Case History O-9

Surgical Site Closure – 30 Sites in Indiana Receive Closure using ORC®

CASE SUMMARY

Surgical Site Closure

The "Surgical Site Closure" strategy was developed by Mr. Steve Sittler, an employee of KERAMIDA in Indianapolis, Indiana. The method is an innovative remedial strategy designed to intelligently integrate natural attenuation, risk-based cleanup goals and focused source removal/treatment to cost-effectively remediate contaminated areas. This approach is best applied at sites where released materials are amenable to biodegradation and where long-term, natural attenuation-type strategies are not suitable for reasons of property transfer or potential off-site liability. This strategy was performed at 30 sites in Indiana for a major oil company.

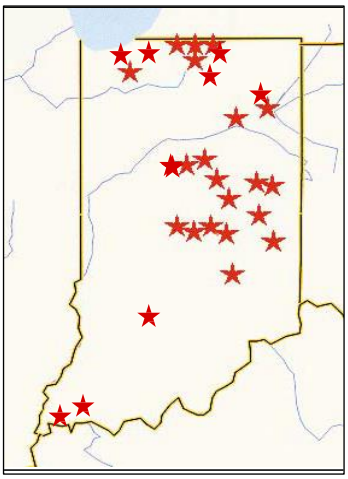

Figure 1. Site Closures in IN

Service Stations/Bulk Storage Terminals - Indiana

From 1998-2008, a total of 30 service station/bulk storage terminal sites were targeted for Surgical Site Closure in Indiana. The subsurface matrix consisted of unconsolidated sediments ranging from low-permeability silty clays with sand stringers to sand and gravel formations. The contaminants of concern were primarily gasoline and diesel fuel. A combination of source removal via excavation coupled with enhanced *in situ* bioremediation using Oxygen Release Compound (ORC®) was performed at most sites.

REMEDIATION APPROACH

The remediation approach included focused soil excavation of the source area and/or ORC direct-push injection. At some sites ORC was applied to the base of the excavation prior to backfilling. Shortly afterwards, a direct-push injection of ORC was completed over the remainder of the plume. The amount of ORC needed at each site location was determined using various site characteristics including contaminant concentration, seepage velocity, and treatment area.

Table 1. Amount of ORC Applied to 30 Sites in Indiana

Site Location	Lbs.	Site Location	Lbs.
South Bend (NW)	400	Bloomington	250**
South Bend (W)	200 650**	Michigan City (S)	1,685 (2)* 1,080**
South Bend (N)	1,350	Marion (N)	100
Elkhart	1,100	Anderson	300
Mishawaka	250	Elkhart (SE)	1,200
Fort Wayne (W)	1,000 3,500(2)**	Kouts	2,000 (3)* 750**
Elwood	100	Remington	1,000
Indianapolis (NW)	800	Kokomo (N)	2,550 (2)*
Indianapolis (E)	200	Kokomo (C)	600
Indianapolis (W)	900 (2)* 650**	Kokomo (W)	4,950 (3)*
New Castle	1,100	Evansville	3,500 (3)*
Cumberland	1,150	Munster	1,150
Muncie (W)	200	Muncie (C)	5,600 (4)*
Connersville	200	Fort Wayne (S)	1,000**
Mt. Vernon	930 (2)*	Mishawaka (W)	2,280

*Total pounds of ORC applied (number of injection events)
**Total pounds of ORC applied via excavation application

Additional ORC injections were performed at 8 sites (Table 1) where site conditions indicated a longer period of bioremediation would be necessary.

RESULTS

Table 2. Summary of BTEX Concentrations at Surgical Site Closure Sites in Indiana (µg/L)						
	Pre-ORC	**3 Mos.**	**6 Mos.**	**12 Mos.**	**24 Mos.**	**Closure**
High Permeability						
South Bend (NW)	2,620	386	151	ND	ND	with ERC
South Bend (W)	26,130	21,650	18,630	11,646	7,800	with ERC
South Bend (N)	19,900	421	476	18	Closed	with ERC
Anderson	2,759	708	650	----	Closed	NFA
Elkhart	2,956	643	1,793	469	Closed	NFA
Elkhart (SE)	1,422	769	1,160	484	171	with ERC
Michigan City (S)	18,900	16.65	15.29	15,540	6,480	with ERC
Mishawaka	318	ND	1,356	17	Closed	NFA
Kouts	10,230	303	387	240	Closed	with ERC
Muncie (C)	25,020	8,800	3,880	7,043	320	NFA
Mishawaka (W)	747	171	161	ND	ND	NFA
Medium Permeability						
Fort Wayne (S)	41,900	31	ND	23	Closed	NFA
Fort Wayne (W)	7,690	3,180	7,070	1,516	ND	NFA
Marion **(benzene)**	8	7	6	1	Closed	NFA
Kokomo (W)	8,980	3,030	2,800	277	194	wth ERC
Low Permeability						
Bloomington	243	ND	ND	7	Closed	NFA
Elwood	93	13	30	3	Closed	NFA
Indianapolis (NW)	524	62	33	2	16	with ERC
Indianapolis (E)	14,070	----	----	630	477	wth ERC
Indianapolis (W)	1,084	1,010	597	359	Closed	NFA
New Castle	294	724	153	ND	19	wth ERC
Mt. Vernon	1,820	1,400	1,100	1,120	149	with ERC
Cumberland	8,539	7	11,388	1,920	341	NFA
Muncie (W)	7	19	12	ND	Closed	NFA
Remington	10,400	1,680	4,800	5,180	----	with ERC
Munster	127	76	111	47	----	NFA
Connersville	133	186	789	ND	Closed	NFA
Evansville	51	82	173	43	16	NFA
Kokomo (C)	10,020	342	2,560	ND	----	NFA
Kokomo (N)	378	260	159	344	198	NFA

*ERC – Environmental Restrictive Covenant (deed restriction allows higher closure levels)

The majority of the sites were successfully treated using only one injection of ORC; however, a handful of sites received multiple applications. Most of these sites indicated that high levels of BTEX were present prior to treatment (>1,000ppb to <50,000ppb) and required additional applications to sustain aerobic bioremediation.

CONCLUSION

The Surgical Site Closure method was successful in reaching site closure at 30 petroleum-impacted sites over a nine-year period. The average time to reach site closure was ~3 years and the average cost to implement the remedial strategy was ~$70,000. Cost analyses indicated that a traditional remediation approach would have ranged from at least $100,000 to potentially $1 million. Actual implementation costs for the Surgical Site Closure approach ranged from approximately $25,000 to $75,000 plus monitoring costs.

CONTACT

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