



Innovative Environmental Technologies, Inc.

**“Field Performance of *In-Situ* Geochemical Stabilization for Non-Aqueous
Phase Liquid Treatment”**

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“Field Performance of In-Situ Geochemical Stabilization for Non-Aqueous Phase Liquid Treatment”



Targeted Contaminants

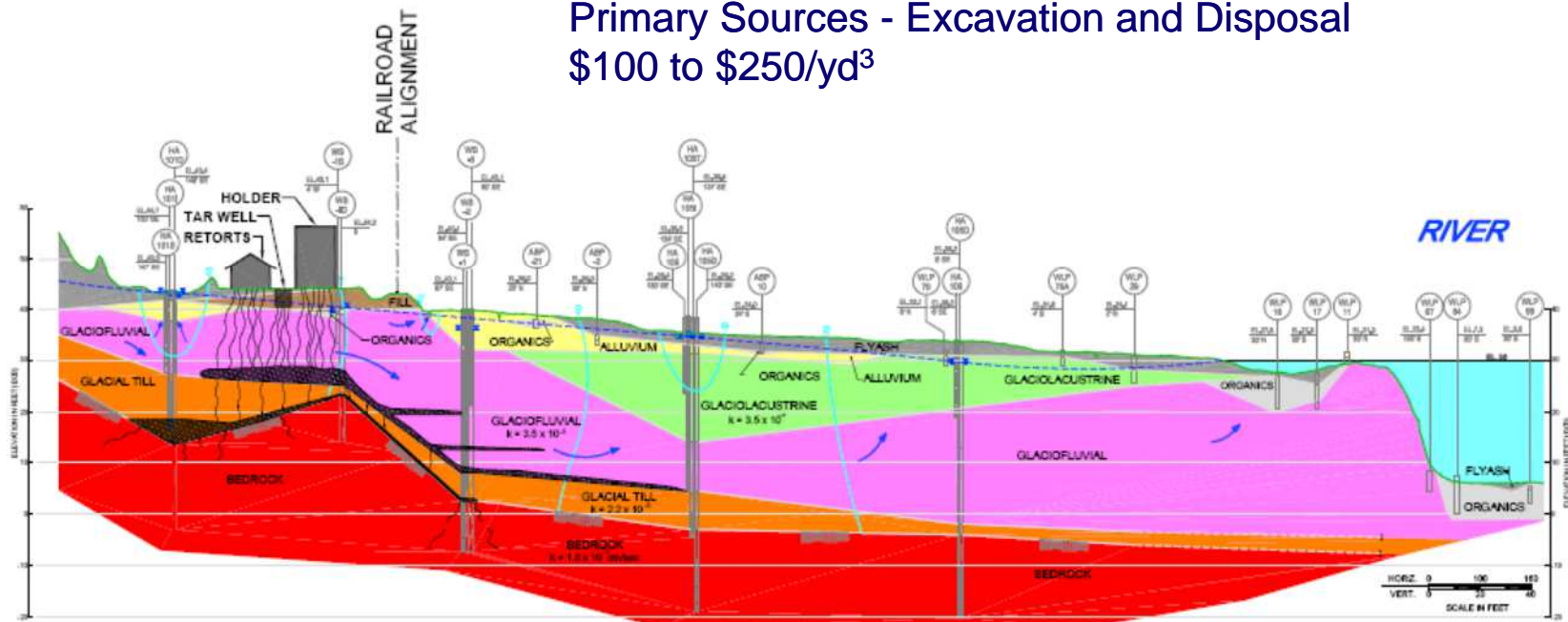
- Polycyclic aromatic hydrocarbons (PAHs) are the product of incomplete combustion, i.e. the burning of fossil fuels, forest fires, coal tar, creosote and diesel.
- PAHs are organic chemicals found almost everywhere, posing a risk for human health because of their potentially carcinogenic nature and bioavailability in water, soil, sediment, and air resources that humans come in contact with daily.
- Degradation rates of PAHs such as **benz[a]anthracene**, **benzo[a]pyrene**, **benzo[b]fluoranthene**, benzo[j]fluoranthene, benzo[k]fluoranthene, **chrysene**, **dibenz[a,h]anthracene** vary depending on molecular weight and the solubility of the PAH compound. PAH compounds can be grouped into different degradation and sequestration fractions in both soil and sediments depending on their bioavailability.

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The NAPL Challenge

Primary Sources - Excavation and Disposal
\$100 to \$250/yd³

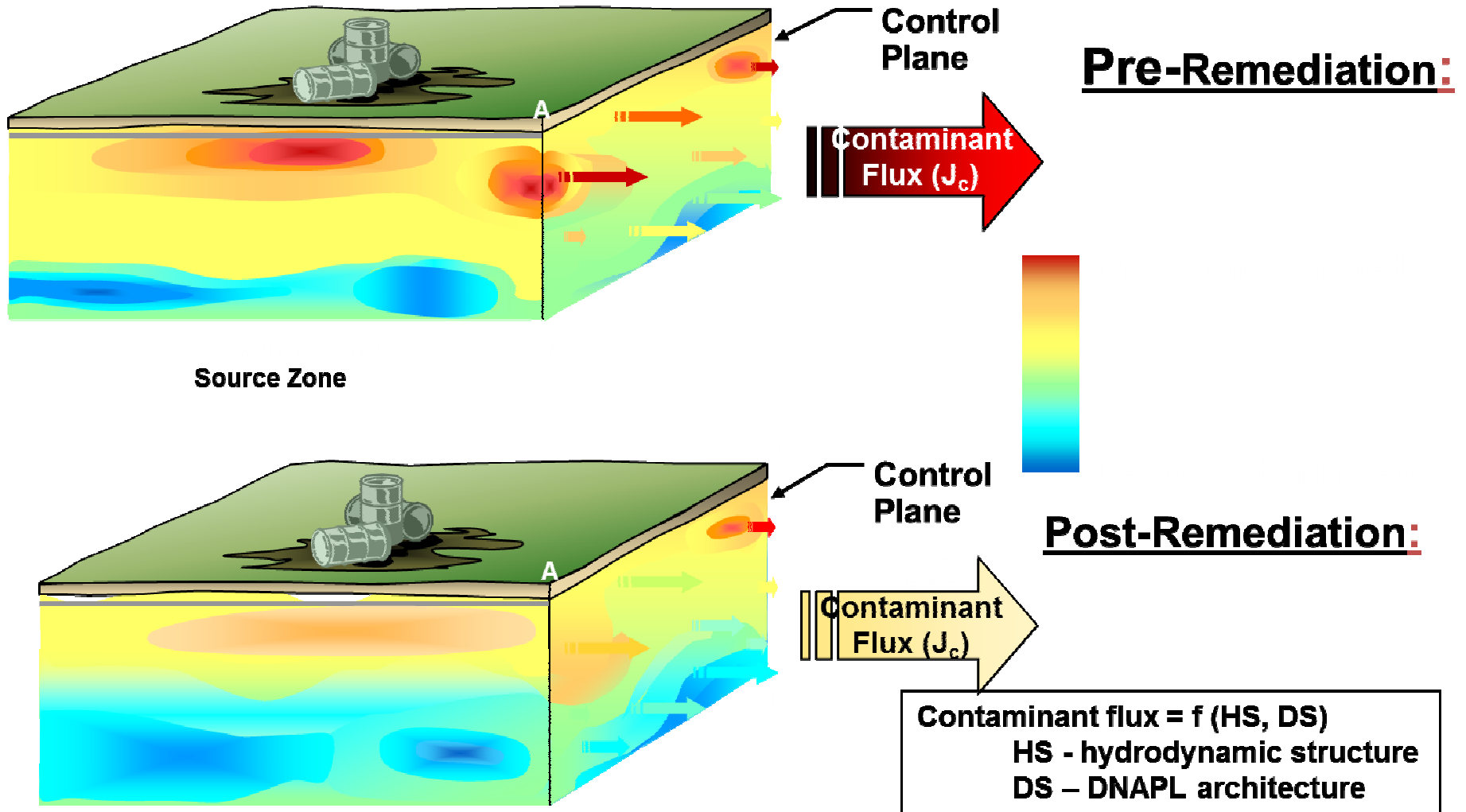


Secondary Sources – More Challenging
>\$250/yd³

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Contaminant Flux



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Remedial Design

- In-Situ Geochemical Stabilization (ISGS) remedial process entails the use of modified permanganate solutions for the purposes of mass removal and flux reduction (i.e., NAPL stabilization).
- The introduction of the permanganate solution results to the migration of the oxidant through the treatment area and consequently to geochemical reactions that destroy the targeted contaminants that are present in the dissolved phase.
- As the oxidant migrates through the treatment area, various (bio)geochemical reactions destroy the targeted compounds present in the dissolved phase. This causes a “hardening” or “chemical weathering” of the NAPL as it steadily loses its more labile components.

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Remedial Design

- A net increase in viscosity of the organic material is observed, which yields a more stable, recalcitrant residual mass.
- Both the insoluble manganese dioxide precipitate, that results from permanganate oxidation, and other mineral species included in the ISGS formulation accumulate along with the NAPL interface, resulting in the physically coating of the NAPL and thereby reducing the flux of dissolved-phase constituents of interest into the groundwater.
- Unlike the typical application of In Situ Chemical Oxidation reagents, ISGS is used to encapsulate NAPL, with chemical oxidation of COIs being a secondary affect. Thus, the overall oxidant dosing is often substantially less than ISCO applications, resulting in rapid, highly effective treatment at a much lower cost.

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Remedial Design

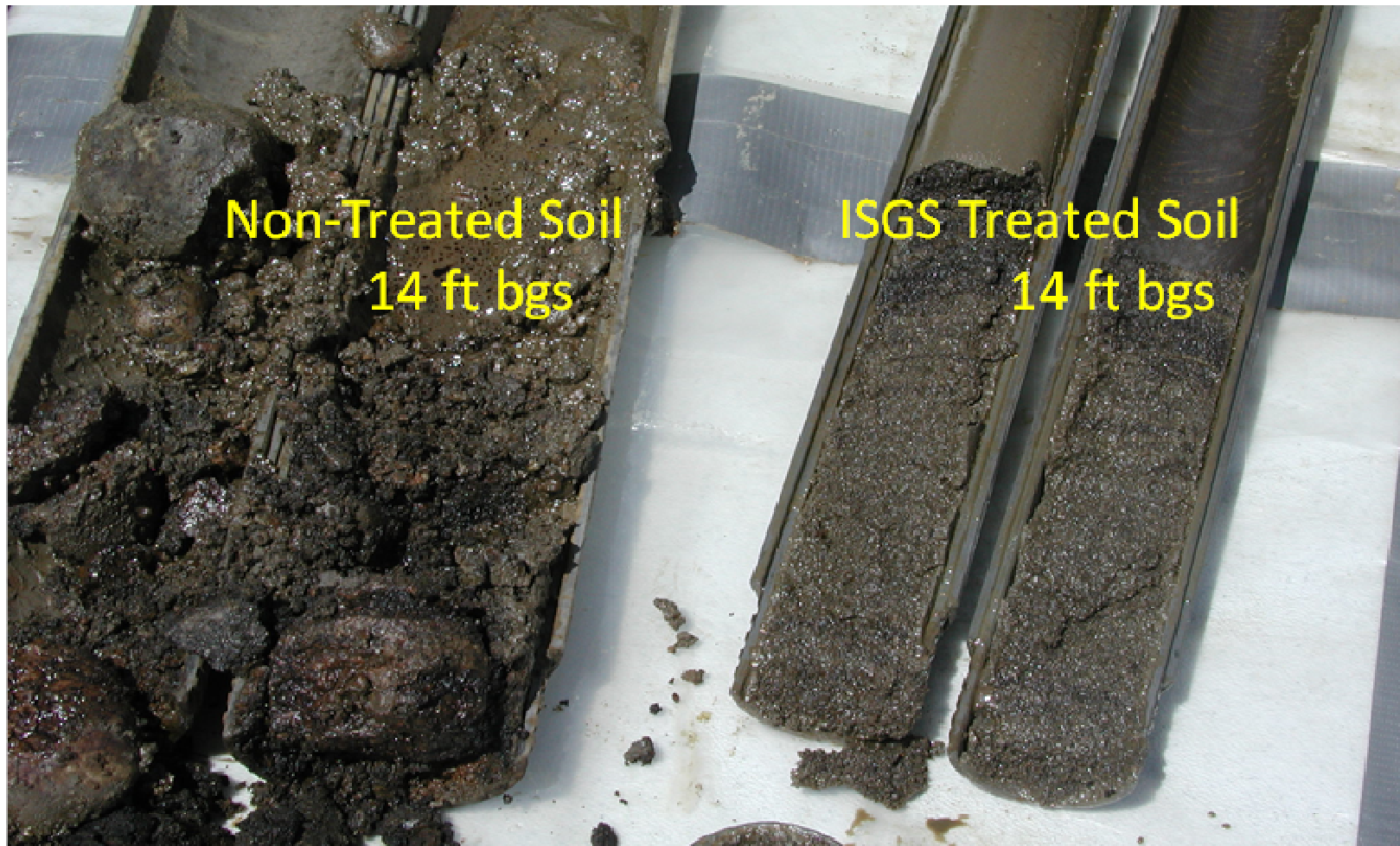
- In the presence of an organic compound (R), MnO_4^- reactions yield an oxidized intermediate (Rox) or CO_2 , plus MnO_2



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Remedial Design



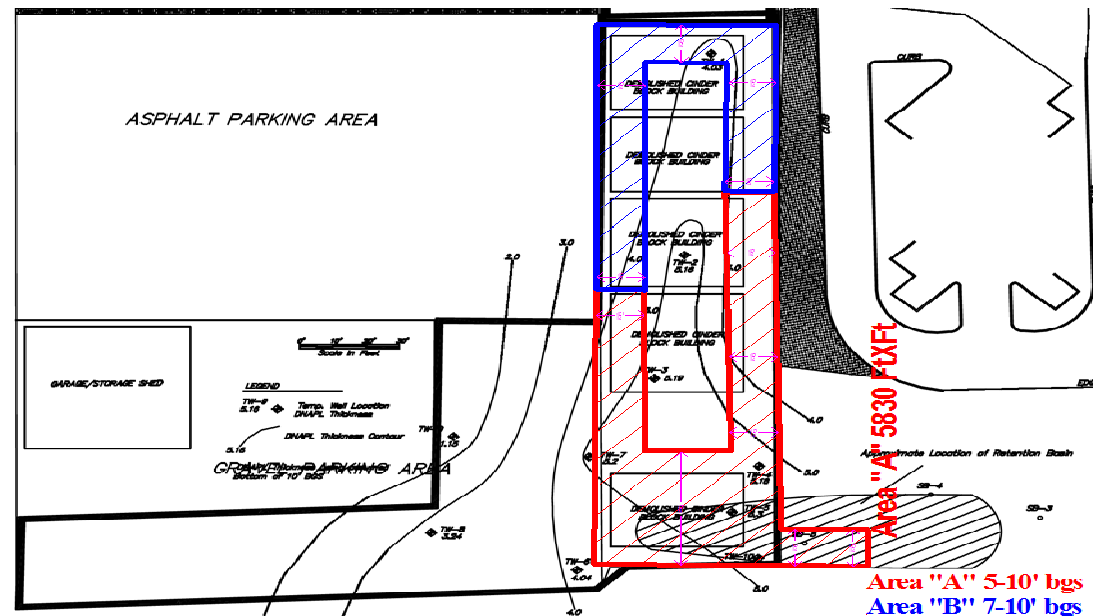
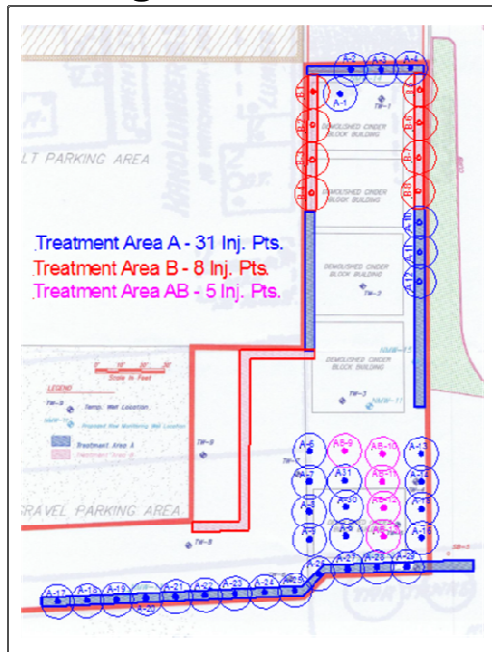
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Remedial Event

- ISGS remedial event was implemented at a site located near Fanwood, New Jersey to remediate soils and groundwater impacted by the historical release of coal tars and heavy ended petroleum compounds.
- Total treatment area of 8,955 square foot area, treating between 5 and 10 feet below ground surface.



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Equipment



IET 20' MOBILE INJECTION SYSTEM



Injection Feed Tank – Configuration



Feed Systems, Safety Systems, Compressed Gas Systems
All piping Welded Stainless Steel
Floors Coated in Chemical Resistant RinoLining

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Groundwater VOC and SVOC Analytical Data

MW-11				MW-12			
Field Parameter	08/30/2013	10/16/2013	01/15/2014	Field Parameter	08/30/2013	10/16/2013	01/15/2014
Acenaphtylene	0.461	0.312	ND 0.10	Acenaphtylene	1.75	ND 0.10	0.151
Benzo(a)anthracene	0.255	0.847	0.146	Benzo(a)anthracene	5.13	0.44	0.385
Benzo(a)pyrene	0.172	0.54	ND 0.10	Benzo(a)pyrene	6.31	0.162	0.248
Benzo(b)fluoranthene	0.218	0.76	ND 0.10	Benzo(b)fluoranthene	6.30	0.222	0.292
Chrysene	0.166	0.508	ND 0.10	Chrysene	5.15	0.224	0.261
Fluorene	0.791	0.314	0.239	Bis(2-Ethylhexyl)phthalate	5.80	ND 2.0	ND 2.0
Benzene	67.5	8.4	14.4	Ideno(1,2,3-cd)pyrene	3.80	ND 0.10	0.105
Ethylbenzene	6.6	ND 5.0	0.77 J	Benzene	10.2	8.2	11.1
Toluene	46.5	ND 5.0	3.0	Ethylbenzene	3.8	1.6	0.51 J
Total Xylenes	19.1	ND 5.0	2.7	Toluene	8.4	1.8	ND 2.0
Total Alkanes	63 J	ND	ND	Total Xylenes	22.4	7.3	2.8

Tables 1 & 2. VOC and SVOC Groundwater Data for MW-11 and MW-12 (µg/L).

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Groundwater VOC and SVOC Analytical Data

MW-13			
Field Parameter	08/30/2013	10/16/2013	01/15/2014
Acenaphthylene	81.3	11.6	0.64
Benzo(a)anthracene	2.92	0.435	0.684
Benzo(a)pyrene	1.75	ND 0.10	0.192
Benzo(b)fluoranthene	2.24	ND 0.10	0.233
Benzo(g,h,i)perylene	0.698	ND 0.10	ND 0.10
Benzo(k)fluoranthene	0.895	ND 0.10	0.121
Chrysene	2.02	0.235	0.409
Naphthalene	1,920	187	1.18
Benzene	100	48.7	175
Ethylbenzene	43.4	10.4	61.9
Toluene	160	24.4	161
Total Xylenes	179	41.6	171
Total Alkanes	3,625 J	ND	ND

MW-14			
Field Parameter	08/30/2013	10/16/2013	01/15/2014
Diethyl phthalate	7.2	-	ND 2.0
Benzene	8.1	7.1	4.6
Ethylbenzene	61.9	ND	ND 5.0
Toluene	2.0	ND 5.0	ND 1.0
Total Xylenes	ND	ND 5.0	ND 1.0
Total Alkanes	6.3 J	ND	ND

MW-15			
Field Parameter	08/30/2013	10/16/2013	01/15/2014
Acenaphthylene	0.197	ND 0.11	ND 0.10
Benzo(a)anthracene	0.459	ND 0.11	0.153
Benzo(a)pyrene	0.497	ND 0.11	ND 0.10
Benzo(b)fluoranthene	0.607	ND 0.11	ND 0.10
Chrysene	0.397	ND 0.11	ND 0.10
Naphthalene	0.453	0.541	ND 0.10
Benzene	0.31 J	0.52 J	ND 1.0
Ethylbenzene	ND	ND 1.0	ND 1.0
Toluene	0.58 J	ND 1.0	ND 1.0
Total Xylenes	0.62 J	ND 1.0	ND 1.0
Total Alkanes	5.4 J	ND 1.0	ND 1.0

Tables 3, 4 & 5. VOC and SVOC Groundwater Data for MW-13, MW-14 and MW-15 (µg/L).

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Free Product Data

Well ID	Sampling Date					
	05/25/2012	06/07/2012	03/14/2013	10/16/13	10/18/13	01/15/14
TW-1/MW-14	4.16	3.90	4.24	ND	ND	ND
TW-2/MW-15	5.34	4.98	5.31	ND	ND	ND
TW-3/MW-11	5.26	5.12	5.37	ND	ND	ND
TW-4	5.35	5.02	5.11			
TW-5/MW-12	5.60	4.99	4.64	ND	ND	ND
TW-6	4.06	4.02	3.75			
TW-7	5.31	5.08	5.11			
TW-8/MW-13	3.43	3.07	3.26	ND	ND	ND
TW-9	1.15	1.14	1.22			
TW-10	5.02	5.09	4.16			

Table 6. Injection Thickness of Free Product (ft).

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Conclusions

- The injection of the In-Situ Geochemical Stabilization (ISGS) solution was very effective in addressing the contamination present on the site located in Fanwood, NJ.
- The groundwater data shows that almost every VOC and SVOC compound either decreased below the laboratory detection limits or recorded significant concentration decreases compared to their baseline sampling values.
- The free product present in the ten wells during the baseline sampling event disappeared within 30 days of the implementation of the injection event. All five monitoring wells sampled after the September 2013 injection event did not record any free product during the three post-injection sampling events of October 2013 (two events) and January 2014.

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Conclusions

- Two pictures of the received soil samples are presented.
- Due to the ISGS solution injection the creosote with the strong odor that was observed above the peat layer was able to “solidify”, with no associated odor (15 days following injection).
- The picture demonstrates the ISGS formation that was created above the peat layer.

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Conclusions



Peat

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Conclusions



Close-up of ISGS

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Questions

