S-ISCO Remediation of Coal Tar Contamination at NYC Brownfield Site Queens, New York

PROJECT FACTS

Site
Former Roofing Products Manufacturer
Queens, NY

Contaminants of Concern
BTEX, PAHs

Objectives
Reduce contaminant mass to below site criteria, and reduce groundwater contaminant flux

Treatment Approach
Surfactant-enhanced In Situ Chemical Oxidation (S-ISCO®) with proprietary surfactant and alkaline activated Klozur® Persulfate.

Results
SOIL: Destroyed >90% of total contamination targeted, including 95% of naphthalene

GROUNDWATER: Decreased >91% contaminant concentrations; no NAPL mobilized; adjacent river protected; no rebound

SOIL VAPOR: Significant VOC & SVOC reductions, including 100% benzene & naphthalene, and 98% BTEX

Summary

Surfactant-enhanced In Situ Chemical Oxidation (S-ISCO®)[1] remediation was successfully implemented to destroy coal tar contamination at a former roofing products manufacturing site in New York City. The treatment consisted of injections of VeruSOL, a proprietary plant-based surfactant and co-solvent mixture, and alkaline-activated Klozur® persulfate, augmented by Primawave pressure-pulsing injection enhancement technology, as well as the RemMetrik℠ process to quantify subsurface contamination, target its treatment and measure remedial effectiveness.

The urban site, surrounded by dense residential and commercial development along a bank of the East River, was contaminated with coal tar repurposed from a nearby Manufactured Gas Plant (MGP) for the roofing manufacturing process. S-ISCO injections, conducted for five months, destroyed greater than 90% of coal tar-related contaminants including BTEX, PAHs and naphthalene in the targeted interval. Soil and groundwater samples taken one year after treatment showed continued decreases in contaminant

[1] Ethical Solutions, LLC acquired the intellectual property developed by VeruTEK Technologies, in September 2014.

concentrations, with elevated iron concentrations and depleted sulfate concentrations indicating microbial activity enhanced degradation of residual contamination.

Site Background

Located on a bank of the East River in a densely developed residential and commercial area in New York City, this 0.73-acre parcel is part of an urban revitalization project and will be redeveloped as a public library and park ranger station. As part of the history of roofing products manufacture at the parcel, MGP coal tar brought onto the site leaked into the subsurface, contaminating the soil and groundwater with benzene, toluene, ethylbenzene, and total xylenes (BTEX), naphthalene, and polycyclic aromatic hydrocarbons (PAHs). Contaminant concentrations in the soil and groundwater exceeded NYSDEC regulatory limits by orders of magnitude.

Technology Background

S-ISCO® *is an innovative Green Chemistry Technology that combines VeruSOL, a biodegradable, plant-based surfactant/co-solvent mixture, with an oxidant system to destroy soil and groundwater contamination in-place. Use of VeruSOL surfactants in an in-situ chemical oxidation process increases the miscibility of organic contaminants bringing them into the aqueous phase, where primary oxidative destruction of contaminants occurs. VeruSOL enhances ISCO by desorbing and emulsifying contaminants for destruction by a co-injected oxidant such as Klozur® persulfate.*

S-ISCO technology was approved as part of the Brownfield Cleanup strategy for the site after results of bench-scale treatability tests and pilot-scale field implementation demonstrated S-ISCO could effectively contact and destroy contamination at the site, including sorbed NAPL. The laboratory and field-scale pilot testing indicated a S-ISCO treatment composed of VeruSOL-3 and alkaline-activated Klozur® persulfate was the optimal remedy for treating site contaminants.

Implementation

S-ISCO implementation took place over a five month period and consisted of injections of VeruSOL-3, sodium persulfate and sodium hydroxide into 34 wells located in the areas in which the greatest contamination had been identified. These wells were variably screened across 6 – 7 foot lengths within the 10 and 22 ft. bgs treatment interval. Injections took place at an average rate of 8 gallons per minute (GPM) per well to 4 wells at a time (32 GPM overall). **Table 1** summarizes the injection parameters.

Table 1: Injection Summary

Chemical	Amount	Injected Concentration
VeruSOL®	29,545 kg	5 g/L
Klozur® Persulfate	152,000 kg	25 - 50 g/L
Sodium Hydroxide	61,950 kg	20 g/L
Total Fluid	1,201,900 gal	--

Monitoring

Monitoring was conducted before, during and after S-ISCO injections to track the progress and performance of the injected chemistry in the subsurface and to confirm that the treatment was not negatively impacting sensitive receptors, particularly the adjacent river. Monitoring included: continuous tracking of water quality parameters using *in situ* data loggers; collection of groundwater samples for analysis at the on-site laboratory; observation of all wells on and off-site for indications of NAPL; and collection of soil and groundwater samples for contaminant analysis.

Results

Soil Contaminant Reductions

Approximately five months after the completion of injections, when results of groundwater monitoring indicated that the sodium persulfate reactions had subsided, VeruSOL had largely degraded and pH conditions were approaching pre-injection levels, 114 soil samples were collected from the treatment area and analyzed for total VOCs and SVOCs. These results were used to calculate the mass of contamination remaining for comparison to the mass calculated before treatment. This analysis indicated that S-ISCO treatment destroyed 90.3% of the mass of total VOCs and SVOCs present in the soil before treatment, including more than 95% of the naphthalene present. Naphthalene, a principal component of coal tar, was the primary SVOC affecting the site soils and groundwater, accounting for almost 65% of the total pre-treatment contaminant mass. **Table 2** shows additional reductions for priority contaminants, including benzene, toluene, ethylbenzene and total xylenes (BTEX).

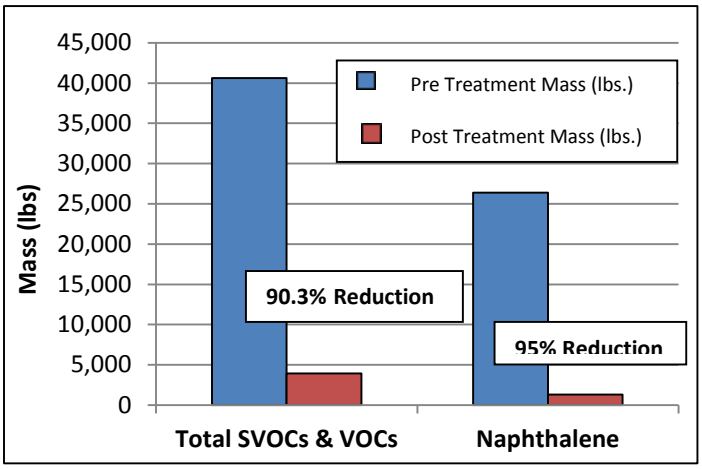

Figure 2: Contaminant Mass Reduction

Table 2: Mass Reductions for Priority Contaminants

Contaminant	Pre-Treatment Mass (lbs.)	S-ISCO Reduction
Naphthalene	26,389	95 %
Benzene	30	85 %
Toluene	267	81 %
Ethylbenzene	348	75 %
Total Xylenes	1,028	60 %
BTEX	1,674	67 %
Total SVOCs & VOCs	40,621	90.3 %

Groundwater Contaminant Reductions

Groundwater samples from the nine on-site monitoring wells, screened across the treatment interval (10-22 ft bgs), were analyzed before and after treatment. This data showed that the S-ISCO treatment achieved the groundwater cleanup objective—asymptotic decreases in VOCs & naphthalene and/or TOGS[2] Ambient Water Quality Standards (AWQS) for Class GA groundwater. Decreases included 92% for xylenes, 87% for benzene, the most toxic and mobile VOC at the site, 90% for ethylbenzene, and 91% for BTEX.

[2] NYSDEC Division of Water Technical and Operational Guidance Series 1.1.1.

Soil Gas Contaminant Reductions

Soil vapor samples collected from three areas adjacent to the site from 4 to 6 bgs were analyzed before (October 2010) and after (April 2011) injections. A total of 4,400 soil gas readings were taken throughout the injection process. Measurements of soil gas pressure indicated that the injected oxidant was not causing a measurable increase in pressure. Reductions in soil gas concentrations are summarized in **Table 3** and shown in **Figure 4,** and included 100% for benzene, ethylbenzene, and naphthalene. Improvement in soil gas contamination included reductions at a sampling location more than 100 feet from the injection area, indicating that the effects of the treatment extended substantially beyond the immediate injection area.

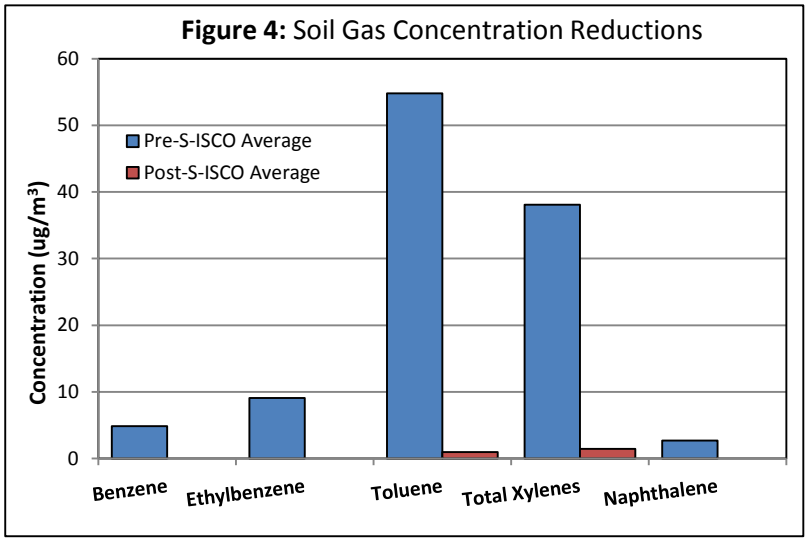

Figure 4: Soil Gas Concentration Reductions

Table 3: Soil Gas Concentration Reductions

Contaminant	Pre-S-ISCO Average	Post-S-ISCO Average	% Reduction
Benzene	4.83	ND	100%
Ethylbenzene	9.10	ND	100%
Toluene	54.80	0.97	98%
Total Xylenes	38.10	1.43	96%
Naphthalene	2.67	ND	100%

Current Site Status

The site received a certificate of completion and is listed on the NYDECs Brownfield Cleanup Program Deemed Complete list as BCP Site Number C241087. Construction of a community library has begun at the site and is anticipated to be completed in 2017.

Conclusions

Destruction of MGP-related coal tar at this urban Brownfield site demonstrates a clear success for the S-ISCO combination of VeruSOL surfactant with Klozur® persulfate as a remedy for MGP-related contamination. The S-ISCO treatment successfully contacted, desorbed and destroyed NAPL contaminants and reduced soil vapor contamination in a controlled process without impacting the adjacent water body (the East River) or the local community. The treatment effectively reduced the source of contamination, as evidenced by substantial decreases in soil contamination, yielding both sustained and continued improvement in groundwater conditions without requiring multiple repeat treatments to enable site closure and site redevelopment