOSED HOTEL, DALLAS, TEXAS



BRIEF DESCRIPTION OF PROJECT:

A parking lot and undeveloped field were planned for development as a multi-story hotel. Historic site development dated back to the late 1800s and included an onsite dry cleaning operation from the 1920s through the 1940s and an adjacent dry cleaning operation from the 1950s through the 1970s. Identified chlorinated solvents impacts including tetrachloroethene (PCE), carbon tetrachloride (Carbon-Tet) and their degradation products, which impacted both soil and groundwater. Ten volatile organic compounds (VOCs) were identified as dissolved-phase chemicals of concern. PCE, TCE, and Carbon-Tet were present in groundwater at levels exceeding residual DNAPL triggers. Additionally, identified VOC

concentrations presented a potential future vapor encroachment issue after the property was developed with a hotel. The downgradient offsite impacted area outside the building development tract is currently in the delineation and assessment process. The remediation of the downgradient plume will be addressed as a second response action area in the TCEQ Voluntary Cleanup Program.

The affected groundwater at the site was in a shallow perched aquifer within fractured limestone interbedded with and overlain by very tight clay soils. There were also very small areas of terrace deposit sands on the north edge of the site. The area below the footprint of the future hotel could not contain chlorinated solvent concentrations above their DNAPL action levels for development to proceed. Project objectives stipulated VOCs underneath the planned hotel could also not be present at concentrations that could produce significant future vapor encroachment after development. For development to proceed, it was necessary for the TCEQ to issue a Conditional Certificate of Completion in the Voluntary Cleanup Program for the development footprint.

The primary sources of the dry cleaning solvent had been removed when those operations went out of business and the building demolished prior to 1980. The secondary source of continued groundwater impacts was the residual DNAPL in the underlying weathered limestone.

The remediation of residual DNAPL and dissolved-phase chemicals of concern in groundwater was accomplished by an ISCO treatment train via 66 injection wells. The treatment area covered approximately 14,000 square feet. A total of 78,000 gallons of solution was injected under this area over approximately 110 days. It was also necessary to chemically modify the clay soils and weathered limestone to enhance fluid flow prior to initiation of the ISCO injections.

All remedial goals were achieved within the 110 days of remedial injections. All contaminant concentrations were reduced to at least one order of magnitude lower than their cleanup goal in each monitor well within the treatment area. Post-remedial analysis confirmed subsequent rebound was minimal with all contaminant concentrations persistently remaining well below their respective cleanup goals.

All residual secondary source areas under the hotel development tract were remediated by the ISCO treatment to below the residential cleanup standards for the site. The RACR and additional required submittals were submitted to the TCEQ in the Fourth Quarter of 2015 for the hotel development tract. TCEQ issued a Phased Conditional Certificate of Completion in the Voluntary Cleanup Program for the development footprint in January 2016, which was subsequently filed in the real property records.

RESULT OF IN SITU REMEDIATION:

The use of ISCO to remediate the residual source areas under this development tract was the only cost-effective remedial technology which would have met both the remedial goals for cleanup and the time and space constraints for the site. The remedial injection required only four months of field activities to achieve the remedial goals for closure. This project was another example of the TCEQ cooperation, which would not have been possible without physical cleanup of the site. The remediated site is currently under construction building a hotel.

