



COGAC™ - Chemically Oxidized Granular Activated Carbon

Jesse Taylor: Remington Technologies





Background

- 💧 Professional Geologist - 36 years
- 💧 1977-1990 Petroleum Geologist – Prospecting for Oil and Gas in Rocky Mt. Region
- 💧 1991 Colorado school of Mines Program – Convert Oilfield Geologists to Environmental Geo-Scientists
- 💧 1991 to 2001 – Environmental Consultant: Emphasis on Hydrocarbon Remediation
- 💧 May 1, 2001 – Founded Remington Technologies



Remedial Injection Chronology

- 💧 Modified Fenton's Reagent
- 💧 Bench Scale Testing to Slow Reaction Rate
- 💧 Colorado School of Mines Catalyzed Persulfate vs. Catalyzed Hydrogen Peroxide (Persulfate/Peroxide radicals)
- 💧 Catalyzed Persulfate – Fe, Peroxide, heat, high pH
- 💧 Bench Scale Testing Persulfate vs. Specialty Products
- 💧 Reaction Rates, DO, ORP, pH
- 💧 Desorption and Rebound
- 💧 COGAC™



COGAC™ Components

- 💧 Sodium Persulfate 20% - 5% Typical
- 💧 Calcium Peroxide 15% to 5% Typical
- 💧 Powdered Activated Carbon 60% to 80% Typical
- 💧 Nitrate – if needed based on background compared to plume area
- 💧 Any Component % can range from 99% to 1%



Component Mechanisms

- 💧 Sodium Persulfate > persulfate radical + sulfate
- 💧 Calcium Peroxide > degrades to hydrogen peroxide over time > best catalyst for persulfate in dozens of bench tests > keeps DO high for months > Ox for aerobic bacteria
- 💧 Carbon > Adsorption (minimizes desorption rebound) > bacterial substrate
- 💧 After chemical oxidation > high sulfate, high DO, high nitrate (when added) = Ox and nutrients



COGAC™ History/Track Record

- November 2011 – 1st Bench Scale Test
- April 2012 – Patent Application
- May 2012 – 1st Pilot Test
- June 2012 – 1st Full Scale Event
- September 2012 – 1st Oil Field Full Scale
- July 9 2013 – Patent Issued



Bench Scale Test Data

Benzene

	BEFORE (ug/L)	AFTER (ug/L)	REDUCTION	% REDUCTION	CORRECTED % REDUCTION
T-1 (PersulfOx)	1120	740	380	33.9%	12.8%
T-2 (SP/HP 4:1)	1210	217	993	82.1%	61.0%
T-3 (Klozur CR)	750	390	360	48.0%	26.9%
T-4 (RegenOx)	1220	835	385	31.6%	10.5%
T-5 (CP/HP 4:1)	1010	732	278	27.5%	6.4%
T-6 (PermeOx)	1110	410	700	63.1%	42.0%
T-7 (COGAC)	1270	0.9	1,269	99.9%	78.8%
T-8 (COGAC w/Nitrate)	1030	0.63	1,029	99.9%	78.8%
T-9 (ORC)	1280	621	659	51.5%	30.4%
T-10 (Standard)	1050	828	222	21.1%	0.0%



After Test Sample Field Parameters

Field Parameters

	Conductivity ($\mu\text{S}/\text{cm}^3$)	TDS (g/L)	DO (mg/L)	pH	ORP
T-1 (PersulfOx)	6481	4.213	4.26	7.12	248.9
T-2 (SP/HP 4:1)	6386	4.149	43.43	6.70	278.0
T-3 (SP/CP 1:1)	4888	3.177	55.78	9.51	131.2
T-4 (RegenOx)	3188	2.071	37.01	8.90	142.1
T-5 (CP/HP 4:1)	2096	1.362	51.56	10.43	72.4
T-6 (PermeOx)	4461	2.899	28.22	8.52	170.7
T-7 (COGAC)	3606	2.342	51.08	7.57	165.9
T-8 (COGAC w/Nitrate)	4514	2.932	54.03	7.77	162.1
T-9 (ORC)	3042	1.977	52.20	8.09	159.3
T-10 (Standard)	2125	1.381	2.55	7.65	186.1



Materials Cost/Results Analysis

Benzene

	COST FACTOR	COST/ % REDUCTION	EVENTS/ 100% REDUCTION	L & E COST	FINAL COST FACTOR
T-1 (PersulfOx)	\$5,000	\$390	7.81	\$4,000	\$70,290
T-2 (SP/HP 4:1)	\$5,000	\$82	1.64	\$5,000	\$16,400
T-3 (Klozur CR)	\$5,800	\$108	1.87	\$4,000	\$18,326
T-4 (RegenOx)	\$8,500	\$810	9.50	\$4,000	\$118,750
T-5 (CP/HP 4:1)	\$6,160	\$962	15.65	\$4,000	\$159,004
T-6 (PermeOx)	\$14,000	\$333	2.38	\$4,000	\$42,840
T-7 (COGAC)	\$7,500	\$95	1.26	\$4,000	\$14,490
T-8 (COGAC w/Nitrate)	\$7,700	\$97	1.26	\$4,000	\$14,742
T-9 (ORC)	\$12,000	\$395	3.28	\$4,000	\$52,480



Benzene

Test #	Before GW	After GW	GW Red.	%GW	%GW Cor.	Before Soil	After Soil	Soil Red.	% Soil	% Soil Cor.
T-1 (SP / Fe) 4:1	1,000	820	180	18.00%	8.91%	1,900	3,200	-1300	-68.42%	-68.42%
T-2 (SP / CP) 4:1	1,100	720	380	34.55%	25.45%	1,900	1,900	0	0.00%	0.00%
T-3 (COGAC)	1,100	23	1077	97.91%	88.82%	1,900	270	1630	85.79%	85.79%
T-4 (Regen Ox)	1,200	950	250	20.83%	11.74%	1,900	1,900	0	0.00%	0.00%
T-5 (CP / Fe) 4:1	1,100	430	670	60.91%	51.82%	1,900	2,100	-200	-10.53%	-10.53%
T-6 Standard	1,100	1,000	100	9.09%	0.00%	1,900	1,900	0	0.00%	0.00%



Chlorobenzene

Test #	Before GW	After GW	GW Red.	% GW	%GW Cor.	Before Soil	After Soil	Soil Red.	% Soil	% Soil Cor.
T-1 (SP / Fe) 4:1	230	220	10	4.35%	12.86%	2,000	900	1100	55.00%	55.00%
T-2 (SP / CP) 4:1	210	190	20	9.52%	18.03%	2,000	310	1690	84.50%	84.50%
T-3 (COGAC)	150	25	125	83.33%	91.84%	2,000	360	1640	82.00%	82.00%
T-4 (Regen Ox)	110	110	0	0.00%	8.51%	2,000	540	1460	73.00%	73.00%
T-5 (CP / Fe) 4:1	210	170	40	19.05%	27.56%	2,000	460	1540	77.00%	77.00%
T-6 Standard	470	510	-40	-8.51%	0.00%	2,000	2,000	0	0.00%	0.00%

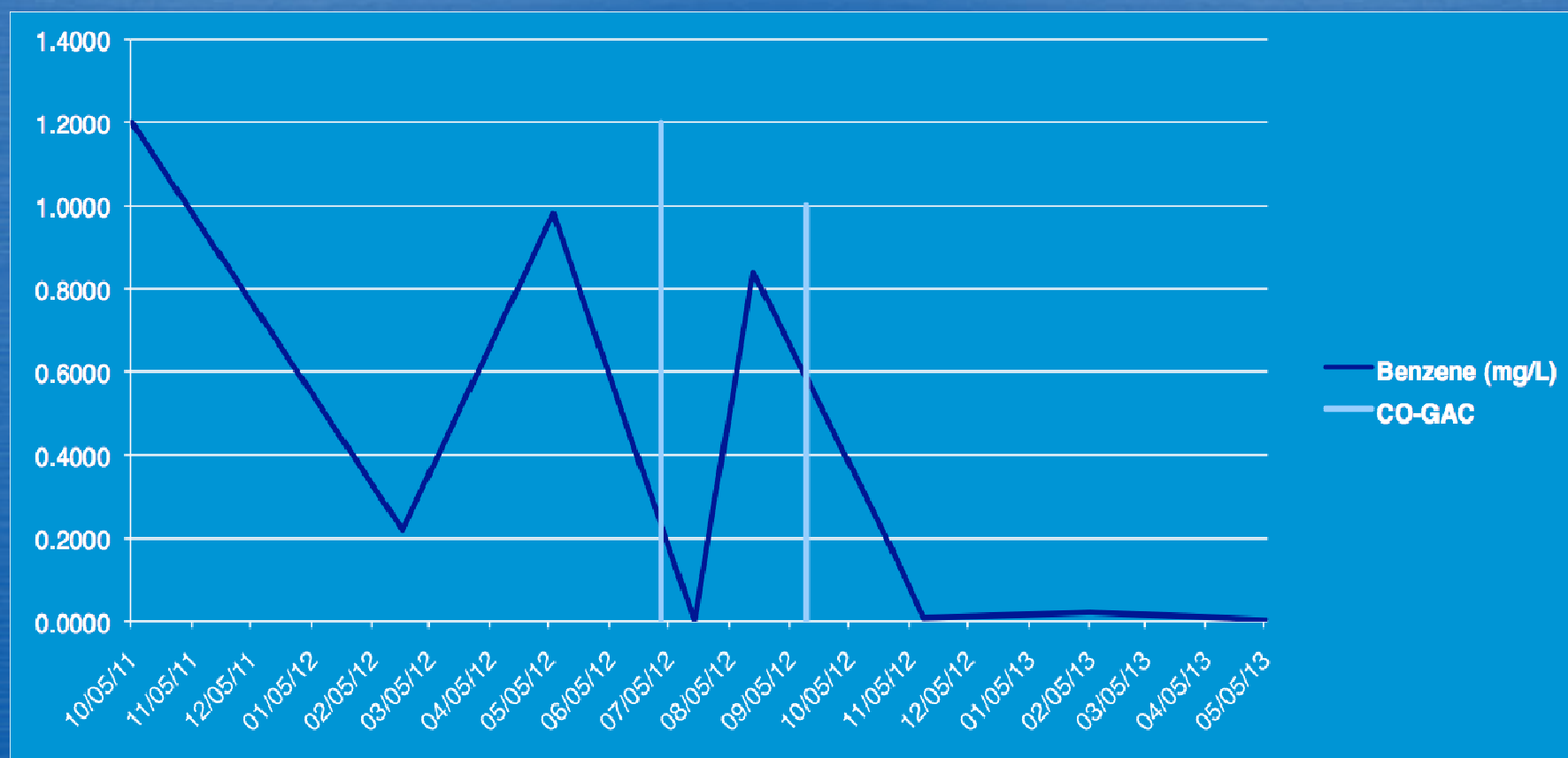


Tetrahydrofuran

Test #	Before GW	After GW	GW Red.	% GW	%GW Cor.	Before Soil	After Soil	Soil Red.	% Soil	% Soil
T-1 (SP / Fe) 4:1	1,500	1,200	300	20.00%	6.67%	1,999	1,999	0	0.00%	0.00%
T-2 (SP / CP) 4:1	1,400	1,200	200	14.29%	0.95%	1,999	749	1250	62.53%	62.53%
T-3 (COGAC)	1,400	990	410	29.29%	15.95%	1,999	1,999	0	0.00%	0.00%
T-4 (Regen Ox)	1,400	1,200	200	14.29%	0.95%	1,999	2,099	-100	-5.00%	-5.00%
T-5 (CP / Fe) 4:1	1,500	1,100	400	26.67%	13.33%	1,999	1,099	900	45.02%	45.02%
T-6 Standard	1,500	1,300	200	13.33%	0.00%	1,999	1,999	0	0.00%	0.00%

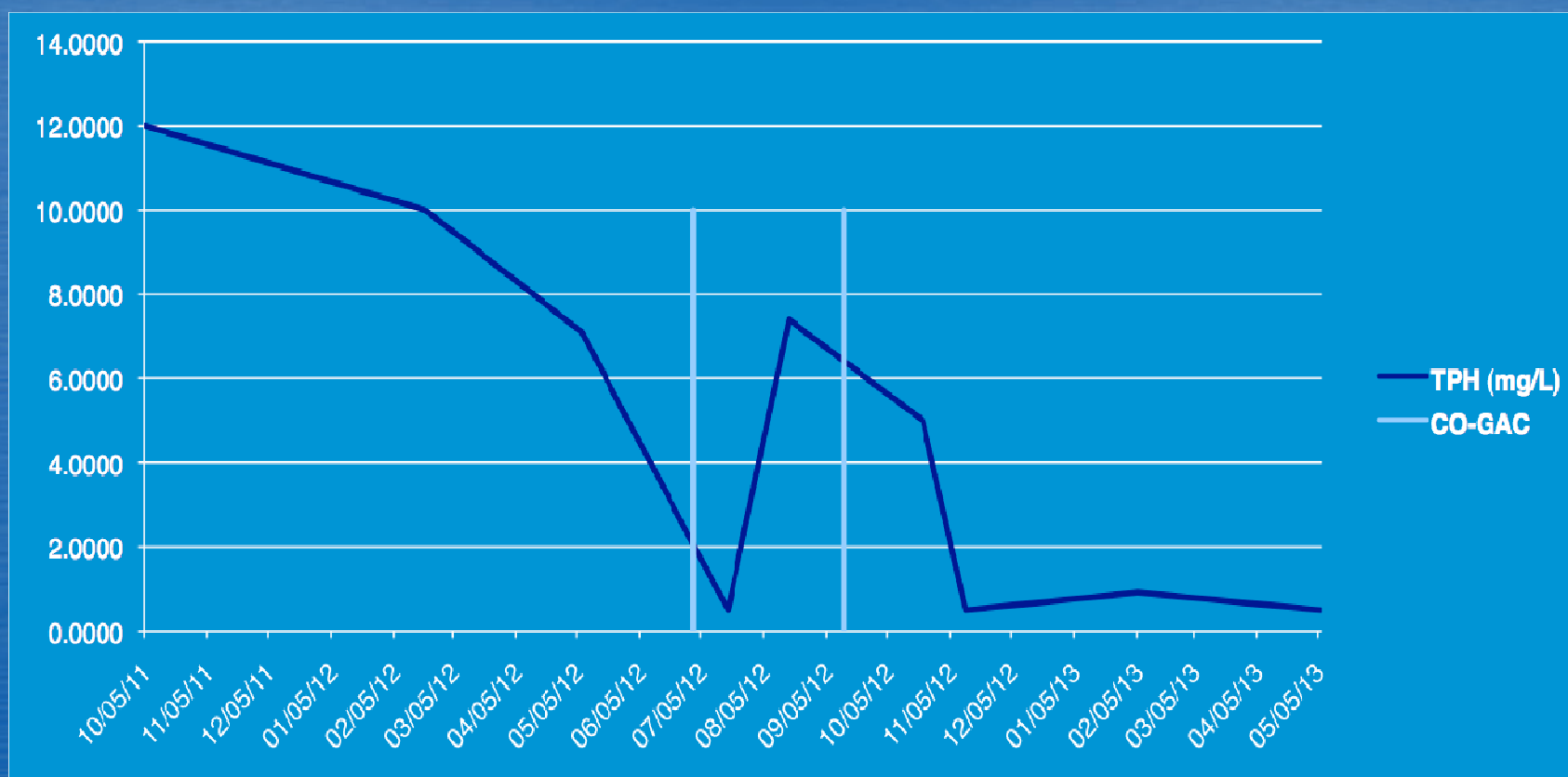


Benzene



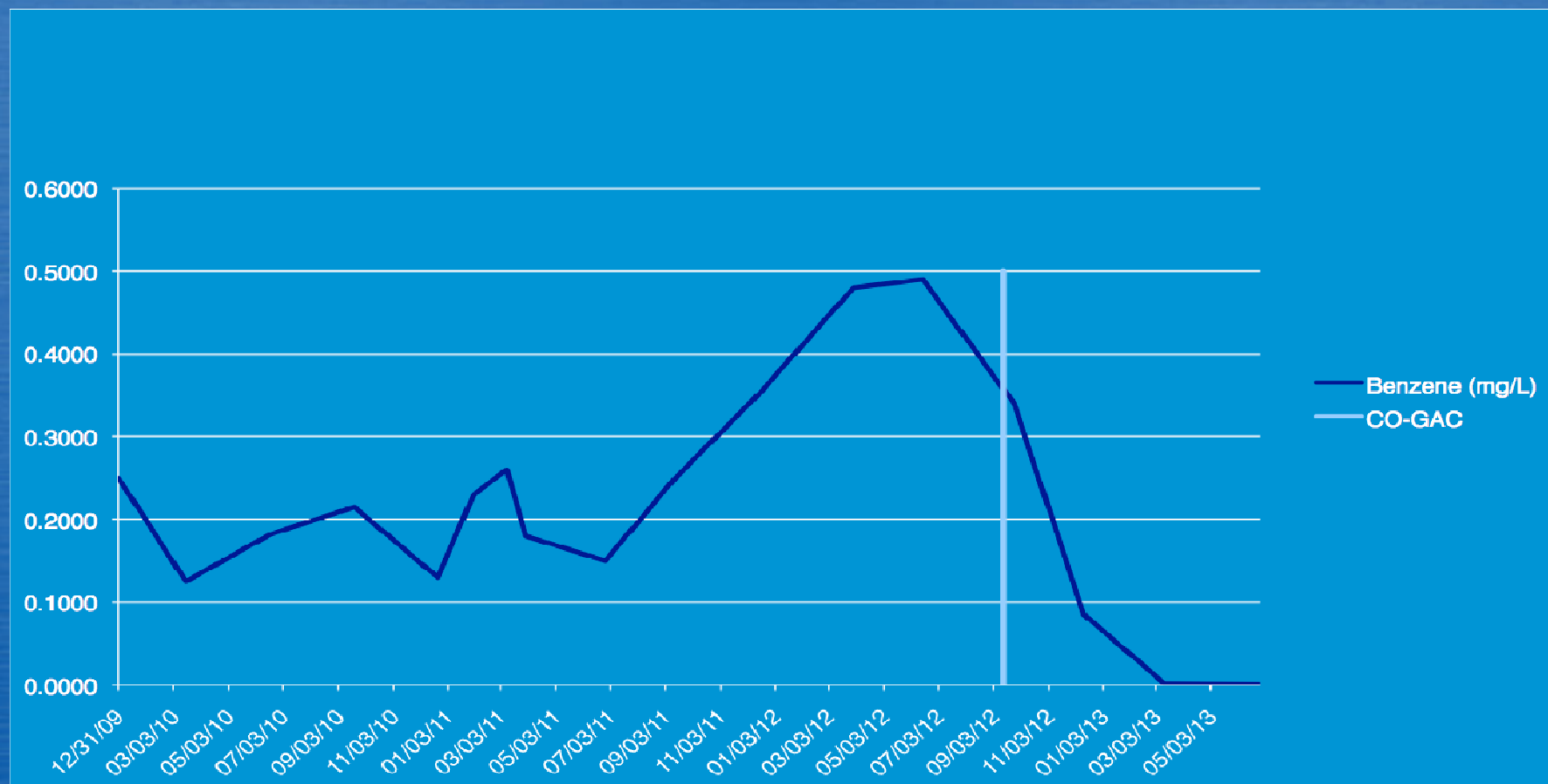


TPH



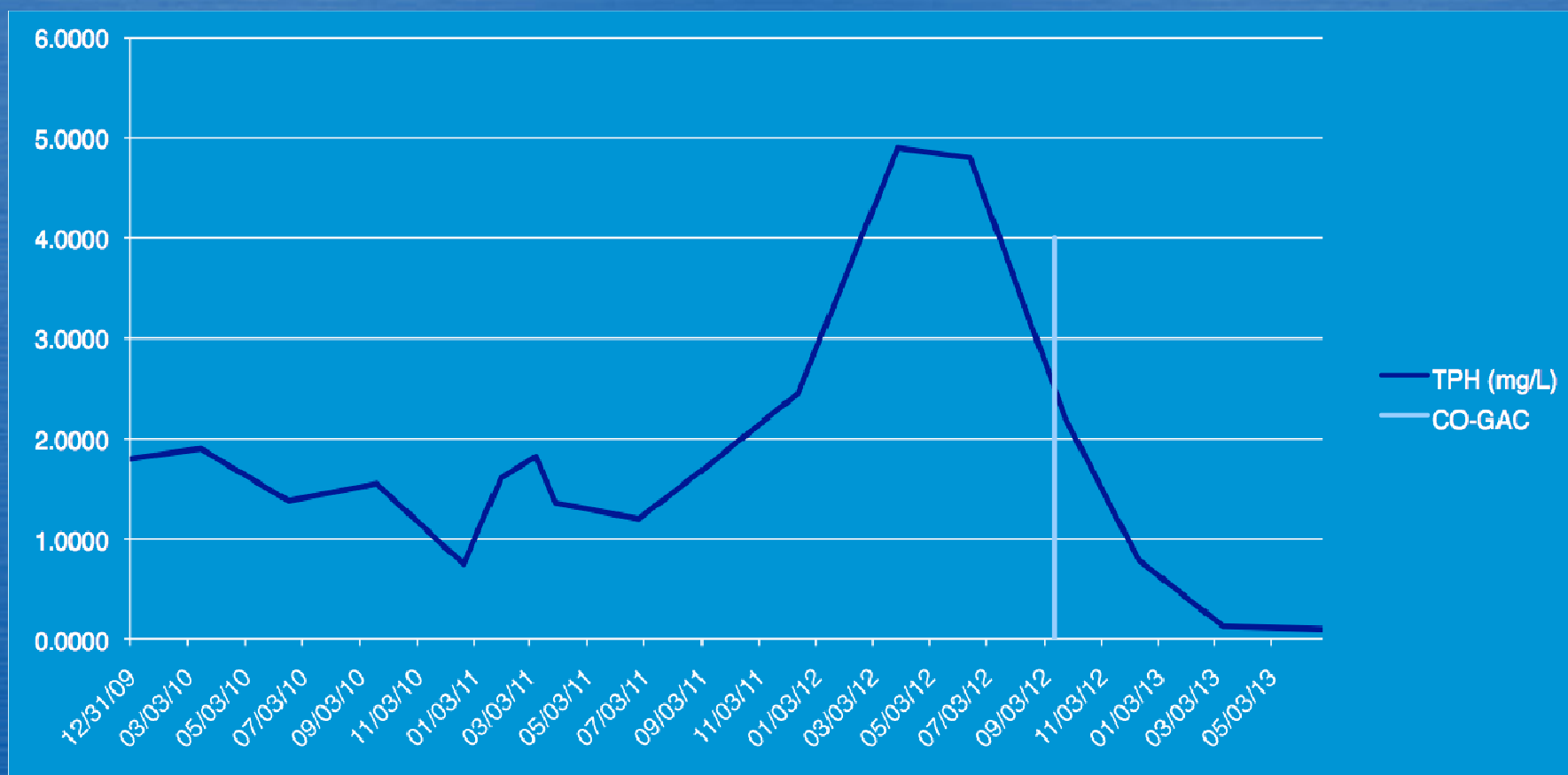


Benzene





TPH





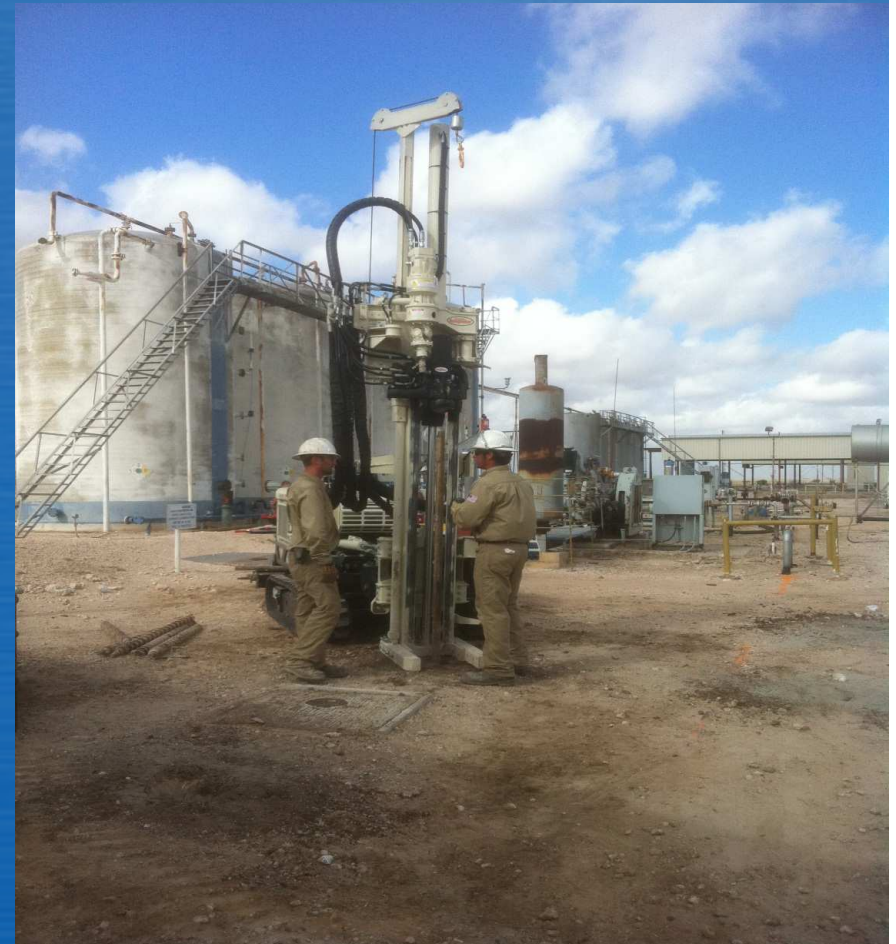
COGAC™ 2013 Year to Date

- 💧 UST Sites - 36
- 💧 Oil Field Sites – 12
- 💧 Industrial Sites – 2
- 💧 225,000 pounds of COGAC™
- 💧 2013 Results – 90% Sites > 80%
Dissolved Phase Mass Reduction after 5
to 1 Quarters Sampling as of October
2013



Injectate Distribution:

- 💧 Injection Depth – surfacing
- 💧 Soil Type – plastic clay – low probability of success
- 💧 Vertical Profile – high vs. low permeability
- 💧 Indurated material – hydraulic fracturing
- 💧 Surface Features
- 💧 Underground Utilities





Injection Dispersion Bench Tests

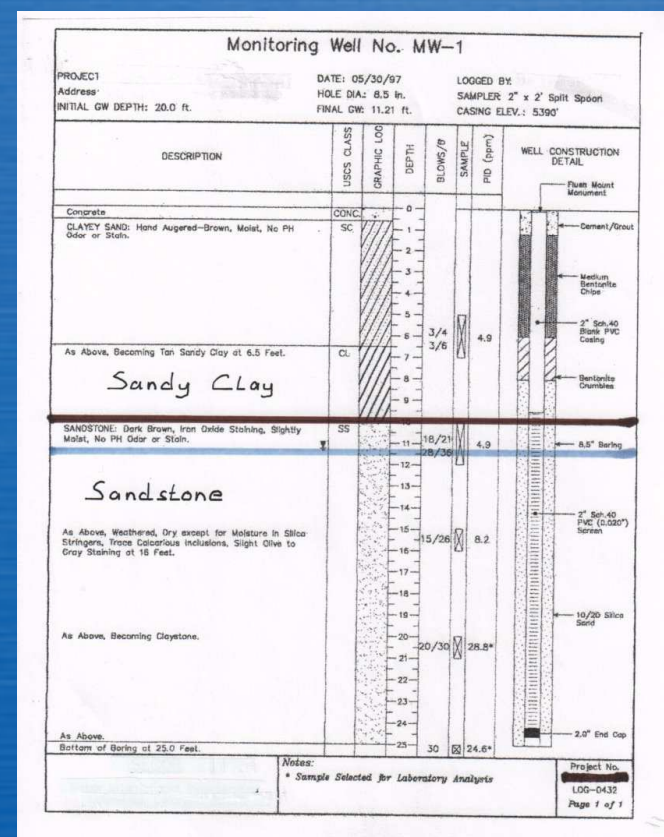
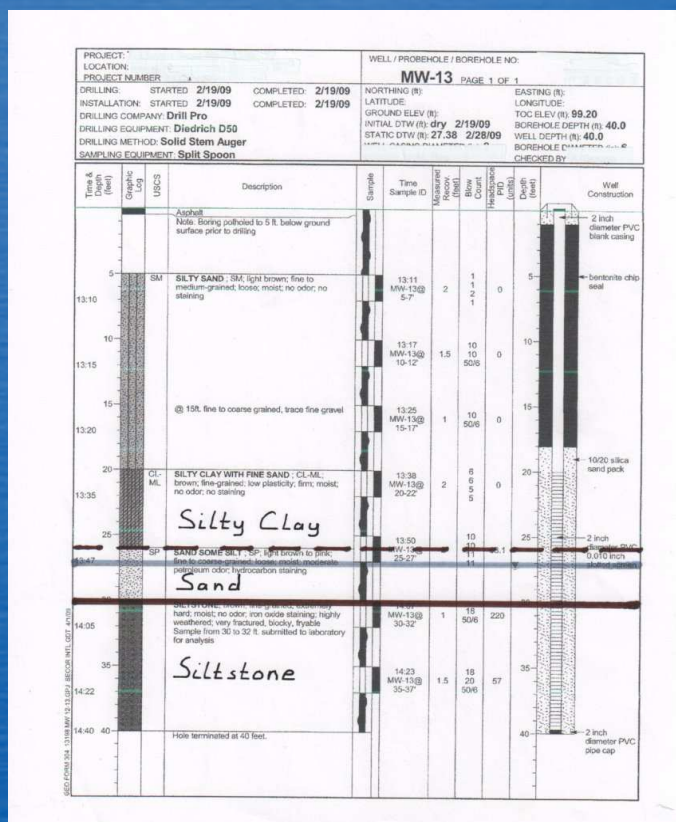




Lithology Geometry

Good

Bad



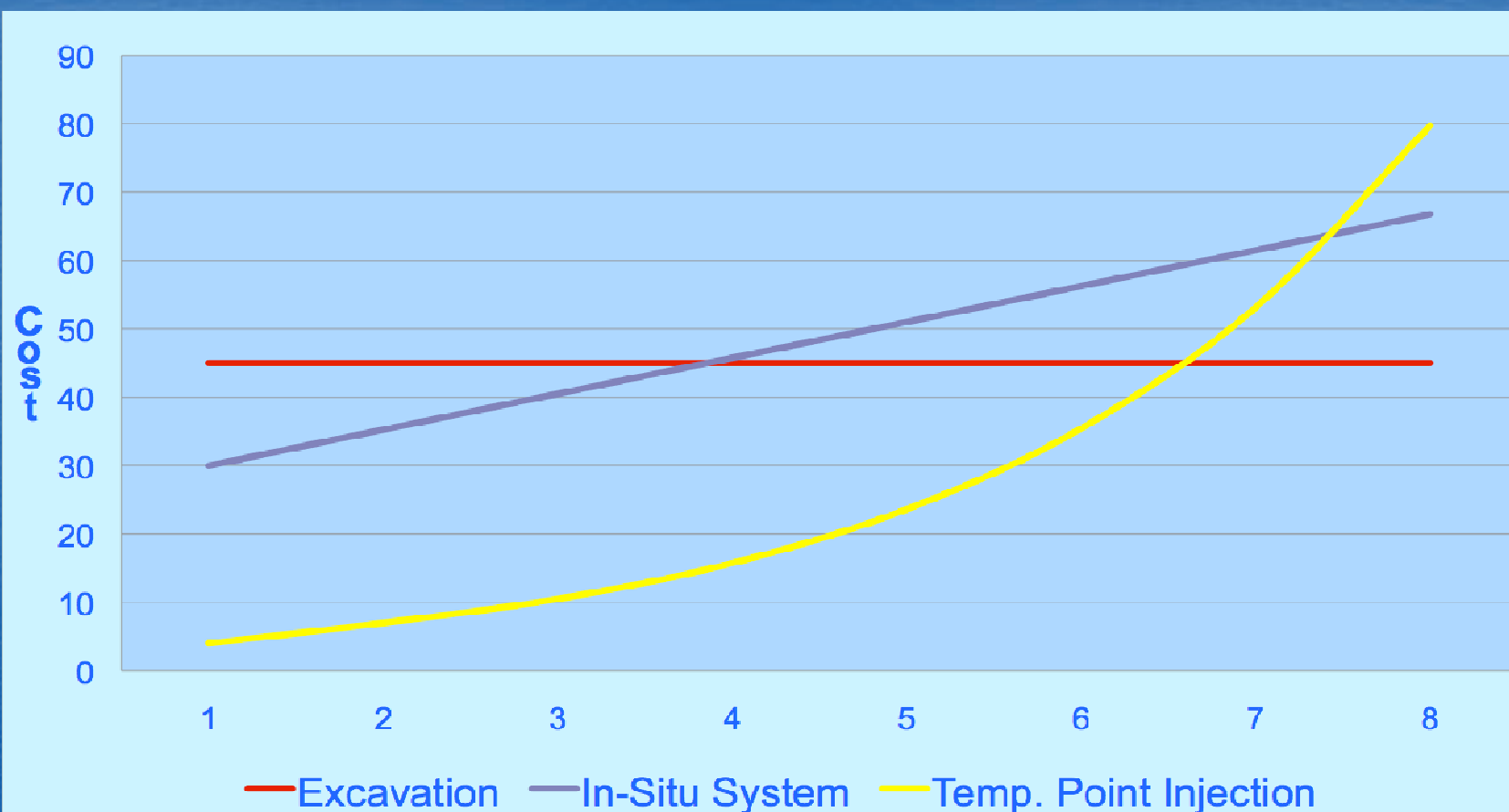


Technology Combinations

- 💧 Low Impact Cellular Excavation/Remedial Backfill/Infiltration System/Injection
- 💧 Fracking Clays and Weathered Bedrock to Improve flow rates for SVE/AS, DPE, etc.
- 💧 Source Area vs. Plume Technology Selection
- 💧 Horizontal Carbon Beds/Removal/Disposal
- 💧 Thermal/Chemical Degradation

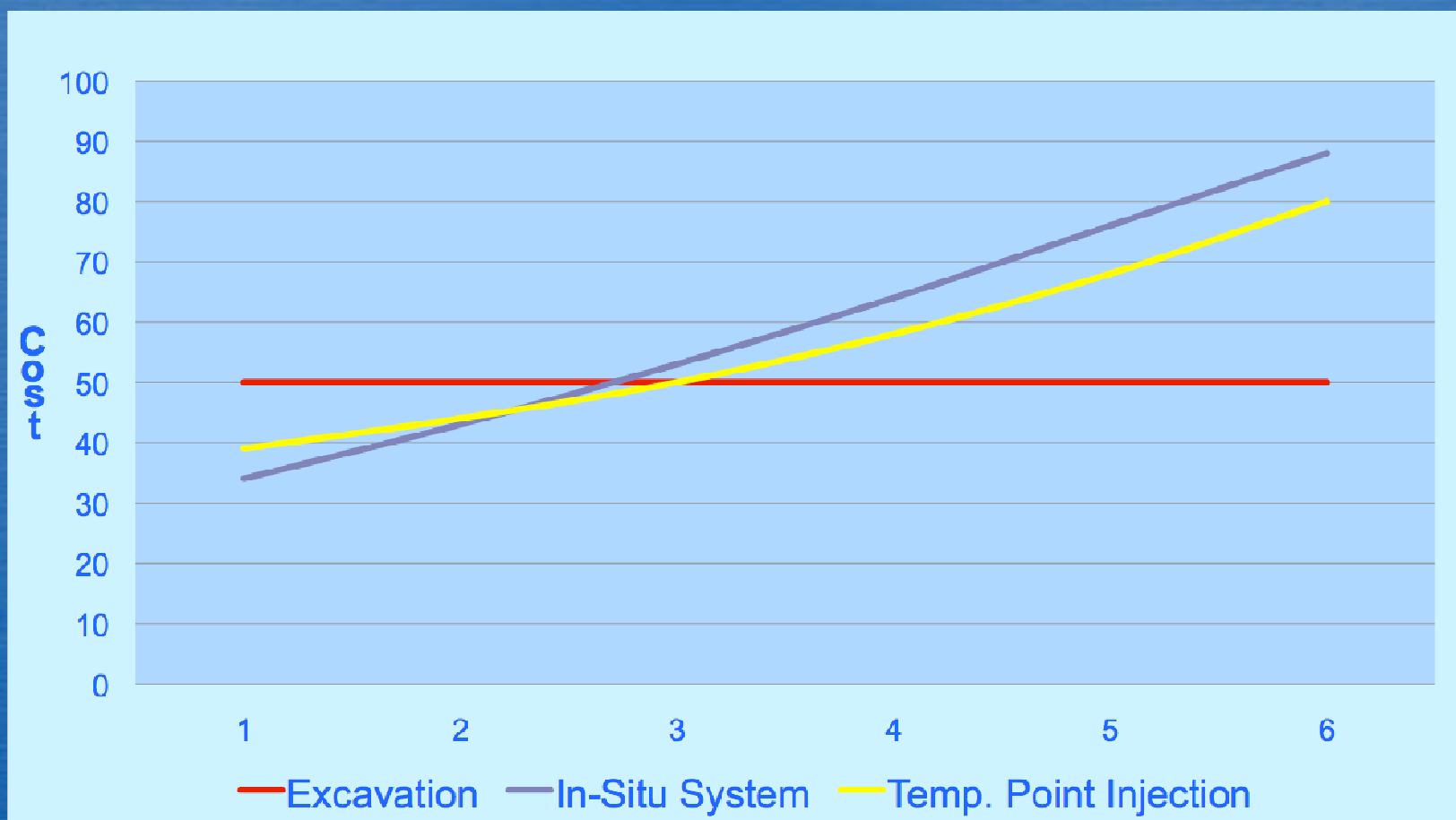


Silty Sand





Plastic Clay





- 💧 **Injected over 10 Million gallons of Remedial Material at over 600 Sites across US**
- 💧 **Zero Lost Time Accidents or OSHA Reportable**
- 💧 **PICS, PECS, LPS, BP, ConocoPhillips, DOT, OSHA Compliant**
- 💧 **All Employees: OSHA, DOT, CDL – HazMat, CPR, First Aid, Health Monitoring, Respirator Training**



Contact Us

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Remington Technologies, LLC is an environmental contractor, specializing in remedial material injection. We are a technical asset to industry consultants by developing and utilizing leading edge technology to successfully cleanup chemically impacted soil and groundwater. Our expertise enables us to resolve problems associated with a variety of site conditions with the ultimate goal of providing the client with clean soil and groundwater. Thus, our motto, "Problem Solved."