Methane Degradation in an Vegetated Cover Test System

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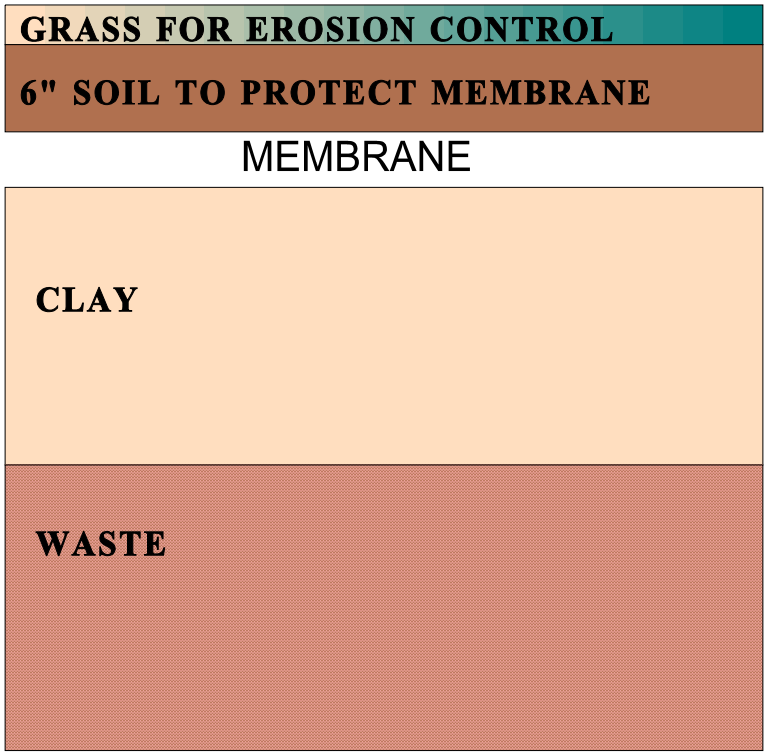
Methane and ET Covers

- Problem: ET Covers are not able to trap landfill gas which contributes to global warming.
- Hypothesis: Rhizosphere of ET covers may consume landfill gases.
- Test: Introduce methane below a simulated ET cover in a lysimeter and measure escaping methane.

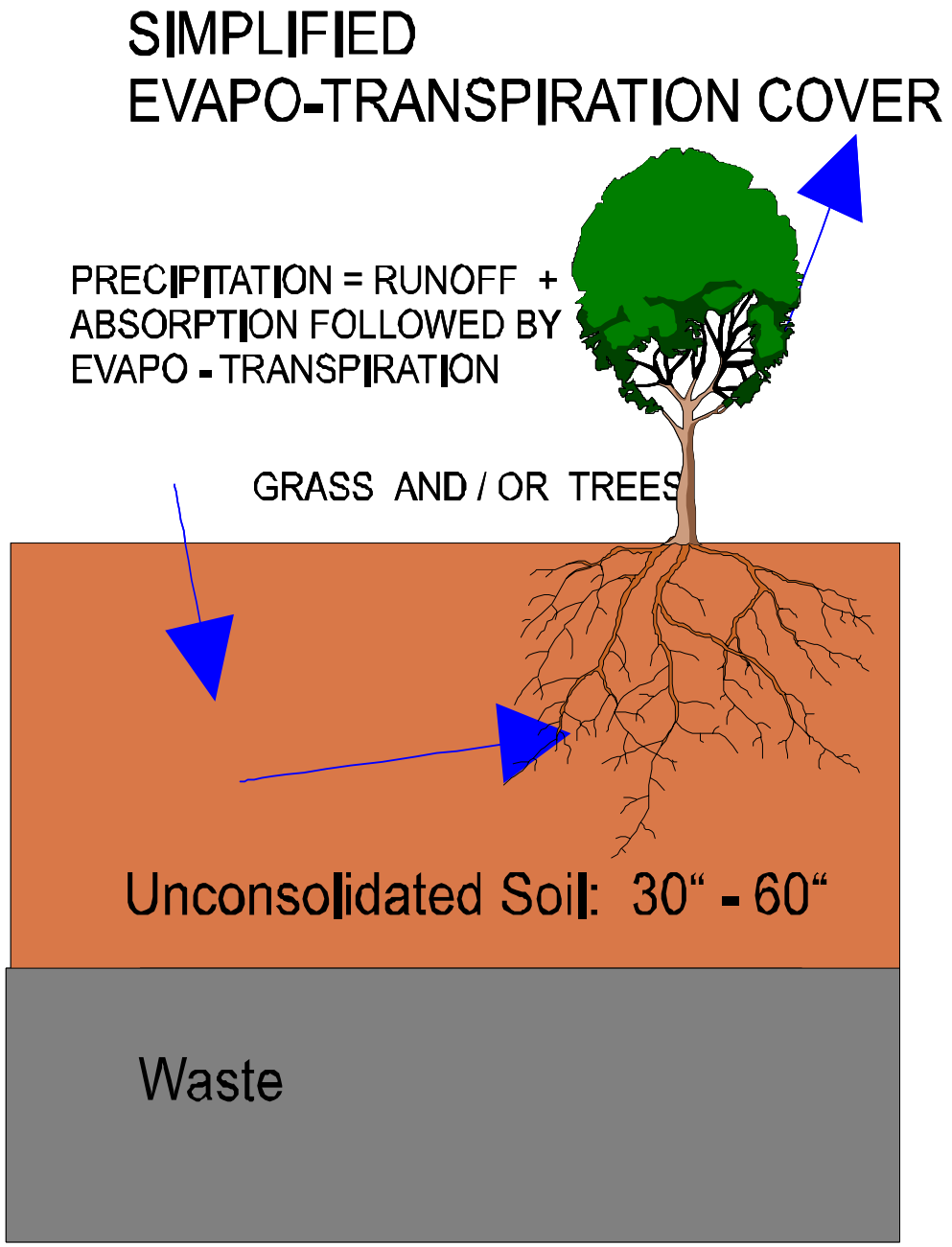
GROSSLY SIMPLIFIED COMPOSITE COVER

In a conventional cover system there is potential for gas collection below water protection layers.

PERCIPITATION = RUNOFF



In ET Covers, there is no impermeable layer, thus no gas collection layer.

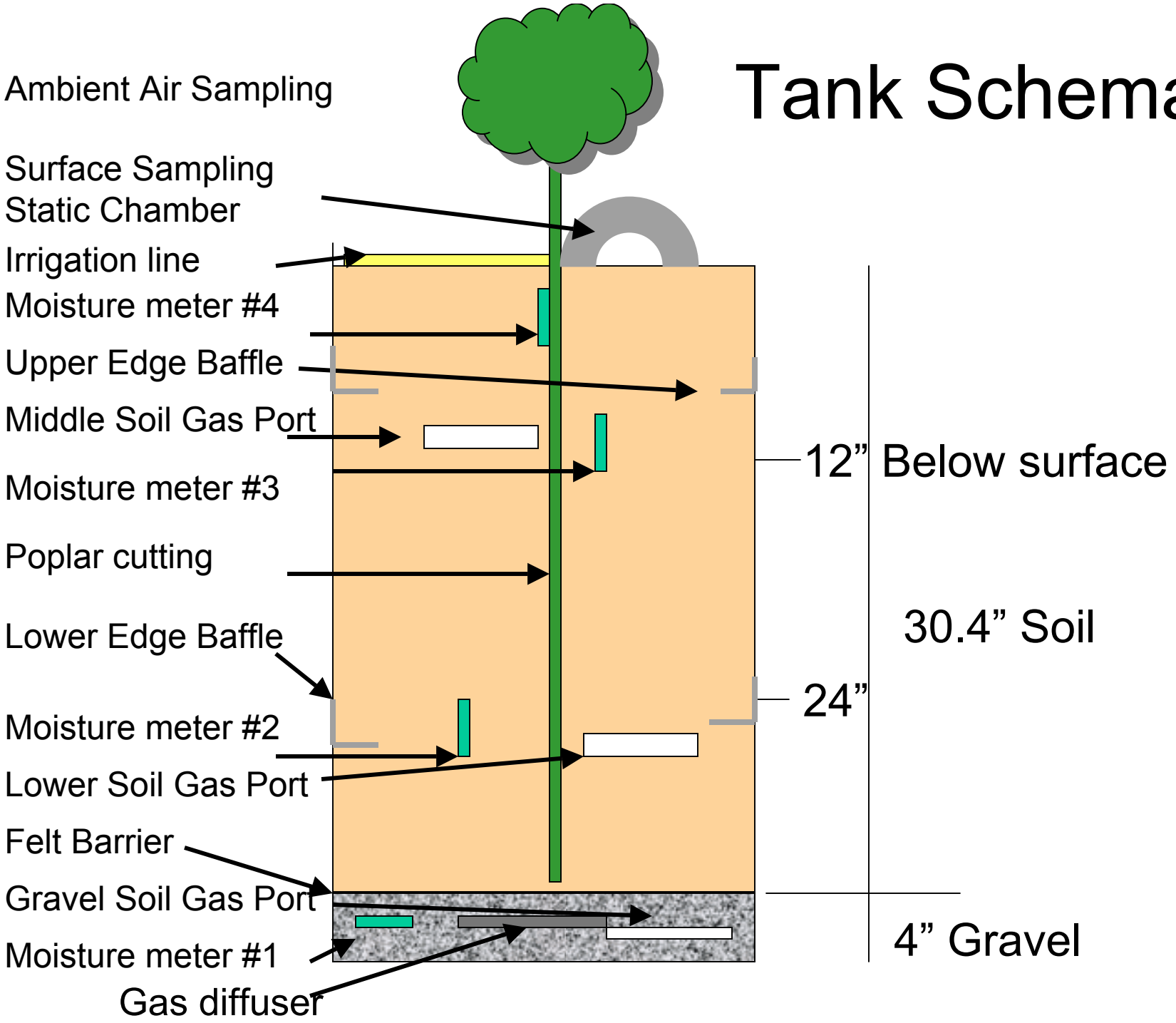


EPA's Test and Evaluation Environmental Chambers

2- 12'x12' stainless rooms, HVAC, 32 lights, air filtration

Chambers control room, with GC FID, sampling ports, light, humidity and temperature controls

Tank Schematic

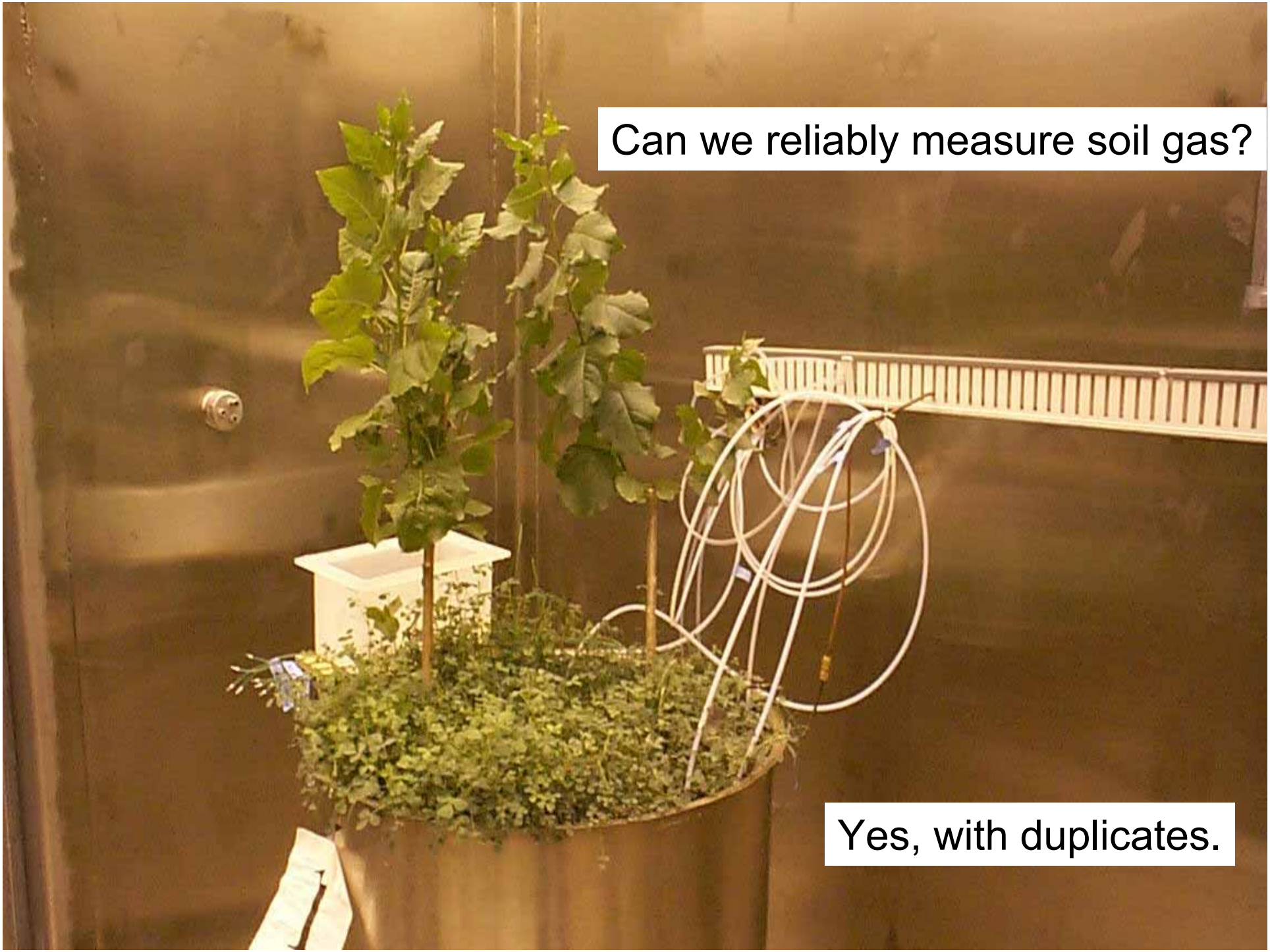


100 gallon stainless tank, PVC screened gas samplers, moisture sensors, two levels of baffle, gravel plenum, felt, copper line delivers methane

Shakedown

Can we grow in here?

Yes!


Can we reliably measure soil gas?
Yes, with duplicates.

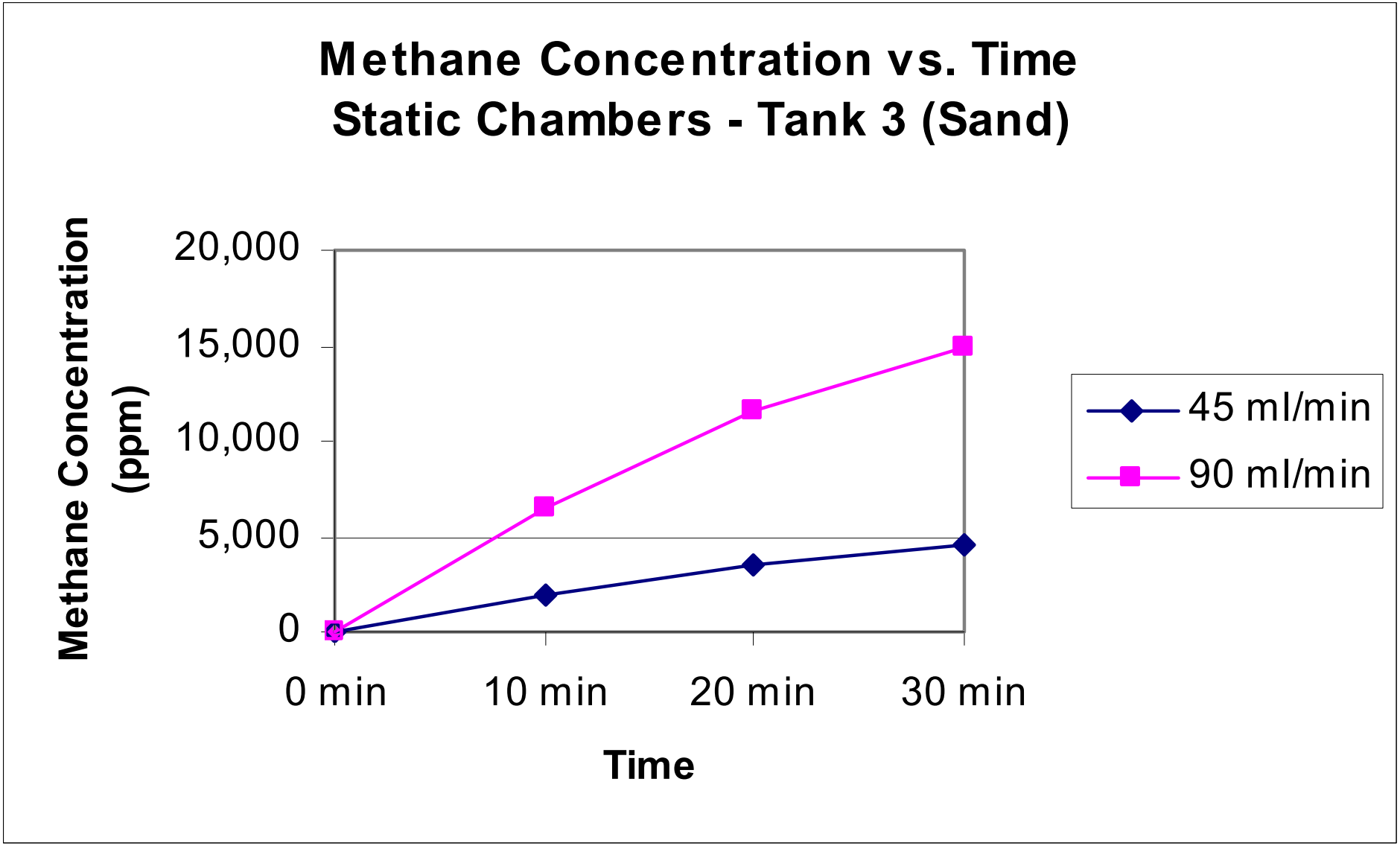
What about gas at the surface?

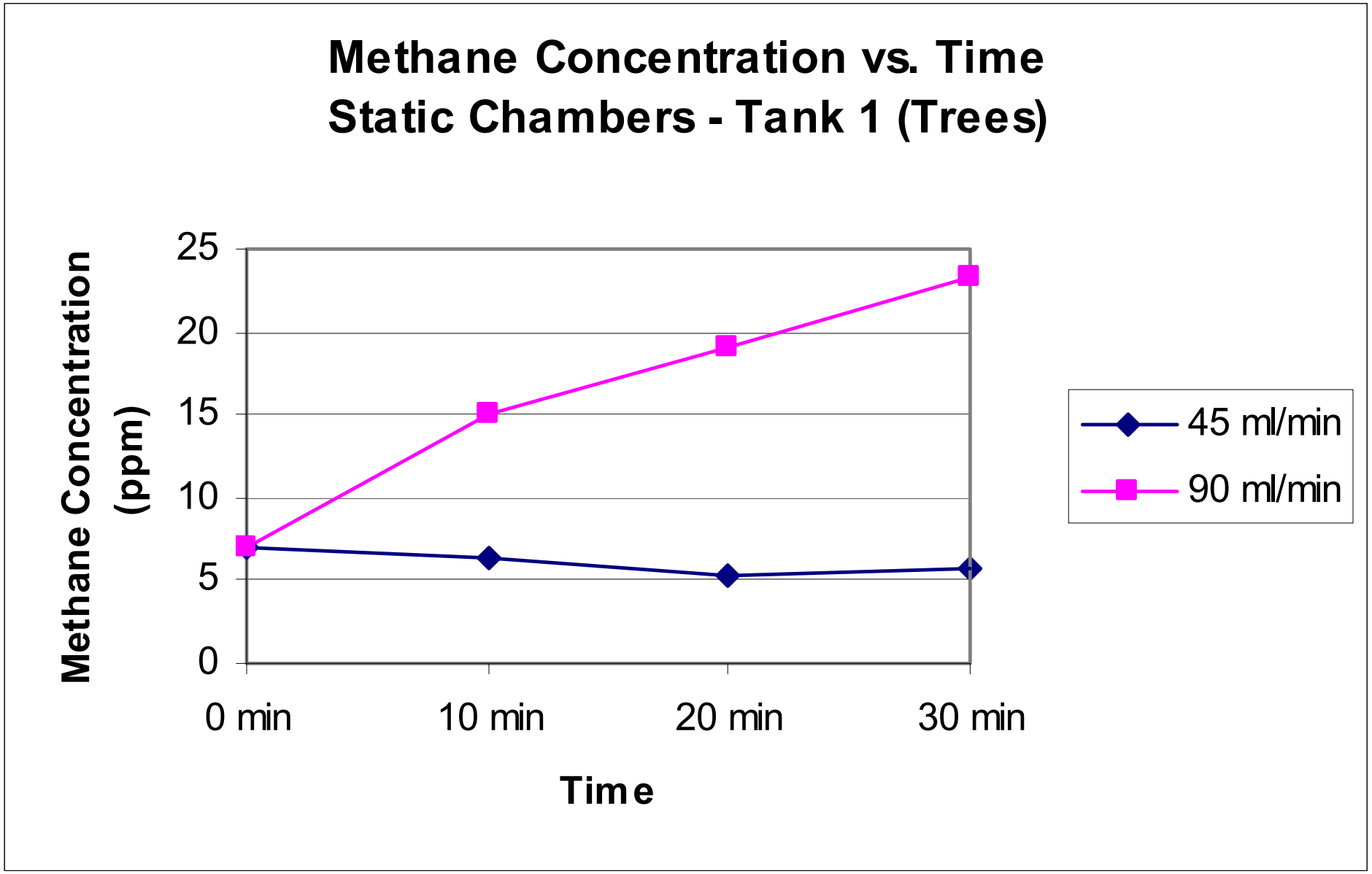
Static gas sampling chambers
(stainless kitchen bowl with cut edge and septa)

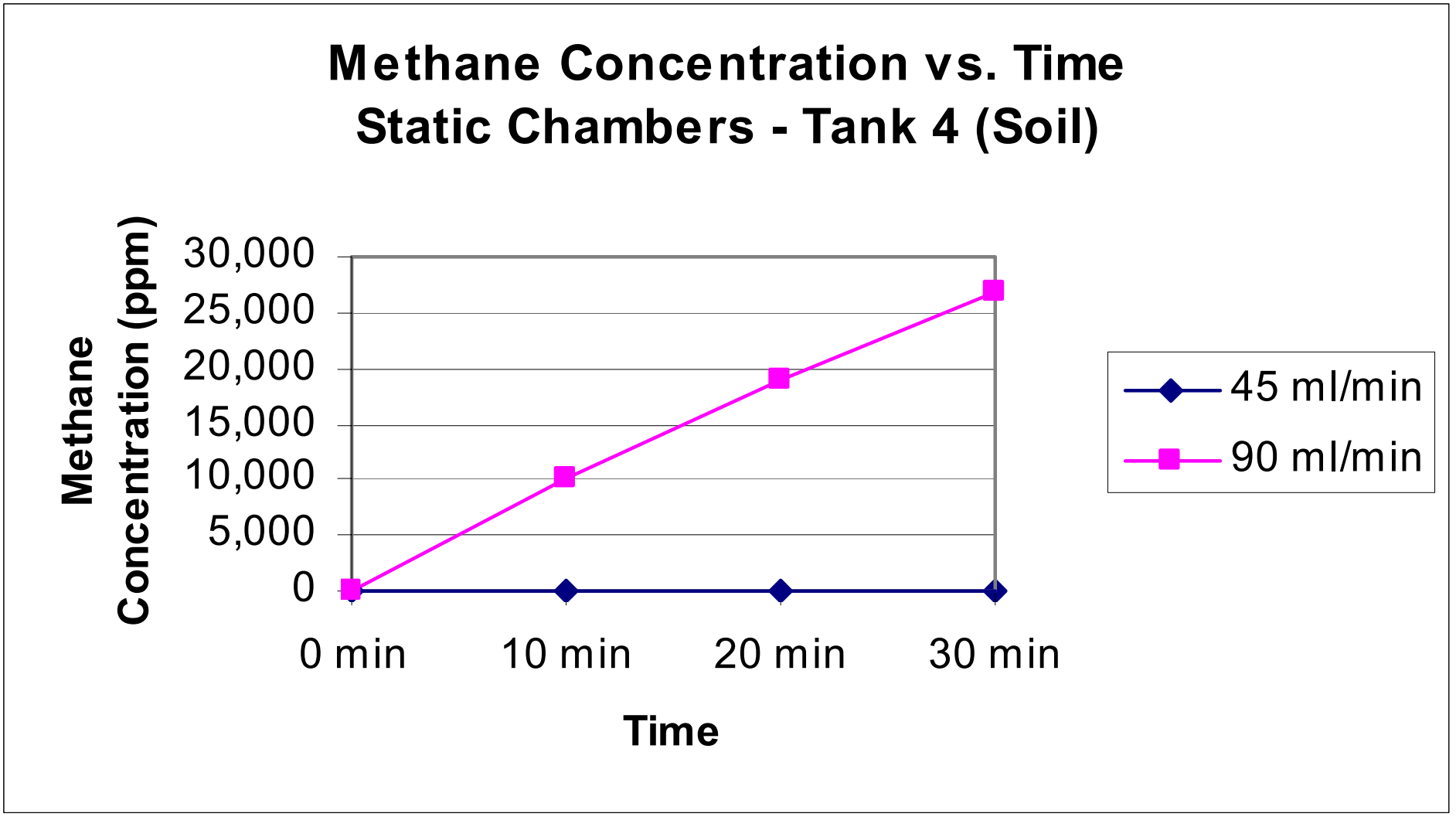
Unplanted Controls: Sand and Rhizosphere Soil

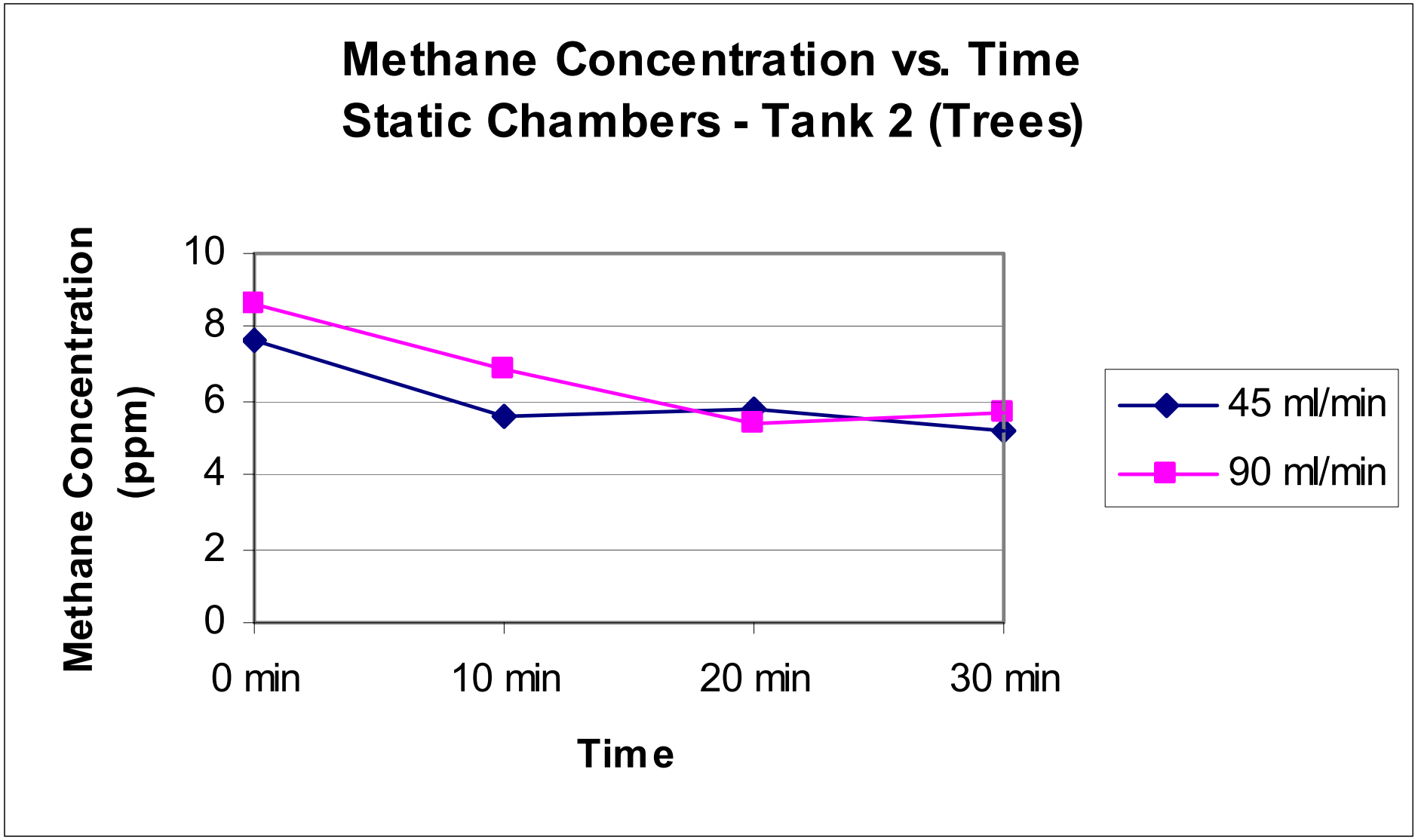
2003 Test Run – "Early Summer in Ohio"

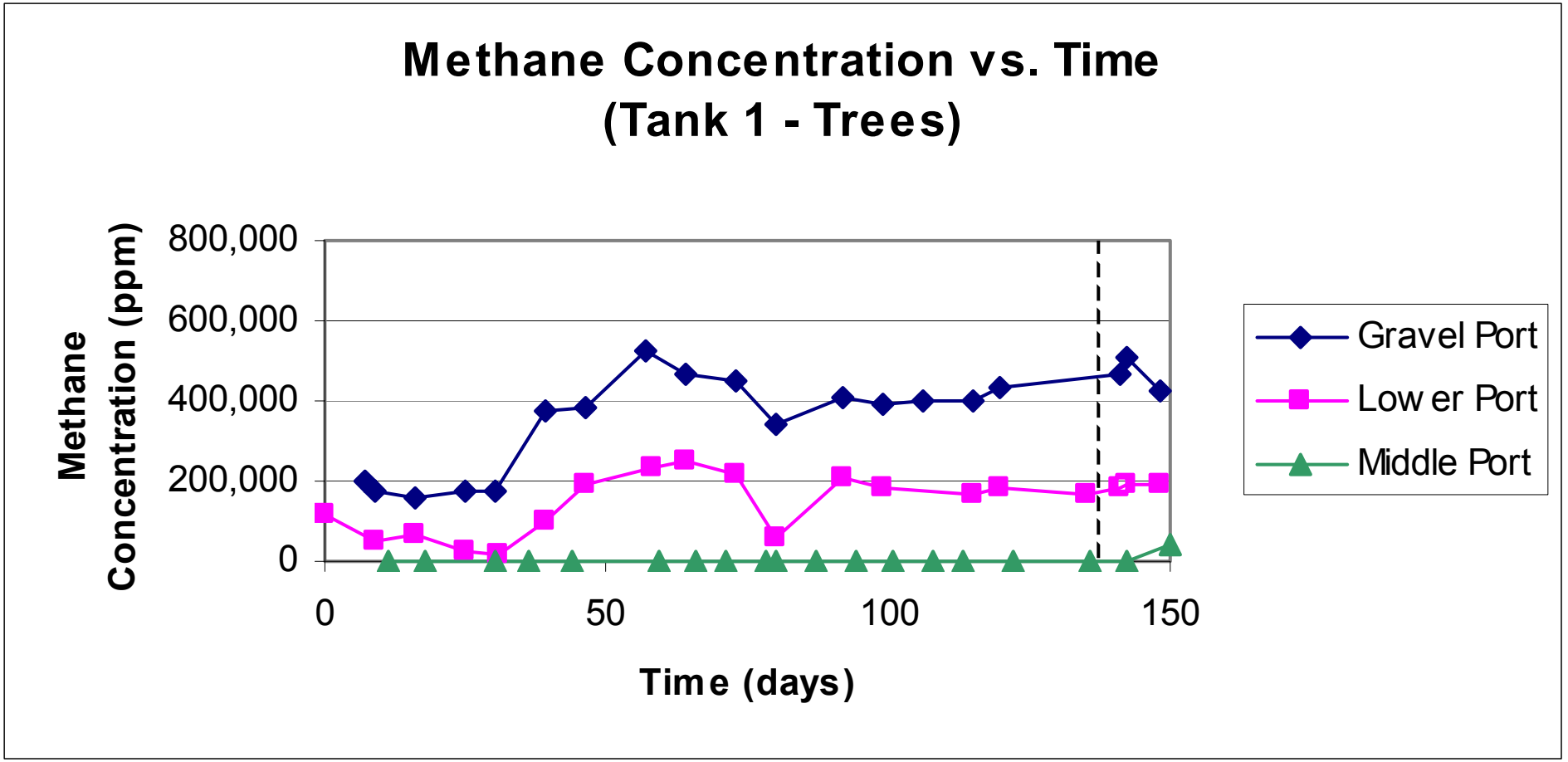
- 4 Tanks = 4 Treatments:
  2 Trees/grass, 1 rhizosphere soil, 1 sand
  - **1 Poplar cutting with fescue-rye mix**
  - **1 Poplar bucket tree with fescue rye mix**
- 50:50 CH_4 and CO_2
- Gas flow rates: 45ml/min; then 90 ml/min
- Lights: 16 hours/ day
- Max temperature 80^{o}F
- Soil: local 'topsoil" and bagged compost
  - **from previous test**
  - **homogenized**

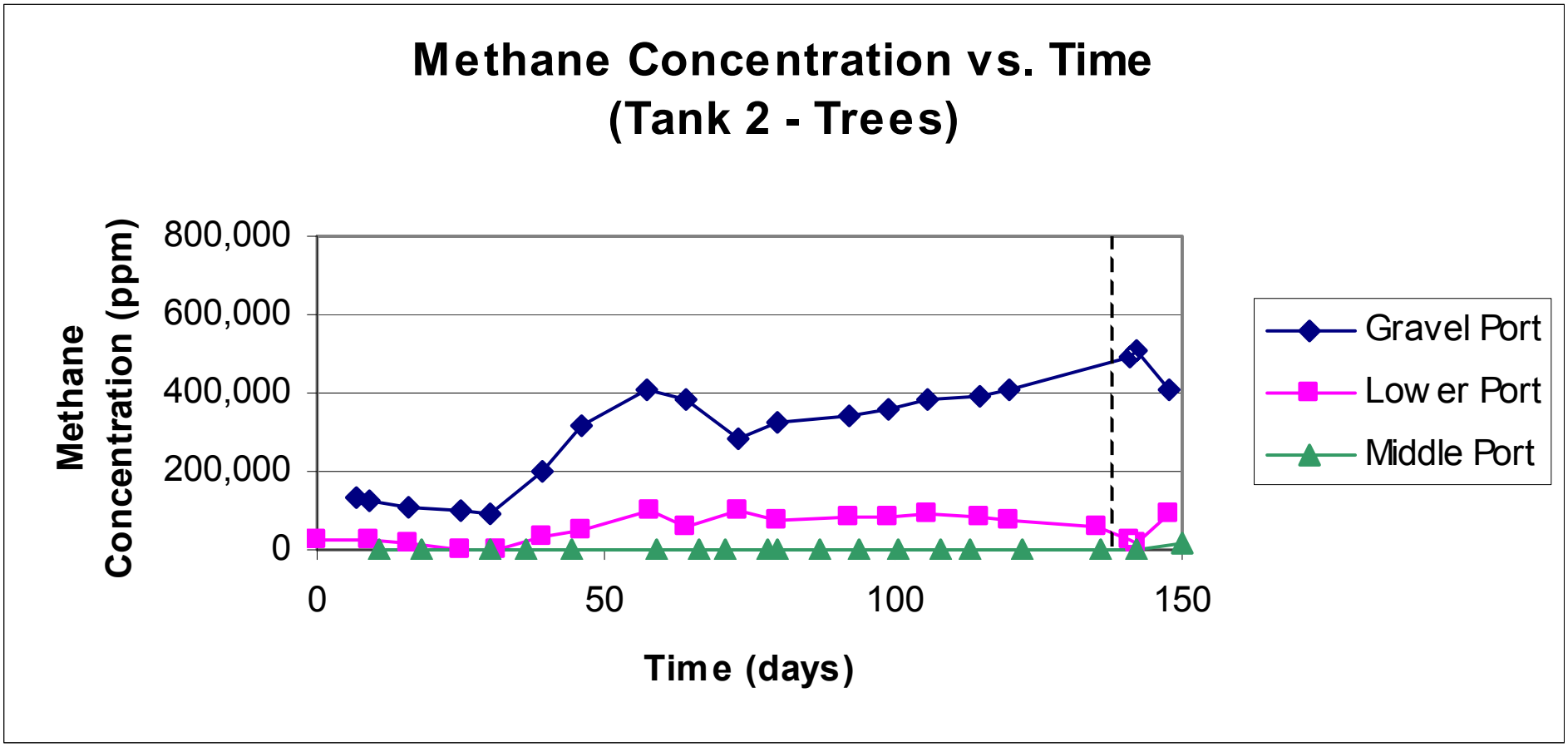

Methane Concentration vs. Time
Static Chambers - Tank 3 (Sand)
Methane Concentration (ppm)
20,000
15,000
10,000
5,000
0
0 min
10 min
20 min
30 min
Time
45 ml/min
90 ml/min

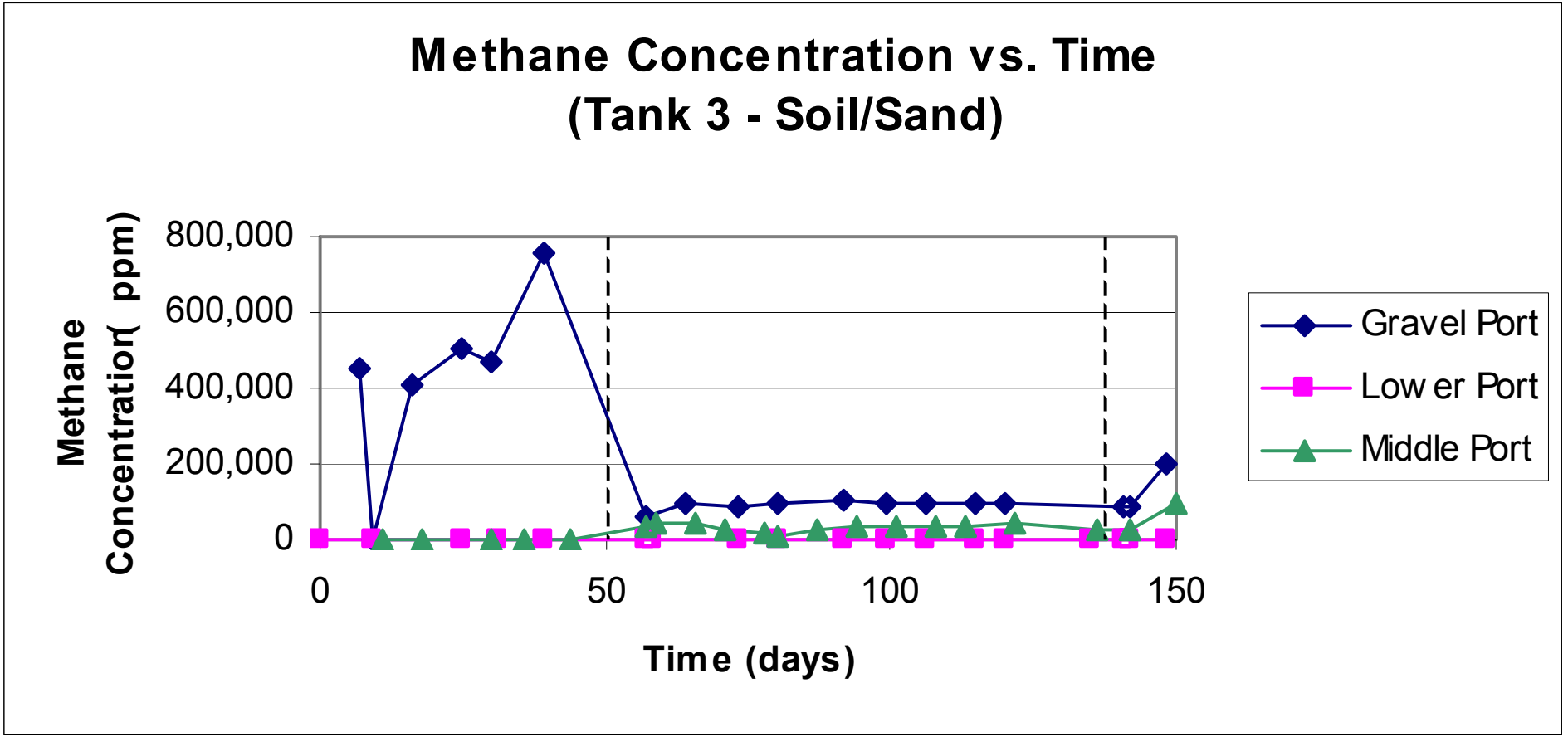

Methane Concentration vs. Time
Static Chambers - Tank 1 (Trees)
Methane Concentration (ppm)
25
20
15
10
5
0
0 min
10 min
20 min
30 min
Time
45 ml/min
90 ml/min

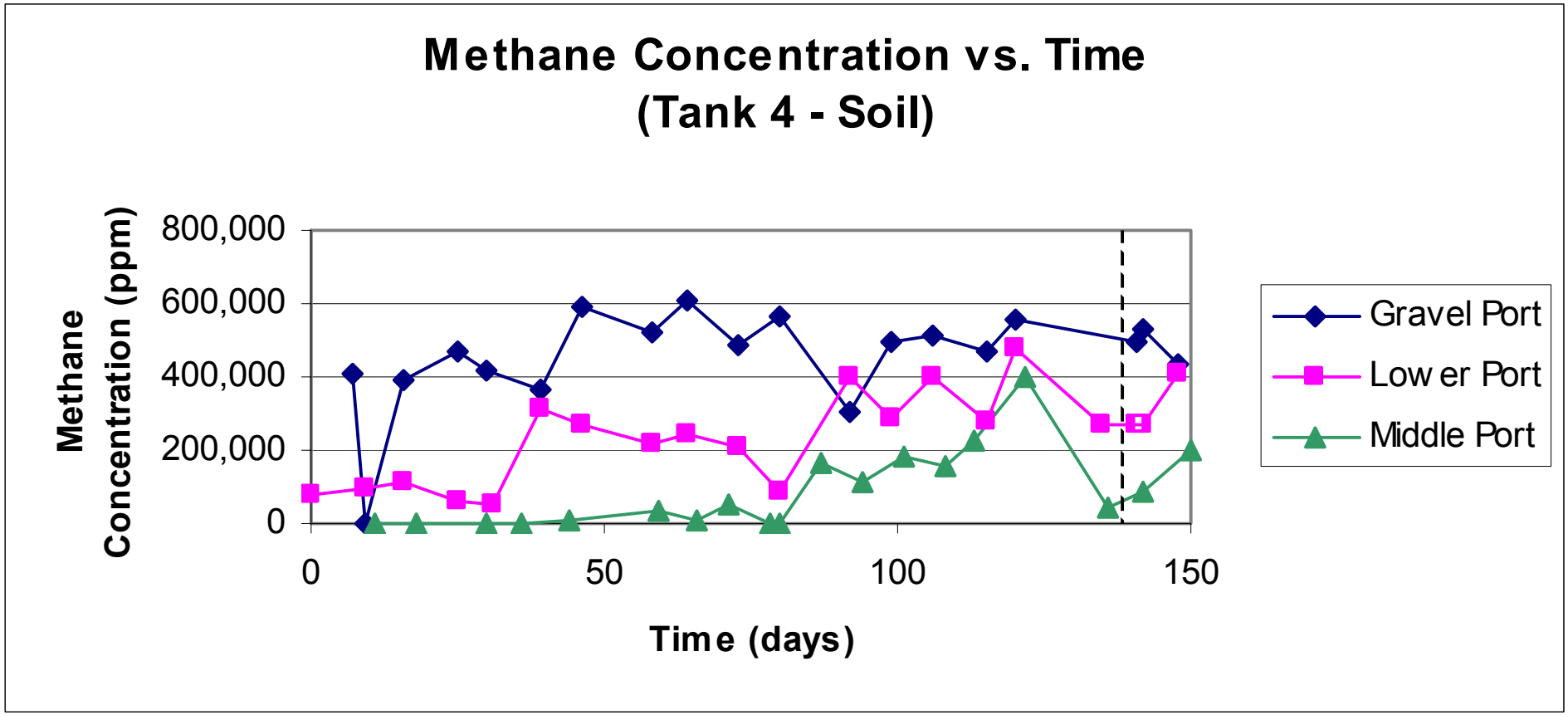

Methane Concentration vs. Time
Static Chambers - Tank 4 (Soil)
Methane Concentration (ppm)
30,000
25,000
20,000
15,000
10,000
5,000
0
0 min
10 min
20 min
30 min
Time
45 ml/min
90 ml/min

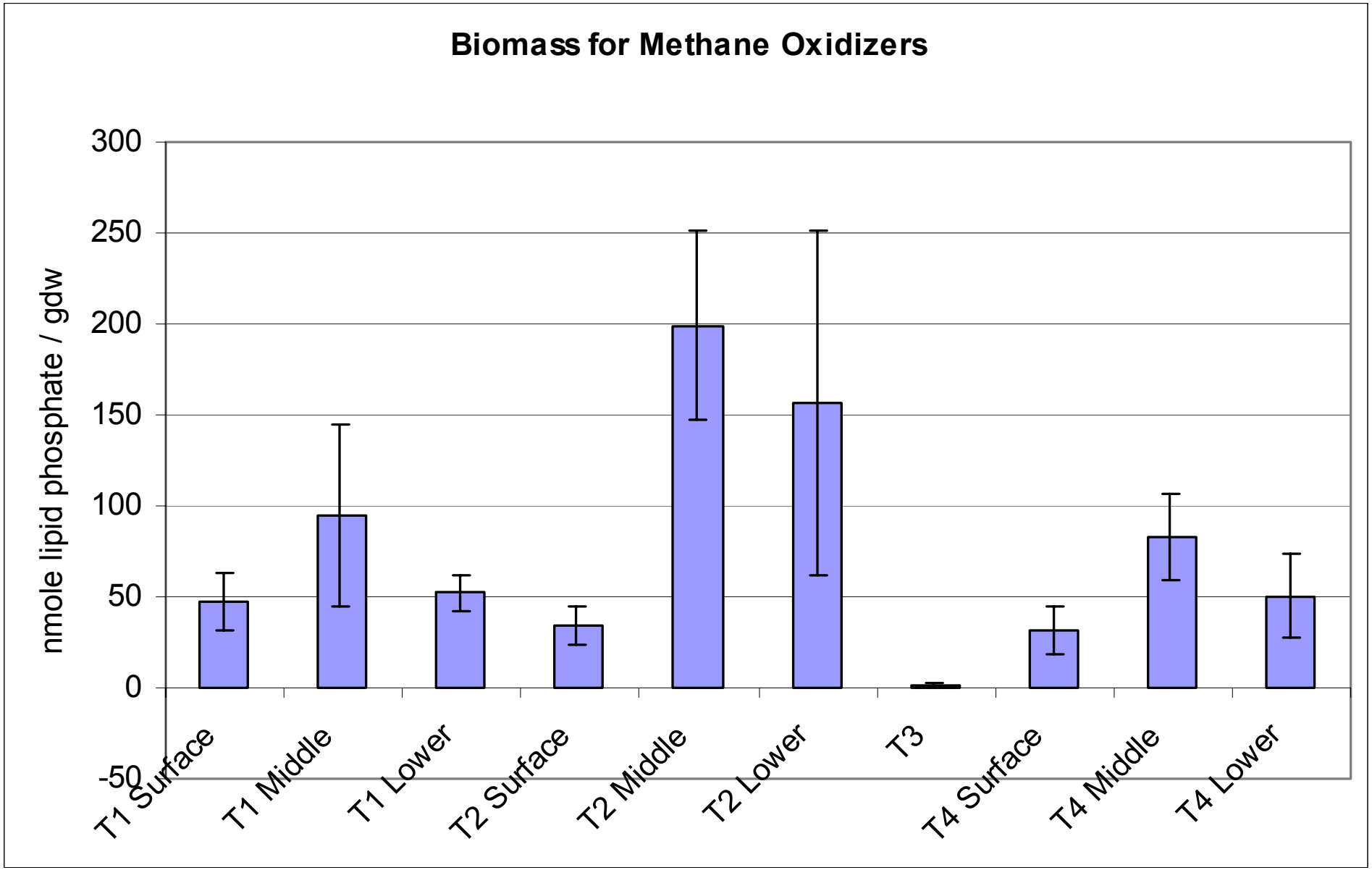

Methane Concentration vs. Time
Static Chambers - Tank 2 (Trees)
Methane Concentration (ppm)
10
8
6
4
2
0
0 min
10 min
20 min
30 min
Time
45 ml/min
90 ml/min


Methane Concentration vs. Time
(Tank 1 - Trees)
Methane Concentration (ppm)
800,000
600,000
400,000
200,000
0
0
50
100
150
Time (days)
Gravel Port
Lower Port
Middle Port


Methane Concentration vs. Time
(Tank 2 - Trees)
Methane Concentration (ppm)
800,000
600,000
400,000
200,000
0
0
50
100
150
Time (days)
Gravel Port
Lower Port
Middle Port


Methane Concentration vs. Time
(Tank 3 - Soil/Sand)
Methane Concentration(ppm)
800,000
600,000
400,000
200,000
0
0
50
100
150
Time (days)
Gravel Port
Lower Port
Middle Port


Methane Concentration vs. Time
(Tank 4 - Soil)
Methane Concentration (ppm)
800,000
600,000
400,000
200,000
0
0
50
100
150
Time (days)
Gravel Port
Lower Port
Middle Port


Biomass for Methane Oxidizers
nmole lipid phosphate / gdw
300
250
200
150
100
50
0
-50
T1 Surface
T1 Middle
T1 Lower
T2 Surface
T2 Middle
T2 Lower
T3
T4 Surface
T4 Middle
T4 Lower

Percent Oxidation in Tank

	Gas flow rate 45 ml/min	90 ml/min
• Tank 1 (tree and grass)	100%	99.96%
• Tank 2 (tree and grass)	100%	100%
• Tank 3 (sand)	76.44%	60.11%
• Tank 4 (soil)	99.88%	28.81%

Mass balance = methane in - methane out

Excavation Observations

- Rhizosphere
  - Tree roots to about 24” bgs
  - Grasse roots to about 8”
  - Aerobic and dry
- Bottom of tanks
  - Anaerobic
  - Saturated
  - Scarcely any roots

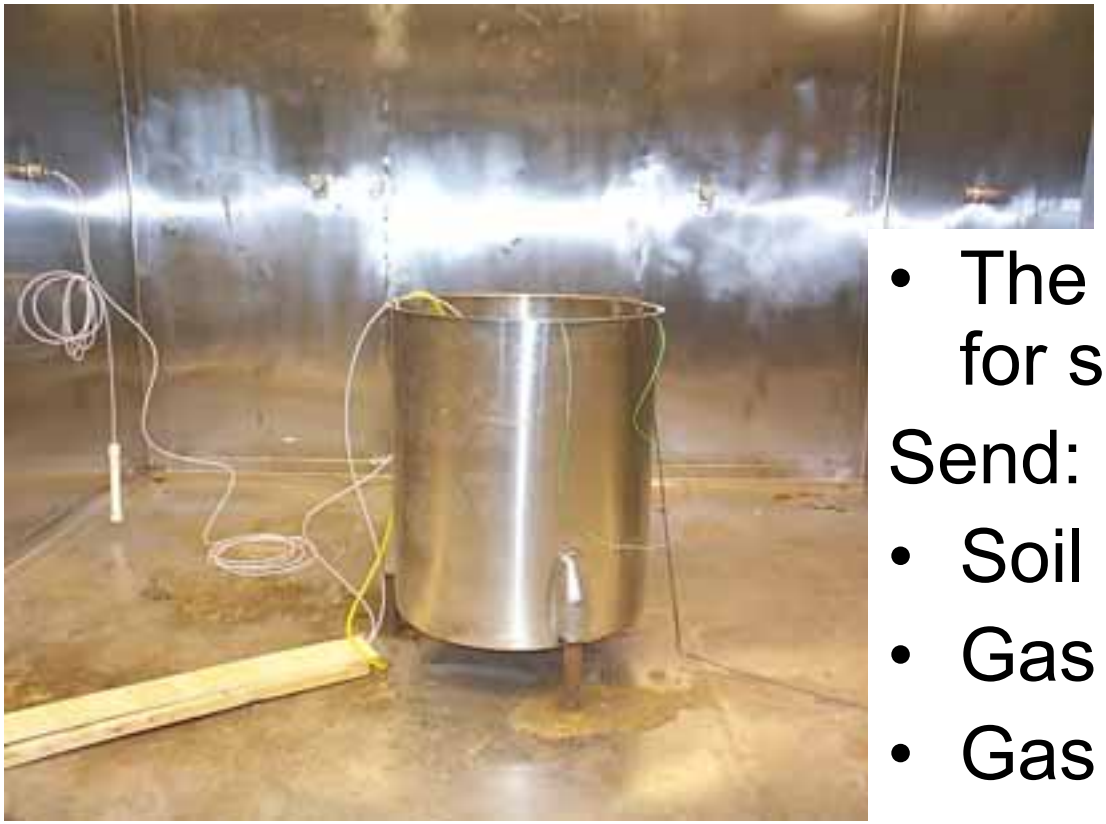
    (previous tests had roots in the drains)

Conclusions

- At certain flows, trees/grass>soil>sand
- 2-3’ vegetated soil is sufficient
- Closer to surface=more roots, microbes, less methane
- Once established, rhizosphere effect continues even without plants, for a time

Current Test: Omaha

- Treatments:
  - Prairie grass mix
    - buffalo grass/gama/grama
  - Prairie grass with poplar cutting
  - Rhizosphere soil
- Nebraska in June light and water
- Gas: 50% CH_4, 50% CO_2
  - 45 ml/min for 8 weeks, then
  - 90 ml/min for 4 weeks



Final note

- The system is available for site specific testing.

Send:

- Soil
- Gas composition
- Gas rate
- Plant selection
- Climate
  - Light duration, temperature regime, watering schedule
- Funding