



Successful Full Scale
Phytoremediation of PCB and
TPH Contaminated Soil

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The Site

- Scrap Yard
- In operation for about 40 years
- No concrete
- Geology - clay, loess and stainless steel
- Contaminants – TPH (15,000 ppm) and PCBs (225 ppm)
- Aerial extent of contamination - ~2 acres
- Vertical extent of contamination - 3 ft

The Situation

- Owned and operated by two brothers
- Contamination discovered shortly after the death of one and prior to the death of the other
- Antiquated operations made it impractical to pursue remediation without shutting down the business
- Only one descendant left alive to oversee closure of the business and remediation on behalf of the corporation

Attitude of the Regulated

- Frustrated
- Angry
- Saddened by loss of jobs for employees
- Disbelief with respect to threat
- Scared of losing most or all of money that had required years of hard work and long hours to accumulate
- Despite it all, wanted to do the right thing and fix the problem

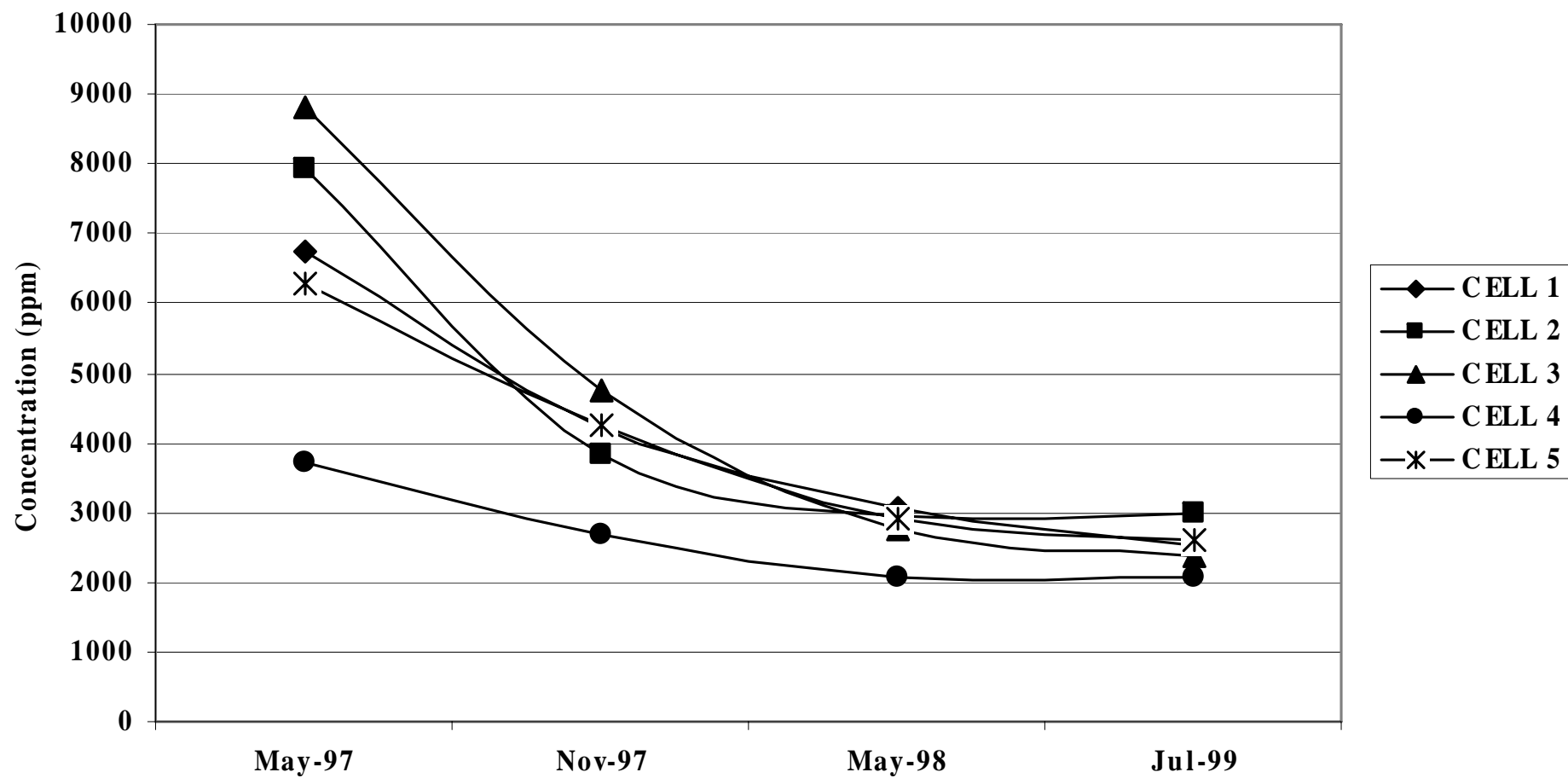
Attitude of the Regulator (MDEQ)

- Knew that the business had money available for cleanup
- Had every intention of ensuring that the regulations were enforced
- Wanted to work with the regulated to minimize impact
- Was open to innovative approaches
- Wanted to see actual destruction of contaminants

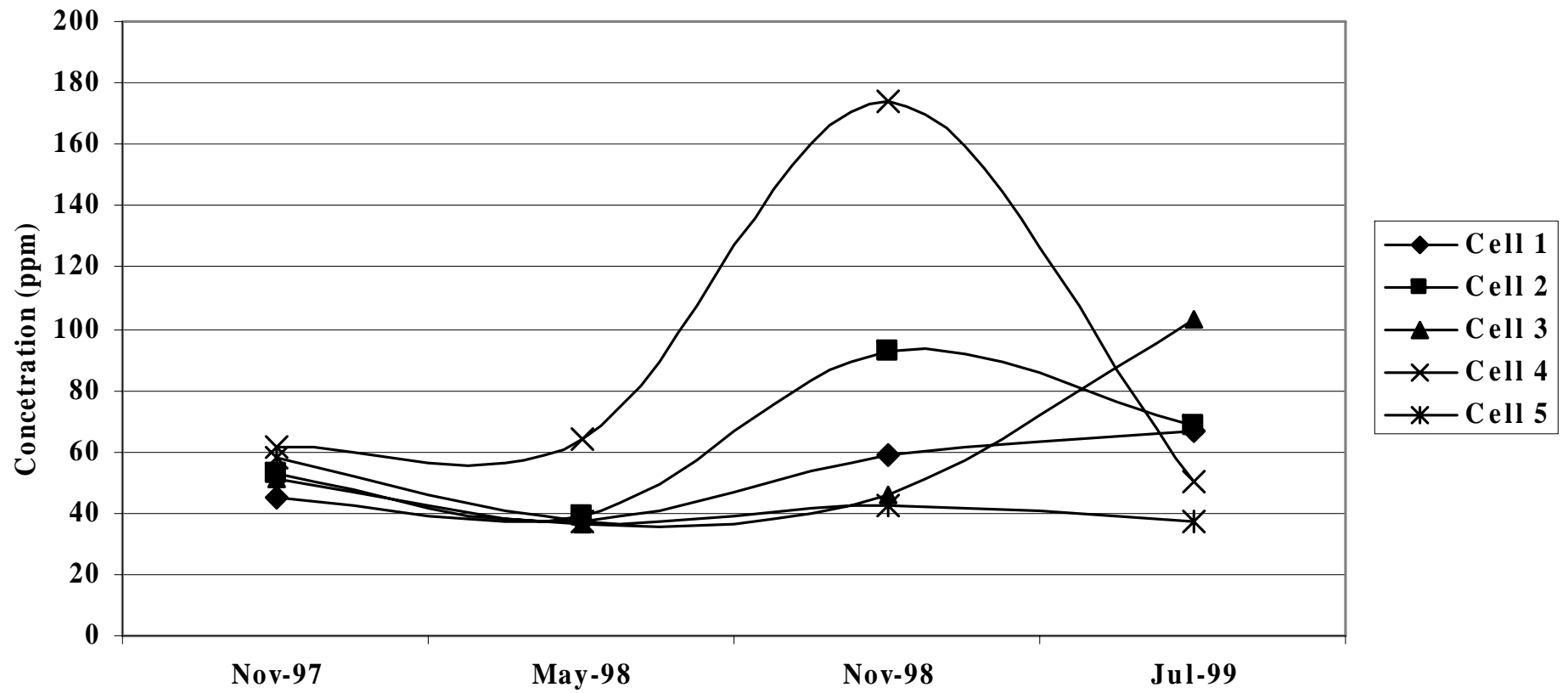
First Attempt - Landfarming

- A dish study was conducted to determine the effect of nutrient, cometabolite and fungal amendments.
- Nutrients helped with TPH degradation in dish study
- A field scale attempt was made to decrease TPH via nutrient addition
- It was hoped that at least the TPH levels could be lowered and reduce the expense of PCB treatment

TPH Trends, 1997-1999



PCB Trends, 1997-1999



Second Attempt - Phytoremediation

- Both sides agreed that landfarming wasn't the answer and probably wouldn't lower TPH to cleanup standards
- Encouraged to look for other approaches
- Phytoremediation was suggested
- A Phytoremediation expert was consulted
- A plan was proposed

Phytoremediation Plan

- Conduct extensive background sampling for PCBs, TPH and nutrients
- Discrete geoprobe sampling (multiple 1 ft core samples)
- Add fertilizer, build irrigation system
- Plant Red Mulberry saplings on two foot centers (PCBs)
- Seed bermuda grass (TPH)

Bad Weather/Worse Timing

- The plan was to plant the trees in January or February. March was the latest we wanted to plant.
- The tree nursery was constantly hit with freezing weather, snow and ice storms until nearly May.
- The trees had been purchased the prior Fall. We had no choice but to plant later than we wanted.



Things Didn't Look So Good

- The trees didn't grow because they were planted so late in the year, mortality was high
- The Bermuda grass grew too well because of the hot weather and irrigation
- Other types of trees/weeds/vegetation were volunteering
- I was beginning to have doubts
- MDEQ remained optimistic and wanted to see it through long enough to give it a chance to work

Replanting

- We needed to make sure that we could actually grow Mulberry trees at the site
- A trial plot was established with trees on 4 ft centers so that we could actually till between the trees to control grass/weed/volunteer tree growth
- We didn't seed Bermuda grass



Site Specific Success

- We proved that we knew how to grow trees on the site,
- We also knew how to grow Bermuda grass
- We knew how to space the trees to make the two work together.

TPH Trends, 2001 - 2002

- 20 lateral sampling locations, 2 discrete depths, comparisons made to background conditions
- Average percentage decrease – 99%
- Average concentration decrease – 3971 ppm
- Maximum concentration reduction for an individual sampling location – 14,800 ppm
- 29 of 40 sampling locations were BDL, the remaining 11 met cleanup standards

TPH Verification, 2003

- 63 lateral locations, 2 discrete depths
- All samples were BDL
- TPH had been completely remediated
- Three PCB samples were taken from the highest concentration areas
- PCB range had decreased from 100 – 225 ppm to 2 to 8 ppm
- Plans were made to sample the ten highest concentration areas to verify PCB trends

Additional PCB Sampling in 2004

Column	Row	Depth (ft)	Units	2000	2004	Percent Reduction
B	3	1	mg/kg	222.6	7.17	97%
A	2	1	mg/kg	142.4	10.2	93%
C	4	1	mg/kg	140.9	5.84	96%
C	3	1	mg/kg	136.1	5.6	96%
C	2	1	mg/kg	131.7	2.68	98%
B	4	1	mg/kg	121	4.44	96%
D	1	1	mg/kg	119.5	3.87	97%
B	2	1	mg/kg	117.2	4.04	97%
B	1	1	mg/kg	111	8.77	92%
A	3	1	mg/kg	105.1	4.38	96%

Full Scale PCB Sampling

- The reductions seen between 2000 and 2004 in the highest concentration areas encouraged us to sample the remainder of the site.
- 208 discrete samples were taken from the site
- The highest concentration found was 8.5 ppm
- 79 of the locations had 1 ppm PCBs or less
- 104 locations had between 1 and 5 ppm PCBs
- The remainder had between 5 and 8.5 ppm PCBs

Take Home Points

- Regulators are the key
 - ◆ Ours had the heart to care about the regulated
 - ◆ Ours had the courage to be innovative
 - ◆ Ours had the dedication to see things through
 - ◆ Ours had the strength to resist pressures to just do things the conventional way

Take Home Points

- The Regulated Must Do Their Part
 - ◆ Ours wasn't adversarial (send your lawyer on vacation)
 - ◆ Ours kept everything above board
 - ◆ Ours called a spade a spade
 - ◆ Ours worked to build a good relationship
 - ◆ Ours believed that the regulator was there to work with him