Ammonia Flux Profiles for Various Soil and Vegetation Communities in California

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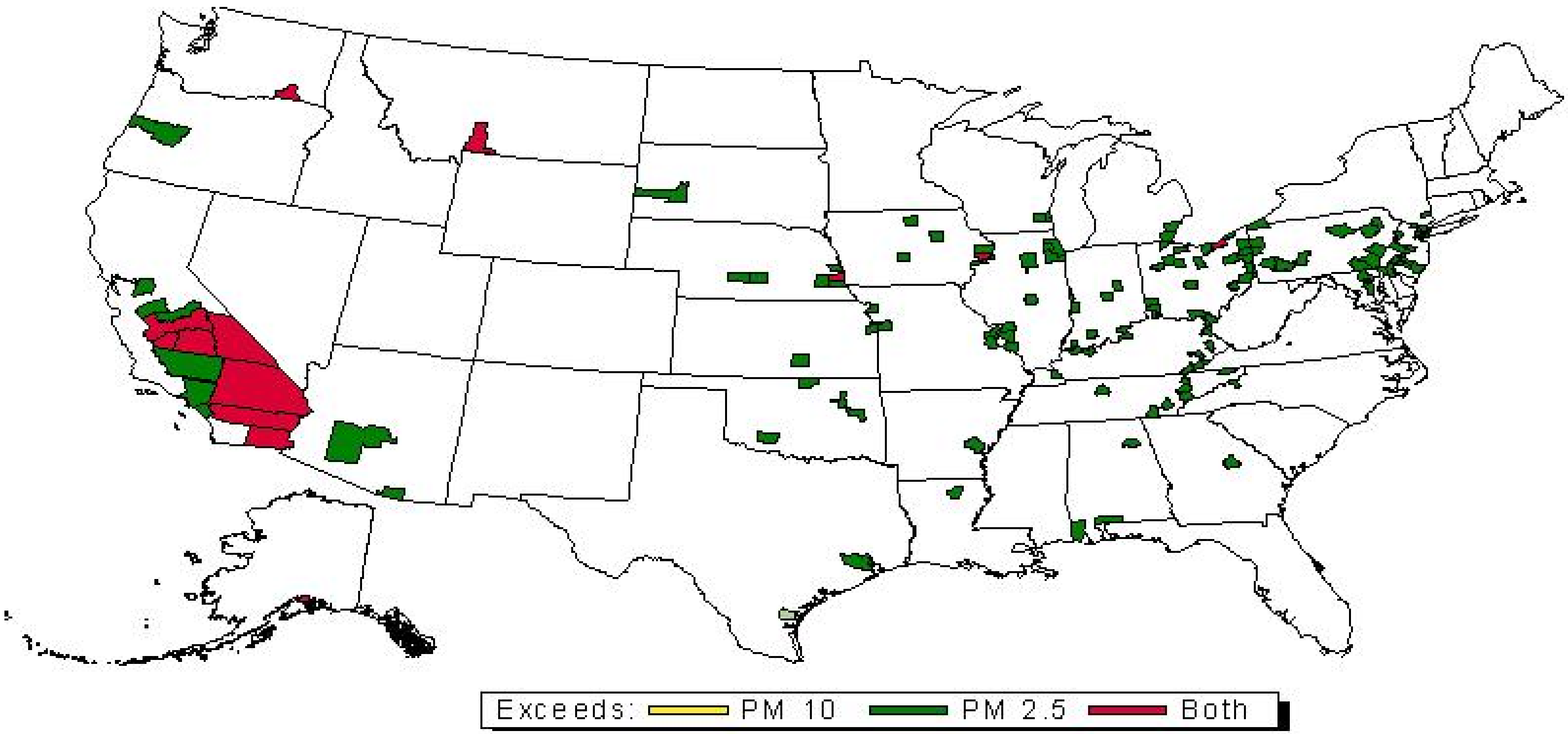
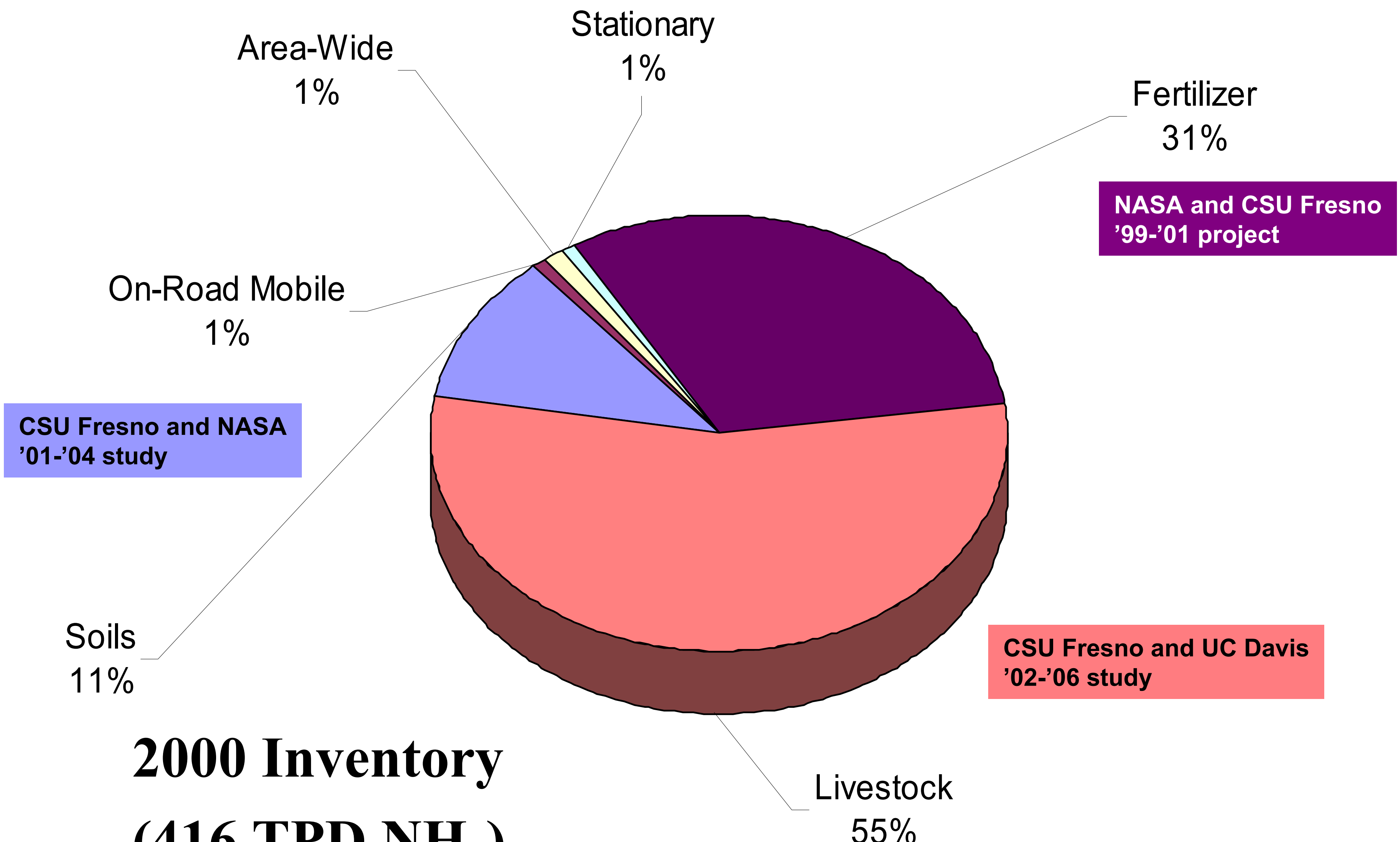
Counties Potentially Not Meeting EPA's PM10 and PM2.5 Standards

(Based on PM10 data and predicted PM2.5 data for1993-1995)



PM10 Std: 24-hr, 99th percentile concentration, 150.0 ug/m3; annual arithmeticmean, 50.0 ug/m3
PM2.5 Std: 24-hr, 99th percentile concentration, 65.0 ug/m3; annual arithmetic mean, spatial avg, 15.0 ug/m3

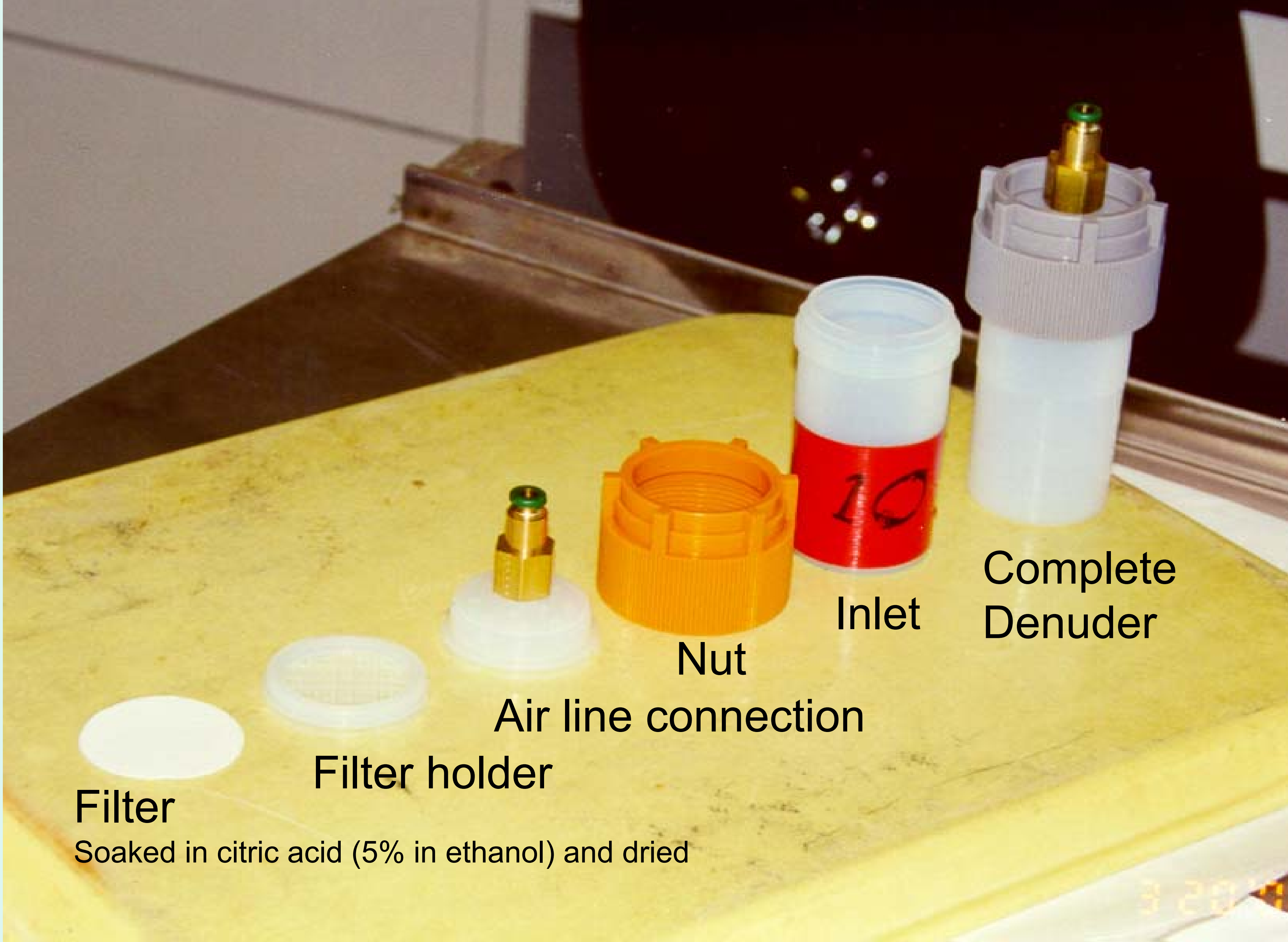
Ammonia Emissions Contributions in the San Joaquin Valley



2000 Inventory

(416 TPD NH_3)

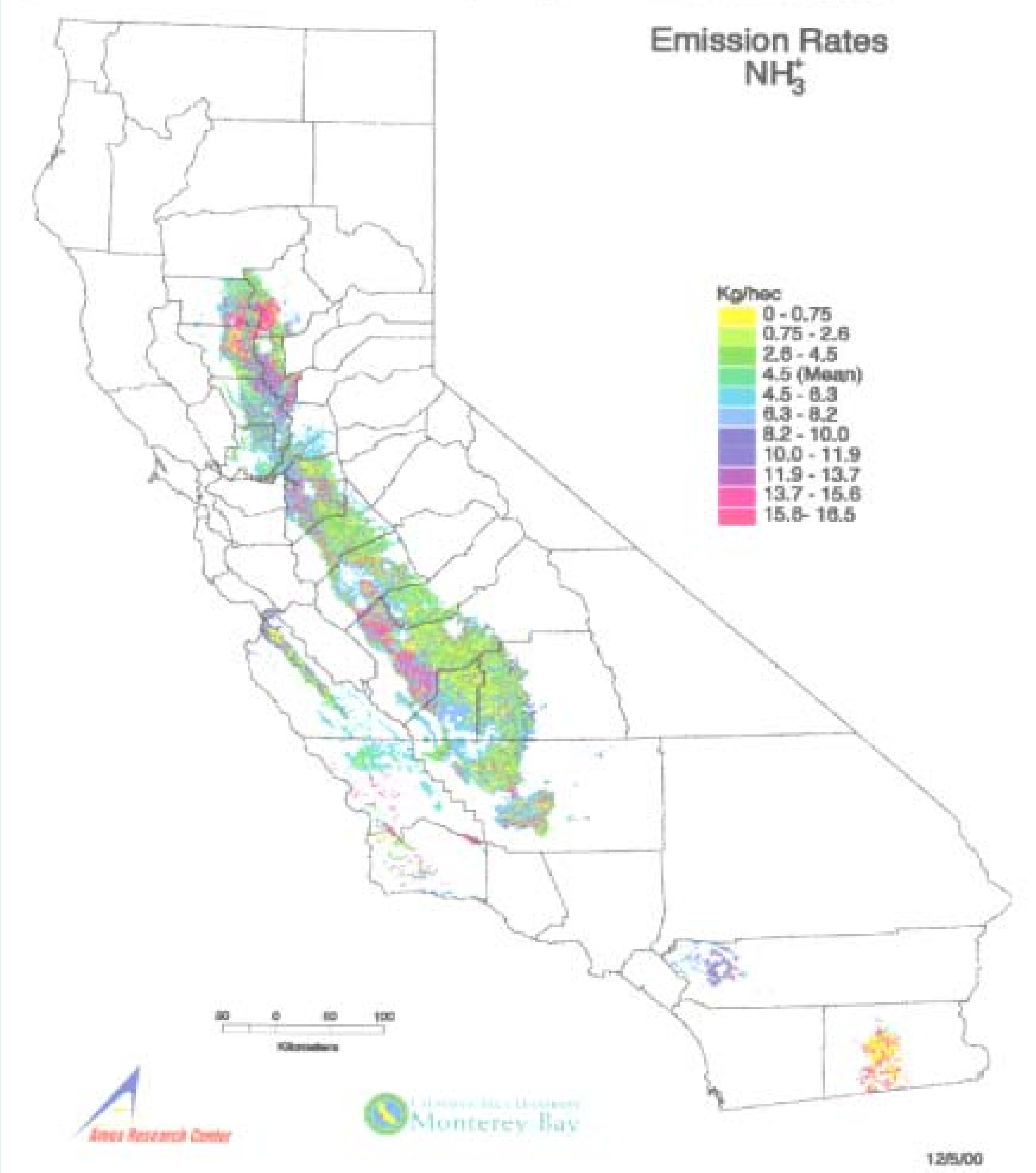

6 2'00



Active denuder used to sample NH_3. Denuders were co-located with anemometers at 0.5, 1.0, 2.0, 4.0, and 10.0 meters. The NH_3 concentration was multiplied by wind speed to calculate flux in micrograms NH_3/meter^2/second.


Citrate impregnated filter

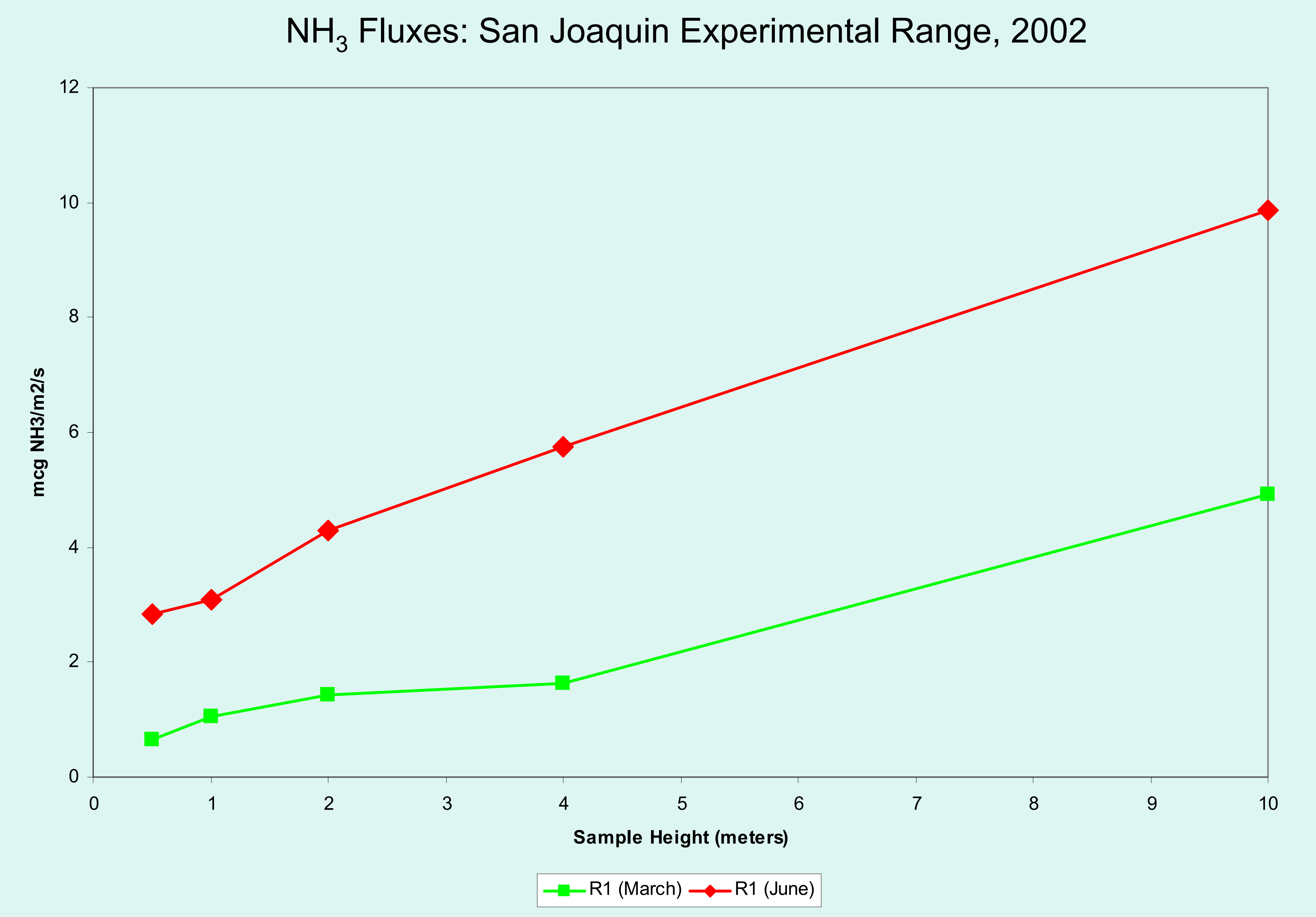
Figure 2. Statewide annual emissions of N-NH_3 directly from chemical fertilizer sources.

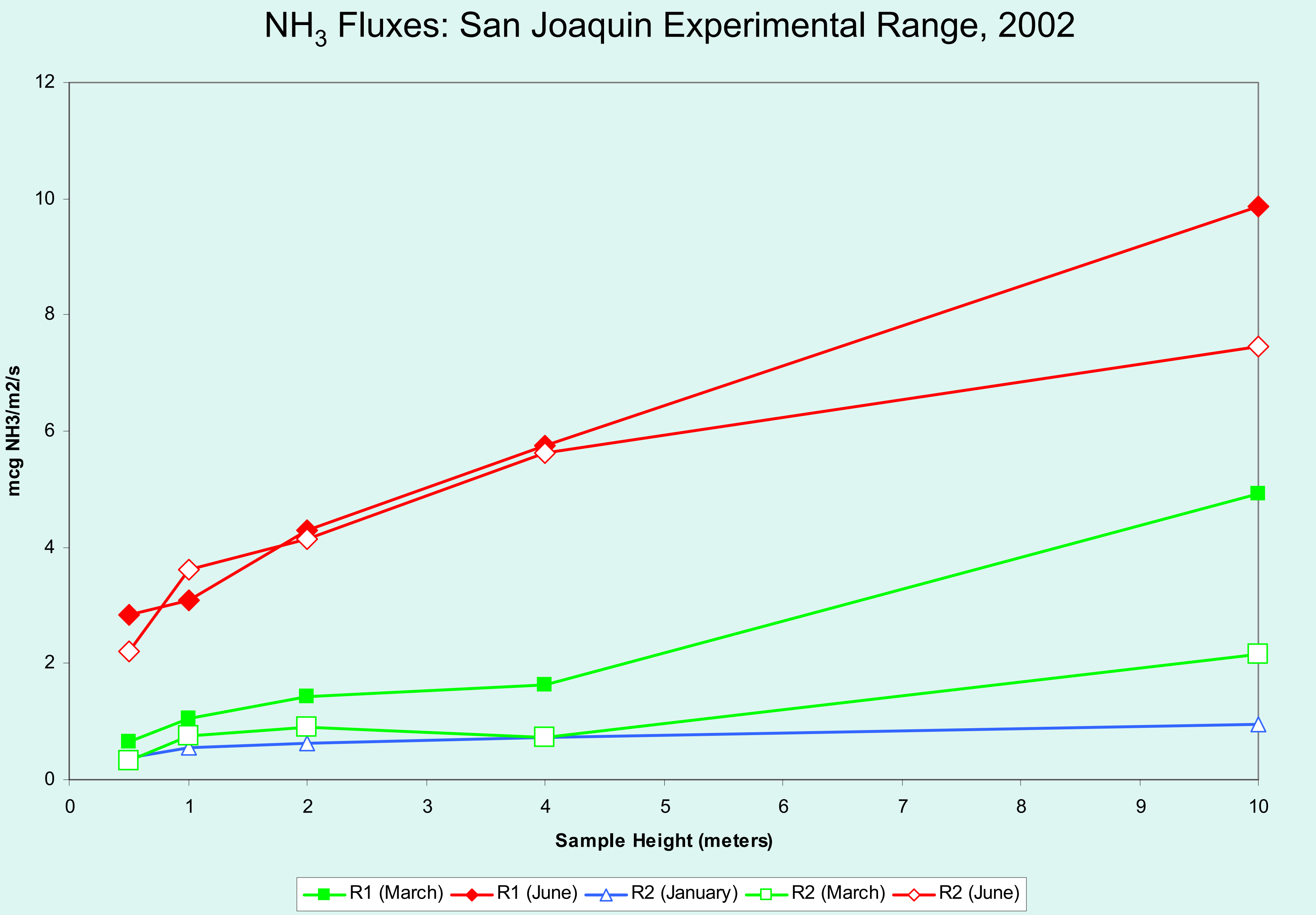


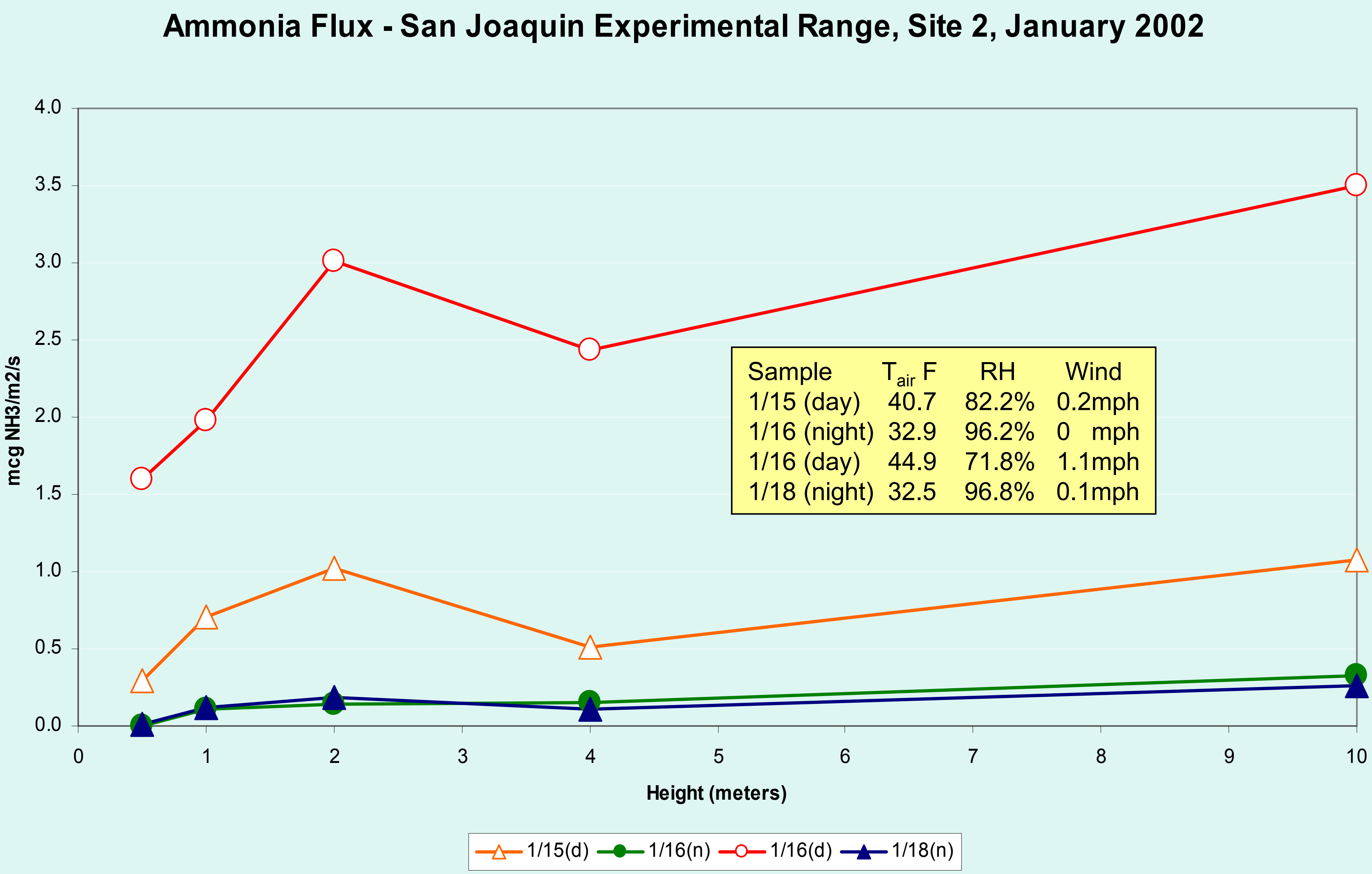
Estimated emission of ammonia as a result of N fertilizer applications: 12×10^6 kg / year ***(total NH_3 emissions from soils: 50×10^6 kg/yr)***

Atmospheric NH_3 related to soils and vegetation communities

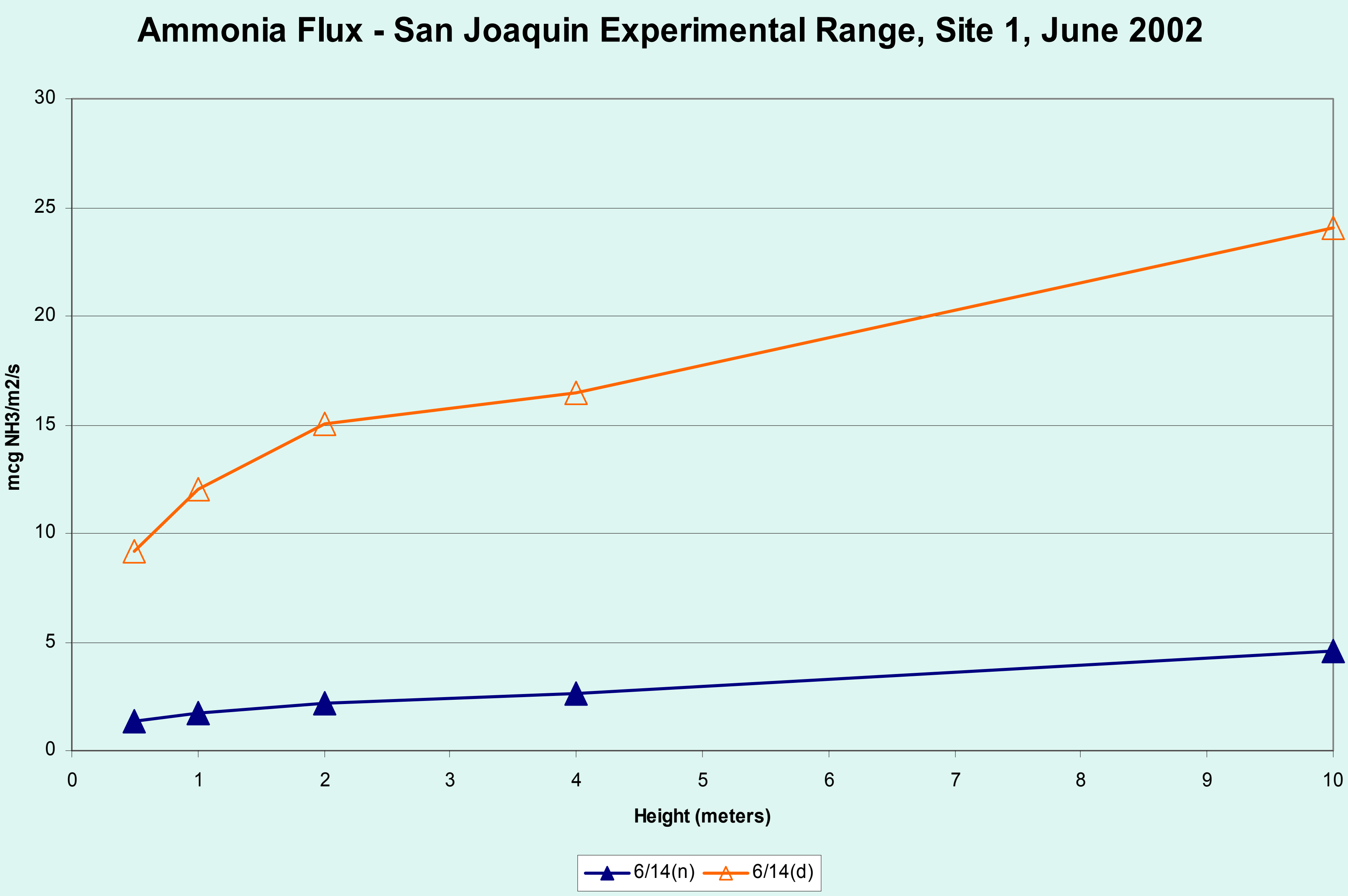
- **Natural vegetation:** Annual grass rangeland, Sierra Nevada coniferous forest, Coastal forest.
- **Annual Cropland:** Barley for silage, Corn for silage, Alfalfa, Cotton.
- **Permanent Cropland:** Wine grapes, Almonds, Citrus


NH3 Fluxes: San Joaquin Experimental Range, 2002
mcg NH3/m2/s
Sample Height (meters)
R1 (March)
R1 (June)
0
2
4
6
8
10
12
0
1
2
3
4
5
6
7
8
9
10


NH3 Fluxes: San Joaquin Experimental Range, 2002
mcg NH3/m2/s
12
10
8
6
4
2
0
0
1
2
3
4
5
6
7
8
9
10
Sample Height (meters)
R1 (March)
R1 (June)
R2 (January)
R2 (March)
R2 (June)



Ammonia Flux - San Joaquin Experimental Range, Site 2, January 2002
mcg NH3/m2/s
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0
1
2
3
4
5
6
7
8
9
10
Height (meters)
Sample T_{air} F RH Wind
1/15 (day) 40.7 82.2% 0.2mph
1/16 (night) 32.9 96.2% 0 mph
1/16 (day) 44.9 71.8% 1.1mph
1/18 (night) 32.5 96.8% 0.1mph
1/15(d)
1/16(n)
1/16(d)
1/18(n)


Ammonia Flux - San Joaquin Experimental Range, Site 1, June 2002
30
25
20
15
10
5
0
mcg NH3/m2/s
0
1
2
3
4
5
6
7
8
9
10
Height (meters)
6/14(n)
6/14(d)

Atmospheric **NH_3** levels appear to be affected by:

Diurnal conditions. Ammonia is higher during the day and the gradient is more pronounced.

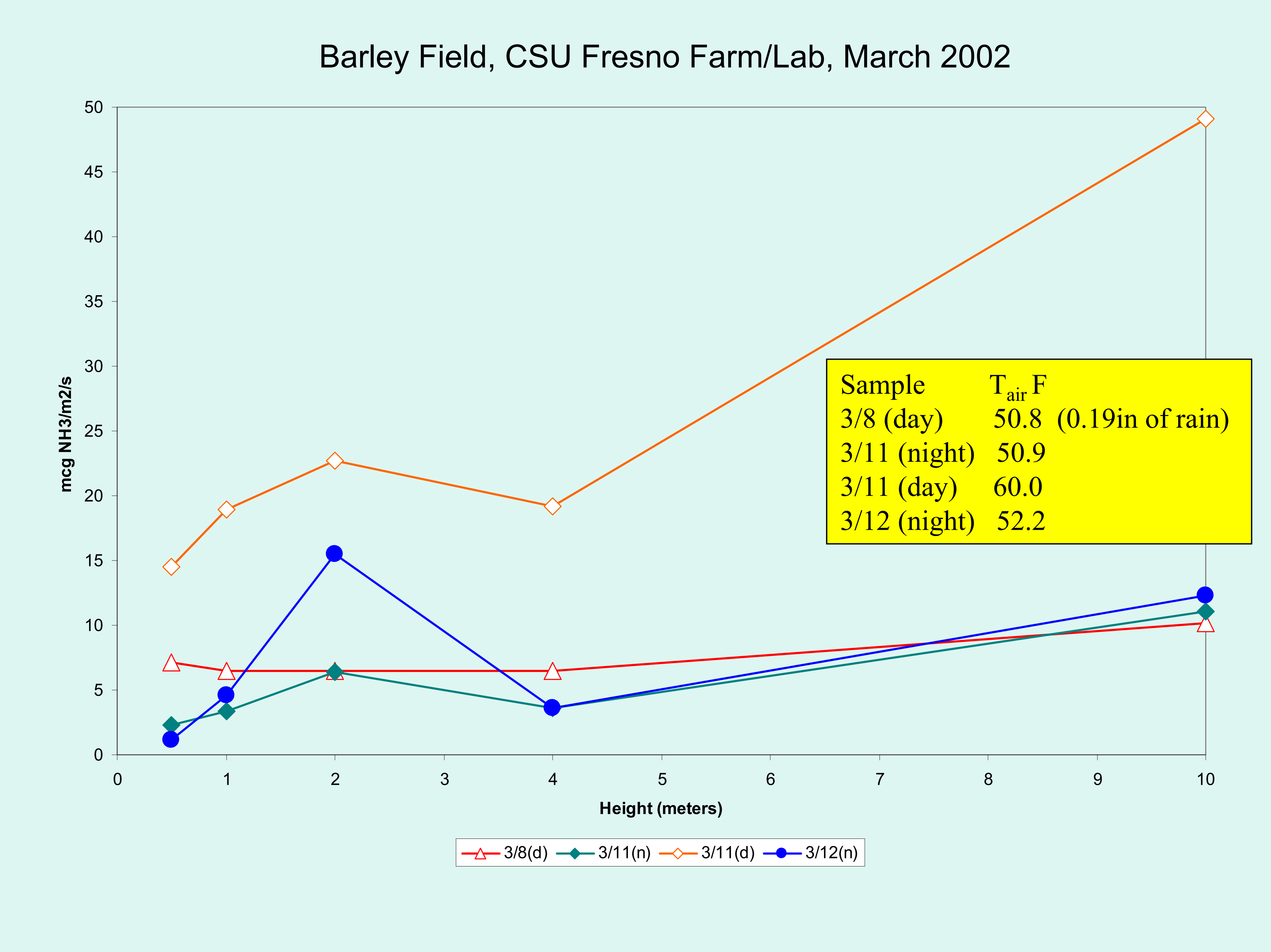
Air temperature. Ammonia is higher when the air temperature is higher.

Relative Humidity or Precipitation. Increased atmospheric moisture appears to reduce NH_3 levels

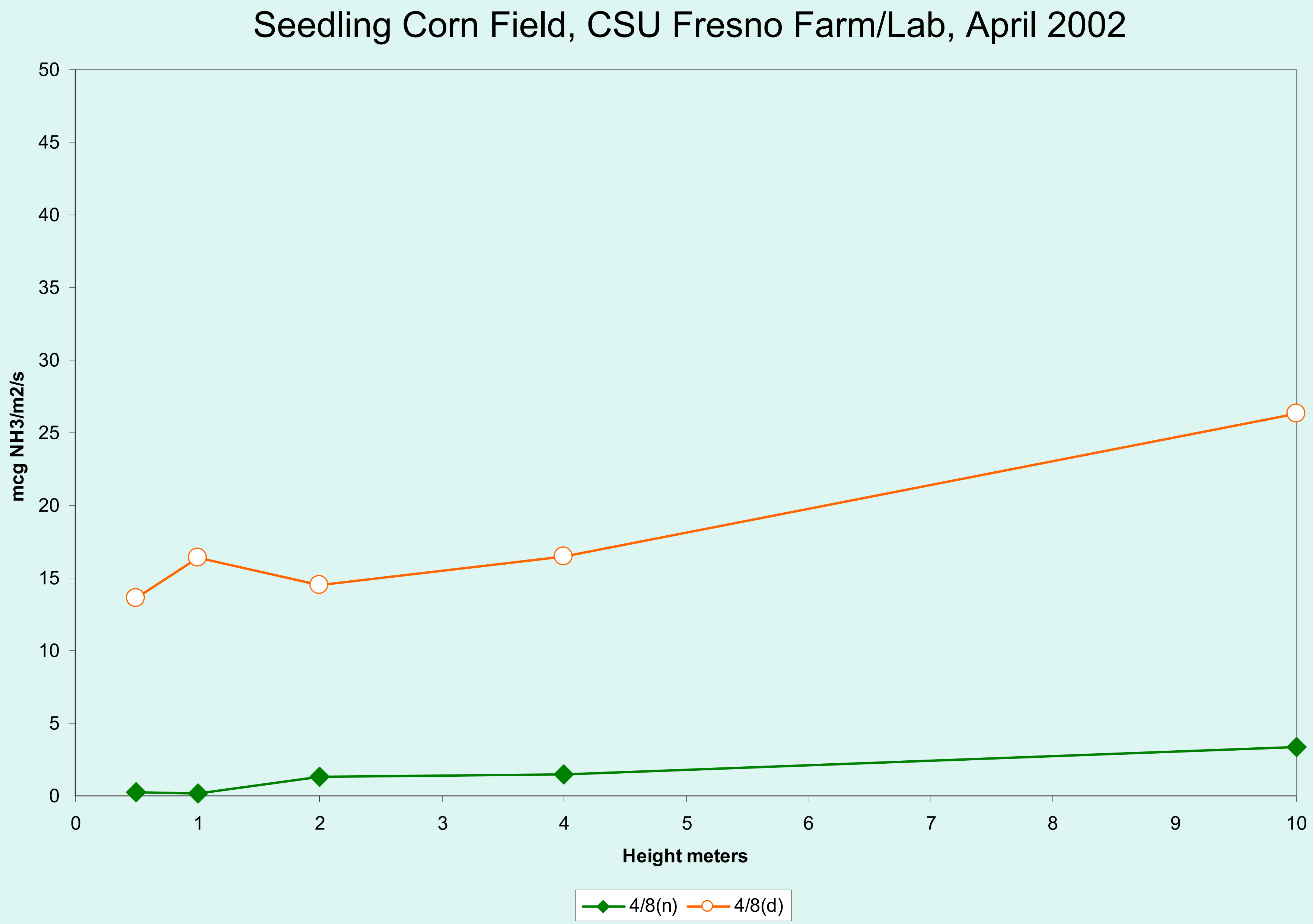
Barley Field, CSU Fresno Farm/Lab

A 40 acre field of barley grown for silage on the farm/laboratory at CSU Fresno was planted in December ’01 and harvested at the end of March ’02. The sampling site was located 300m into the field from the north (upwind) edge. NH_3 samples were collected in January and again in March, just prior to cutting the barley for silage.

The field was planted to a second crop, corn, in early April. The same sampling site was used for that second crop.

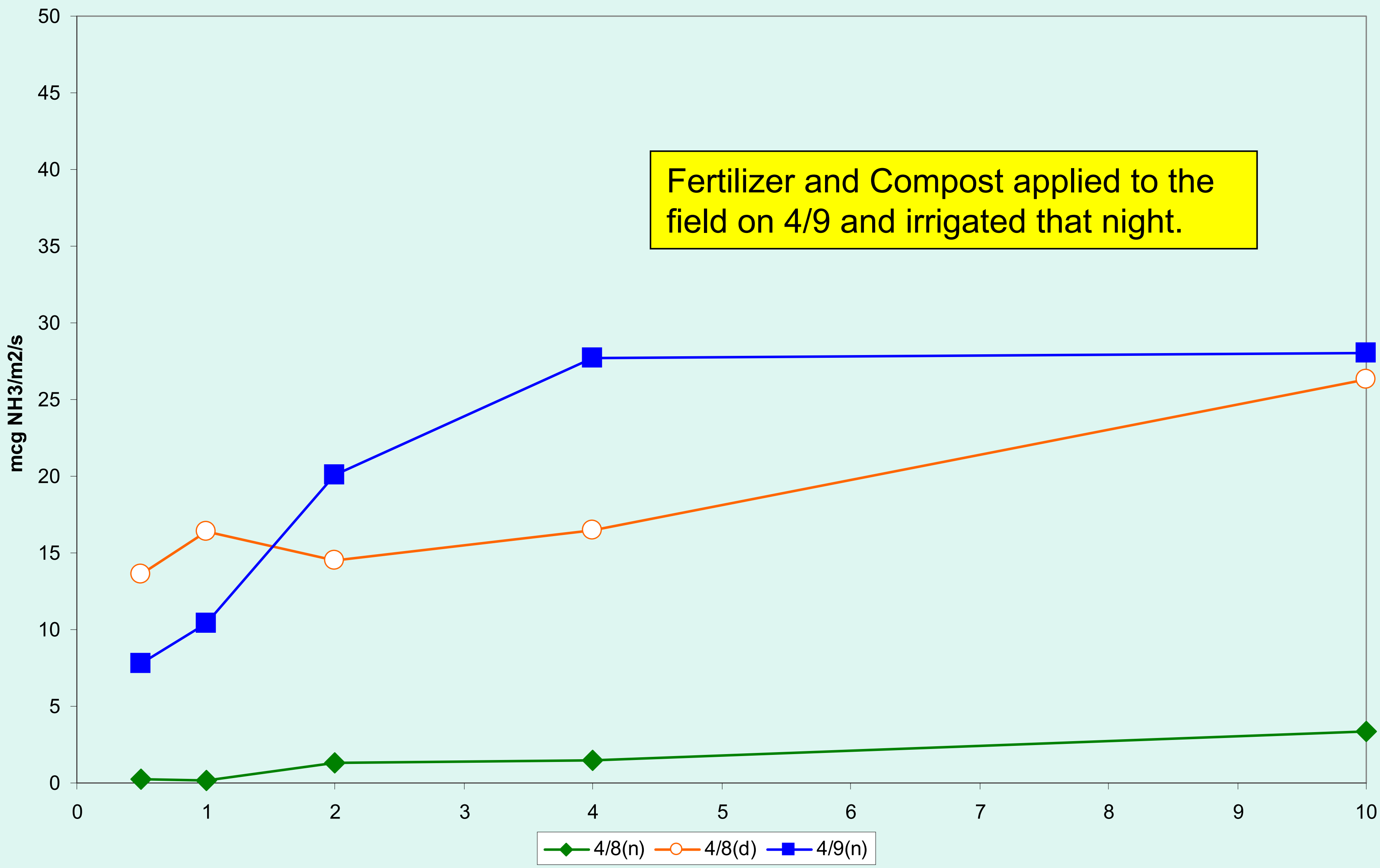


Barley Field, CSU Fresno Farm/Lab, March 2002
mcg NH3/m2/s
Height (meters)
50
45
40
35
30
25
20
15
10
5
0
0
1
2
3
4
5
6
7
8
9
10
Sample T air F
3/8 (day) 50.8 (0.19in of rain)
3/11 (night) 50.9
3/11 (day) 60.0
3/12 (night) 52.2
3/8(d)
3/11(n)
3/11(d)
3/12(n)



Seedling Corn Field, CSU Fresno Farm/Lab, April 2002
mcg NH3/m2/s
0
5
10
15
20
25
30
35
40
45
50
0
1
2
3
4
5
6
7
8
9
10
Height meters
4/8(n)
4/8(d)

Seedling Corn Field, CSU Fresno Farm/Lab, April 2002



FLINT DAIRY. A 2000 cow dairy located 10km east of Hanford, CA in Kings County. The dairy utilizes "free stall" management where the cows are fed on gently sloping concrete that is flushed with a large flow of water several times a day to remove the waste. Solids in the flush water are separated from the liquid which is stored in a series of lagoons for subsequent flushing of the free stalls and eventually is part of the irrigation water for the surrounding cropland.

The dairy is surrounded by sorghum and alfalfa fields that are used to recycle nutrients from the dairy waste and to produce forage for the dairy herd.

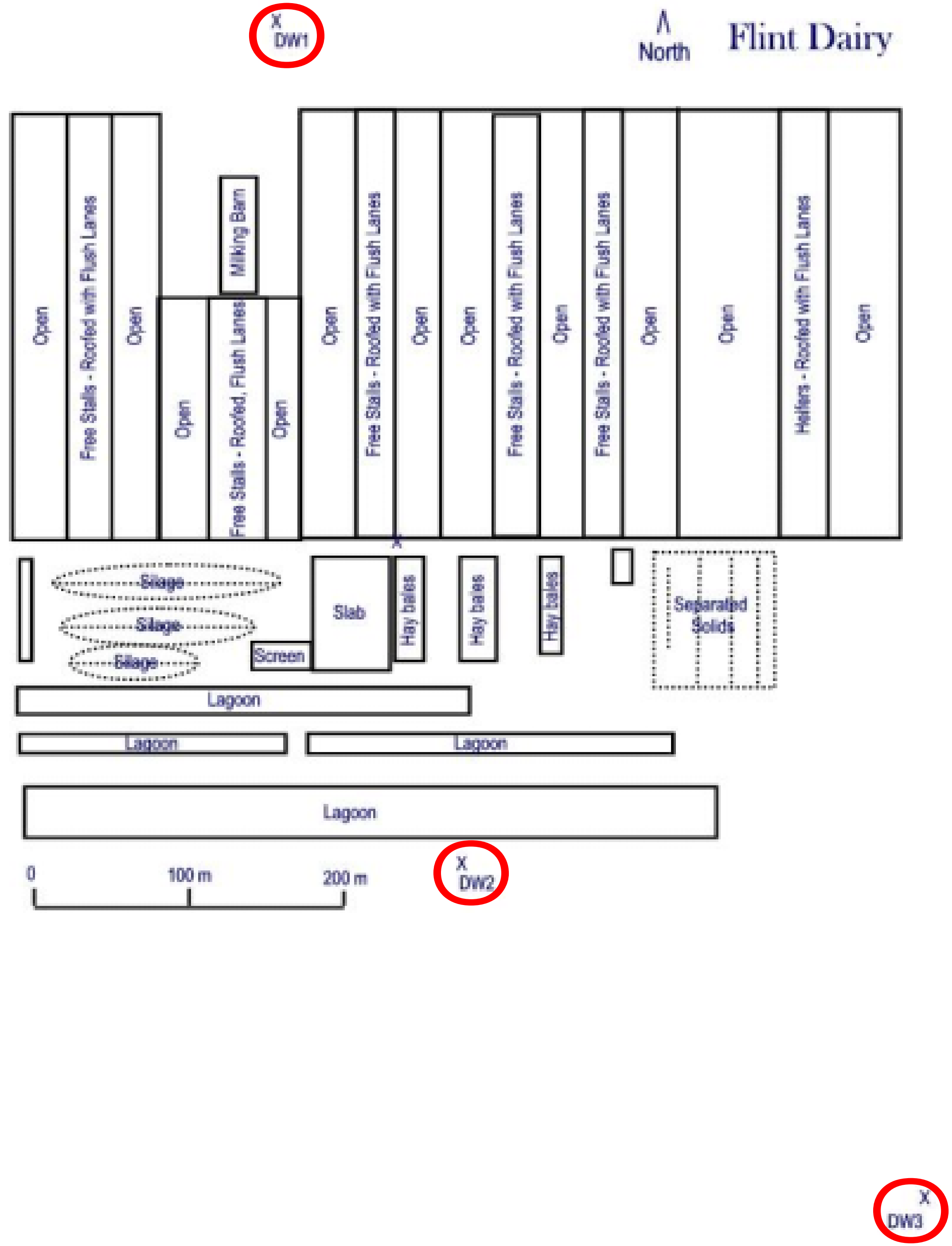
Three sampling sites were located at the dairy: an Up-Wind Fenceline site, a Down-Wind Fenceline site and a Down-Wind Field site.

Up Wind Fenceline site (DW1). Looking SE, downwind.

Ammonia sampling was done at the Flint Dairy located 5 miles east of Hanford, CA.

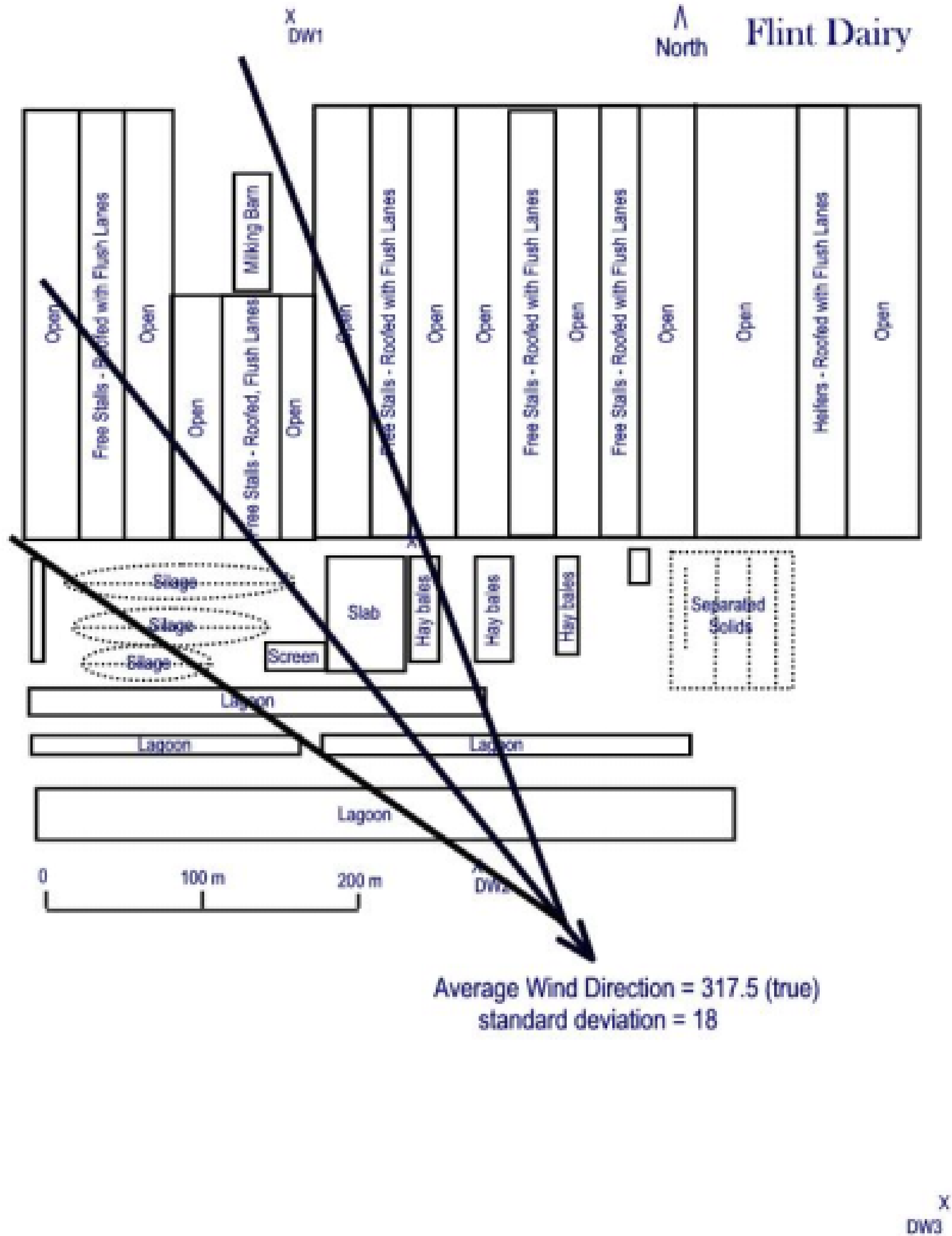
Three sampling sites were established at the dairy:
DW1-Up Wind Fenceline
DW2-Down Wind Fenceline of the dairy next to the lagoon.
DW3-Down Wind Field between silage fields.

Sampling began in late August and continued until October 23.



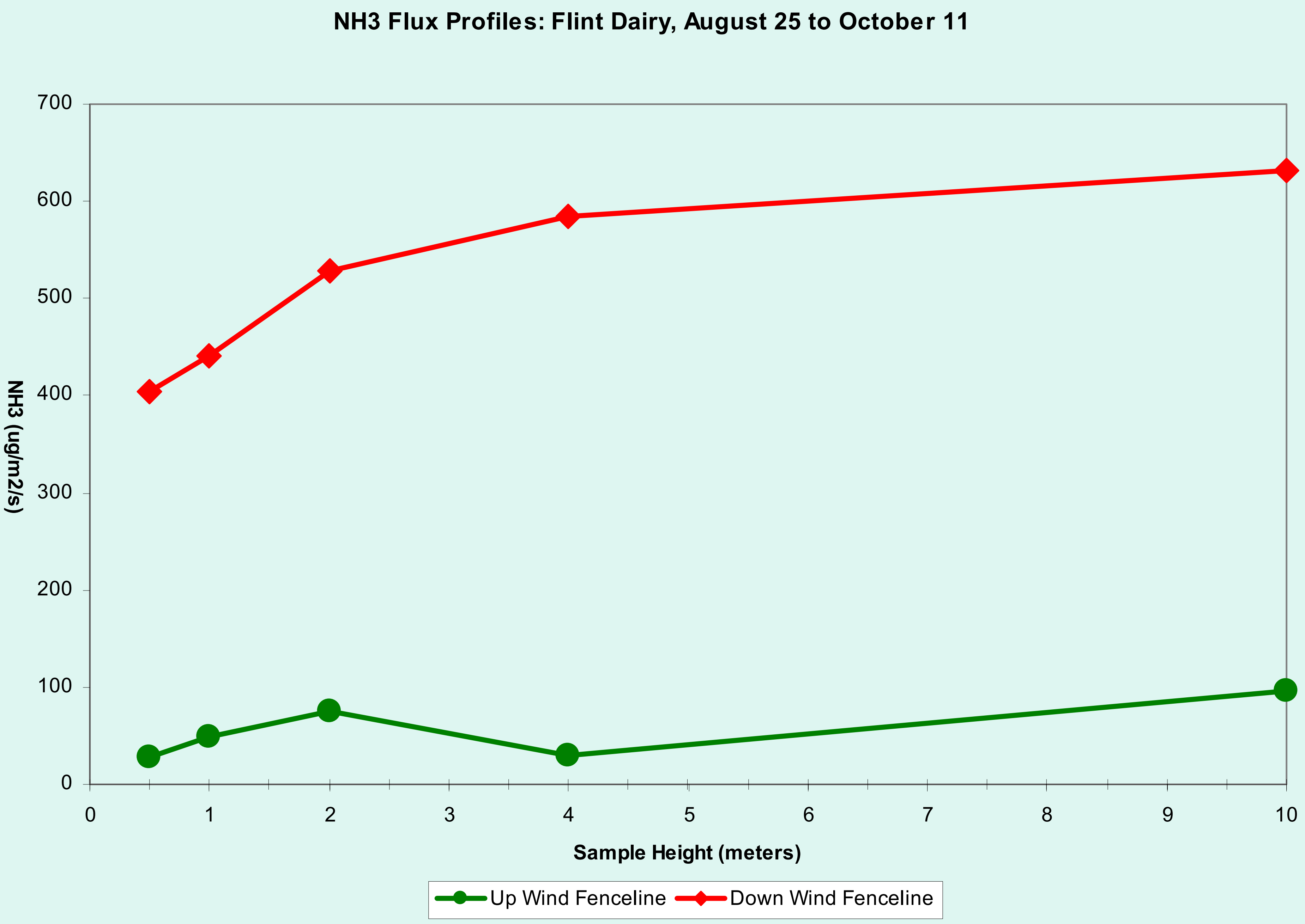
Wind direction during the afternoon and evening was from the northwest. Wind occurred 79% of the time between late August and early October. The average wind direction was from 317.5 degrees with a standard deviation of 18 deg.

The average wind speed for those sampling periods was 1.6 mph at 2 meters and 4.5 mph at 10 meters.

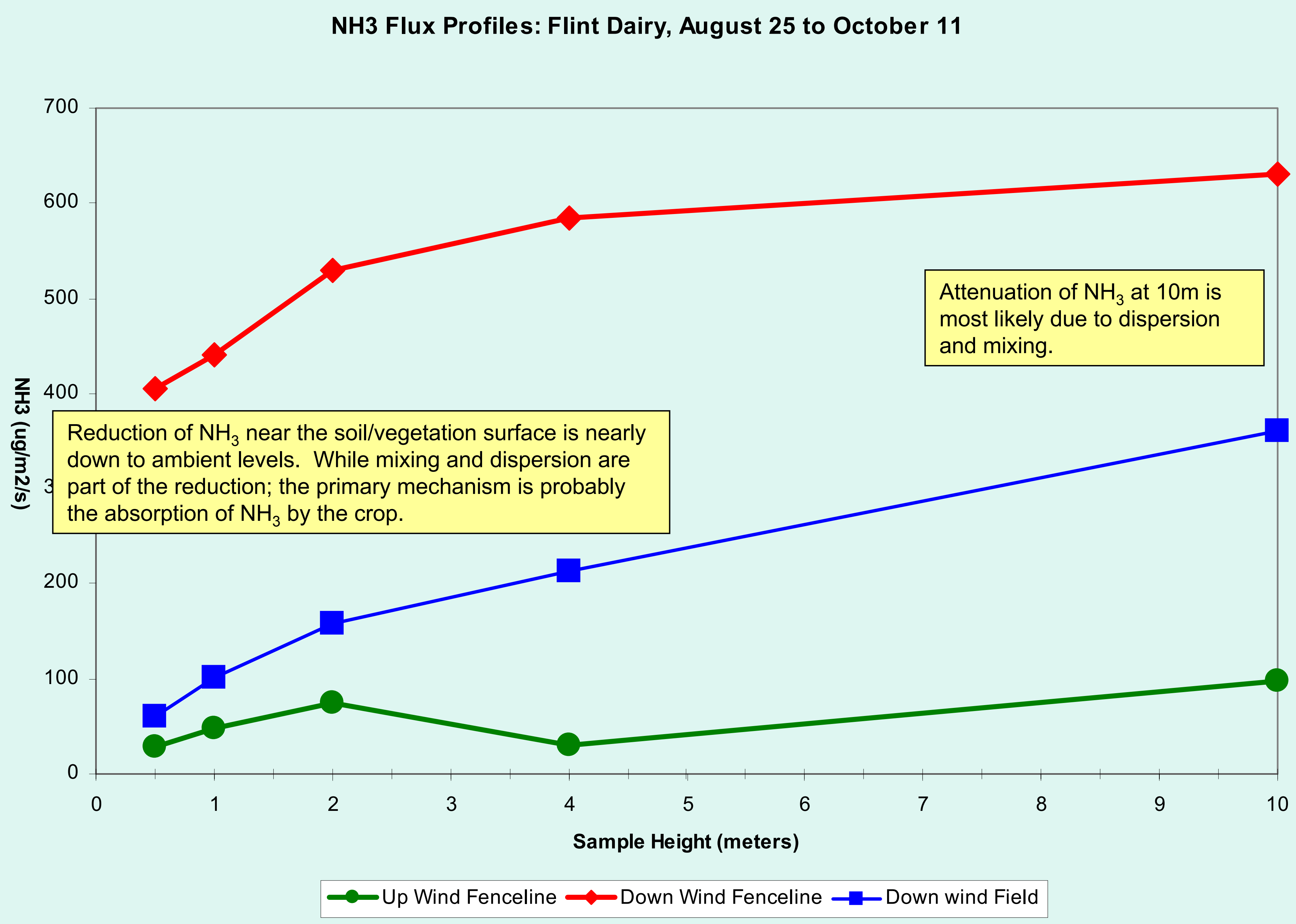


Up Wind Fenceline site (DW1) looking NW, upwind

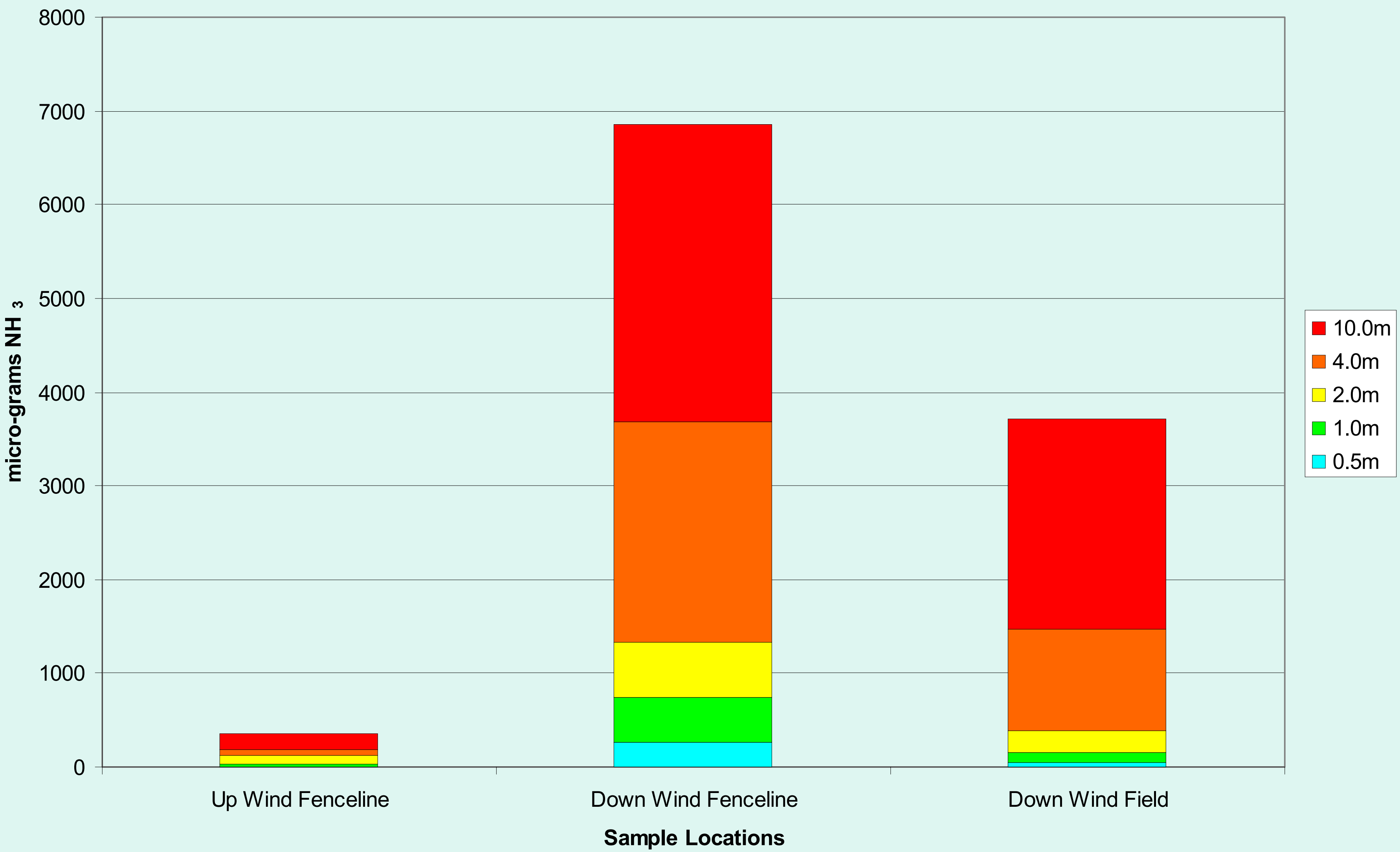
Down Wind Fenceline site (DW2) on south edge of main lagoon. Looking NW, upwind


NH3 Flux Profiles: Flint Dairy, August 25 to October 11
NH3 (ug/m2/s)
700
600
500
400
300
200
100
0
0
1
2
3
4
5
6
7
8
9
10
Sample Height (meters)
Up Wind Fenceline
Down Wind Fenceline

Downwind Field site (DW3) looking NW to the Down Wind Fenceline site, 300m across the field at the “X”


NH3 Flux Profiles: Flint Dairy, August 25 to October 11
NH3 (ug/m2/s)
Sample Height (meters)
0
100
200
400
500
600
700
0
1
2
3
4
5
6
7
8
9
10
Attenuation of NH_3 at 10m is most likely due to dispersion and mixing.
Reduction of NH_3 near the soil/vegetation surface is nearly down to ambient levels. While mixing and dispersion are part of the reduction; the primary mechanism is probably the absorption of NH_3 by the crop.
Up Wind Fenceline
Down Wind Fenceline
Down wind Field

10 meter Ammonia Profiles (Sept. 27 to Oct. 2)

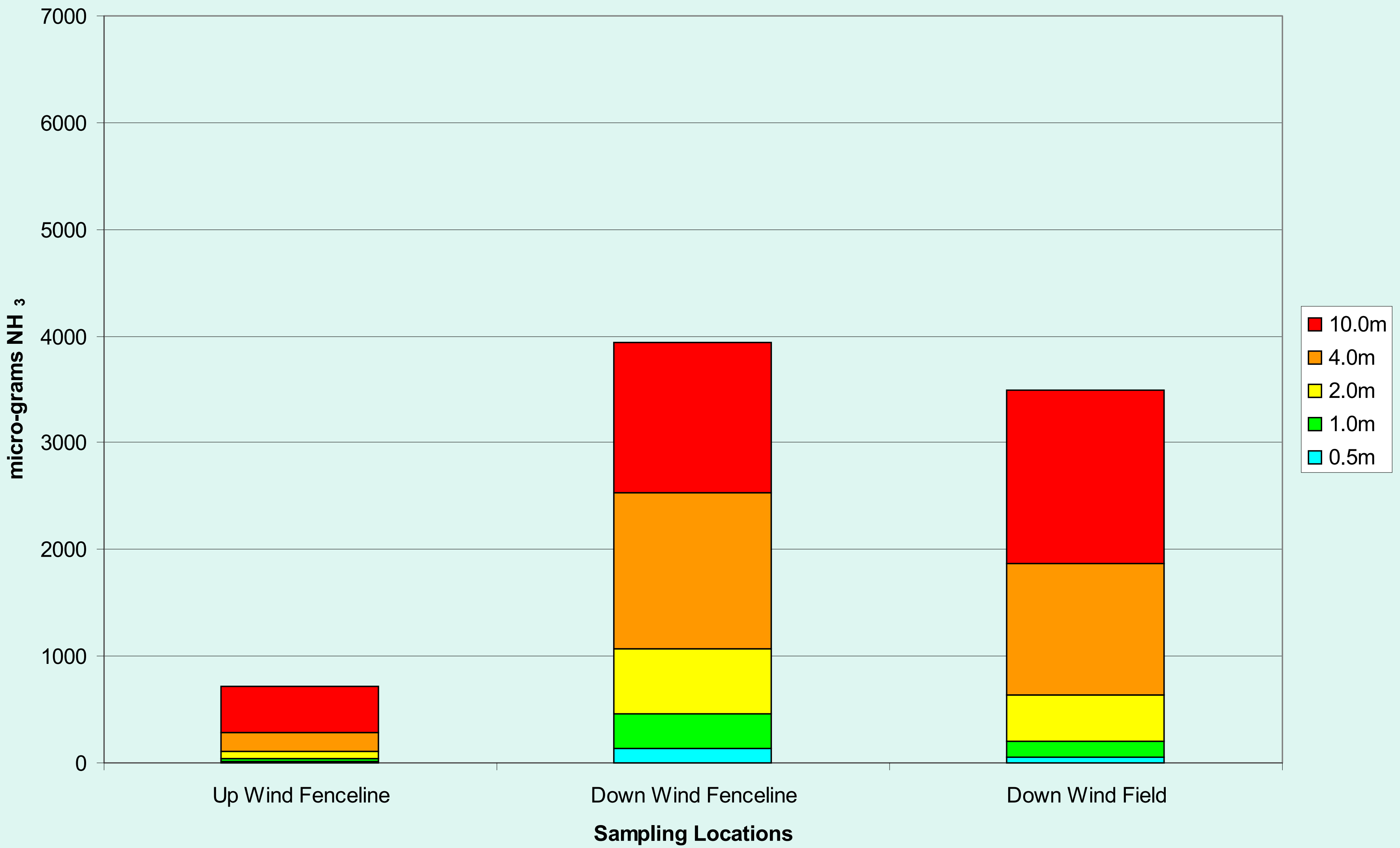


Ammonia Profiles from corrected flux values for a period of consistent wind direction
Silage crops were 1.5 to 2.0 meters high, just prior to harvest.

Harvest of the Sorghum crop in early October. The vegetation is cut and allowed to dry for a few days. Here the dry material is being picked up to be fermented into silage for winter forage at the dairy.

Down Wind Field sampling site after harvest of the sorghum. The Up Wind Fenceline site is 300m NE of this site at the “X”

10 meter Ammonia Profiles (Oct. 18,21,23)



Ammonia Profiles from corrected flux values for a period of consistent wind direction
Field surfaces were bare, disked soil.

How is atmospheric $\mathbf{NH_3}$ affected by soils/vegetation – sources or sinks?

- NH_3 can be released from the soil surface by microbes in the N cycle. The microbes are probably temperature dependent so NH_3 levels should be higher during the day and in spring/summer.
- The diffusion characteristics of NH_3 are likely to be similar to CO_2. It would enter leaves through stomata where it would dissolve (NH_4^+) as soon as it encountered moisture on a cell wall.
- The second case, vegetation as a sink, appears to predominate based on these data.

Atmospheric $\mathbf{NH_3}$ is likely to be absorbed by vegetation when it is actively growing during daylight when stomata are open.

- Irrigated crops would be more likely to absorb NH_3 because the open stomatal area would be greater and NH_3 would also be absorbed by high soil moisture.
- The absorption would be irreversible because the NH_3 would be quickly taken up and used by the plant.
- An actively growing crop should produce a gradient of concentration or flux from the atmosphere to the crop surface.

Conclusions: NONE!

- ***NH_3 <u>indications</u> at this point in the study:***
- NH_3 from soils and vegetation is affected by air temperature, RH%, precipitation and cultural practices such as fertilization and irrigation.
- Dairies are a significant source of NH_3
- Crops surrounding and downwind of the dairy may be very effective in absorbing NH_3 from the air.
- *Nitrogen and other nutrients in liquid and solid dairy waste are recycled when the dairy effluent is used to irrigate the crops around the dairy. It appears that these same crops are just as useful to recycle atmospheric NH_3 emissions from the dairy.*