World-Recognized Expertise Leveraged At the Local Level

From engineering iconic skyscrapers, to using microbes to clean up hazardous waste - and everything in between.

36,000 passionate professionals, 500 offices, 40 countries strong

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Generating Definitive Data for Biodegradation:

Case Studies on Practical Use of Stable Isotope Probing

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Christine Warford – WSP Minneapolis
Judy Andrews – WSP Minneapolis
Daniel Liwicki – WSP Denver

Stable Isotope Probing (SIP)

Why *use SIP*

How *does it work*

When *to use - 3practical examples*

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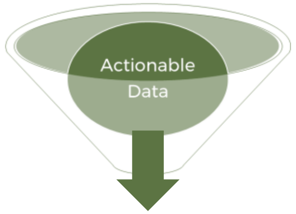
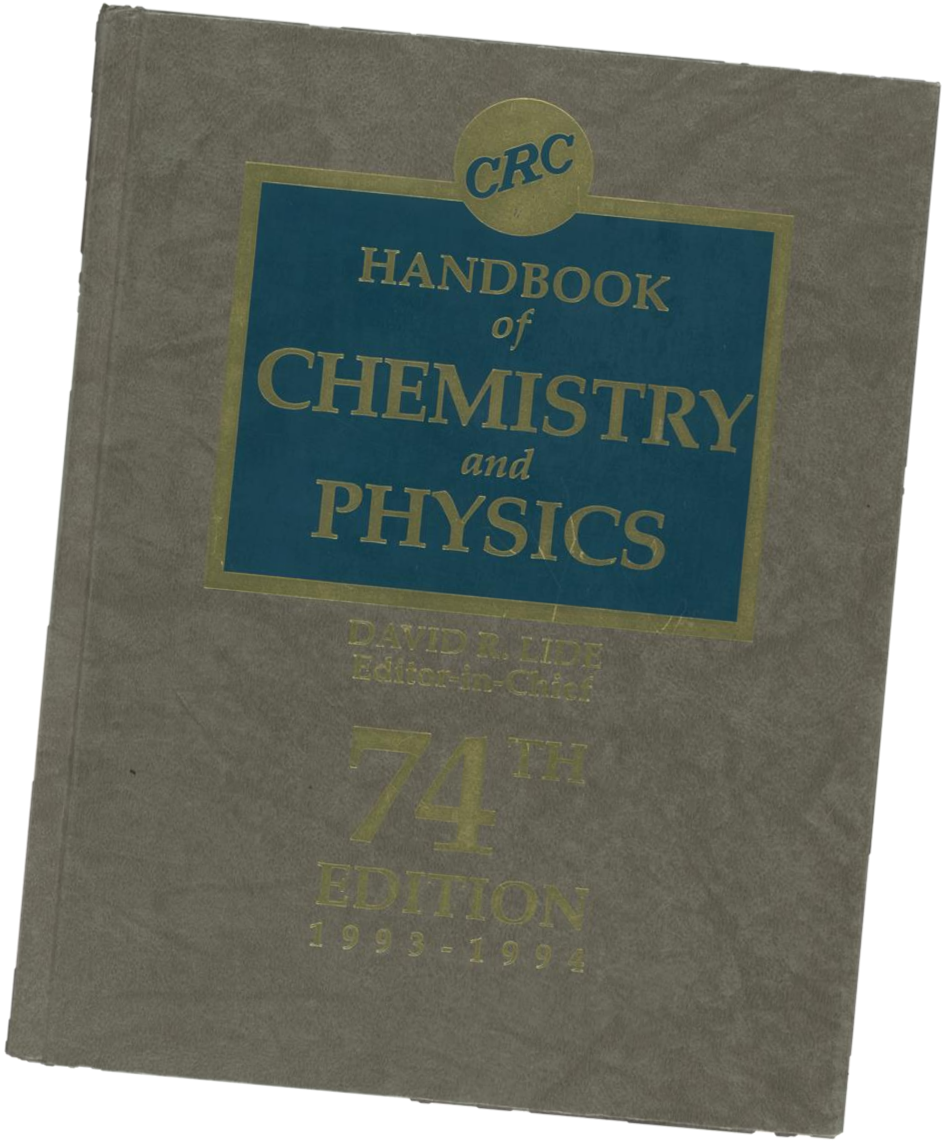
WHY

Actionable Data:



Actionable Data:



Actionable Data:

What Matt Calls Fail Small/Win Big

Definition: Actionable data that defines efficacy and/or mechanism of contemplated treatment strategy performed using site media at sub full-scale

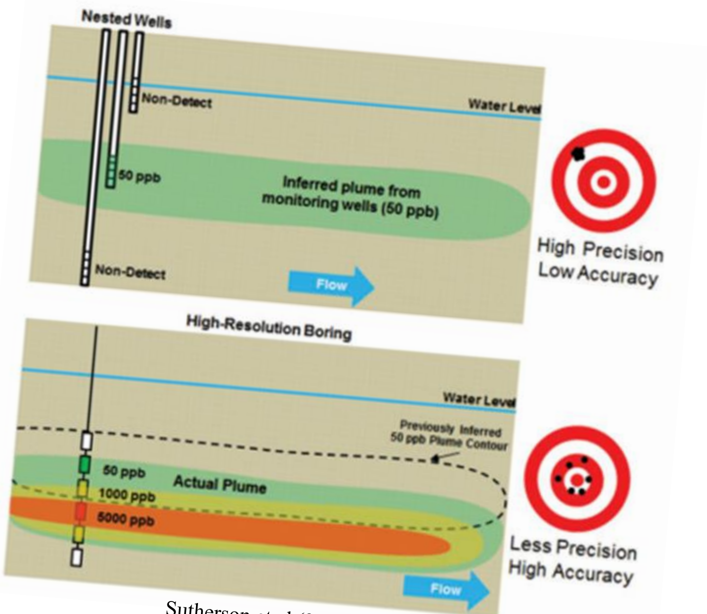
Bench-Scale: *Ex situ*

- Matt typically uses for abiotic (ISCO/ISCR) treatment options
- Estimate amendment dose
- Confirm stability across varying conditions
- Identify undesirable intermediates
- Check for full-scale safety concerns (e.g., heat, off gassing, etc)

Actionable Data

Definition: Any data collection activity specifically planned to define project direction

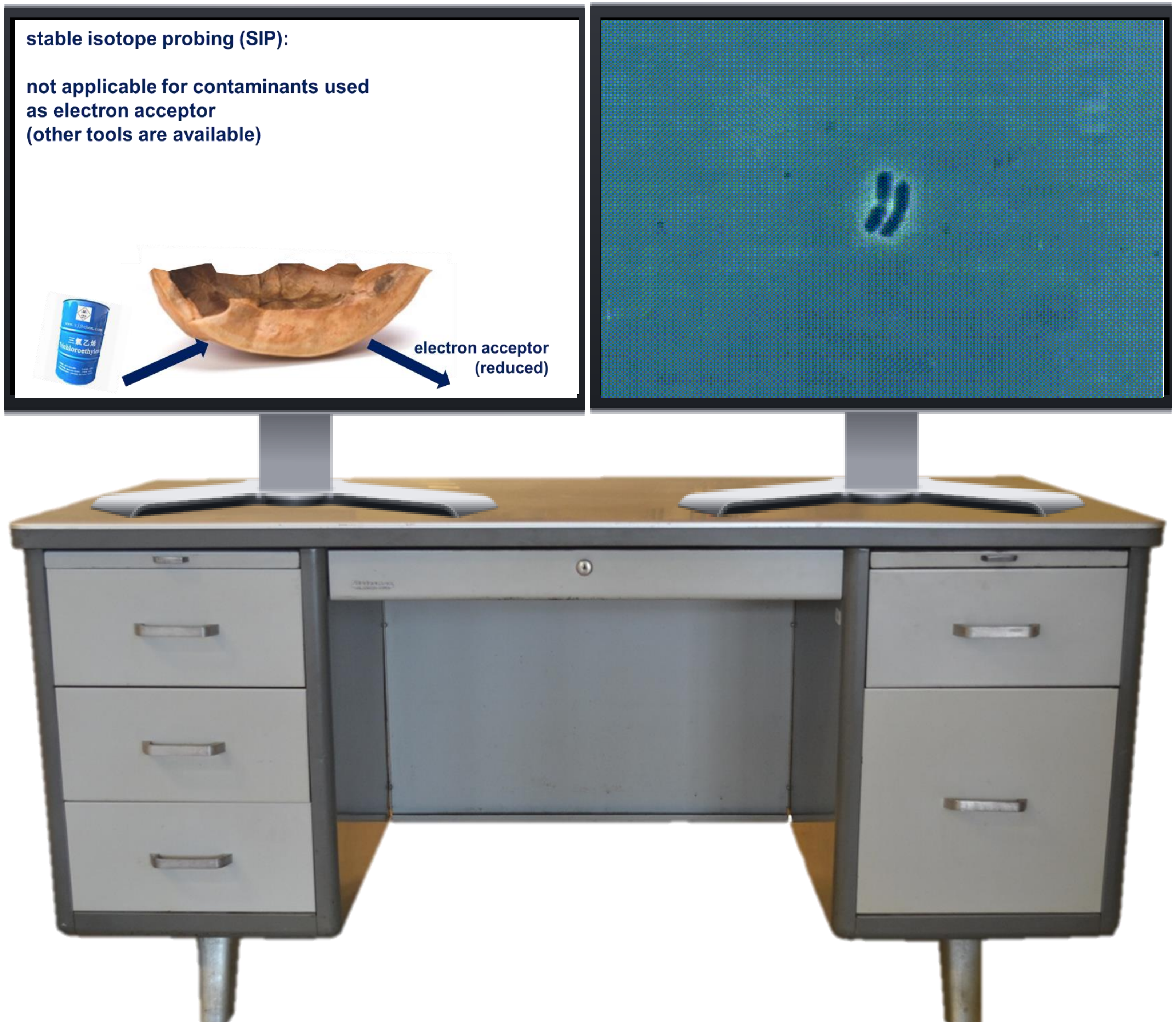
Example:



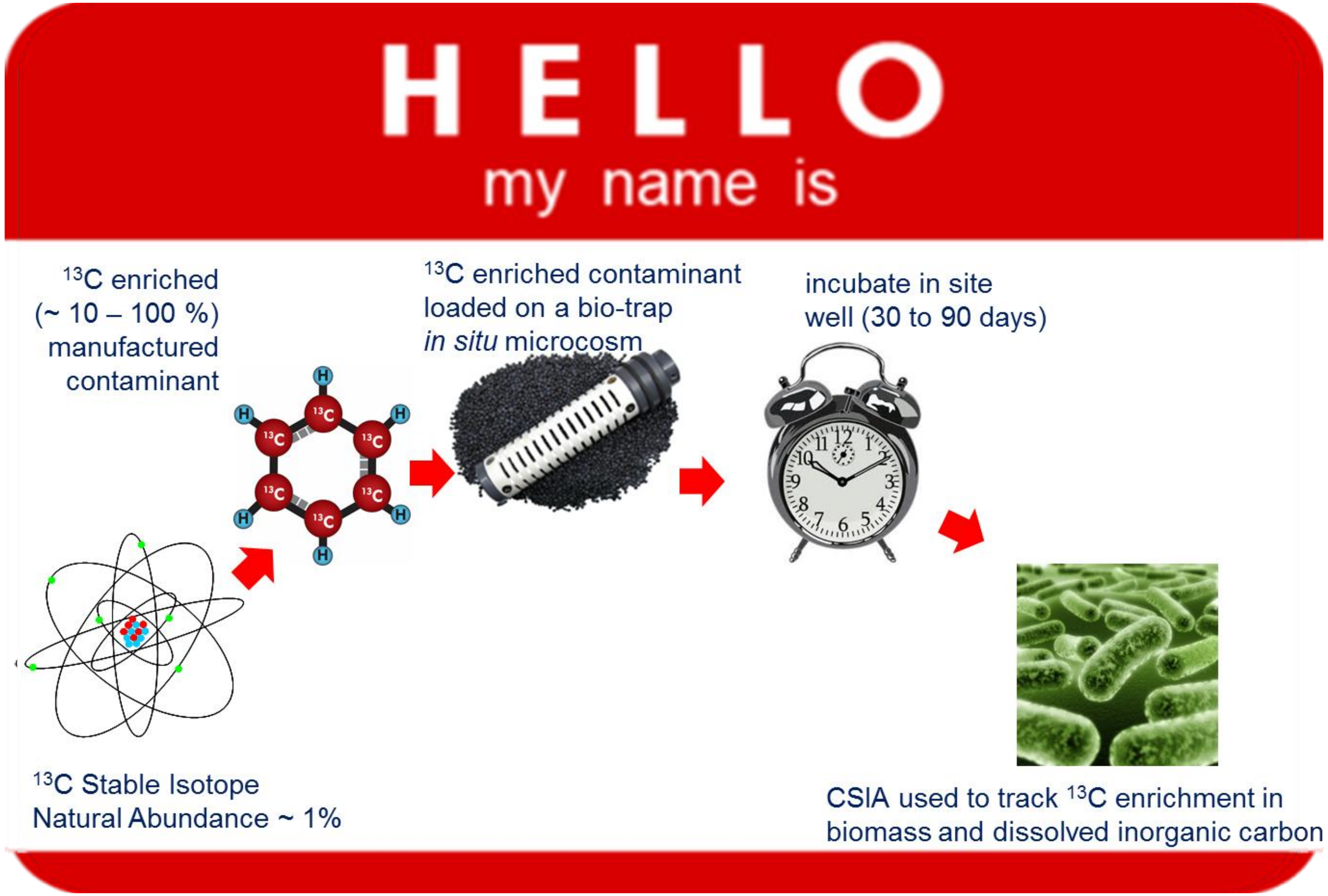
Sutherson et al (2015)

HOW

Stable Isotope Probing



The SIP Label



WHEN

Groundwater Treatment Case Studies

Case Study 1 – MNA vs Enhanced Aerobic Treatment of Benzene

Case Study 2 – Bio Contribution of a Chem/Bio Treatment Train of Benzene

Case Study 3 – Stimulating Multiple Degradation Pathways for the Treatment of Chlorobenzenes

Case Study 1: MNA vs Enhanced Aerobic Treatment of Benzene

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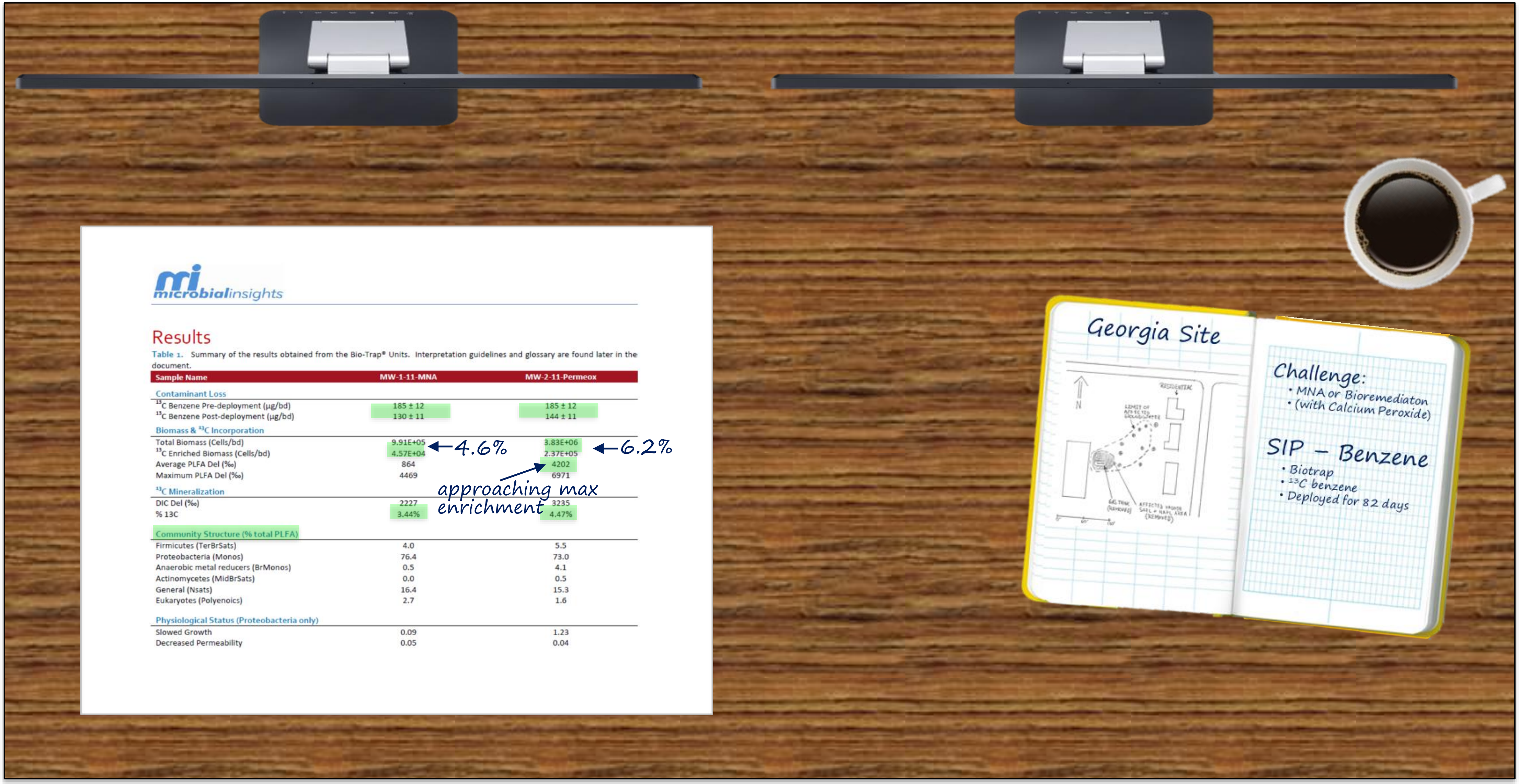

microbialinsights

Results

Table 1. Summary of the results obtained from the Bio-Trap® Units. Interpretation guidelines and glossary are found later in the document.

Sample Name	MW-1-11-MNA	MW-2-11-Permeox
Contaminant Loss		
^{13}C Benzene Pre-deployment (µg/bd)	185 ± 12	185 ± 12
^{13}C Benzene Post-deployment (µg/bd)	130 ± 11	144 ± 11
Biomass & ^{13}C Incorporation		
Total Biomass (Cells/bd)	9.91E+05	3.83E+06
^{13}C Enriched Biomass (Cells/bd)	4.57E+04	2.37E+05
Average PLFA Del (‰)	864	4202
Maximum PLFA Del (‰)	4469	6971
^{13}C Mineralization		
DIC Del (‰)	2227	3235
% 13C	3.44%	4.47%
Community Structure (% total PLFA)		
Firmicutes (TerBrSats)	4.0	5.5
Proteobacteria (Monos)	76.4	73.0
Anaerobic metal reducers (BrMonos)	0.5	4.1
Actinomycetes (MidBrSats)	0.0	0.5
General (Nsats)	16.4	15.3
Eukaryotes (Polyenoics)	2.7	1.6
Physiological Status (Proteobacteria only)		
Slowed Growth	0.09	1.23
Decreased Permeability	0.05	0.04

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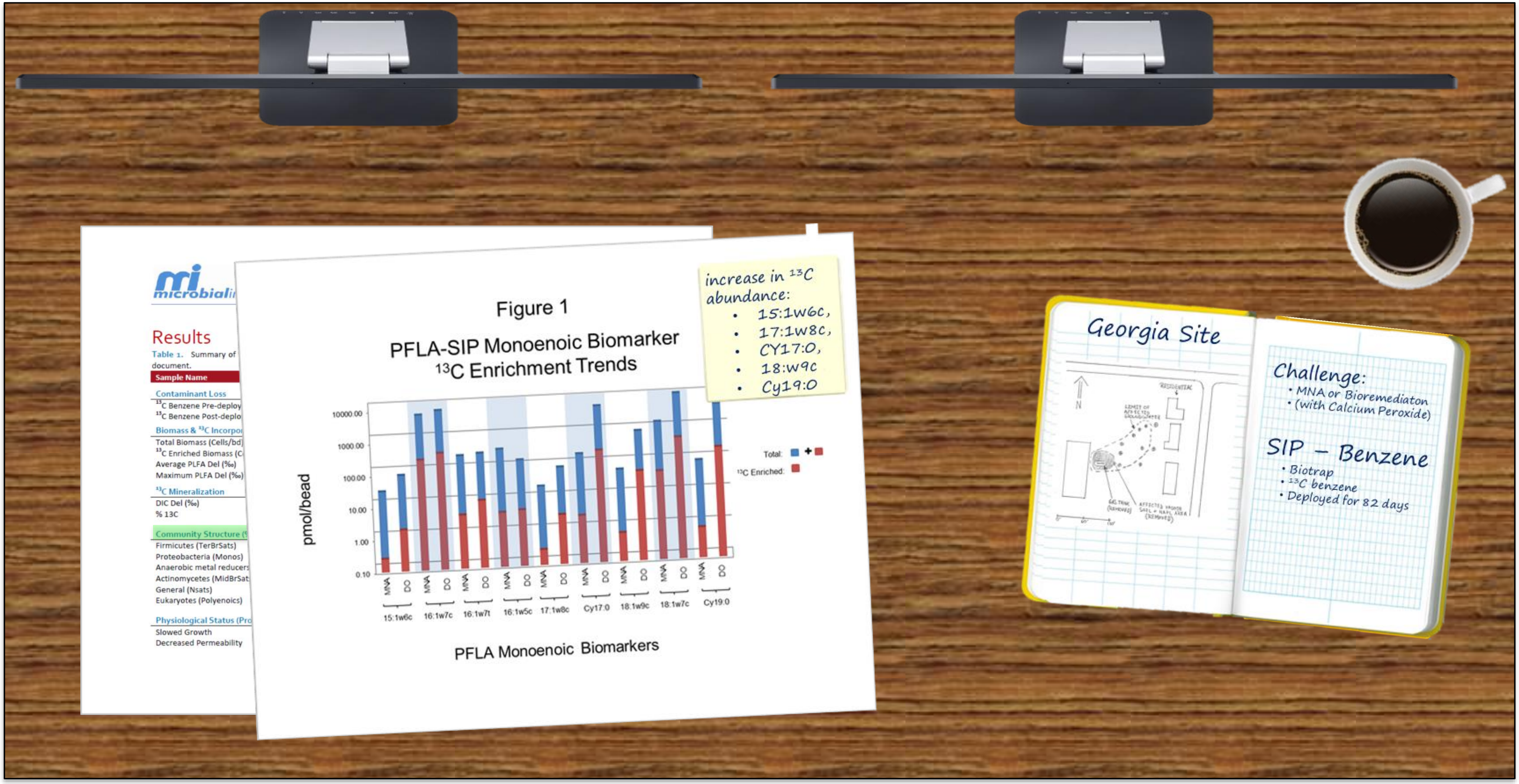
Case Study 1: MNA vs Enhanced Aerobic Treatment of Benzene



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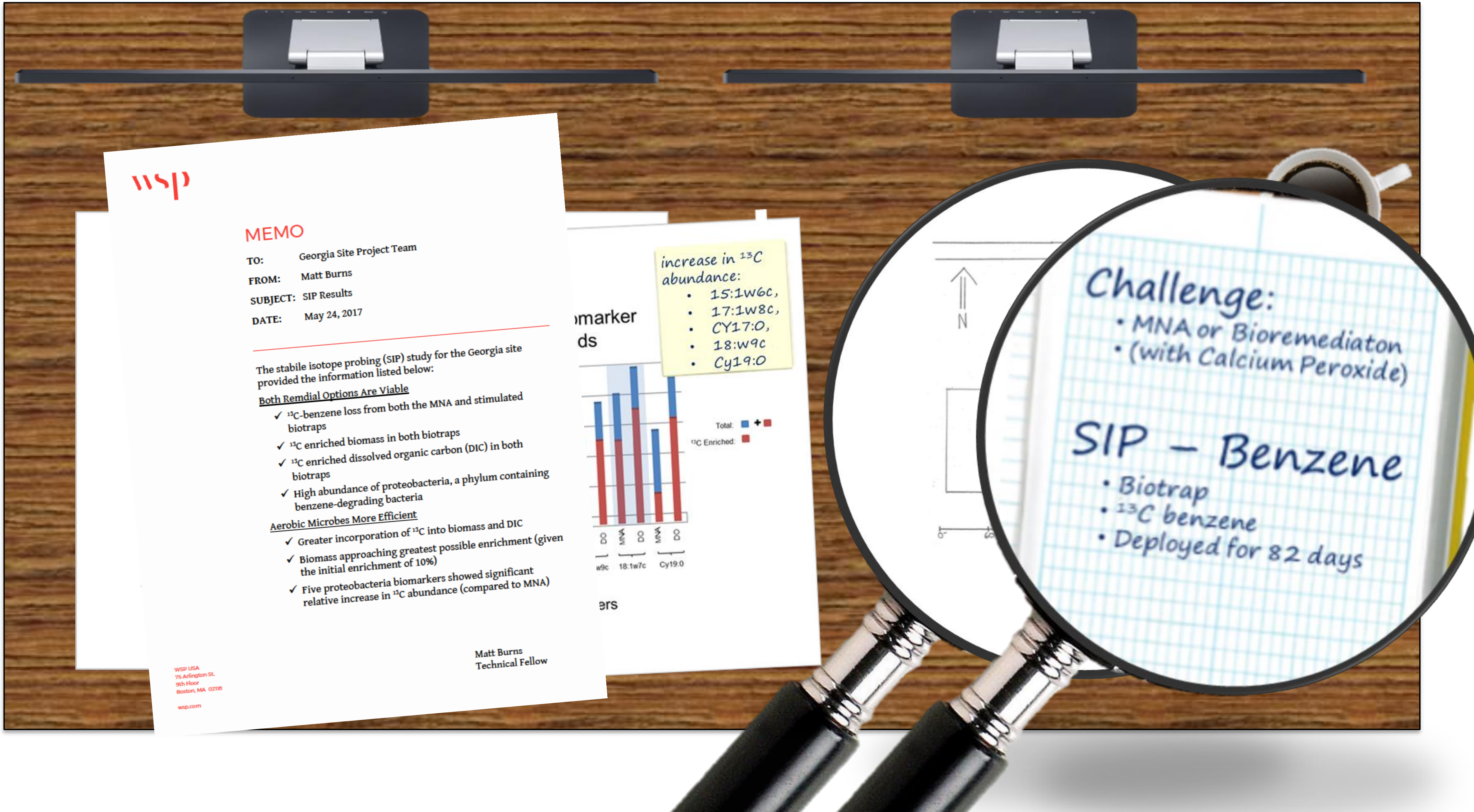
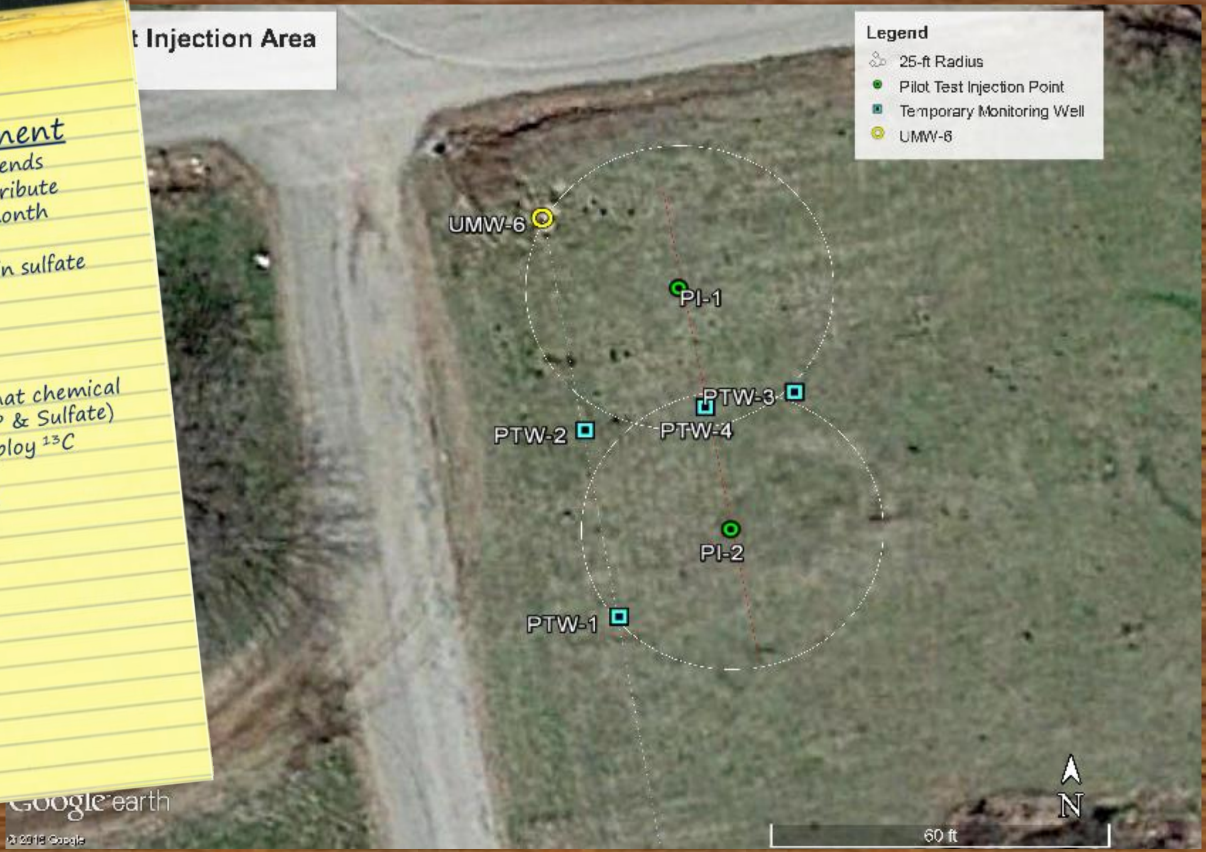


Case Study 2: Bio Contribution of a Chem/Bio Treatment Train of Benzene

Plan to Assess Bio Component

- Basic: benzene concentration trends
  - ISCO relatively quick – attribute degradation within first month
  - Post 1 month = bio
  - Correlate bio to decrease in sulfate concentrations
- Advanced Diagnostic – SIP
  - Apply amendment
  - Monitor for indicators that chemical oxidation complete (ORP & Sulfate)
  - When ORP negative, deploy ^{13}C benzene bated biotrap
  - Incubate for one month



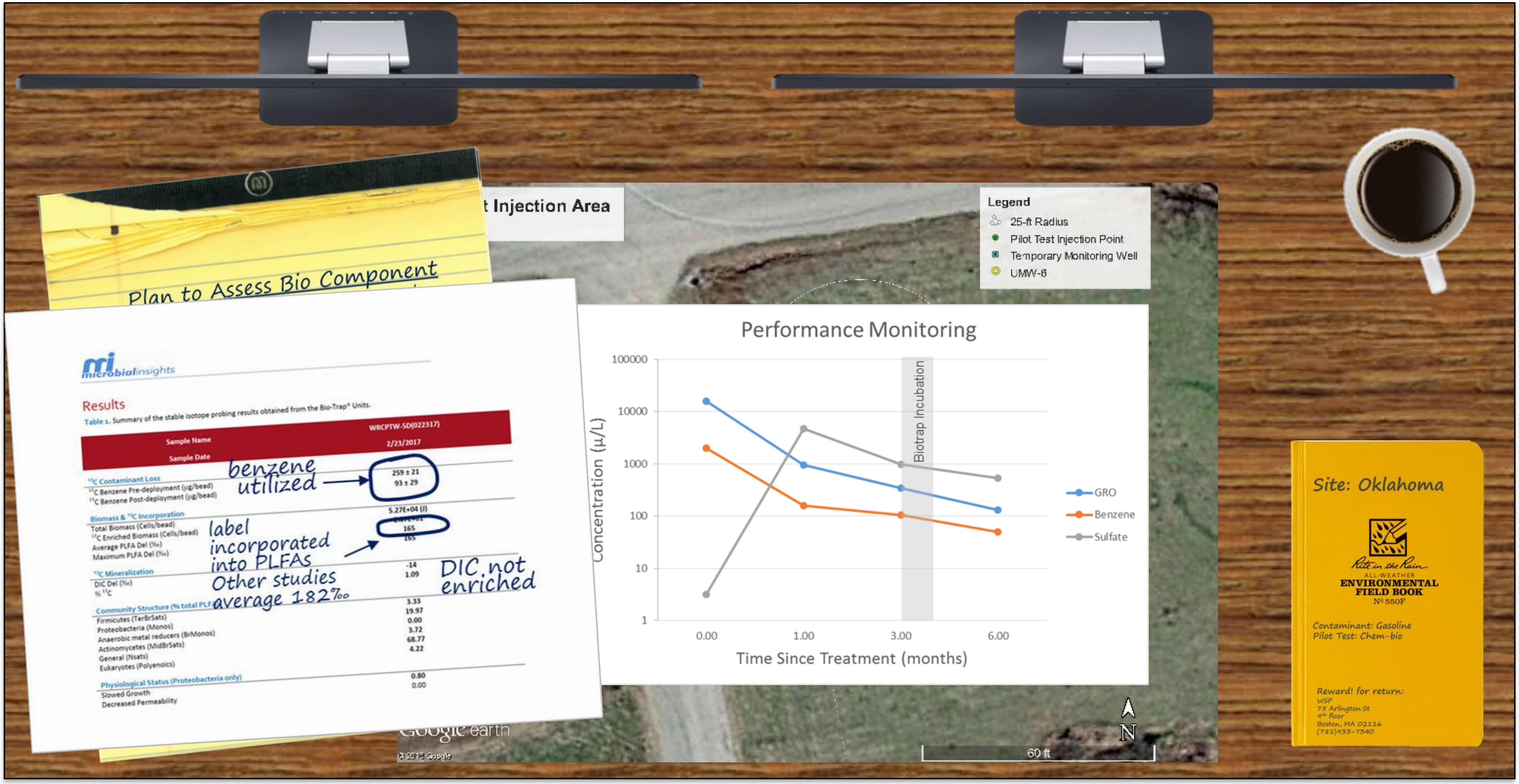
Site: Oklahoma

Rite in the Rain
ALL-WEATHER
ENVIRONMENTAL FIELD BOOK
Nº 550F

Contaminant: Gasoline
Pilot Test: Chem-bio

Reward! for return:
WSP
75 Arlington St
4th floor
Boston, MA 02116
(781)933-7340

Case Study 2: Bio Contribution of a Chem/Bio Treatment Train of Benzene



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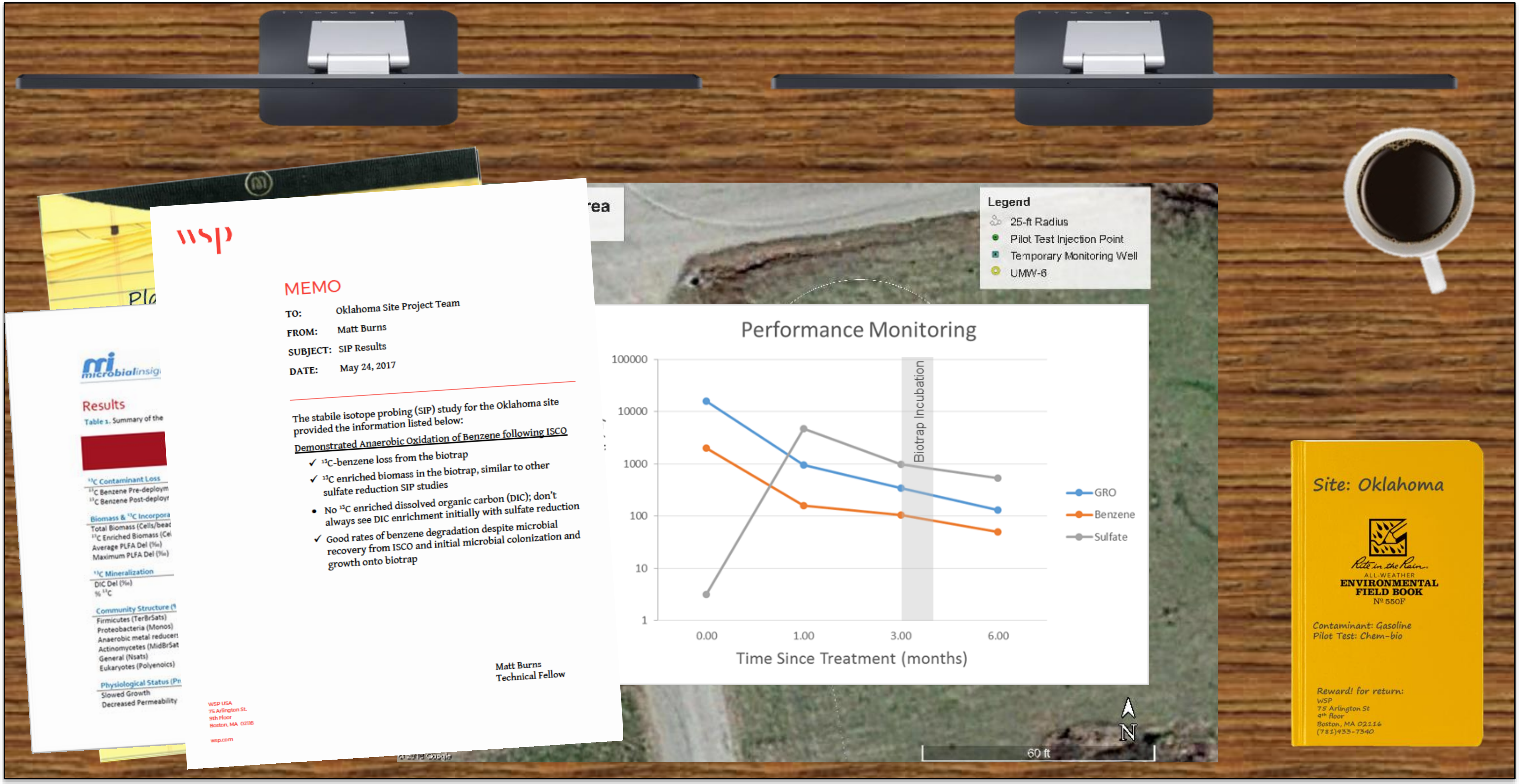
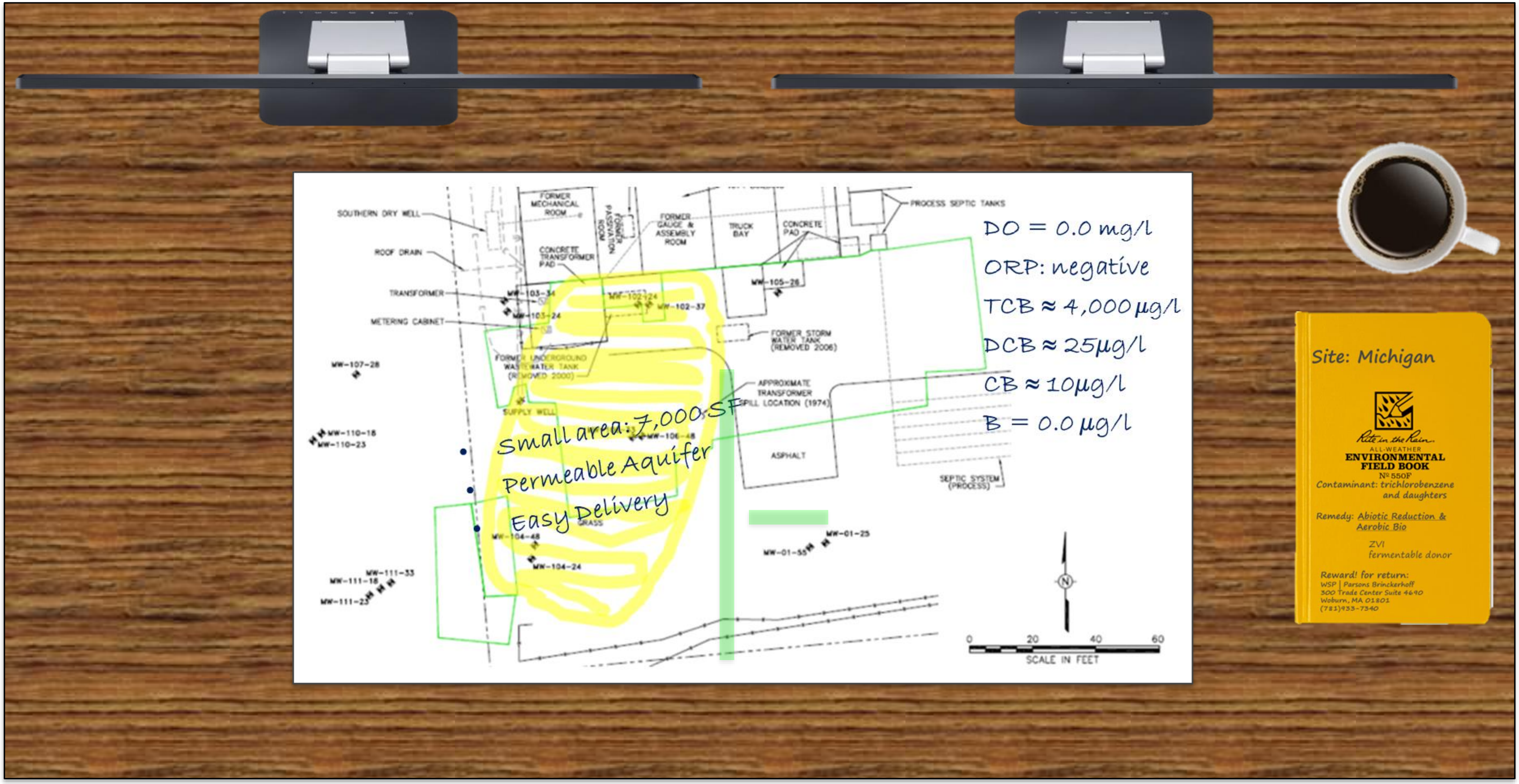


Case Study 3: Stimulating Multiple Degradation Pathways for the Treatment of Chlorobenzenes



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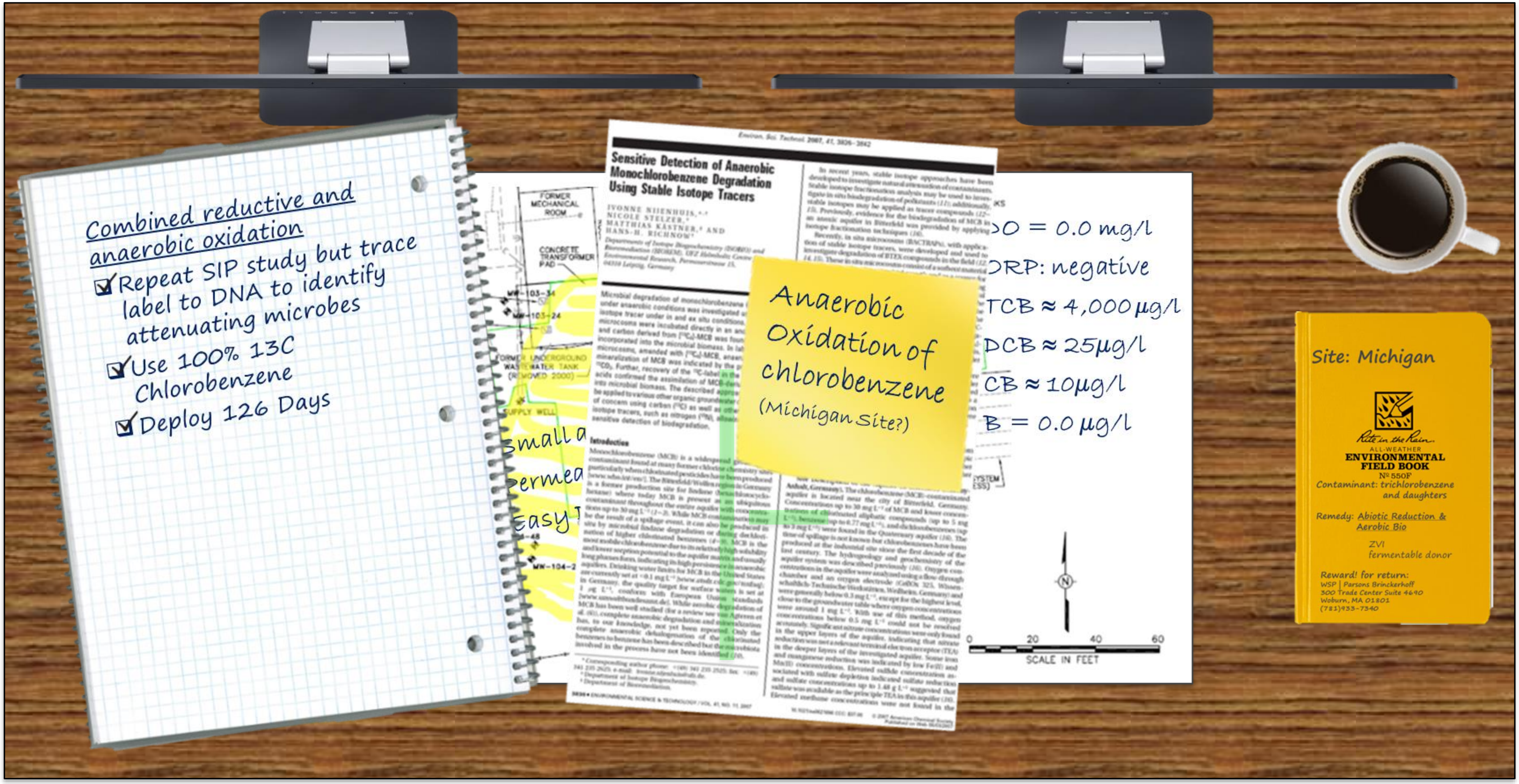

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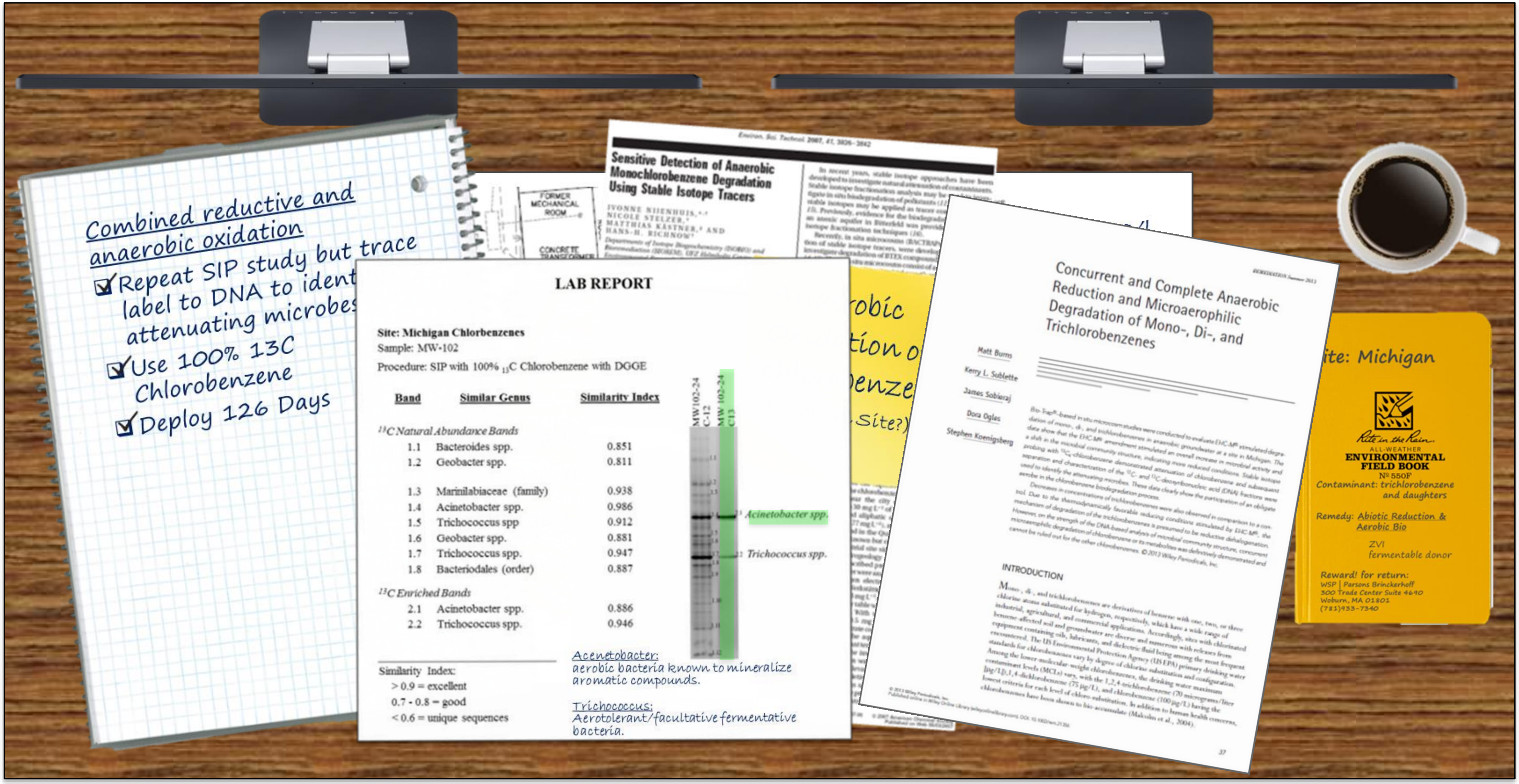

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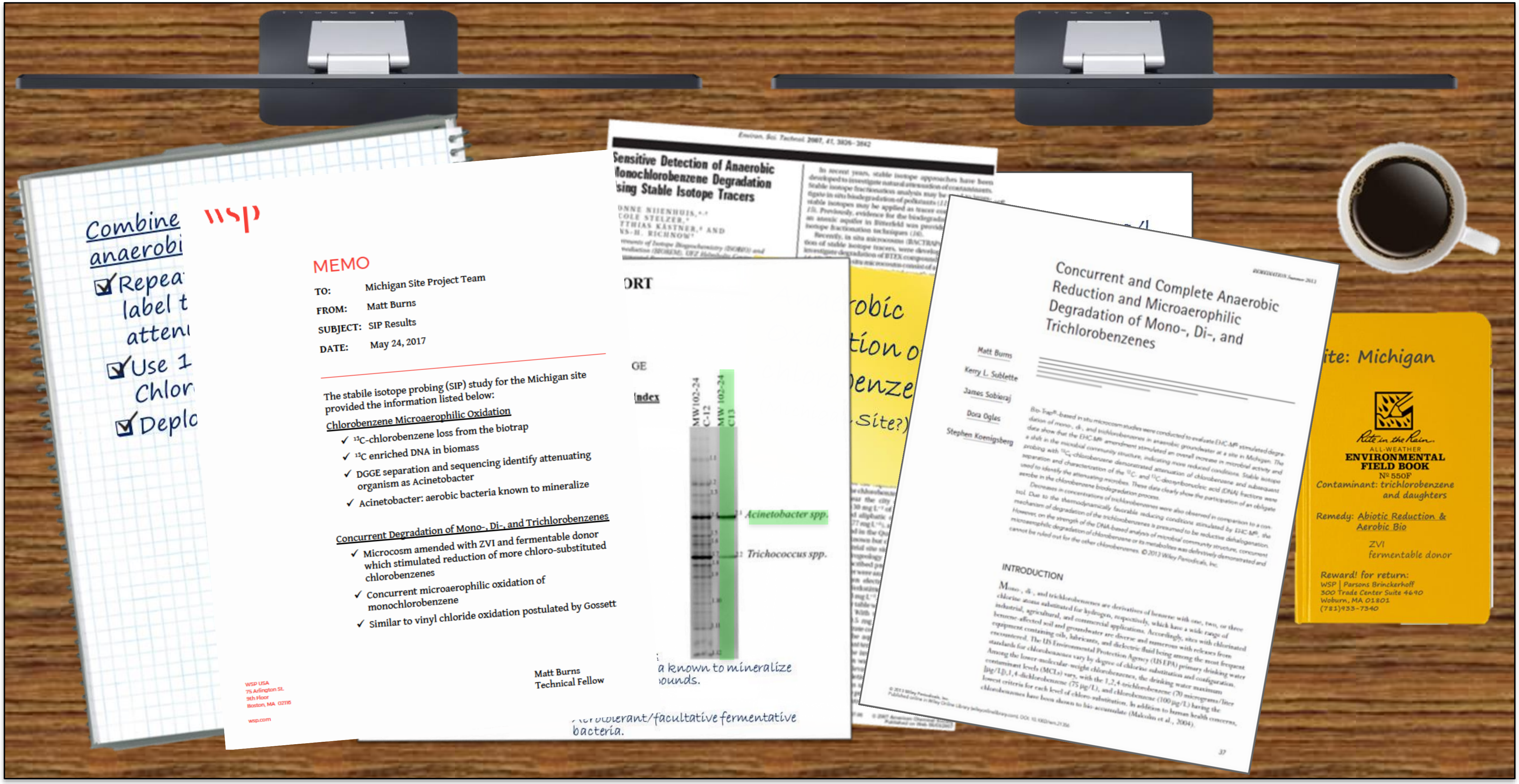

Conclusions

- Collect actionable data early in the project management cycle
- Focus on actionable data that provides a fail small/win big opportunity