

Observed Contaminant Half-Lives – Will Natural Attenuation Achieve the Goal?

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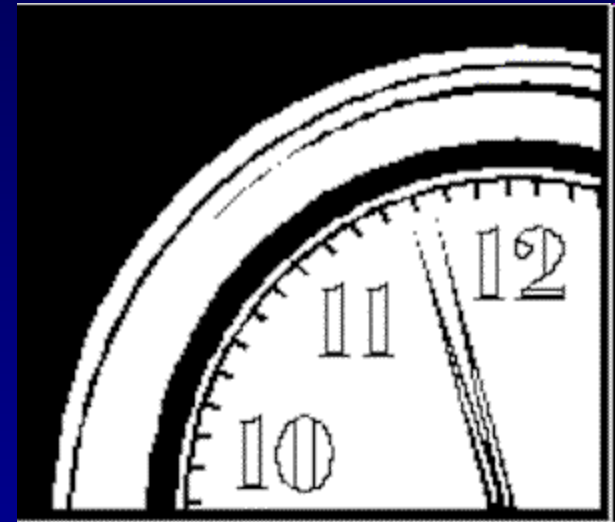
Presenting

- Benzene & MTBE half-life data from
 - 34 petroleum spill sites in mid-Atlantic US
 - 61 benzene & 114 MTBE impacted wells
- How these data might be used to determine whether or not to actively remediate



Outline

- Background
- Approach
- Results
- Analysis
- Conclusions
- Questions



Background

- Release & First Steps
 - Locate spill source
 - Interim recovery (e.g., product recovery, excavation)
 - Characterize the problem
 - Address imminent risks
- Remedial Decision Making
 - **Evaluate necessity / benefit of active remediation**
 - Determine how to remediate
- Remedy Planning and Implementation



Background (cont.)

Benefits & Drawbacks of Active Remediation

- **Possible Benefits**

- **Accelerated cleanup**
- Contaminant containment (if unstable)
- Reduced near-term excessive risk (if any)

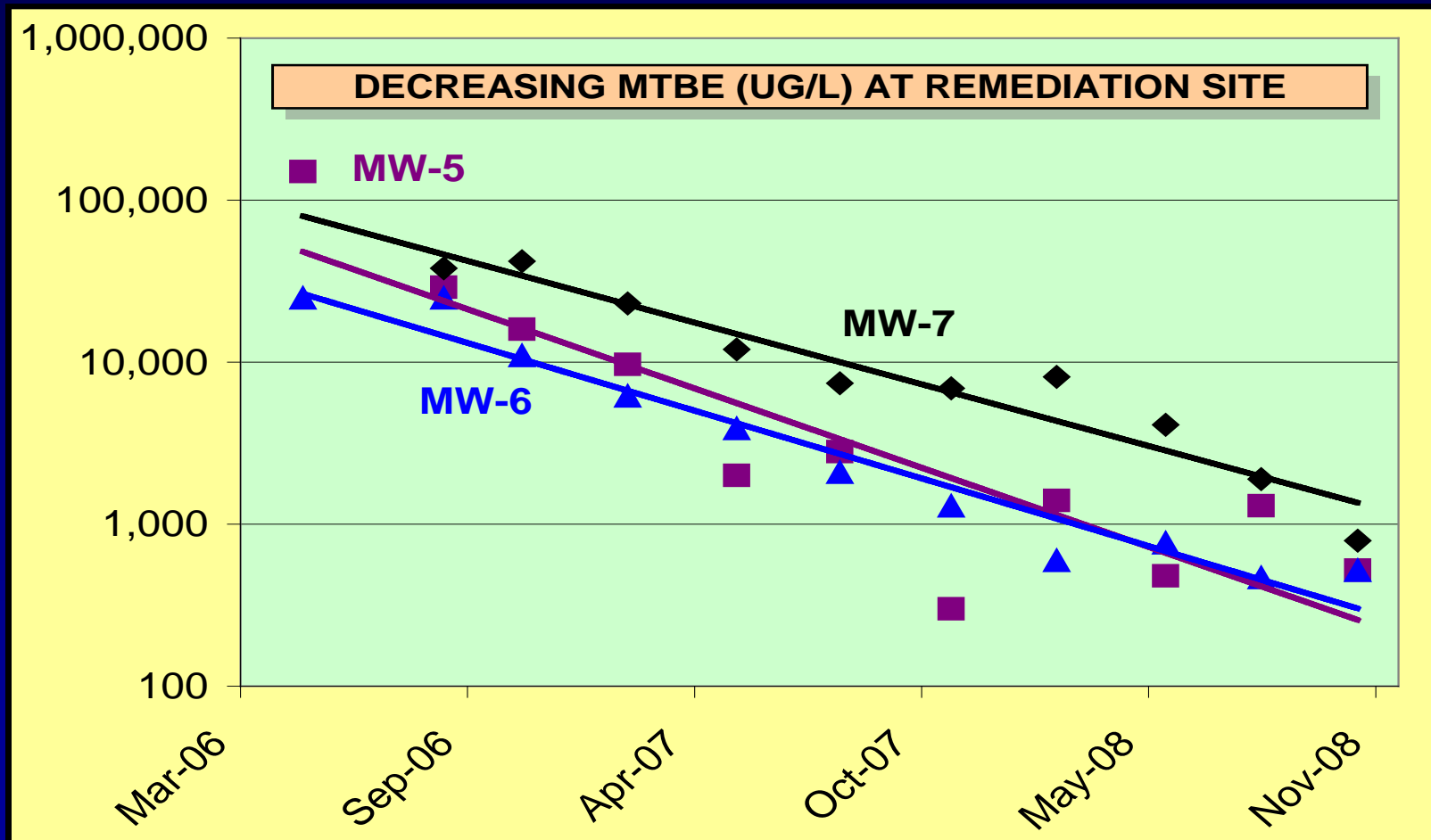
- **Potential Drawbacks**

- Increased cleanup cost
- Front loaded cash flow
- Business disruption
- High energy use
- Other natural resource consumption / depletion
- Human resource intensive
- Air emissions / degradation
- Waste production
- Possibility of disrupting natural attenuation processes underway



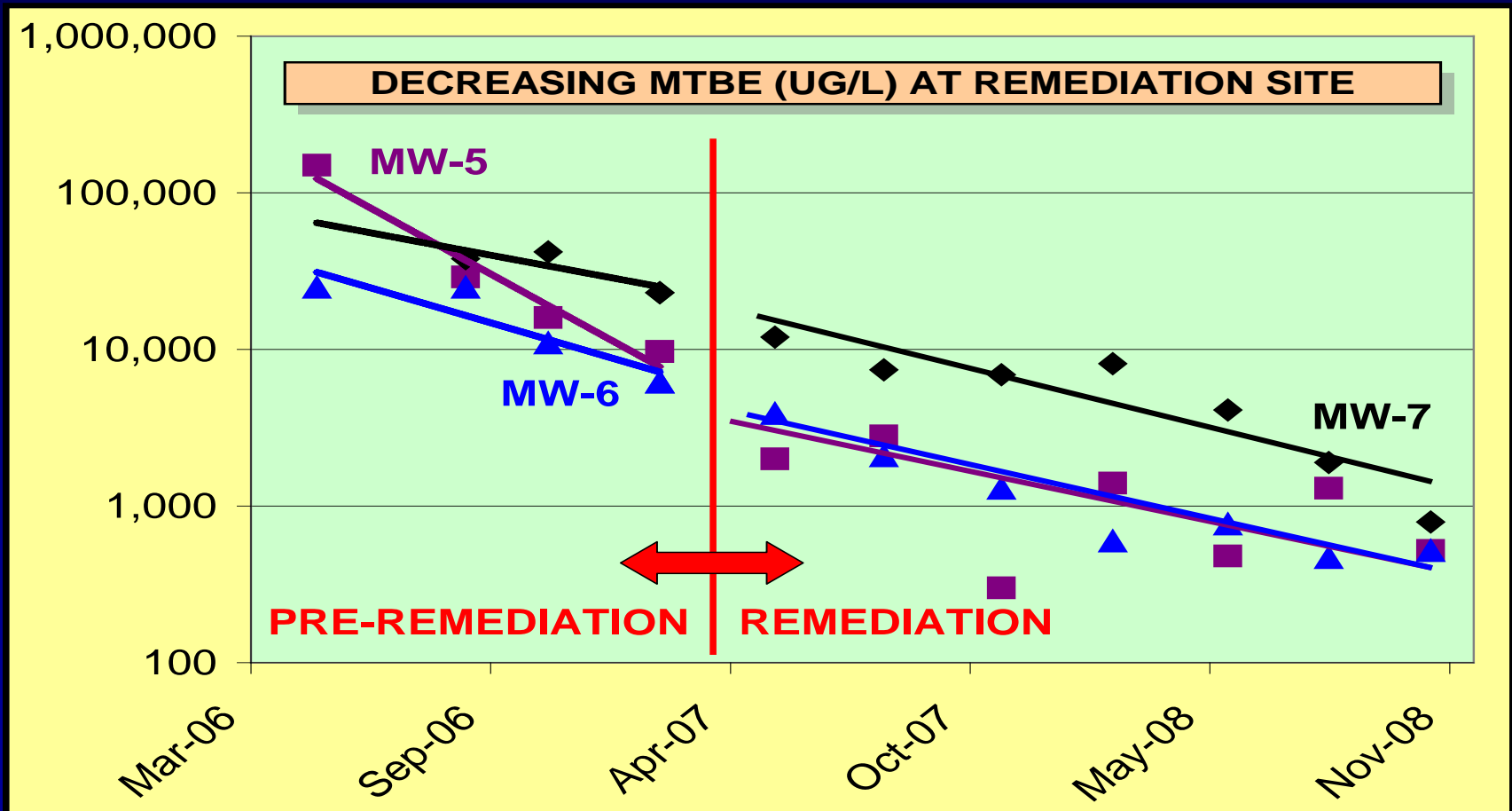
Background

Accelerated Cleanup



Background

Accelerated Cleanup



Background (cont.)

Necessity / Benefit of Accelerated Cleanup

- Key question - how long will NA take?
 - Depends on:
 - NA rates
 - Time needed for NA to achieve target cleanup levels
- Problem - site-specific NA rates not known
- Solution – initially use generic NA rates to bracket NA cleanup time frame



Approach

Deriving & Using Contaminant Half-Lives

- Compiled benzene and MTBE groundwater data
 - 34 MNA sites
 - 61 benzene wells
 - 114 MTBE wells
- Selected wells w/ no historical free product / source material in contracting plume
 - Avoided areas w/ ongoing partitioning of contaminant mass to groundwater



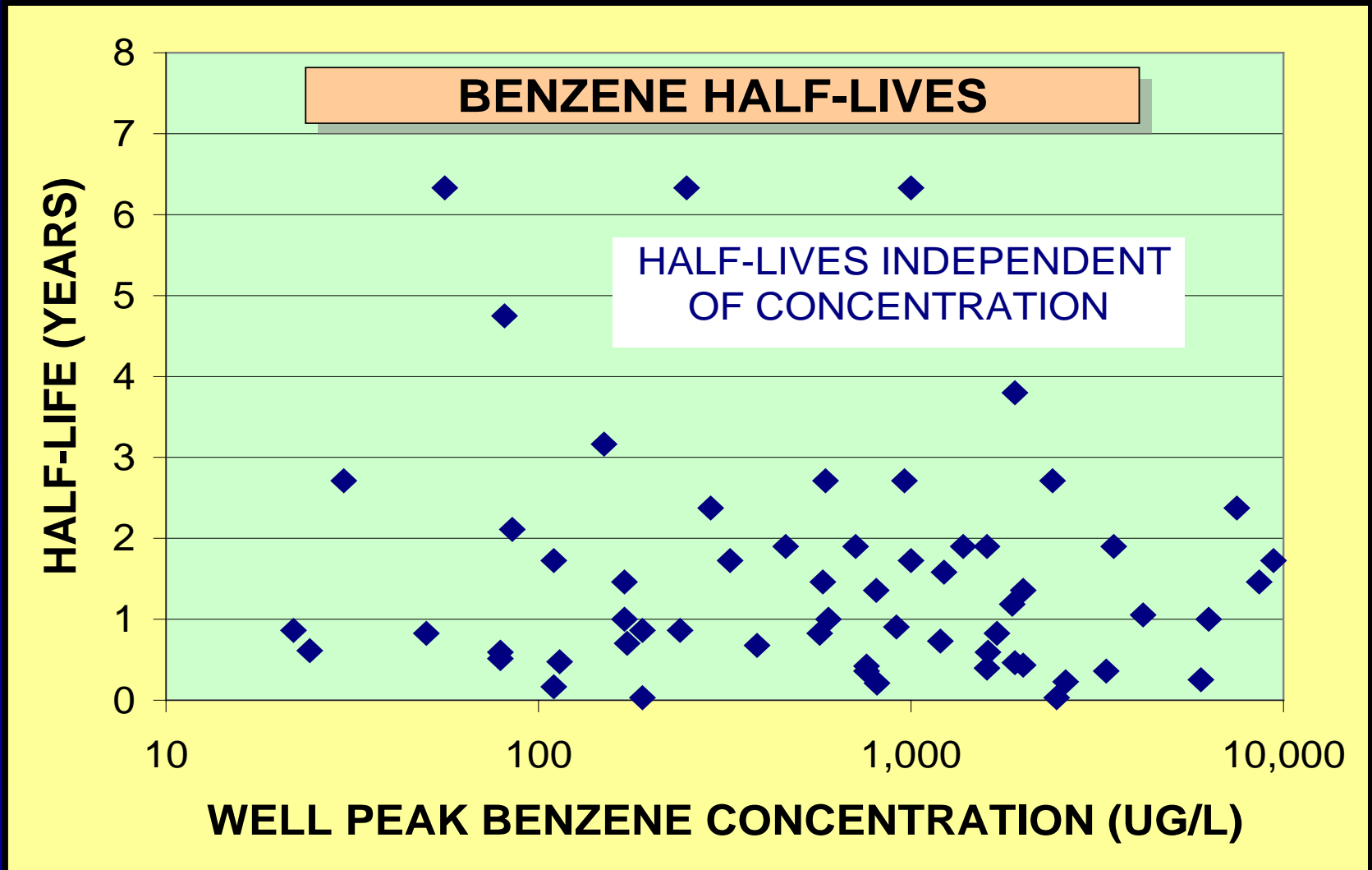
Approach

Deriving & Using Contaminant Half-Lives

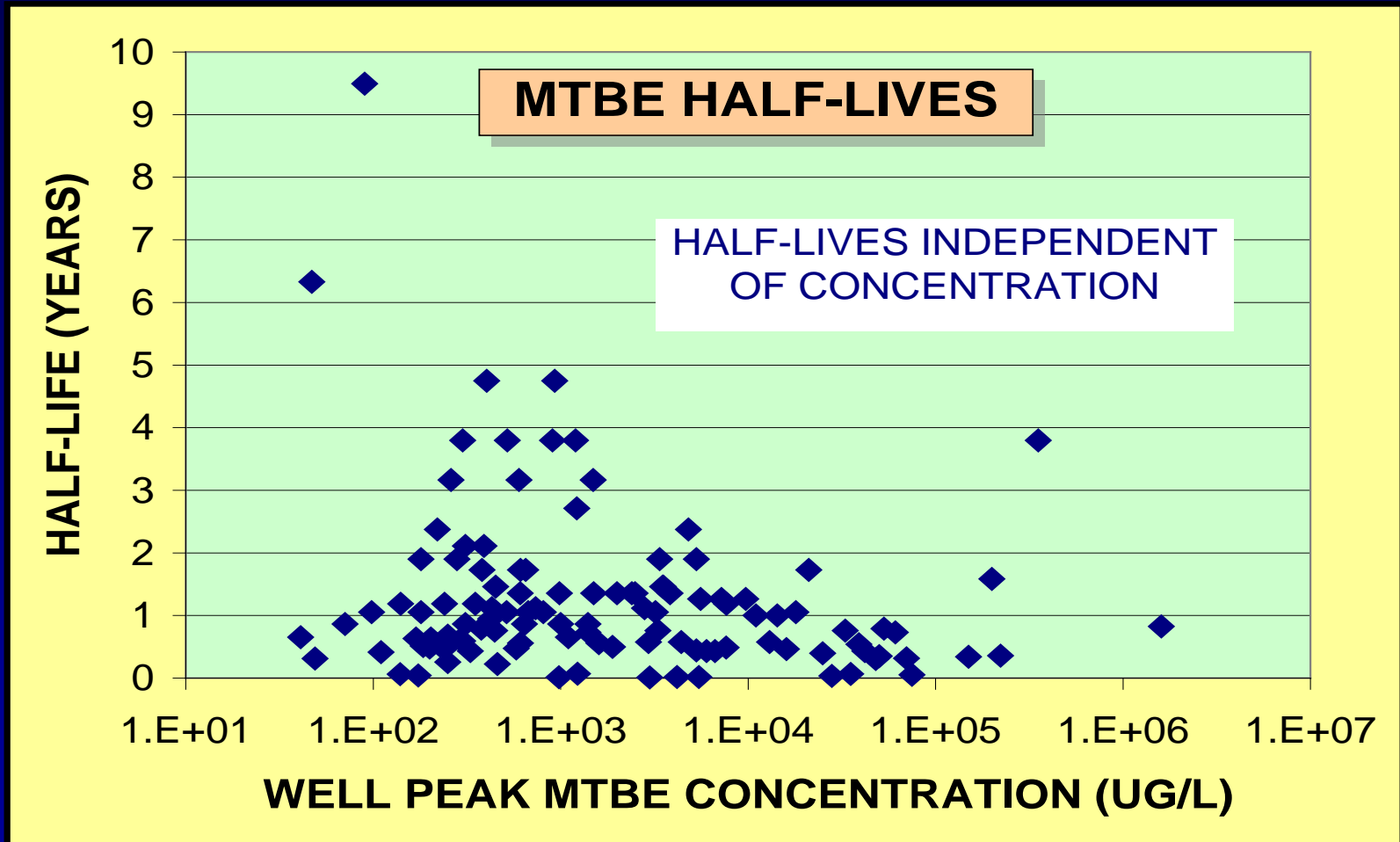
- Fit data to exponential decay curve to derive half-lives
 - $C = C_0 * e^{-k t}$
 - $T_{1/2} = - \ln 0.5 / k$
- Evaluated magnitude & distribution of half-life values by contaminant, geology, and maximum concentration
- Used half-life frequency distribution to assess probability of NA cleanup timeframes



Results (cont.)




Results (cont.)



Results

Half-life (years)


	RANGE	MEAN*		MEDIAN
Benzene	0.03 - 6	1.5	1.4	1.1
MTBE	0.01 - 9	1.3	1.4	0.86

*Half-life data **not** normally distributed – skewed



Results

Median Half-life (years)

	Overburden Wells	Bedrock Wells
Benzene	1.4	0.93
MTBE	1.1	0.82



Results (cont.)

– Half-life data

- No correlation w/ contaminant concentration
- Benzene slightly longer than MTBE
- Bedrock slightly shorter than overburden
- Generally consistent with literature values

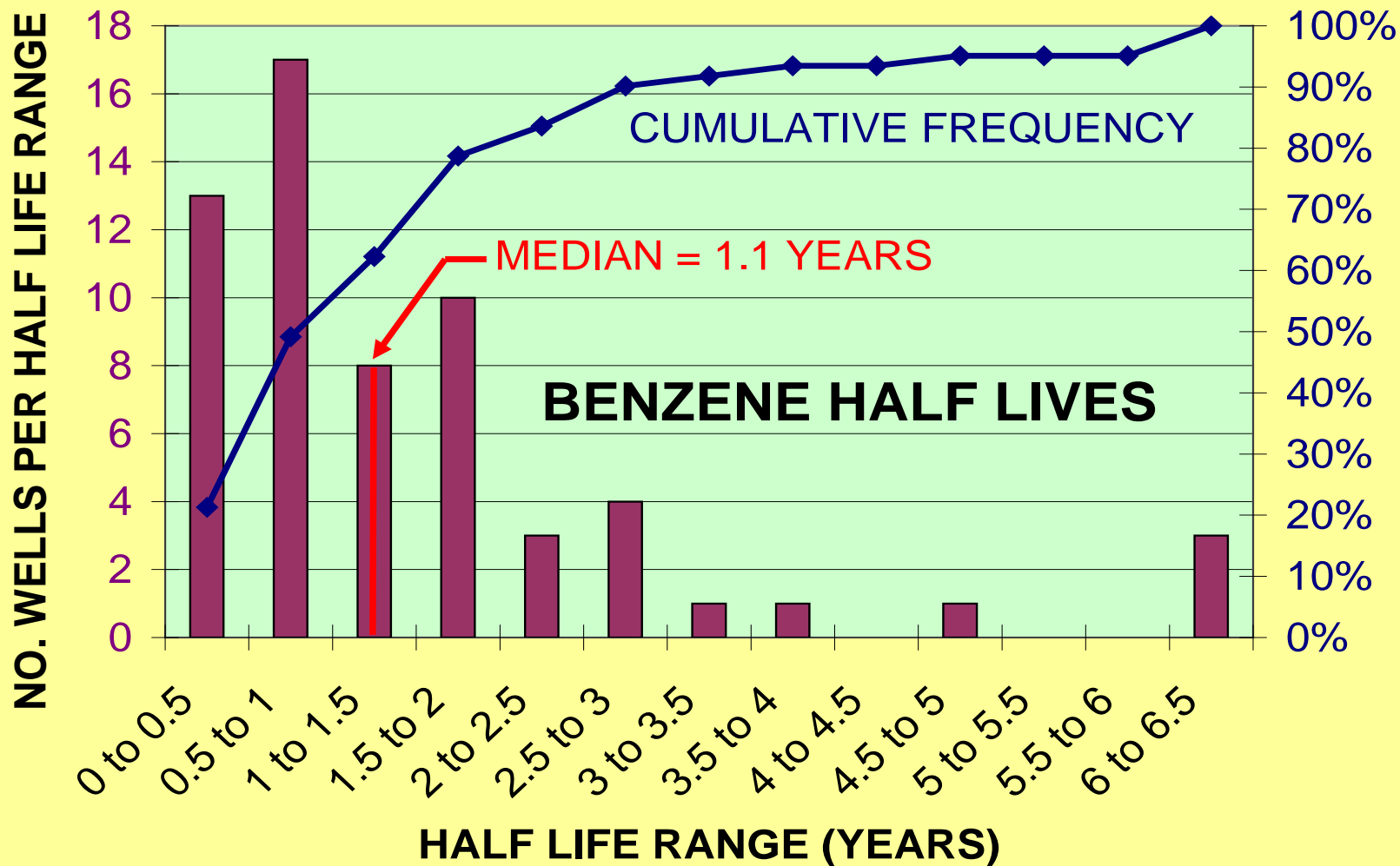
– Main attenuation mechanism

✓ Dispersion & dilution indicated

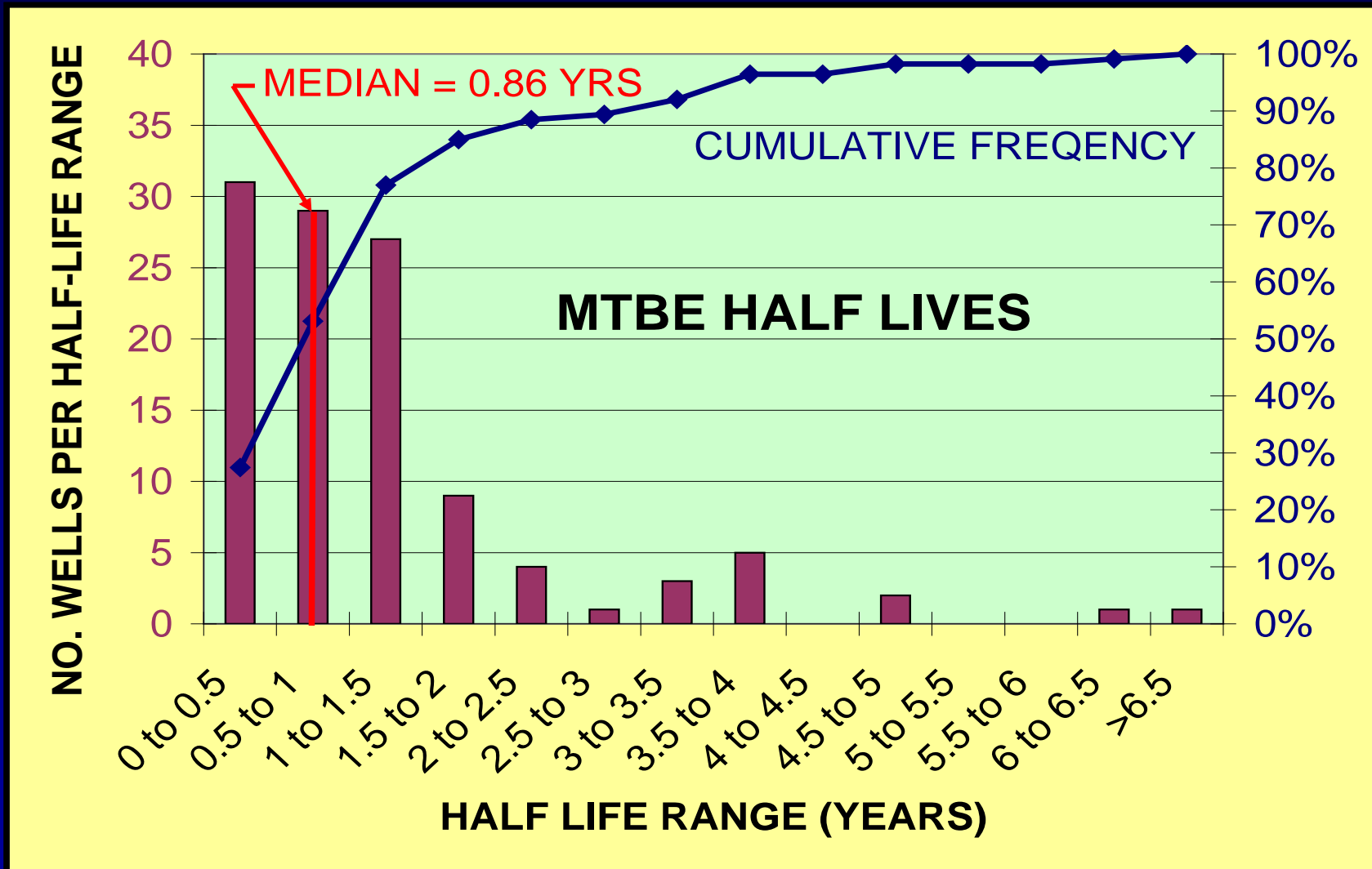
- ✗ Biodegradation favors shorter benzene half-life vs MTBE
- ✗ Volatilization favors shorter benzene half-life vs MTBE



Results (cont.)

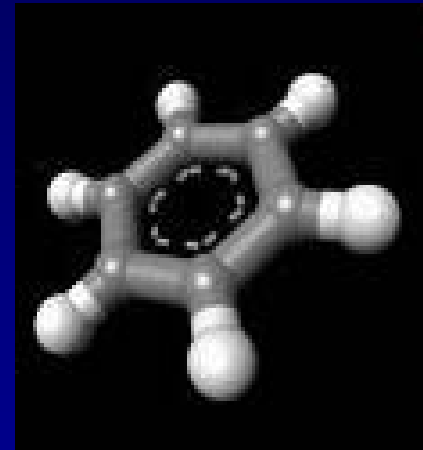


Results (cont.)

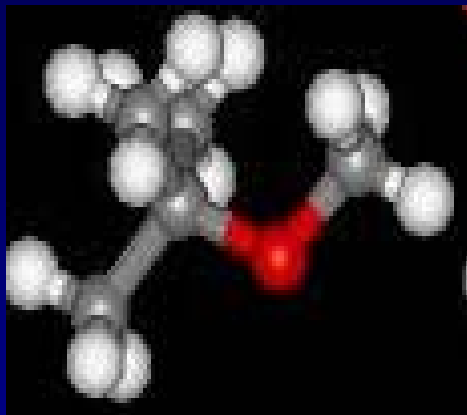


Results (cont.)

- Benzene half life
 - ≤ 0.5 yr in 20% of wells
 - ≤ 1 yr in 50% of wells
 - ≤ 1.5 yrs in 65% of wells
 - ≤ 2 yrs in 80% of wells



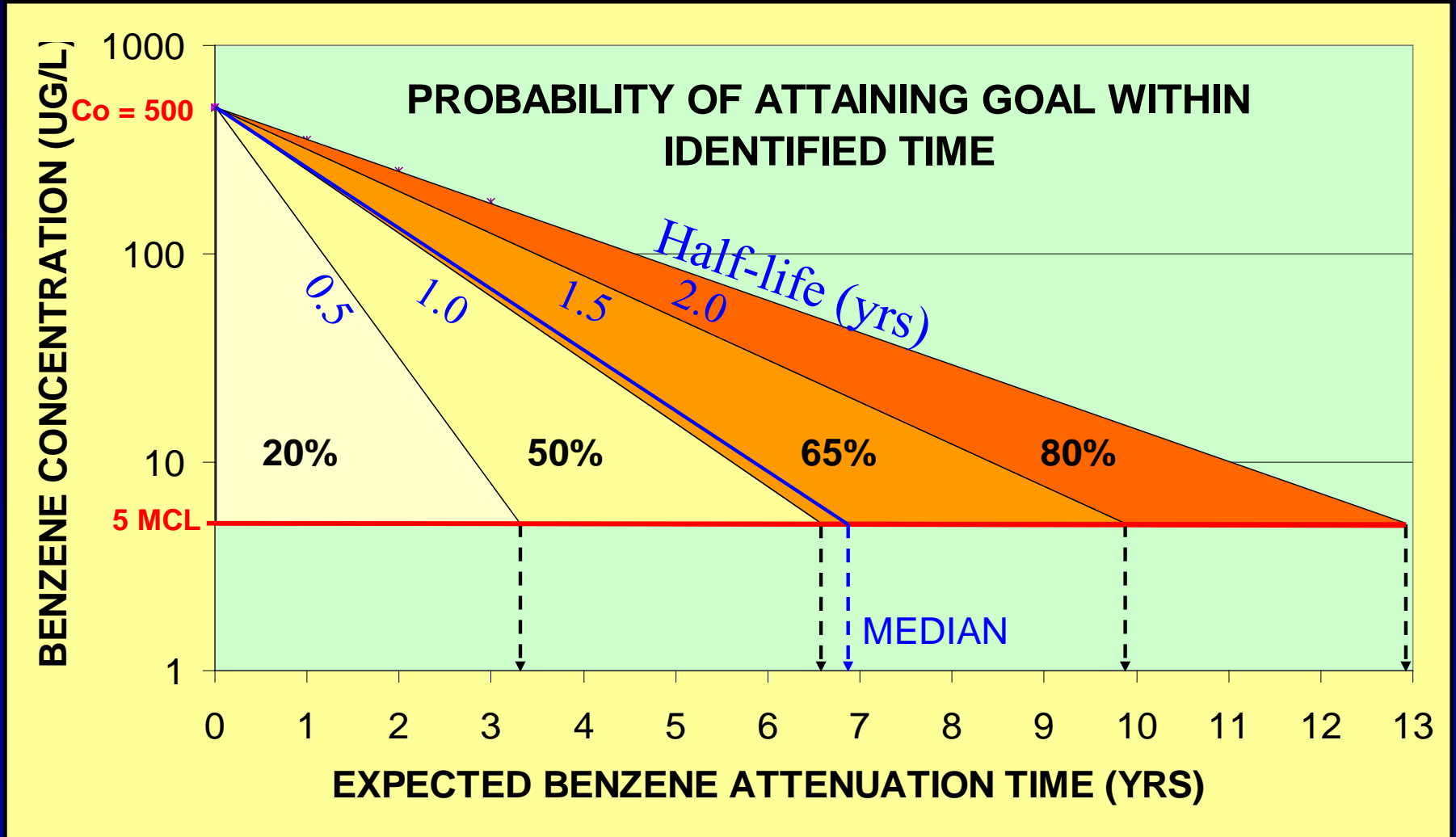
Results (cont.)

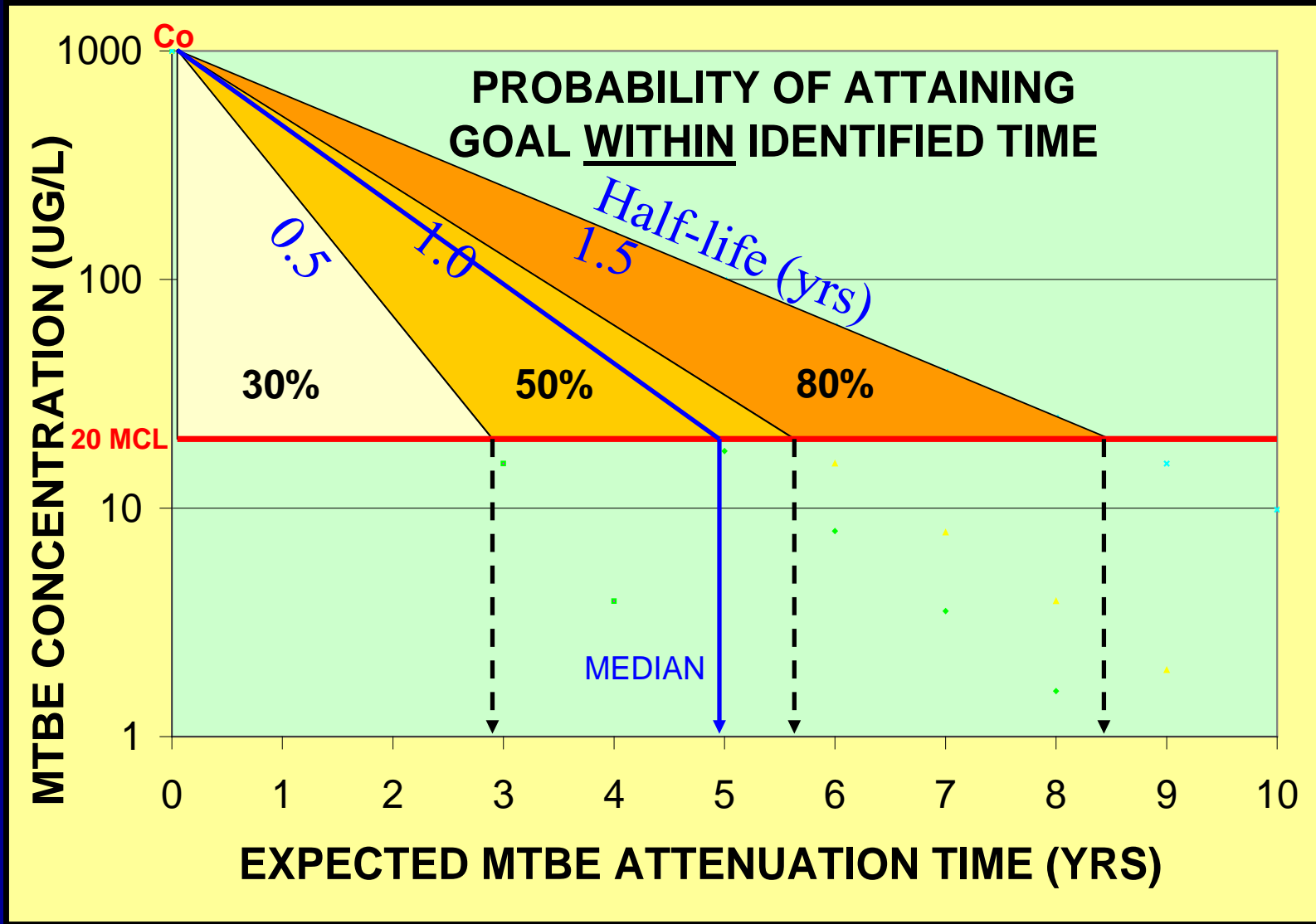


- MTBE half life
 - ≤ 0.5 yr in 30% of wells
 - ≤ 1 yr in 50% of wells
 - ≤ 1.5 yrs in 80% of wells



Analysis





Conclusions

- Benzene & MTBE half-lives derived from 175 non-source area wells at 34 site in mid-Atlantic US
- Half-lives
 - Independent of initial concentration
 - Median: benzene 1.1 yrs; MTBE 0.86 yrs
 - Shorter in bedrock than overburden wells
 - Generally consistent with literature values
- Attenuation mechanism indicated– dispersion / dilution



Conclusions (cont.)

- Half-life frequency distributions from this & other studies may be used to bracket likely NA time frames
- Probable NA rates / time frames may help determine whether it is cost effective to actively remediate



Acknowledgements

- Coauthors:
 - Michael Lowe*
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 - Ross Tabachow*

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Questions, Comments, and Discussion

