A Multi-Site Performance Comparison of Semi-Continuous Carbon, Nitrate and Sulfate Monitors

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Study Objectives and Approach

- Objectives
  - Assess the operational characteristics and performance of the R&P 5400C, 8400N, and 8400S carbon, nitrate, and sulfate monitors for application for routine use at Speciation Trends Sites; and
  - Evaluate the use of an automated point data collection system for data processing and integration with visualization tools for real time display and reporting.
- Approach
  - Develop and implement consistent operating SOPs;
  - Assess inter- and intra-site comparisons of 24hr average monitor readings with corresponding Speciation Trends Filter-Based Sampler results;
  - Develop monitor auditing protocols and perform independent performance evaluation of monitor data output to evaluate consistency among operating sites and sampler performance; and
  - Phased installation and operation of Information Processing Systems and MeteoStar LEADS data acquisition/visualization tools.

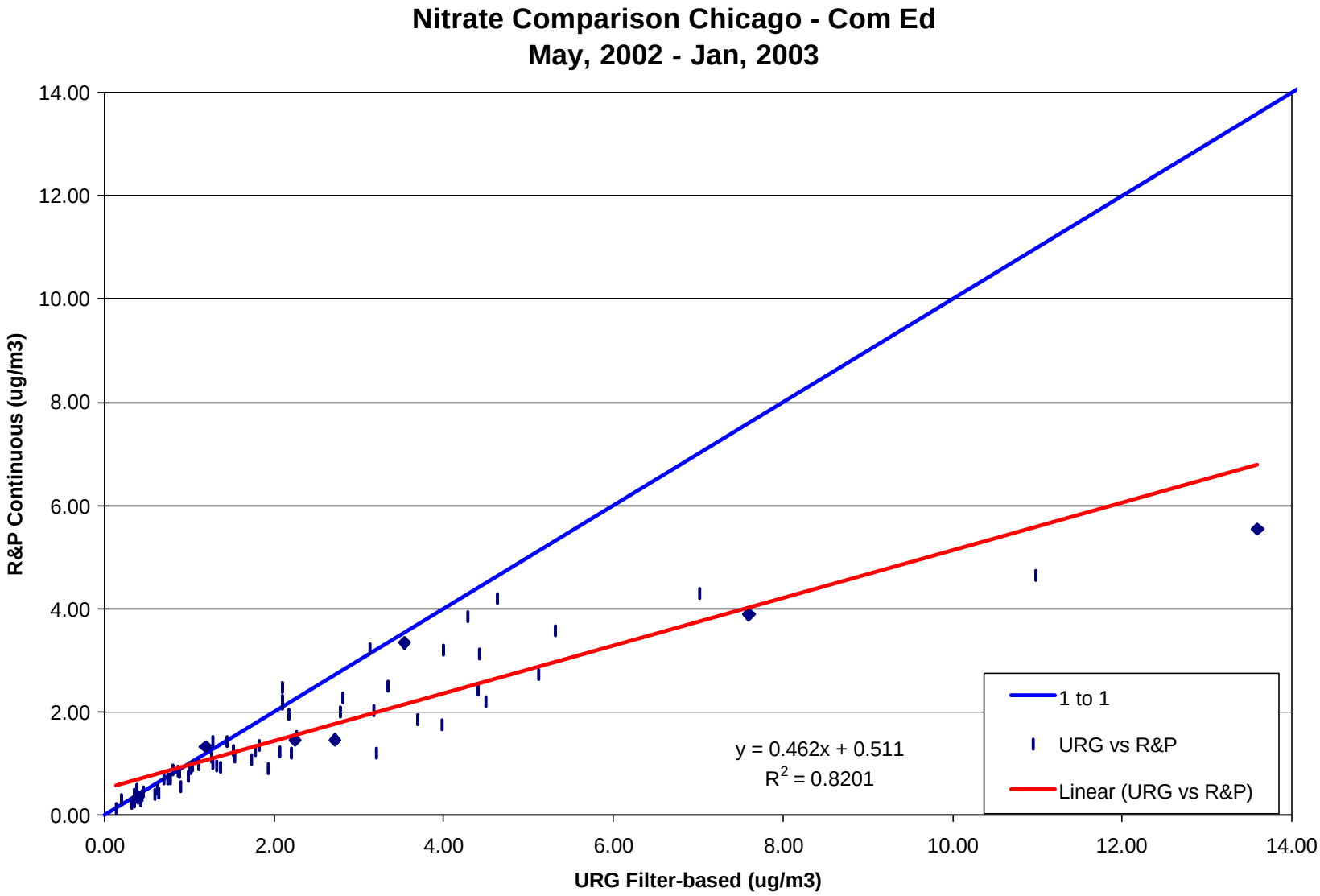
Schedule and Output

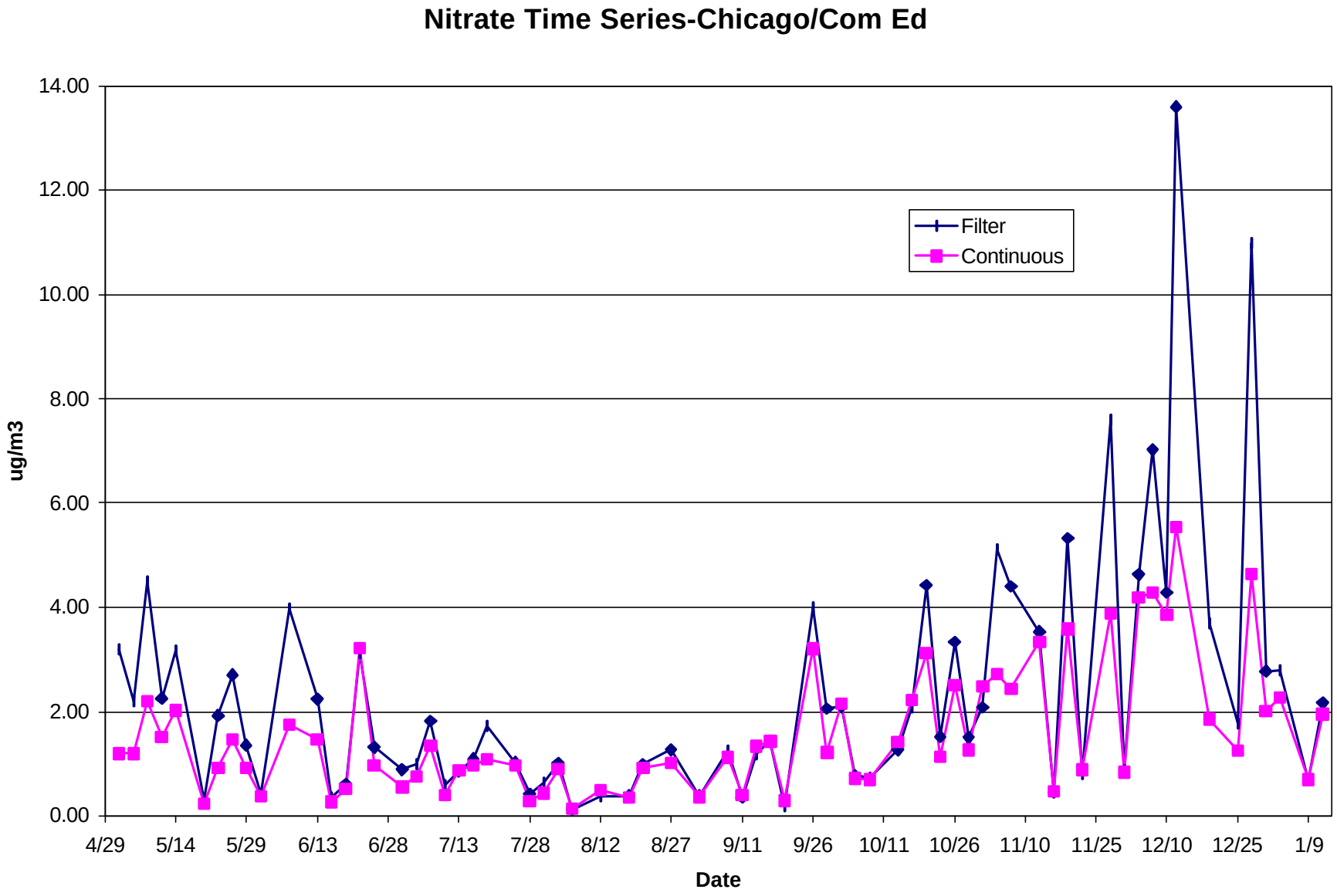
- Test Sites: Seattle, WA; Phoenix, AZ; Deer Park, TX; Chicago, IL; and Indianapolis, IN.
- Study Period: July, 2002-July2003
- Implementation: SOPs in place at start-up; All sites report standardized monthly data summaries in Excel format. EPA Montgomery Lab perform periodic performance evaluation audits. Automated data collection systems installation staggered over initial project period.

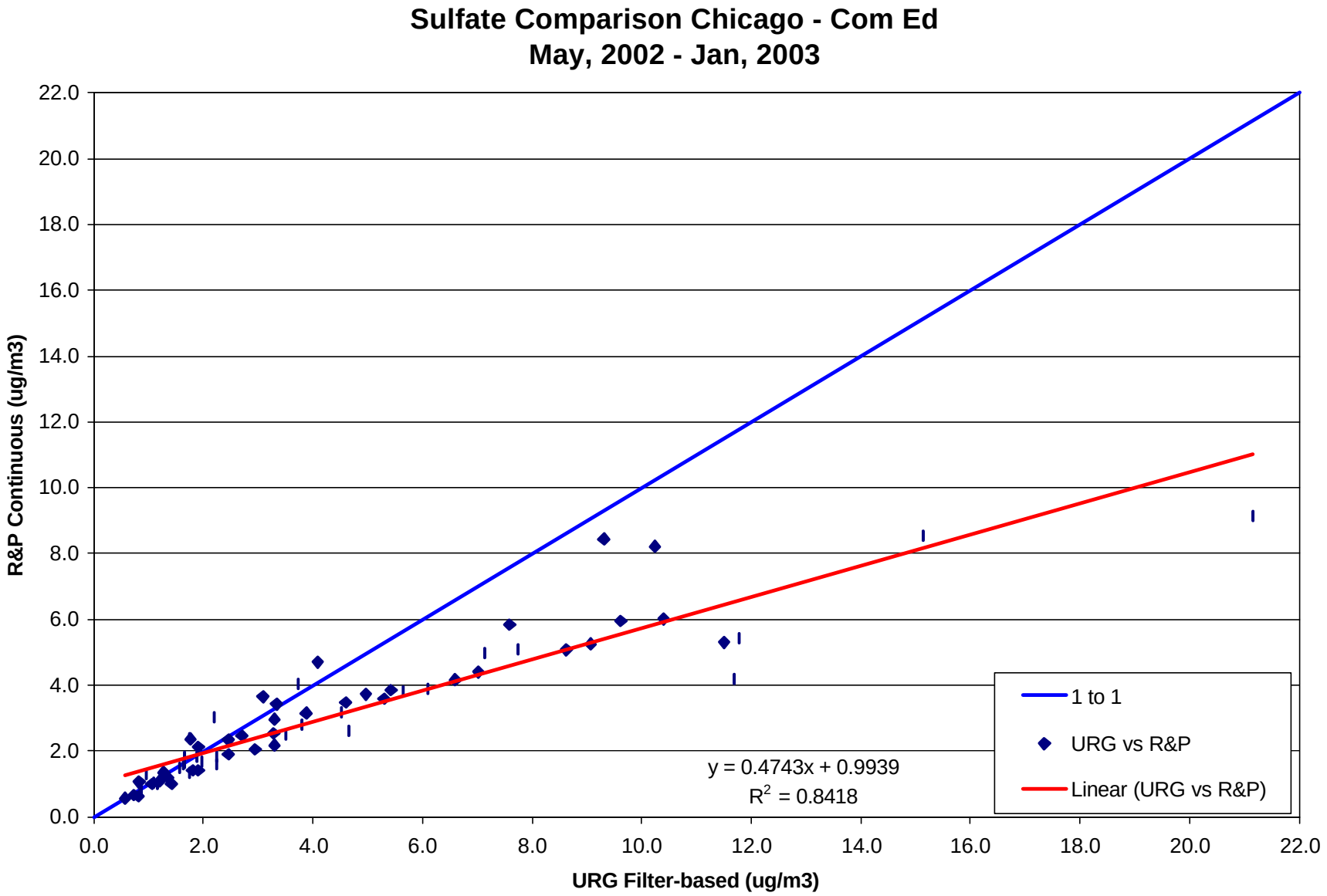
Representative Site Installation

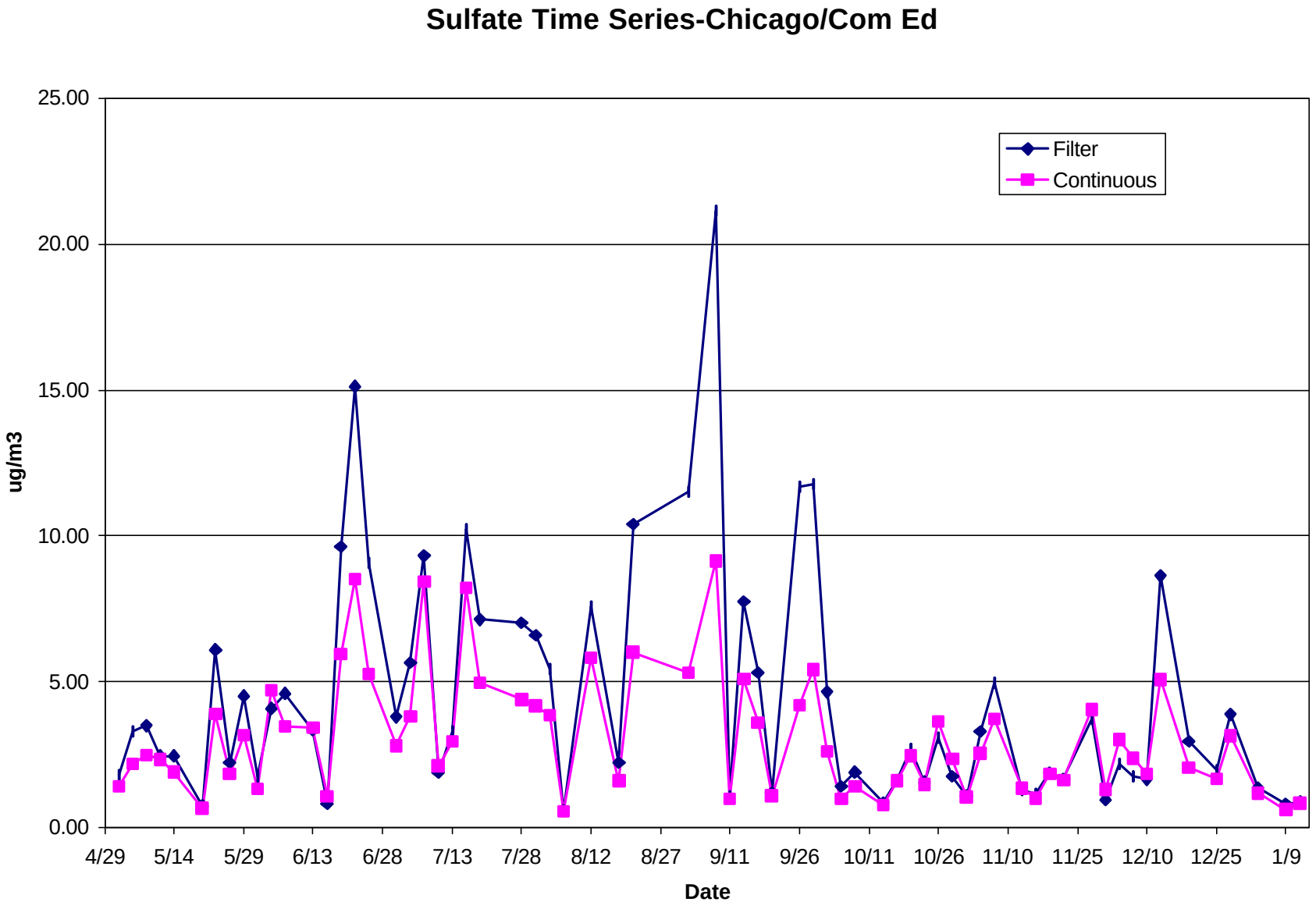
Continuous Monitor Trailer

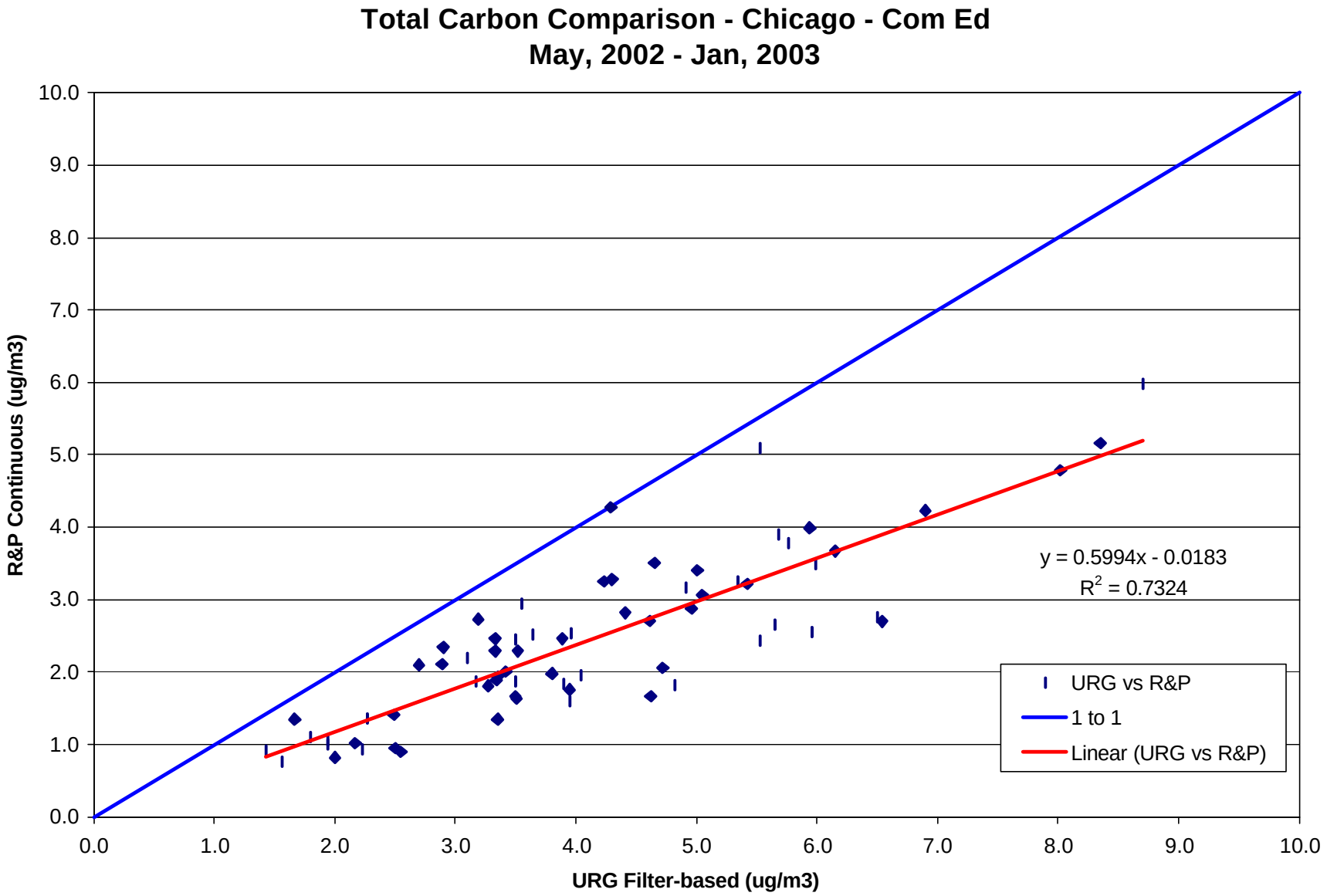
Monitor Installation

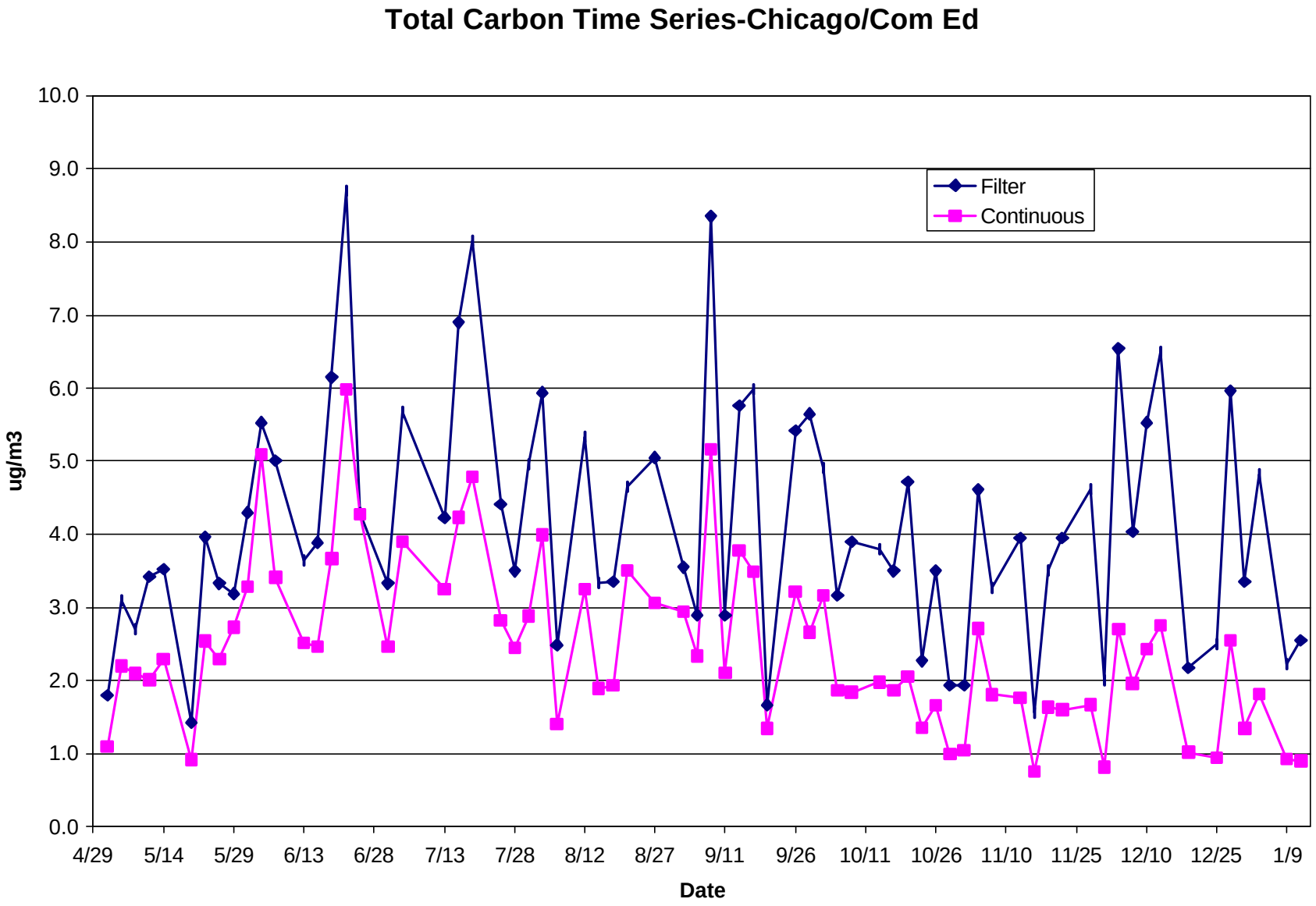

Nitrate Comparison Chicago - Com Ed
May, 2002 - Jan, 2003
R&P Continuous (ug/m3)
URG Filter-based (ug/m3)
0.00
2.00
4.00
6.00
8.00
10.00
12.00
14.00
y = 0.462x + 0.511
R2 = 0.8201
1 to 1
URG vs R&P
Linear (URG vs R&P)

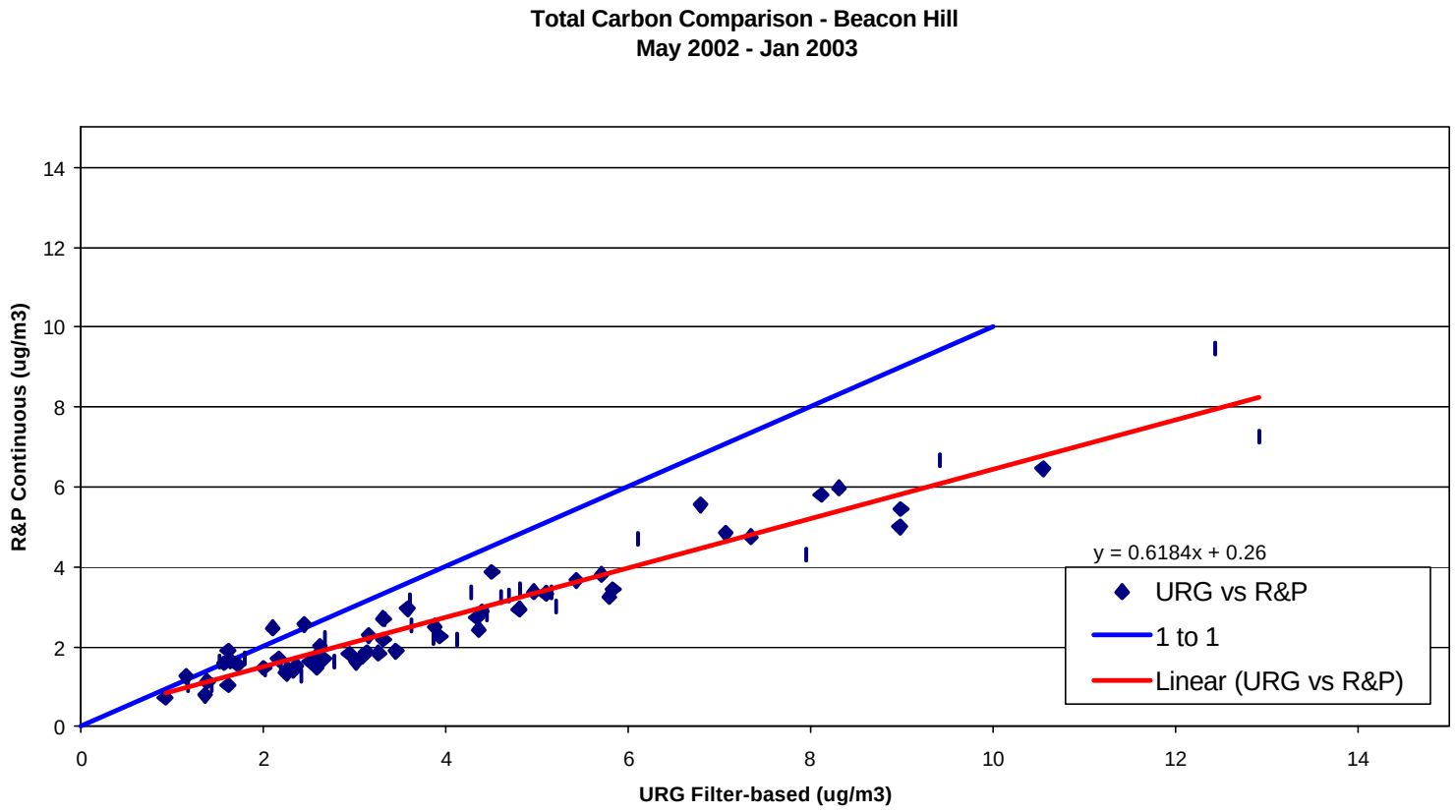

Nitrate Time Series-Chicago/Com Ed
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
ug/m3
Filter
Continuous
4/29
5/14
5/29
6/13
6/28
7/13
7/28
8/12
8/27
9/11
9/26
10/11
10/26
11/10
11/25
12/10
12/25
1/9
Date

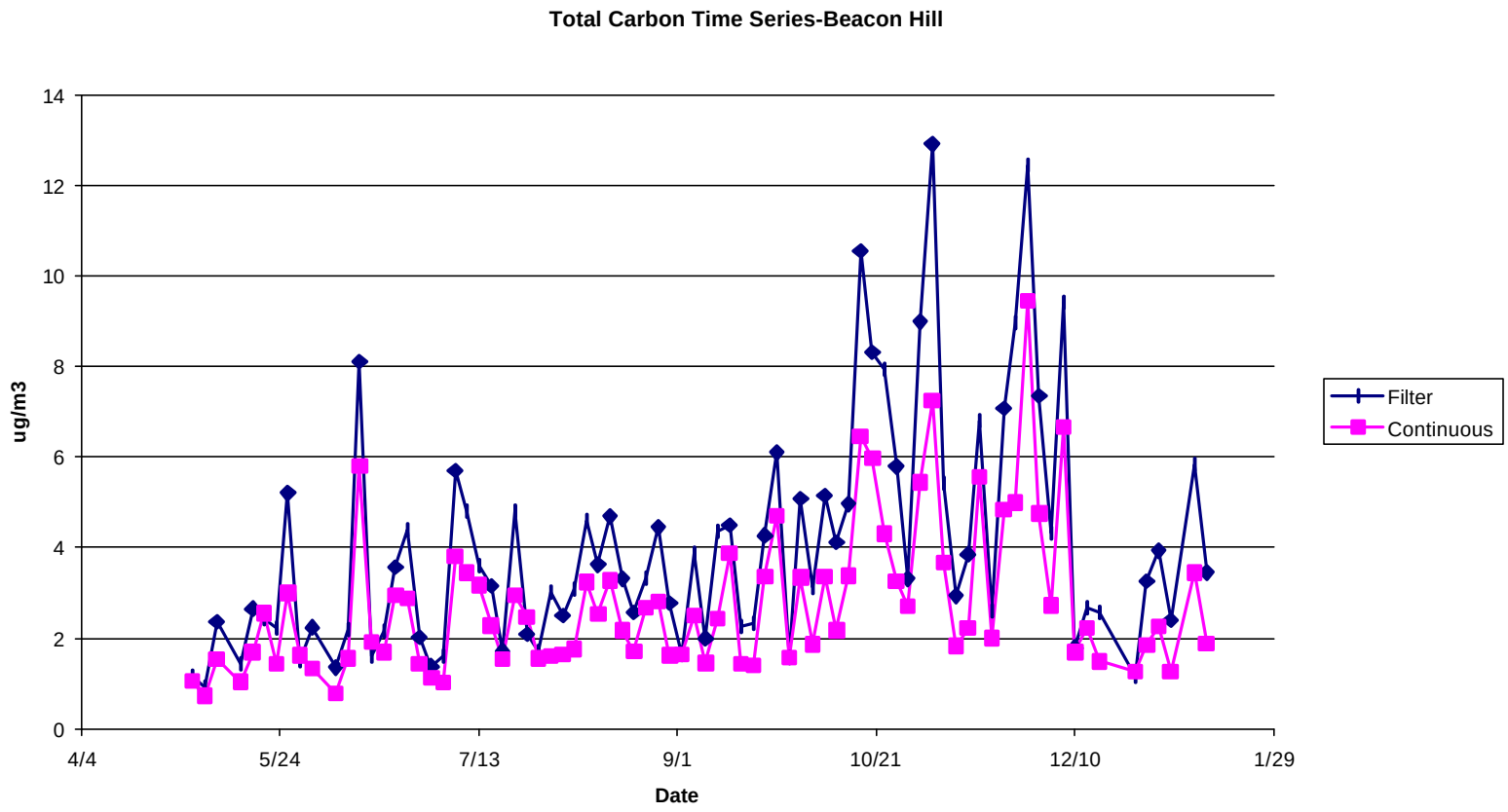

Sulfate Comparison Chicago - Com Ed
May, 2002 - Jan, 2003
R&P Continuous (ug/m3)
URG Filter-based (ug/m3)
0.0
2.0
4.0
6.0
8.0
10.0
12.0
14.0
16.0
18.0
20.0
22.0
y = 0.4743x + 0.9939
R2 = 0.8418
1 to 1
URG vs R&P
Linear (URG vs R&P)

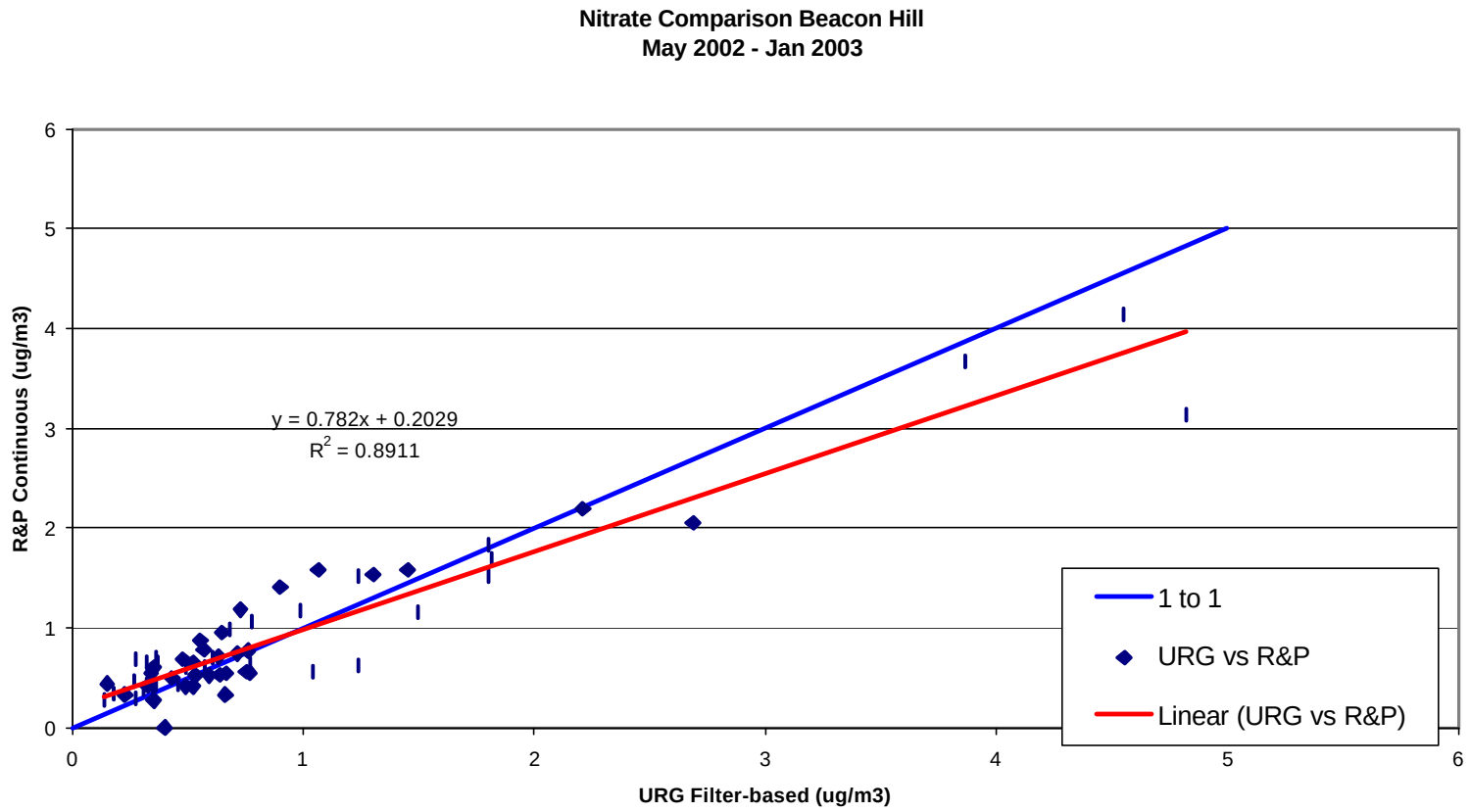

Sulfate Time Series-Chicago/Com Ed
25.00
20.00
15.00
10.00
5.00
0.00
ug/m3
Filter
Continuous
4/29
5/14
5/29
6/13
6/28
7/13
7/28
8/12
8/27
9/11
9/26
10/11
10/26
11/10
11/25
12/10
12/25
1/9
Date

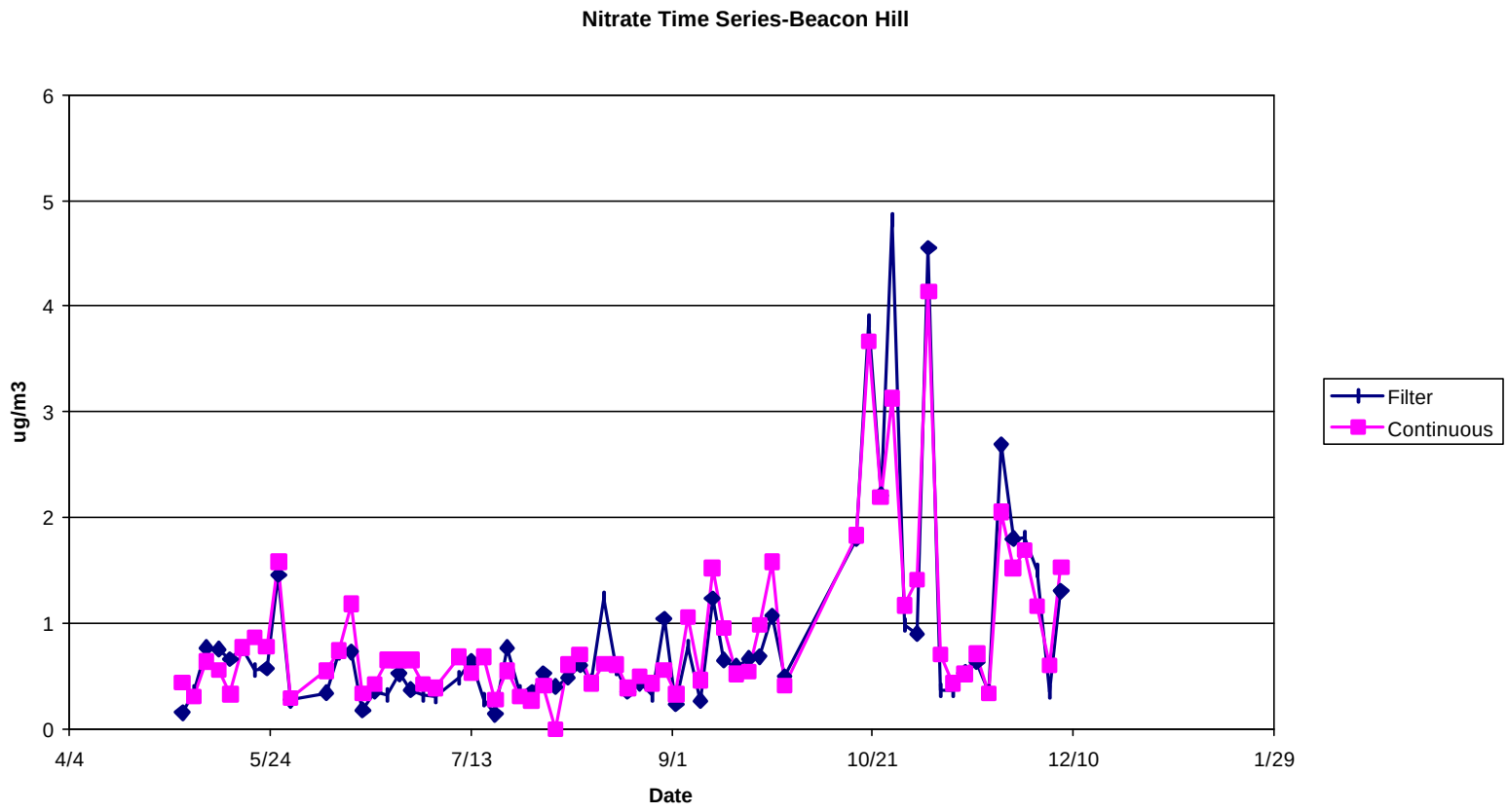

Total Carbon Comparison - Chicago - Com Ed
May, 2002 - Jan, 2003
R&P Continuous (ug/m3)
URG Filter-based (ug/m3)
0.0
1.0
2.0
3.0
4.0
5.0
6.0
7.0
8.0
9.0
10.0
y = 0.5994x - 0.0183
R2 = 0.7324
URG vs R&P
1 to 1
Linear (URG vs R&P)


Total Carbon Time Series-Chicago/Com Ed
ug/m3
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
Filter
Continuous
4/29
5/14
5/29
6/13
6/28
7/13
7/28
8/12
8/27
9/11
9/26
10/11
10/26
11/10
11/25
12/10
12/25
1/9
Date

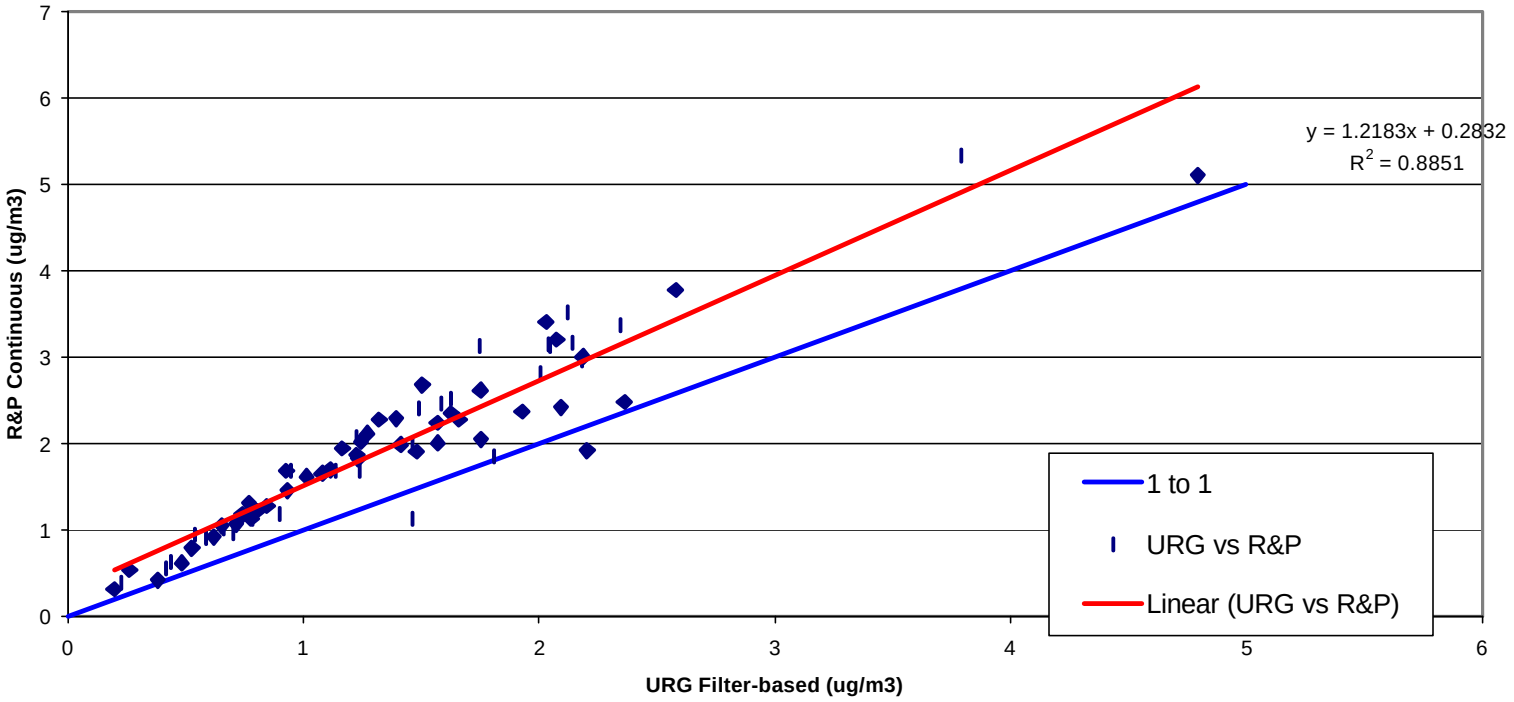

Total Carbon Comparison - Beacon Hill
May 2002 - Jan 2003
R&P Continuous (ug/m3)
URG Filter-based (ug/m3)
0
2
4
6
8
10
12
14
y = 0.6184x + 0.26
URG vs R&P
1 to 1
Linear (URG vs R&P)

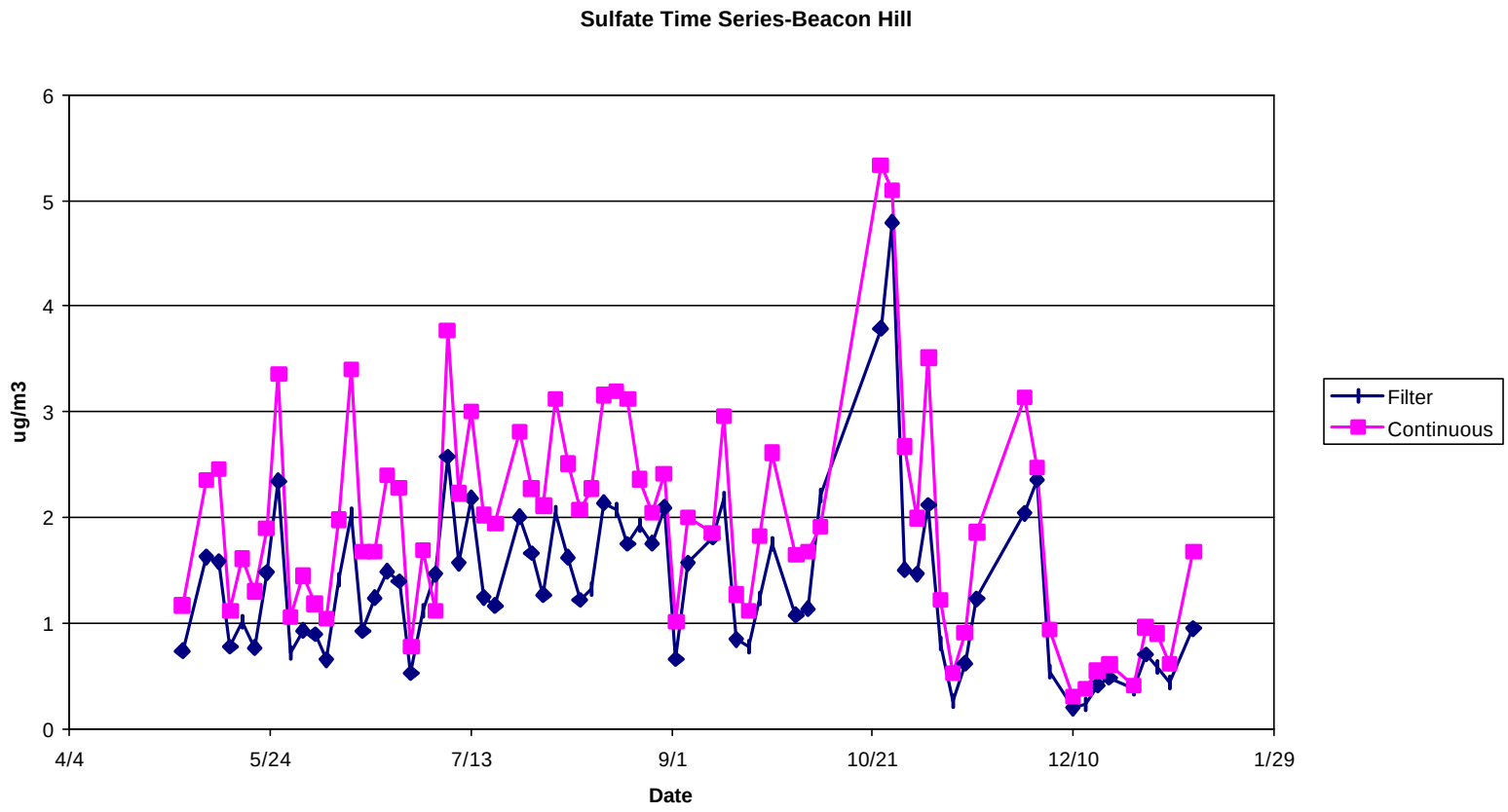

Total Carbon Time Series-Beacon Hill
ug/m3
14
12
10
8
6
4
2
0
4/4
5/24
7/13
9/1
10/21
12/10
1/29
Date
Filter
Continuous


Nitrate Comparison Beacon Hill
May 2002 - Jan 2003
R&P Continuous (ug/m3)
URG Filter-based (ug/m3)
y = 0.782x + 0.2029
R2 = 0.8911
1 to 1
URG vs R&P
Linear (URG vs R&P)
0
1
2
3
4
5
6


Nitrate Time Series-Beacon Hill
ug/m3
0
1
2
3
4
5
6
4/4
5/24
7/13
9/1
10/21
12/10
1/29
Date
Filter
Continuous

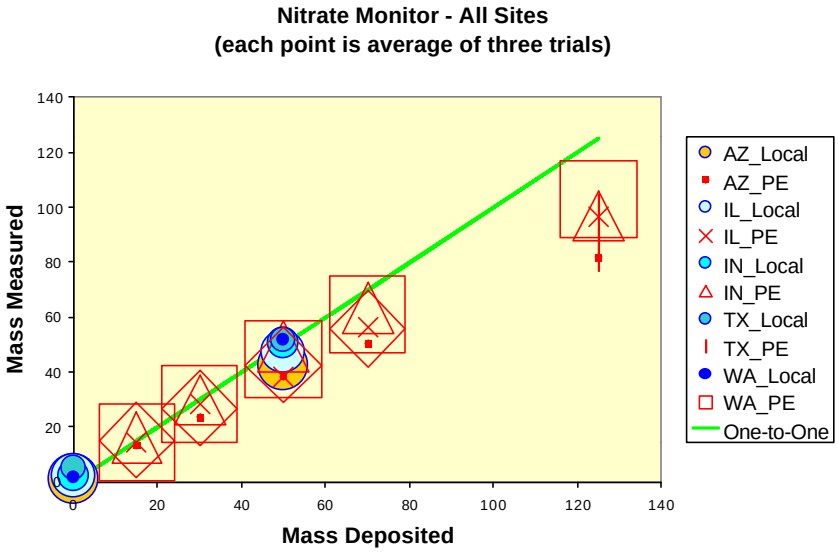
Sulfate Comparison Beacon Hill May 2002- Jan 2003

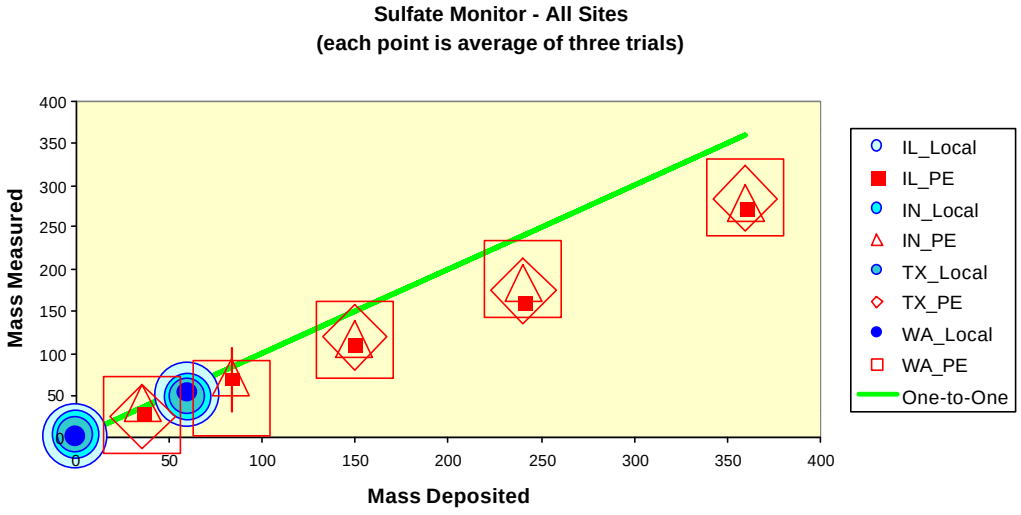



Sulfate Time Series-Beacon Hill
ug/m3
0
1
2
3
4
5
6
4/4
5/24
7/13
9/1
10/21
12/10
1/29
Date
Filter
Continuous

Results of Performance Evaluation Audit #1

1. Prepare 5 blind aqueous spike audit solution concentrations using KNO_3 and $(NH_4)_2SO_4$
2. Verify concentrations by ion chromatography analysis
3. Use constant volume spike for each solution 0.5ul for NO_3 and 0.2ul for SO_4 to maintain constant aqueous volume deposited on flash strip of each monitor.
4. Each site to analyze local aqueous blank, local 100ng/ul nitrate and 300ng/ul sulfate standards and triplicates of each of the 5 audit solutions.





Total Carbon Comparison Summary

Site	Period	Range	Slope	Intercept	R^2
IL	5/02-1/03	1.5-9µg/m^3	0.60	-0.02	0.73
WA	5/02-1/03	1-13	0.62	+0.26	0.92
IN	6/02-1/03	2-14	0.53	+0.35	0.75
TX	9/02-12/02	1-12	0.20	+1.67	0.29
AZ	12/02-2/03	3-22	0.32	+0.91	0.87

Y=mx+b where y=R&P5400conc. and x=Speciation Trends Network(STN) Sampler

Findings to date:

R&P5400 consistently measures lower than STN sampler across concentration range at all sites

In most cases, average monitor response correlates well with STN measurements.

Nitrate Comparison Summary

Site	Period	Range	Slope	Intercept	R^2
TX	9/02-12/02	0.2-2µg/m^3	1.23	+0.53	0.21
WA	5/02-1/03	0.2-5	0.78	+0.20	0.89
IN	7/02-1/03	0.2-12	0.56	+0.25	0.85
IL	5/02-1/03	0.2-14	0.46	+0.51	0.82
AZ	9/02-2/03	0.2-15	0.59	+0.99	0.86

Y=mx+b where y=R&P8400Nconc., and x=Speciation Trends Network(STN) Sampler

Findings to date:

R&P8400 24hr-average concentrations are lower than corresponding STN 24hr-average concentrations across measured range. There is better agreement at lower nitrate levels and diverge as concentrations increase. With exception of Texas site, response correlation is good.

Sulfate Comparison Summary

Site	Period	Range	Slope	Intercept	R^2
WA	5/02-1/03	0.5-5µg/m^3	1.22	+0.28	0.89
TX	9/02-12/02	1-6	0.74	+1.65	0.87
IL	5/02-1/03	0.5-21	0.47	+0.99	0.84
IN	7/02-1/03	0.5-21	0.59	+0.99	0.83

Y=mx+b where y=R&P8400Sconc., and x=Speciation Trends Network(STN) Sampler

Findings to date:

R&P8400S 24-average concentrations compare favorably with STN average concentrations at sulfate levels below ~5µg/m^3 and increasingly are lower than STN values at higher concentrations. Response correlation is good.