

# Modeling Bioaugmentation Rates at Kelly Air Force Base

Presented by

Grant R. Carey

Environmental Institute for Continuing Education (EICE)

Waterloo, Ontario, Canada



# Acknowledgements

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Megan Roworth, Conestoga-Rovers &  
Associates



# Introduction

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- biostimulation / bioaugmentation
- evaluation tools
- biodegradation rates
  - influence remediation timeframe
  - understand site processes



# Purpose

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- visualization methods
- estimate biodegradation rates
- assess rate variability
  - spatial and temporal



# Bioaugmentation

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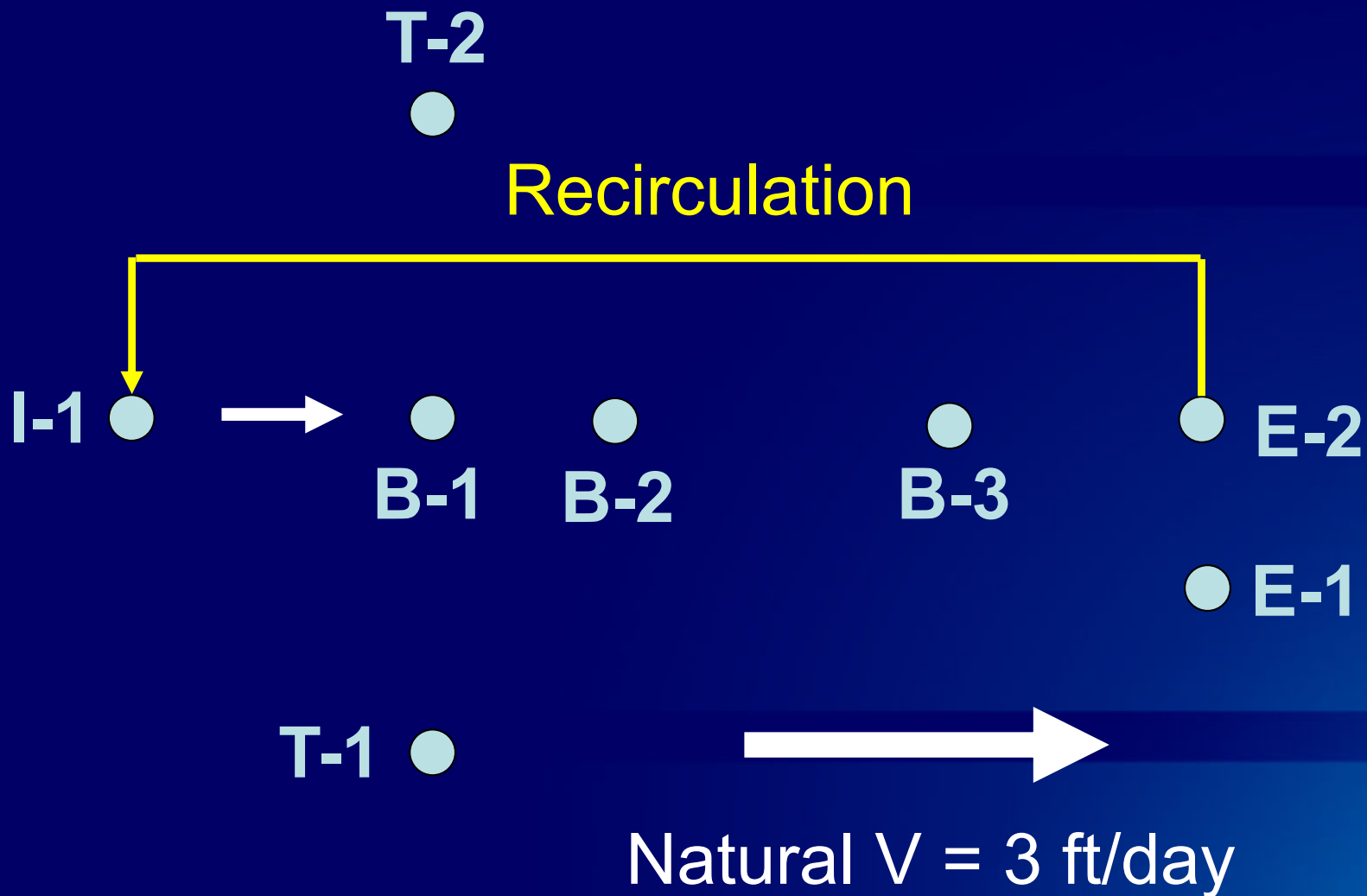
## Kelly AFB

### Overview

Major et al., 2002, Environmental Science & Technology, 36: 5106-5116.



# Site Map



# Bioaugmentation

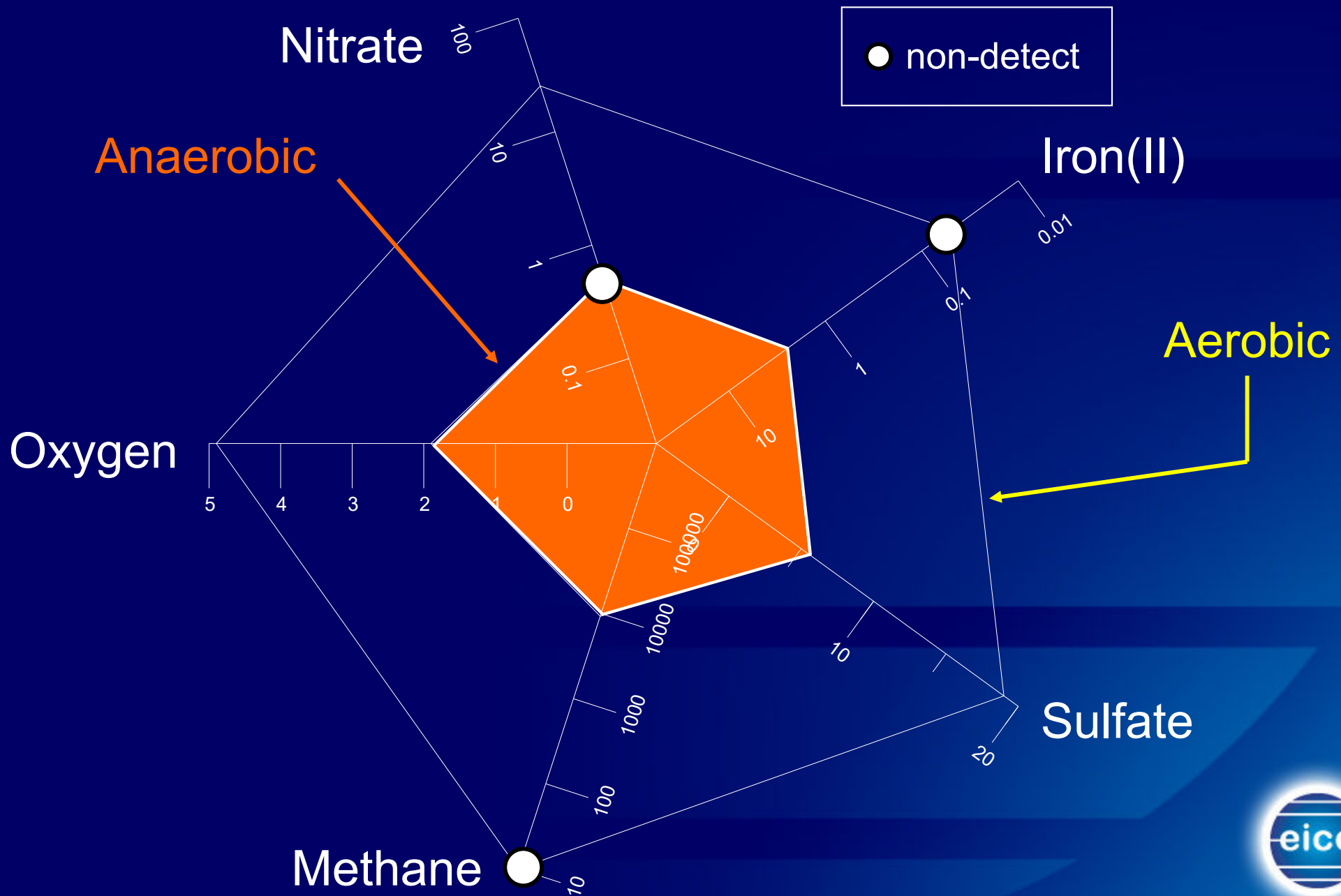
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Kelly AFB

Visualization



# SEQUENCE-Redox Diagram

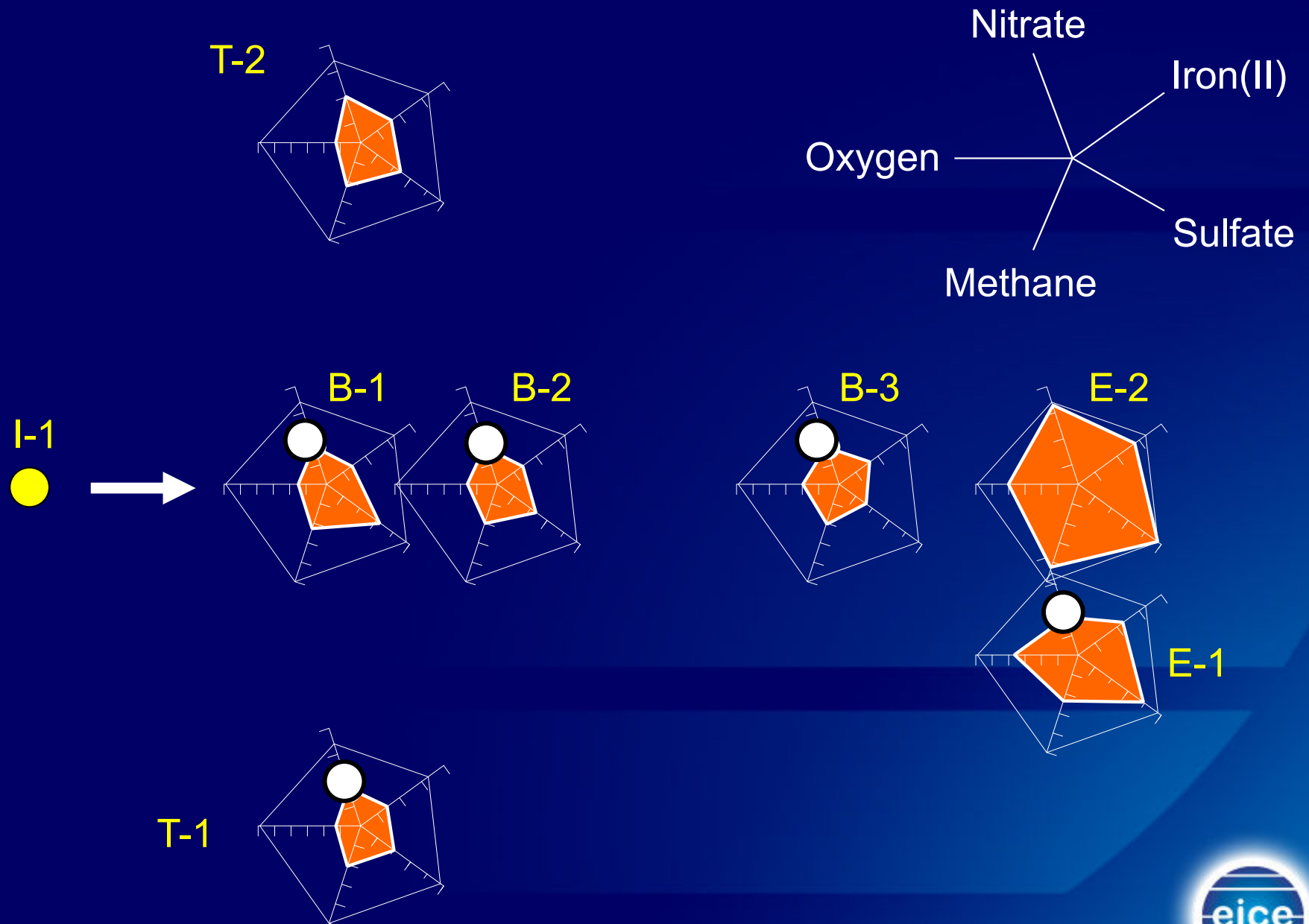




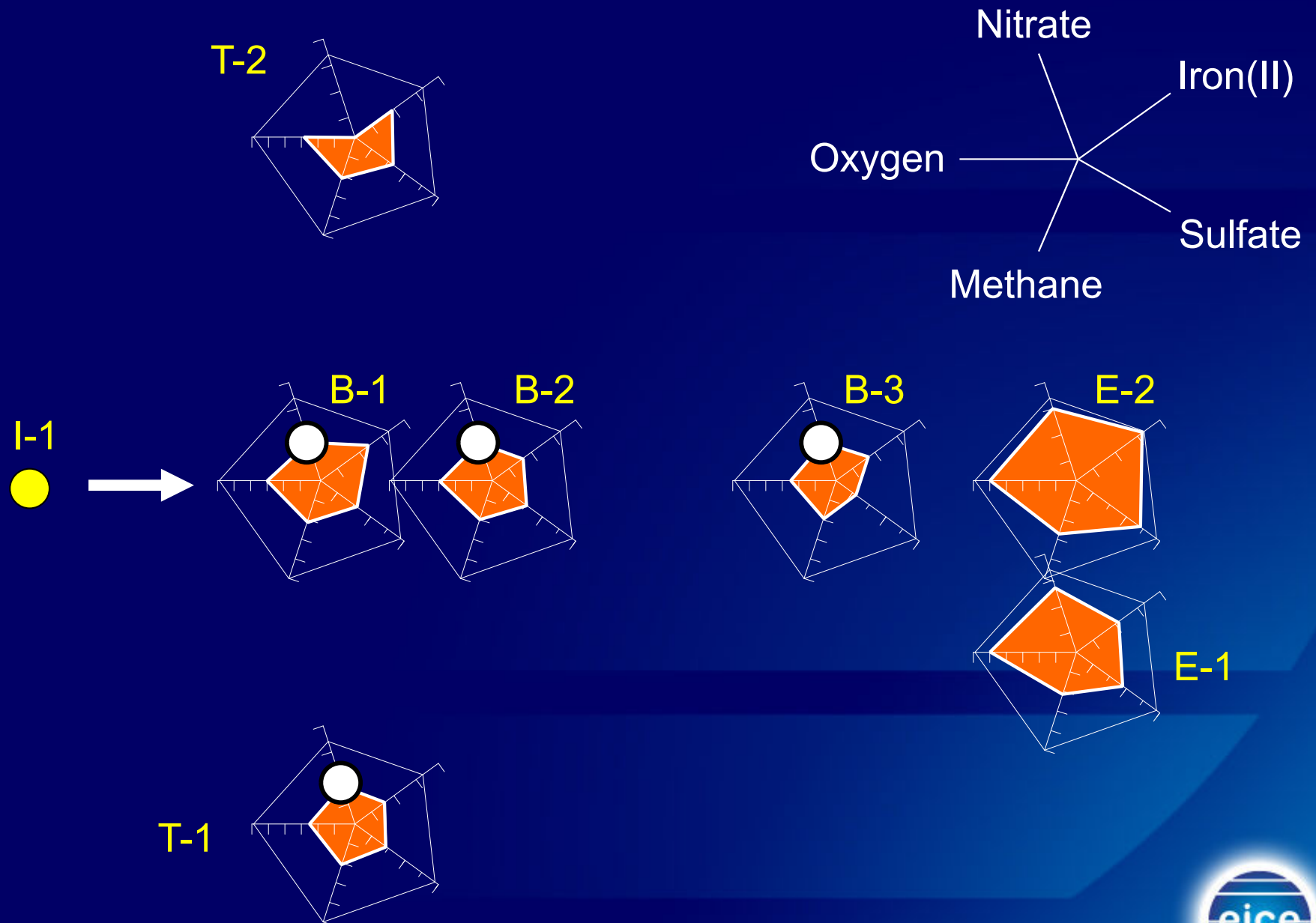
# SEQUENCE-Redox: Pre-test



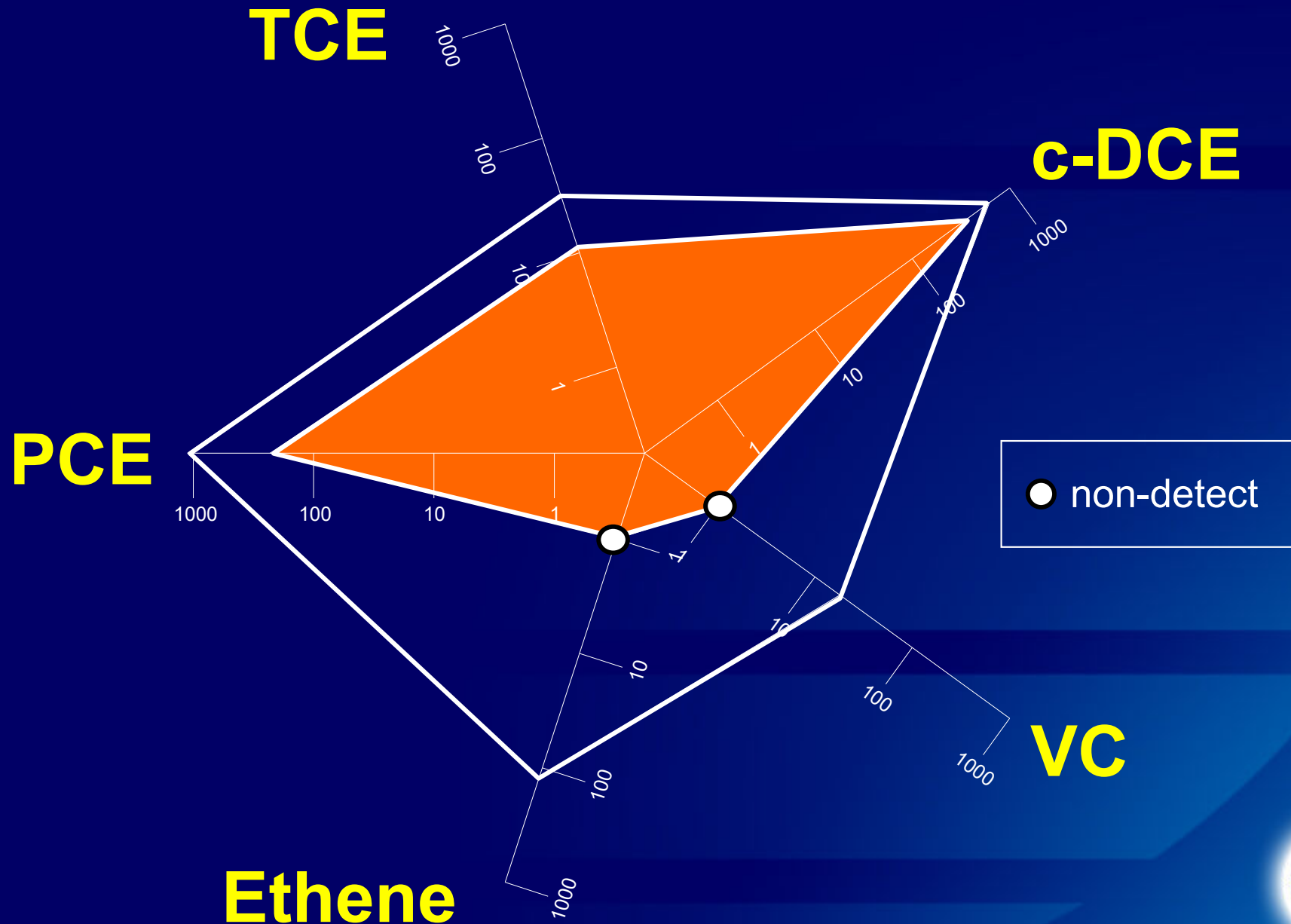
# SEQUENCE-Redox: Biostimulation



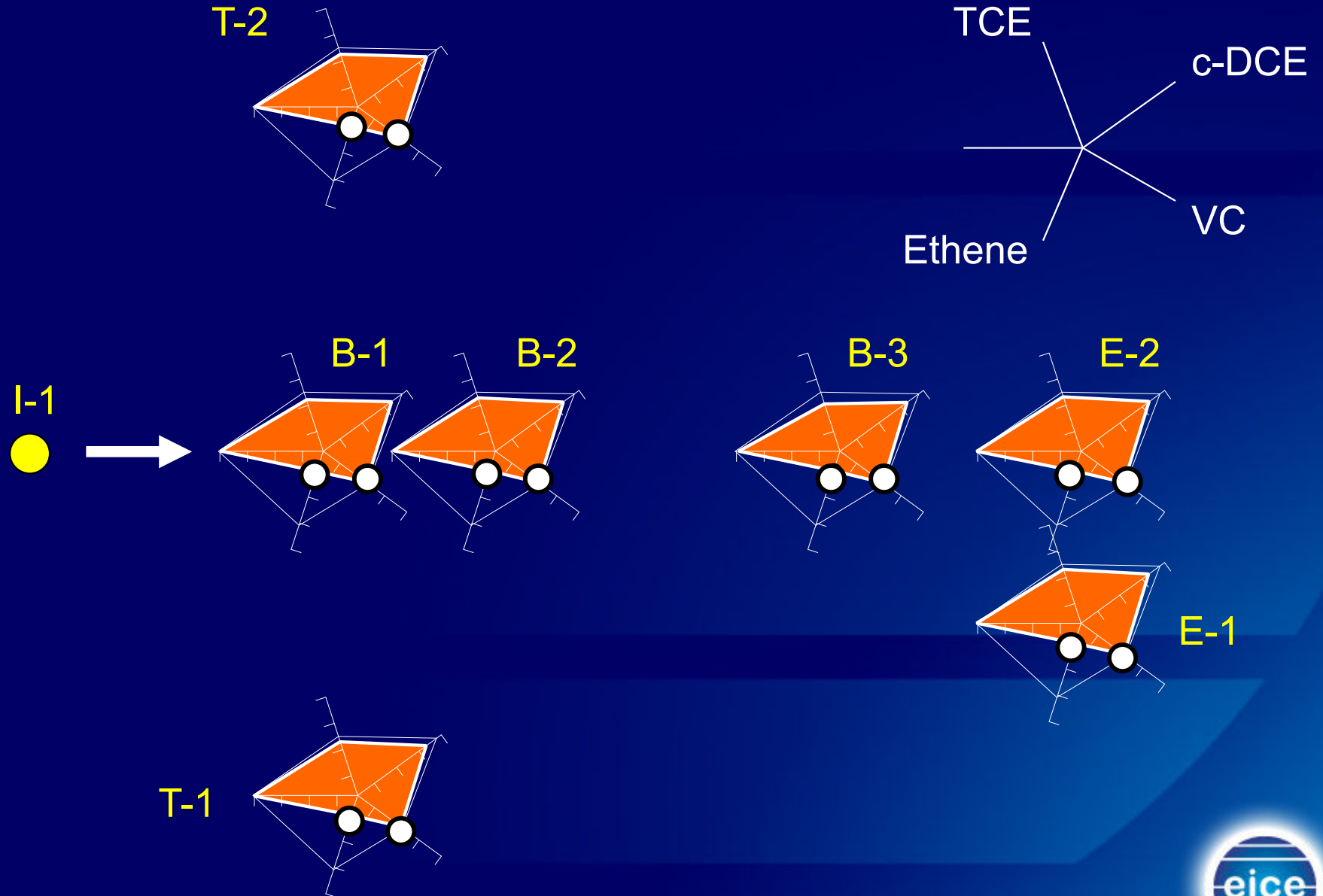
# SEQUENCE-Redox: Bioaugmentation



# SEQUENCE-CAH Diagram



# SEQUENCE-CAH: Pre-test



# SEQUENCE-CAH: Biostimulation



# SEQUENCE-CAH: Bioaugmentation



# Bioaugmentation

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## Kelly AFB

### Rates





# BioRedox-MT3DMS

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- electron donors and acceptors
- sequential transformations
- oxidation, halorespiration, co-metabolism
- variable rates, pathways, mechanisms
- NAPL dissolution
- substrates, competitive inhibition

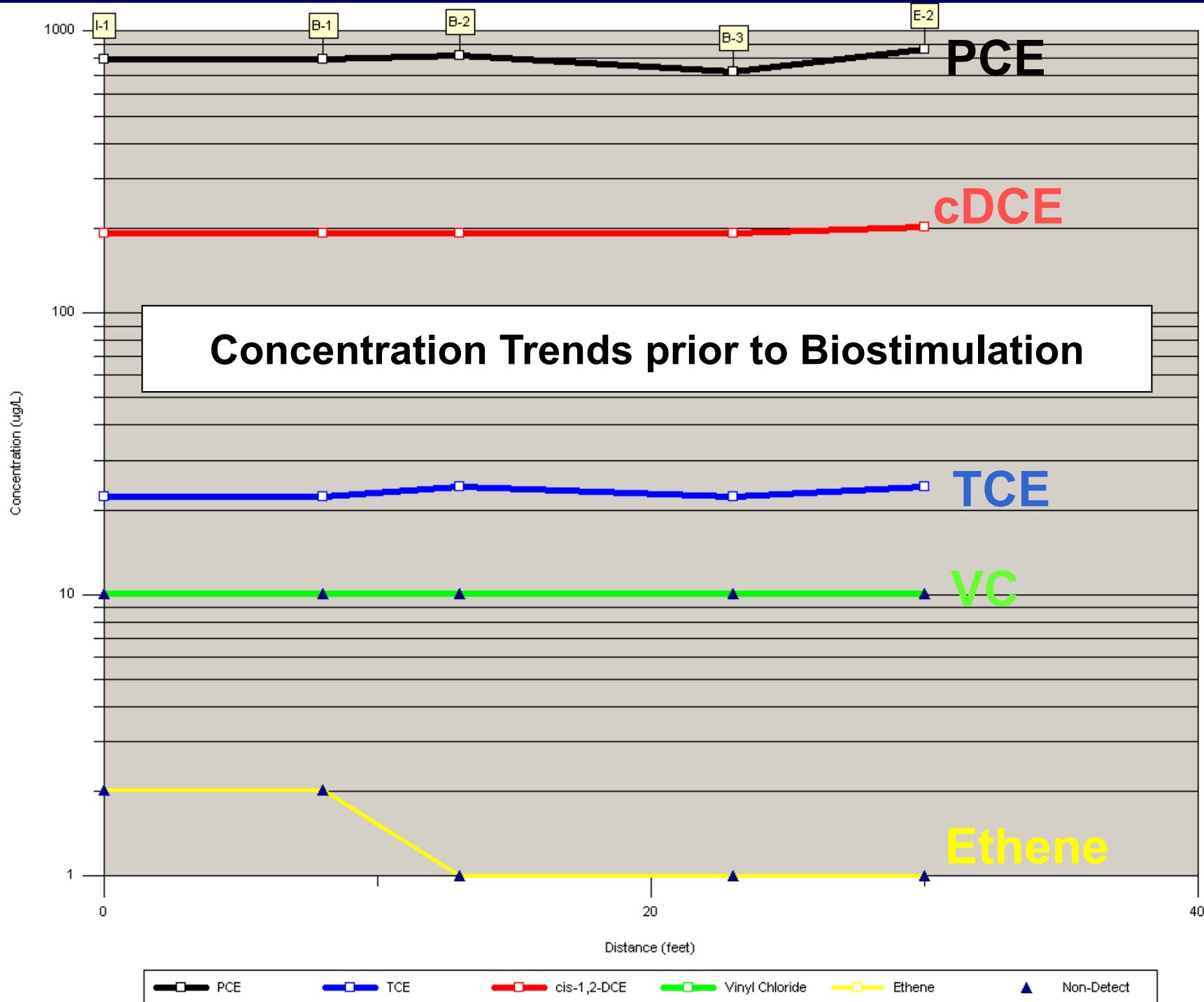


# Modeling Approach

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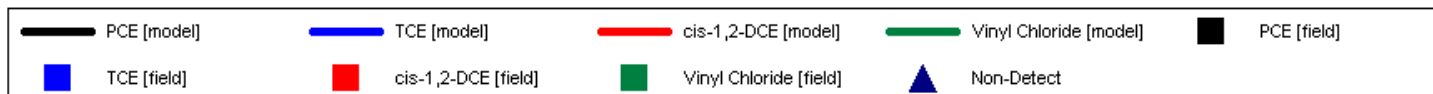
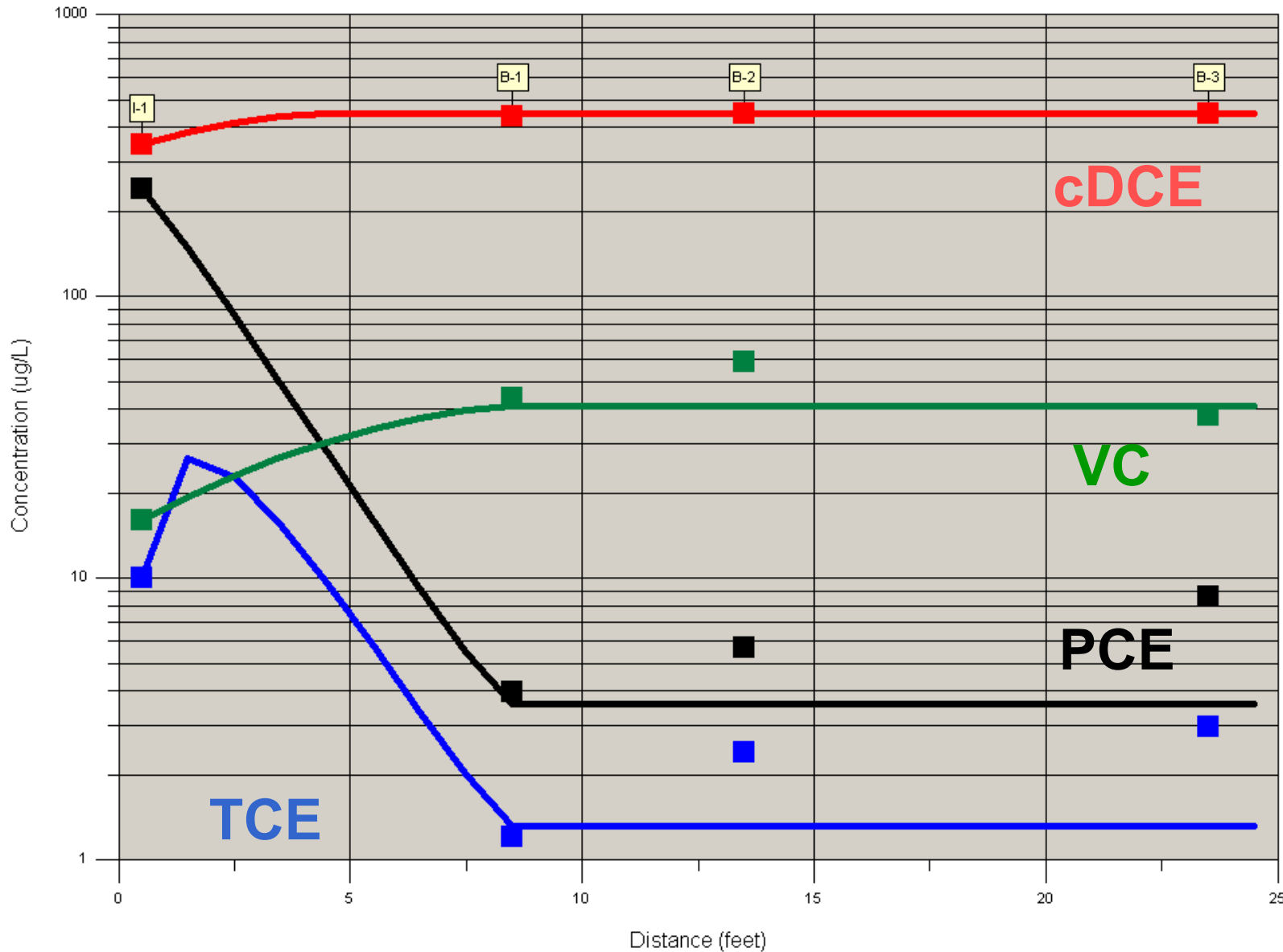
- tracer test (2-D)
  - pumping  $V = 21$  ft/day
  - longitudinal dispersivity = 2 ft
  - transverse dispersion - small
- reactive transport
  - sequential decay (PCE through ethene)
  - substrate-dependent rates
  - 1-D: cost-effective





Model vs. Observed: July 17, 2003

Day 72



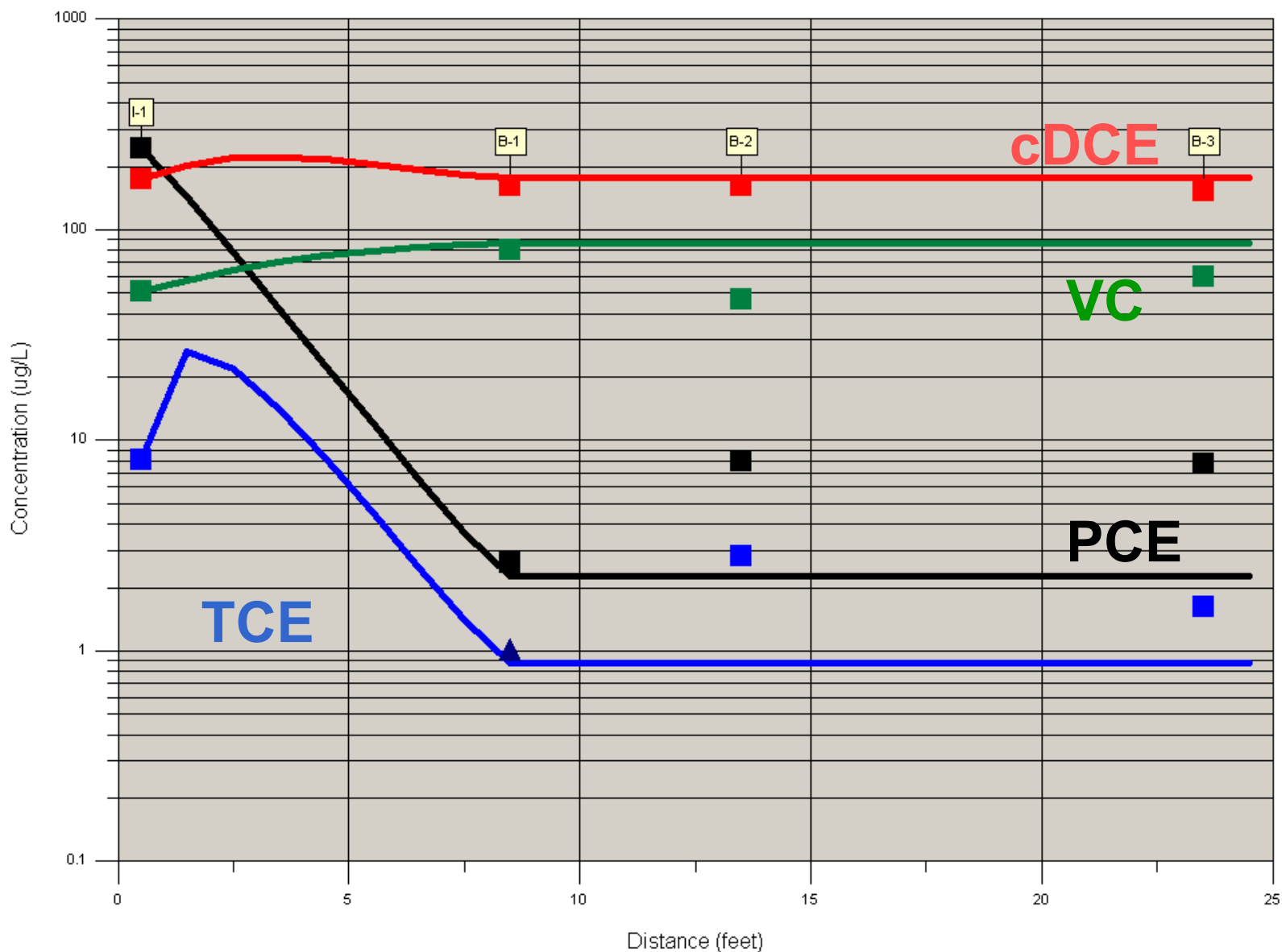
I-1 to B-1  
Half-life (h)

PCE	0.7
TCE	0.2
cDCE	48.0
VC	33.0



Model vs. Observed: August 7, 2003

Day 93



I-1 to B-1  
Half-life (h)

PCE 0.6

TCE 0.2

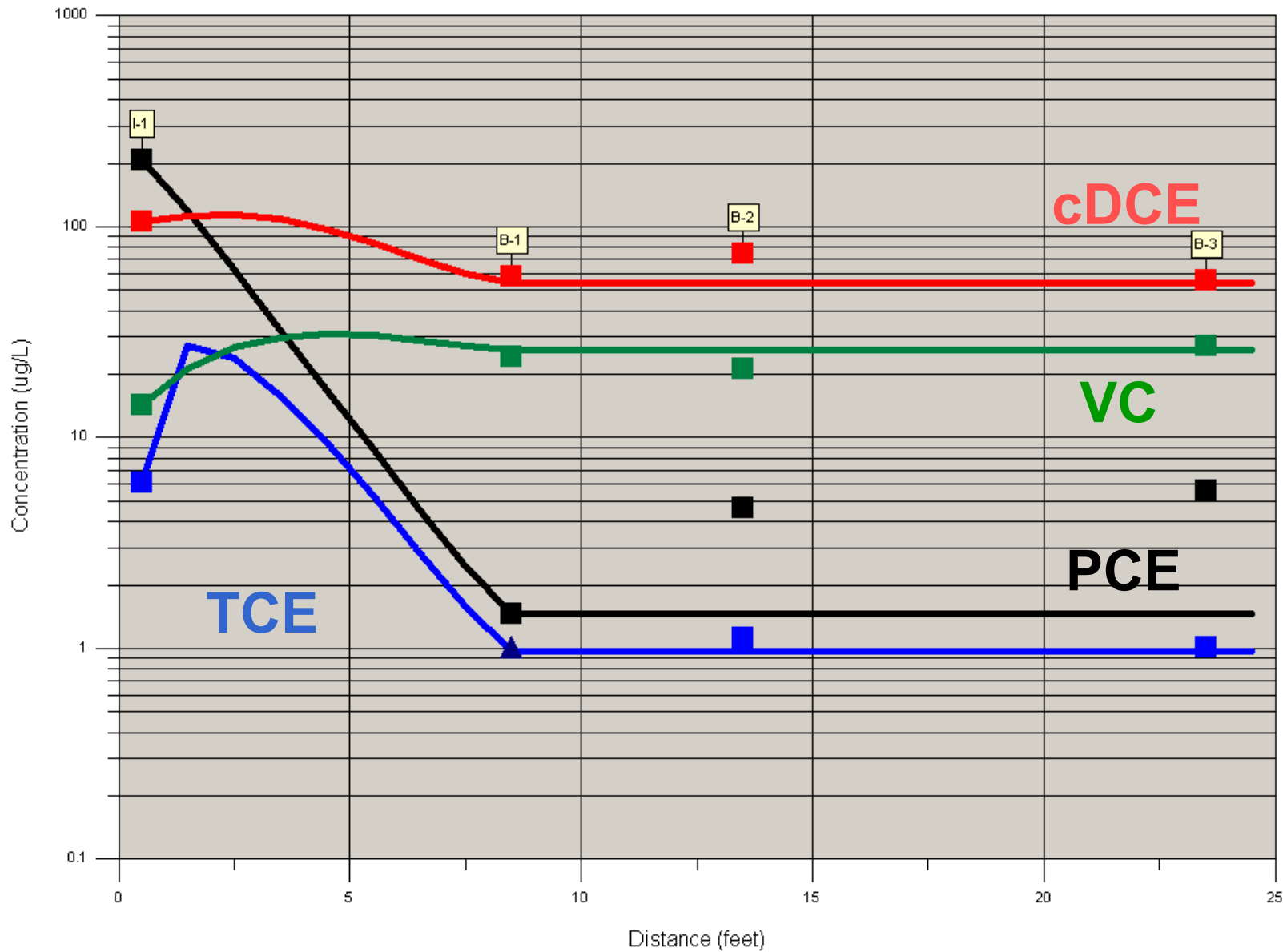
cDCE 6.9

VC 6.7



Model vs. Observed: August 29, 2003

Day 115



I-1 to B-1  
Half-life (h)

PCE	0.6
TCE	0.3
cDCE	2.4
VC	1.4

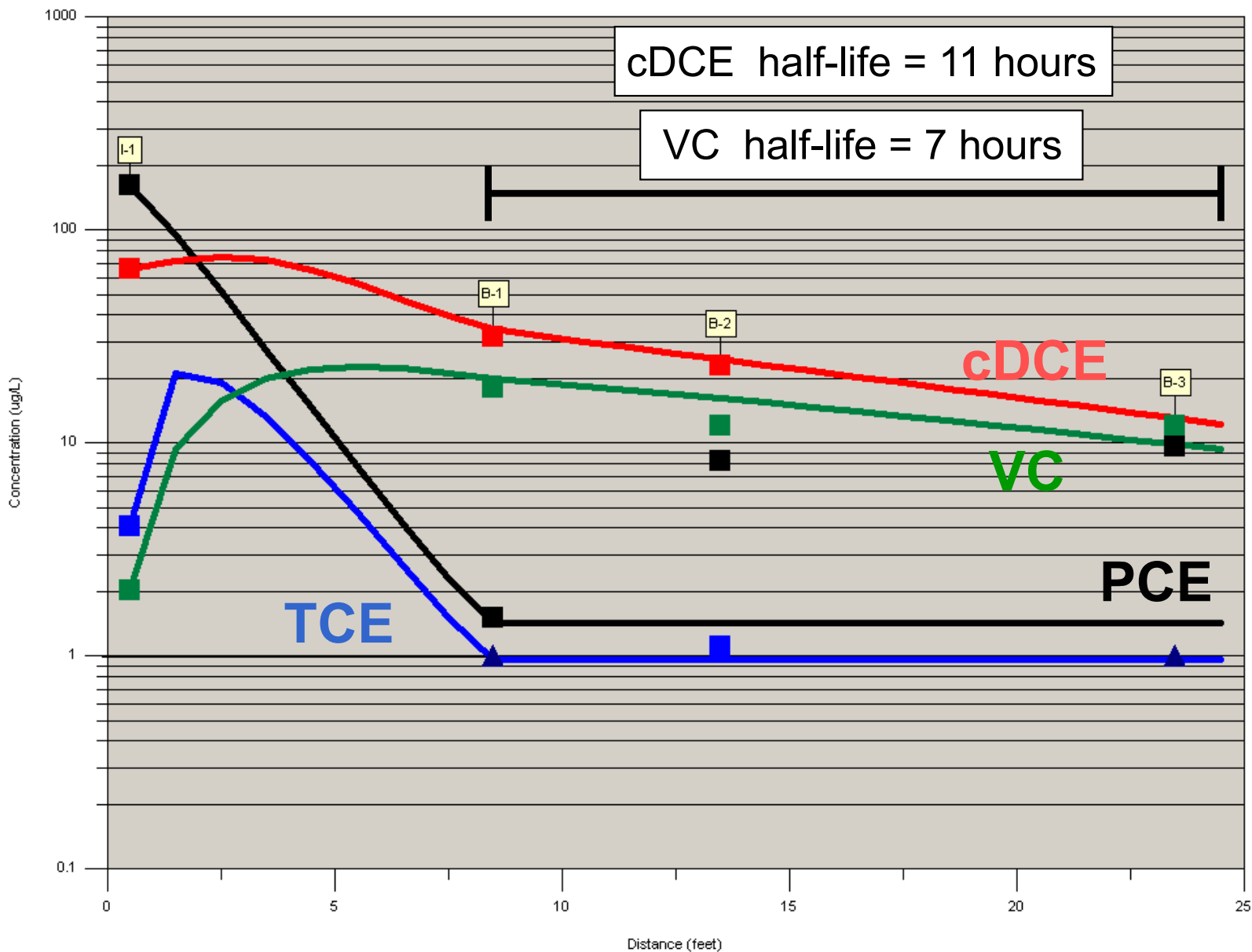


Model vs. Observed: September 25, 2000

Day 142

cDCE half-life = 11 hours

VC half-life = 7 hours



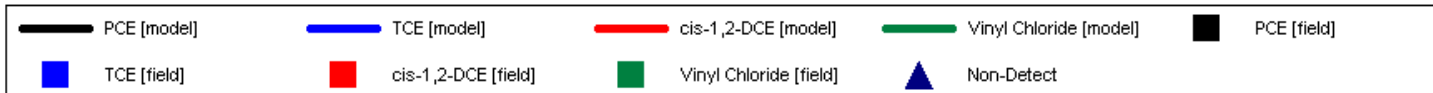
I-1 to B-1  
Half-life (h)

PCE 0.6

TCE 0.3

cDCE 2.2

VC 1.7



# Faster downgradient rates...

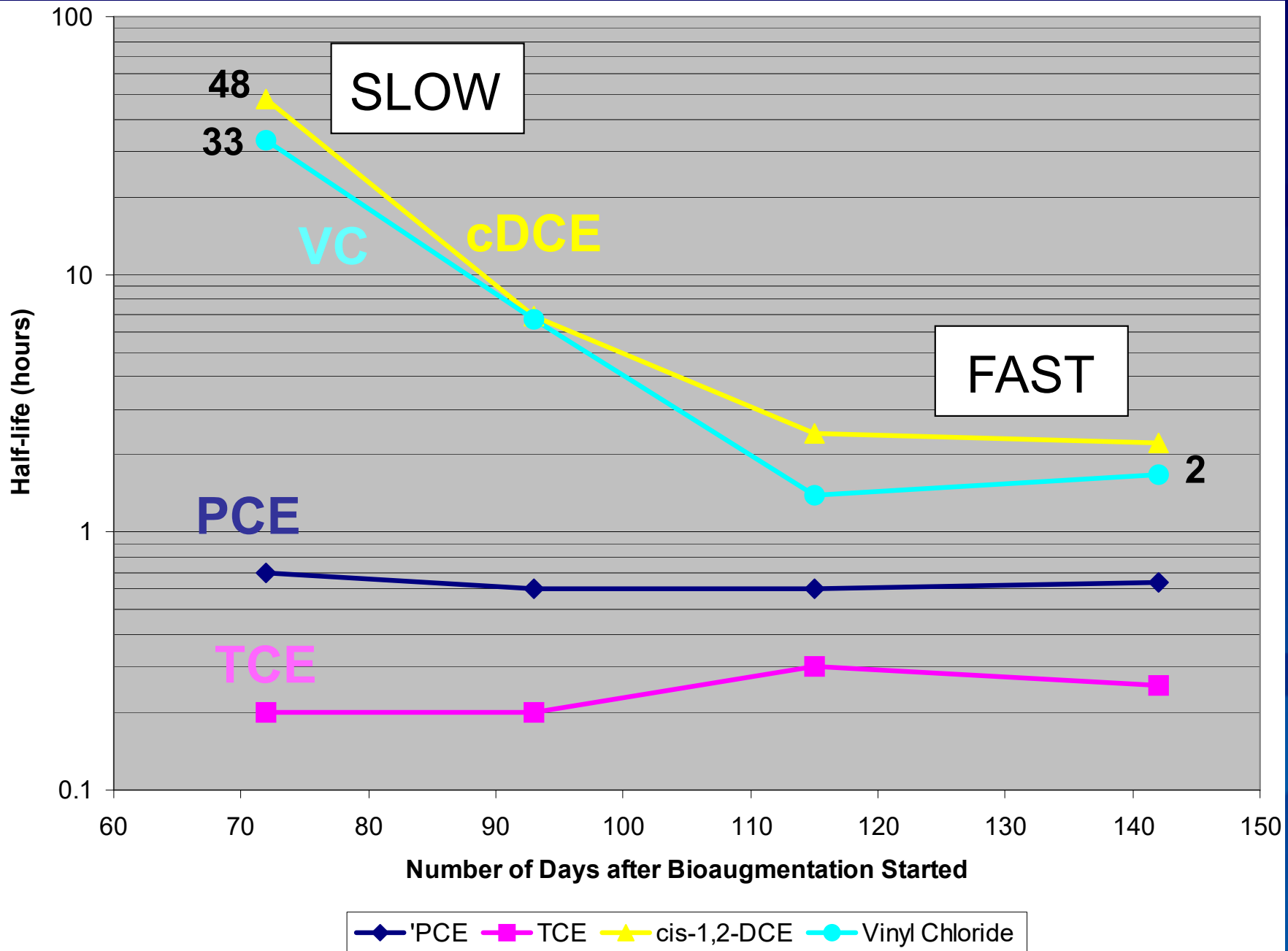
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- correlate with:
  - increase in acetic acid and lactic acid
  - decrease in sulfate
- electron donor delivery
  - full-scale systems





# Half-life vs. Time



# Conclusions

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- radial diagram visualization
  - correlating multiple parameter trends
- PCE and TCE rates - consistent
- cDCE and VC rates
  - increased 20 to 25 times (2.5 to 5 months)
- increasing downgradient rates



# Remediation ToolKit

- **FREE** for:
  - regulatory agencies
  - academic institutions
- More info: [www.ENSSI-SW.com](http://www.ENSSI-SW.com)

