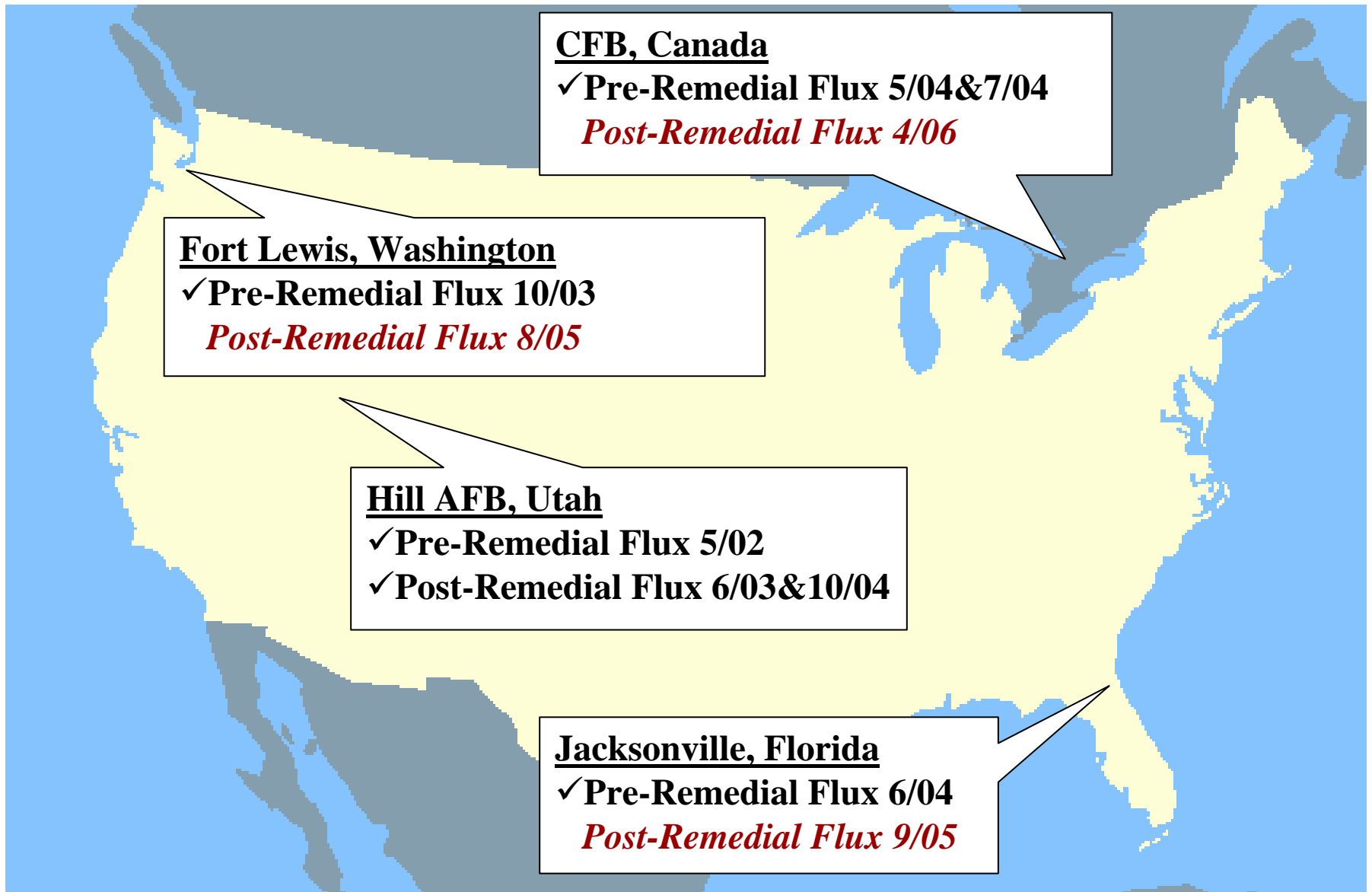




# The Measurement and use of Contaminant Flux as an Assessment Tool for DNAPL Remedial Performance

Michael C. Brooks  
Carl G. Enfield  
A. Lynn Wood  
Michael D. Annable

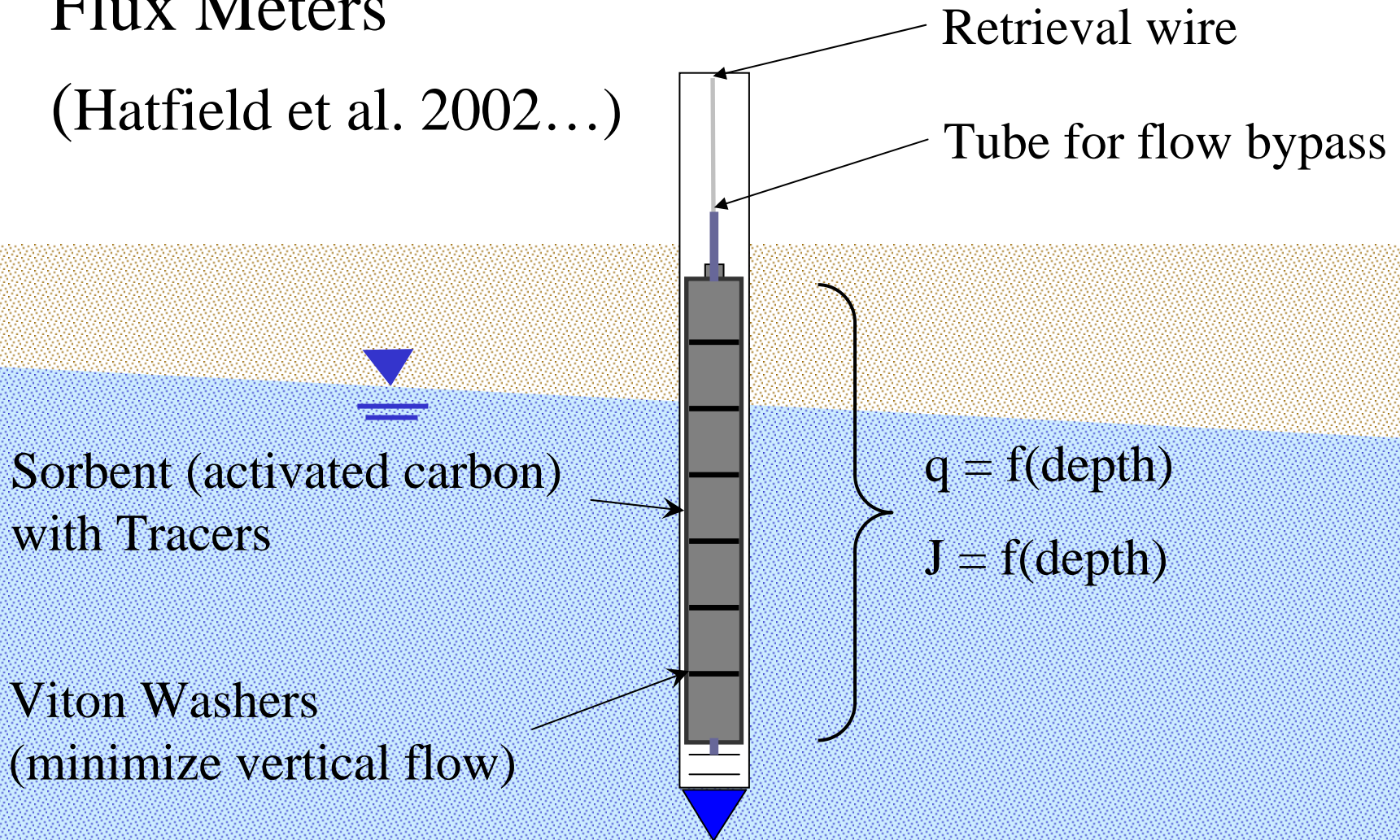
# DNAPL Field Sites



# Field Measurement Techniques

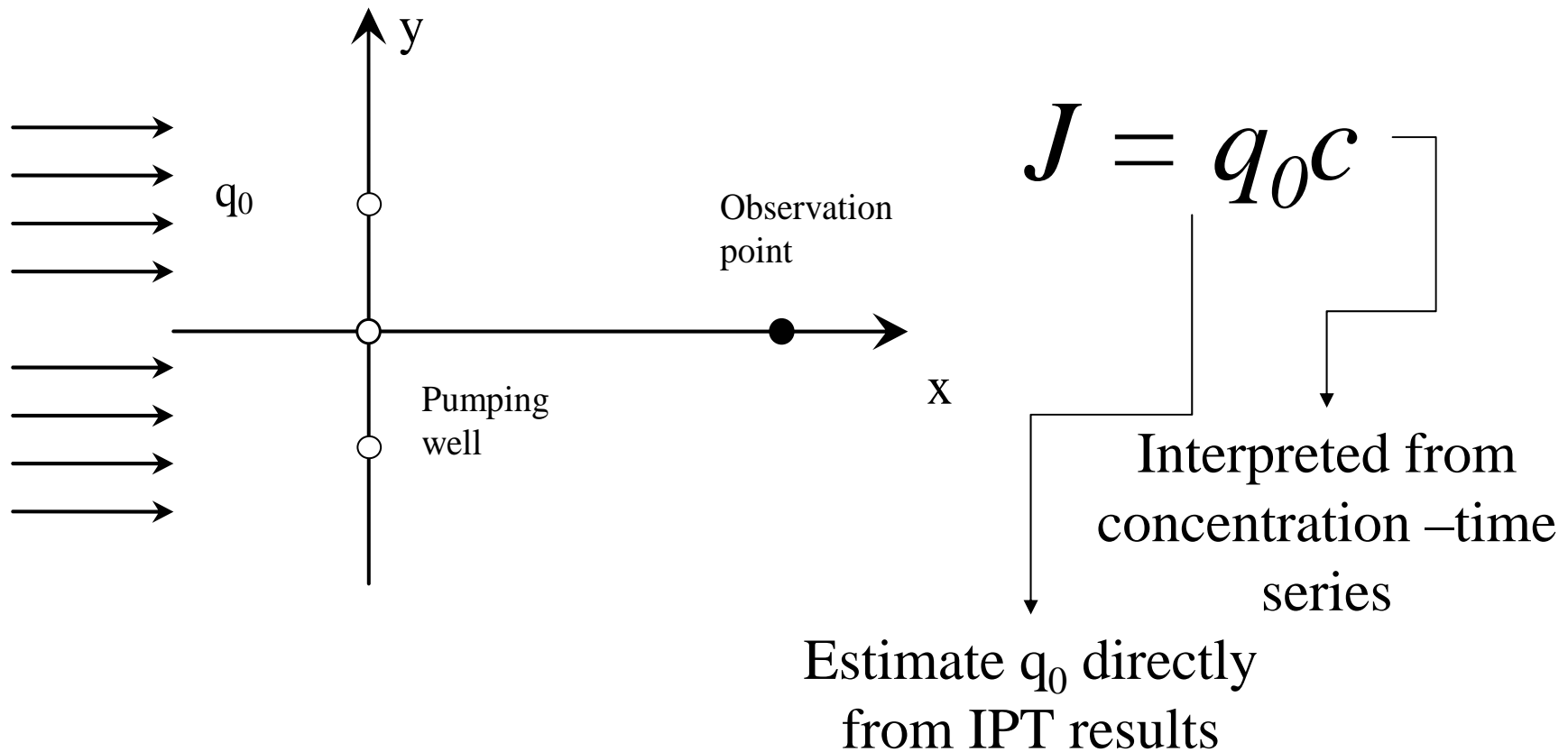
## Flux Meters

(Hatfield et al. 2002...)

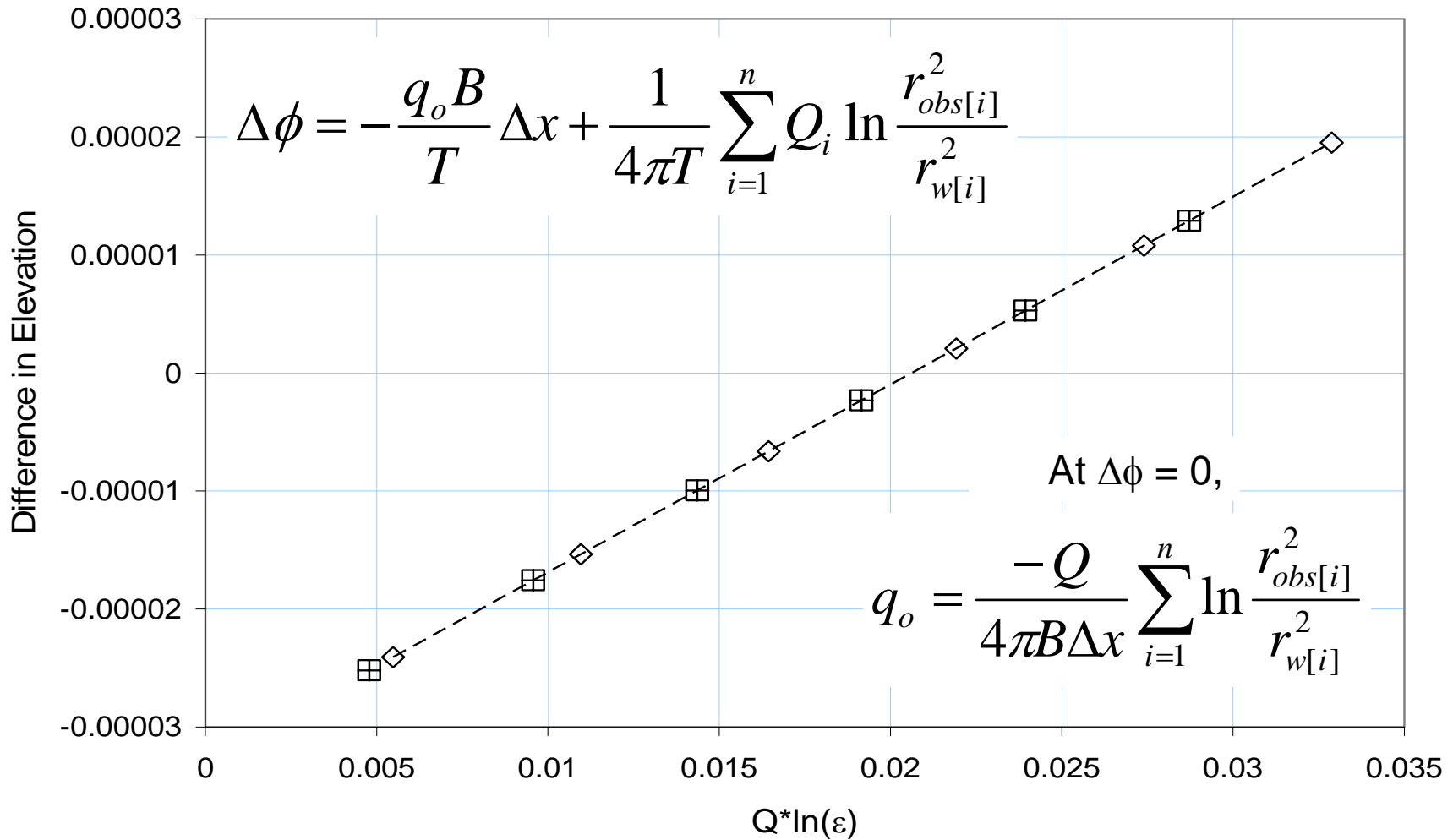


# Field Measurement Techniques

Integral Pumping Tests (Schwarz et al., 1998;  
Teutsch et al. 2000; Ptak et al. 2000...)



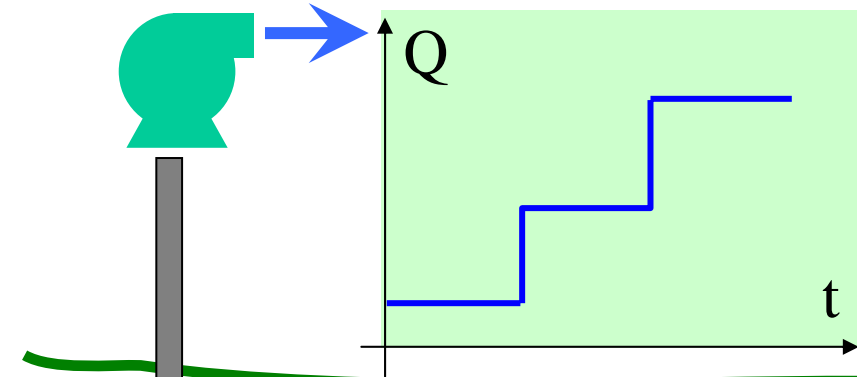
# Superposition of Uniform flow and multiple Sink terms



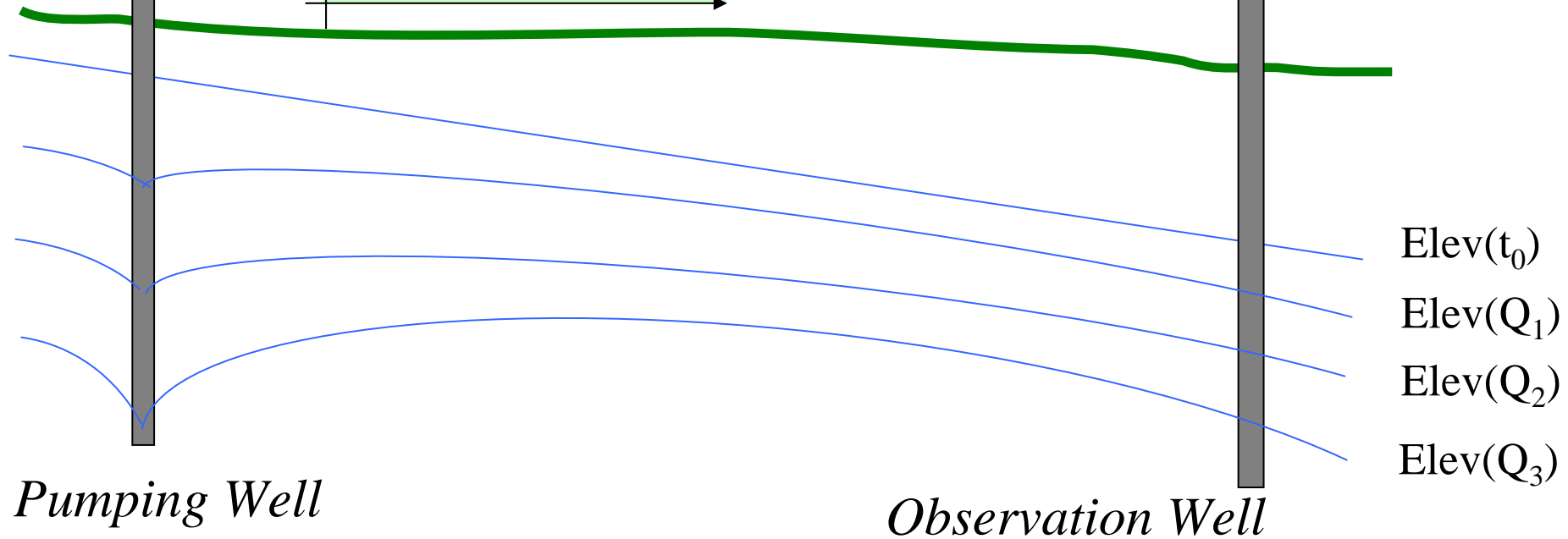
◇ Flux Well 1 □ Flux Well 2 + Flux Well 3

# Method

1) Measure  $Q = f(t)$



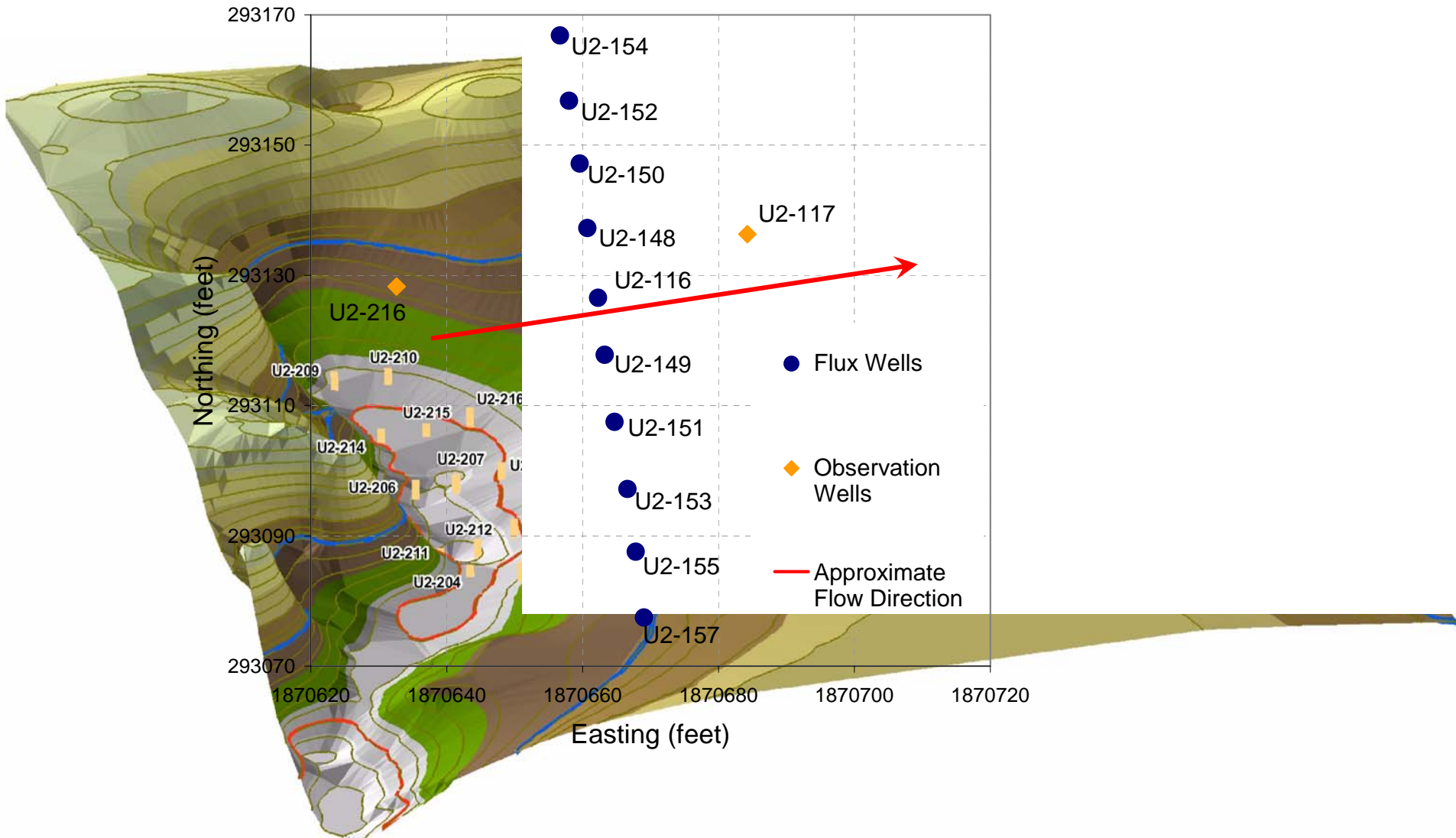
2) Measure  
Elevations =  $f(Q)$



*Pumping Well*

*Observation Well*

# Hill AFB OU2 Layton, Utah

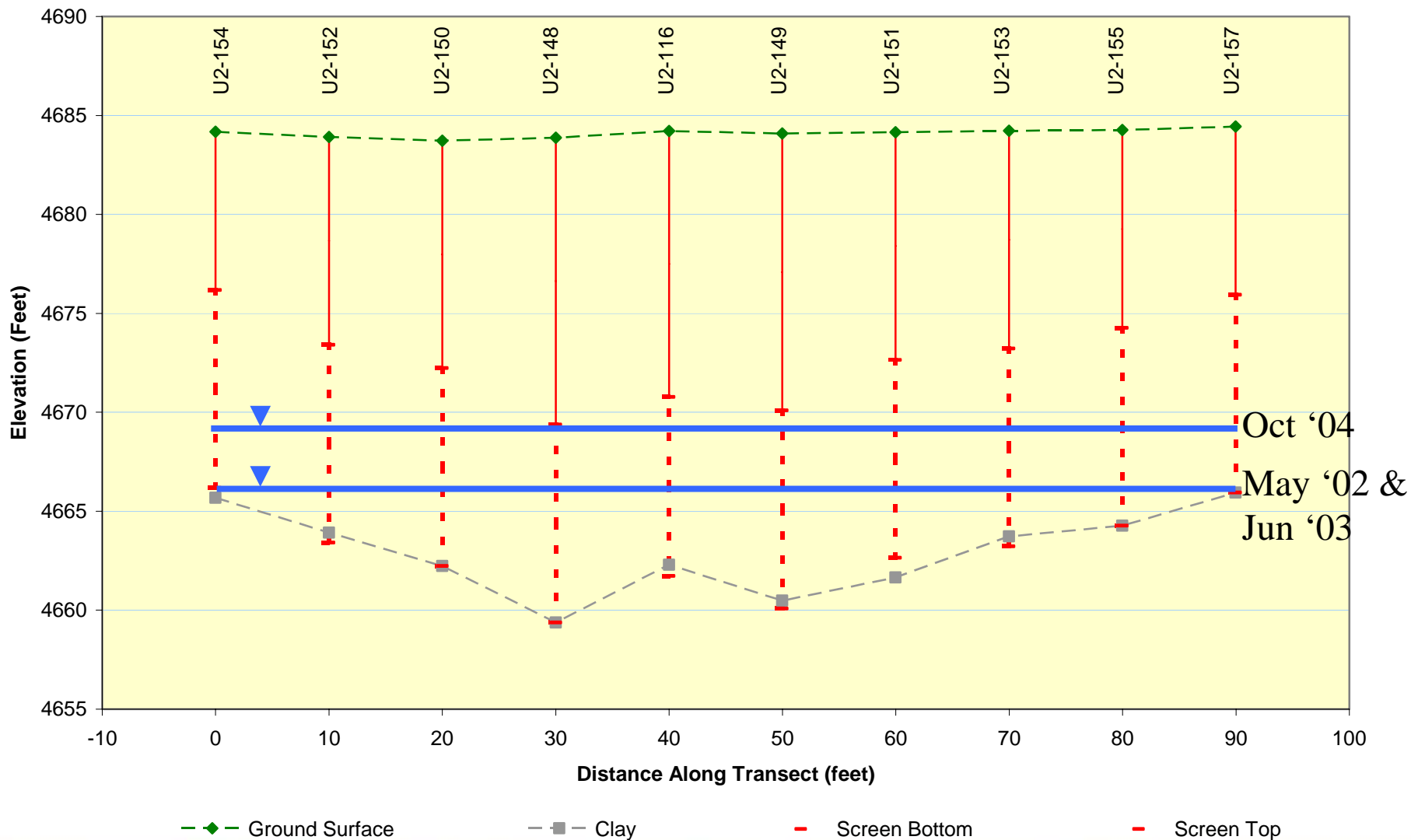


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# Hill AFB OU2 Layton, Utah

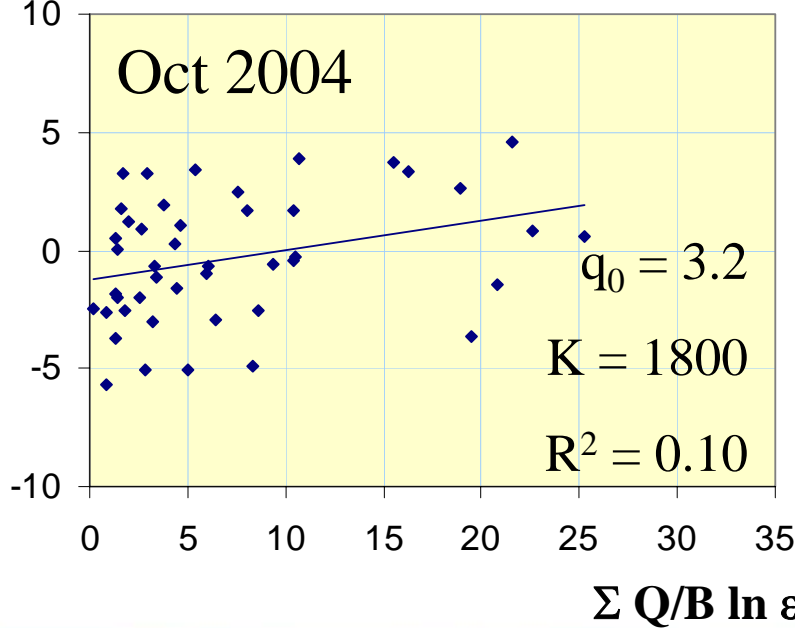
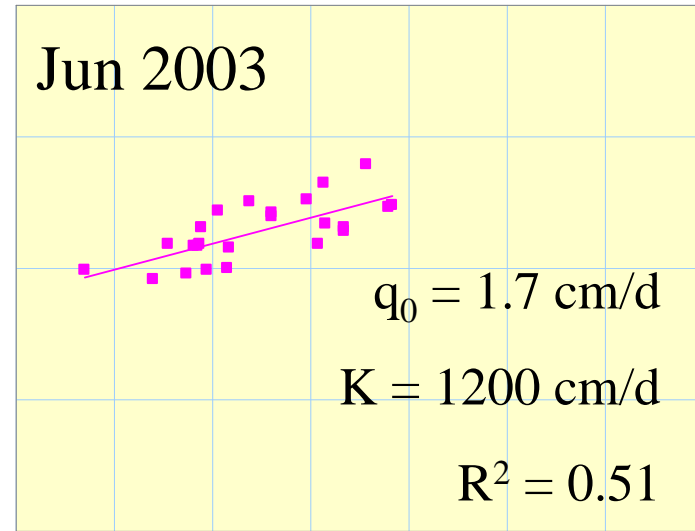
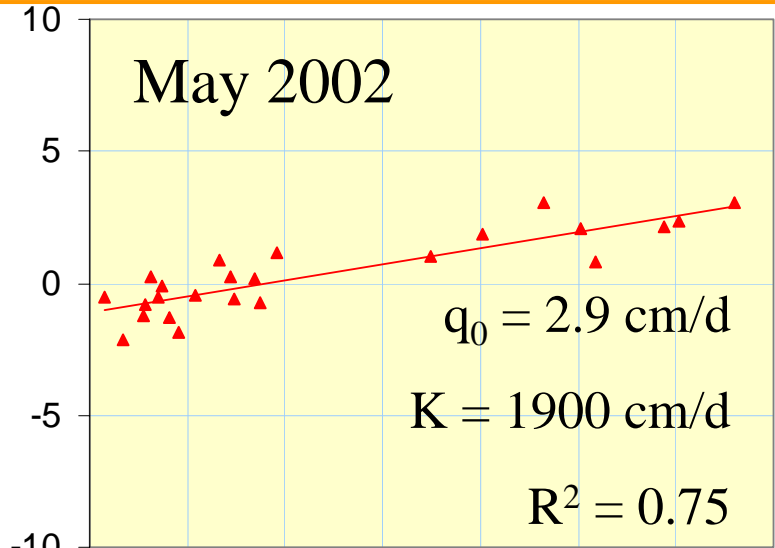
## Hill AFB Flux Well Transect



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Difference in Water Elevation  
[Obs - Pumping Well] (cm)



Famous Utah Mega-Storms (1 in 25 year or longer Return Period):

December 20-26, 1916

February 5-12, 1949

September 4-6, 1970

September 26-30, 1982

May 4-9, 1986

September 5-10, 1991

October 26-28, 1991

January 6-11, 1993

May 3-7, 1993

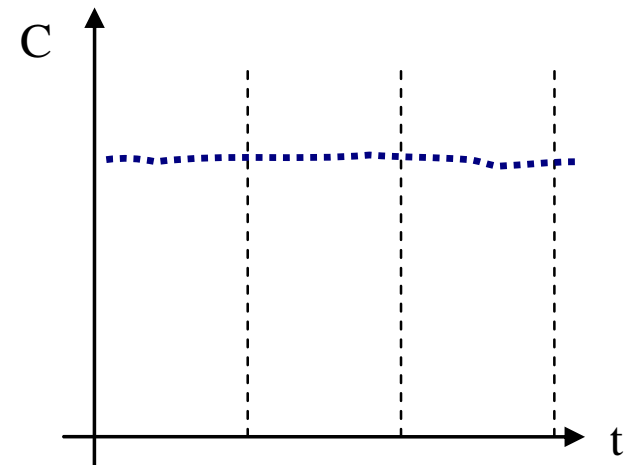
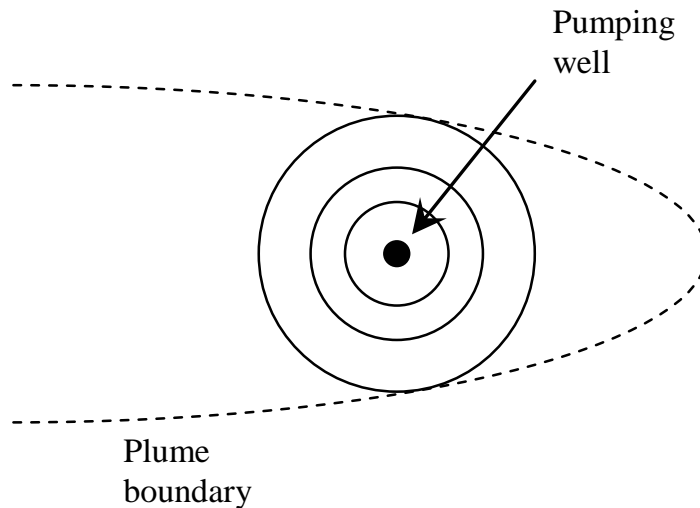
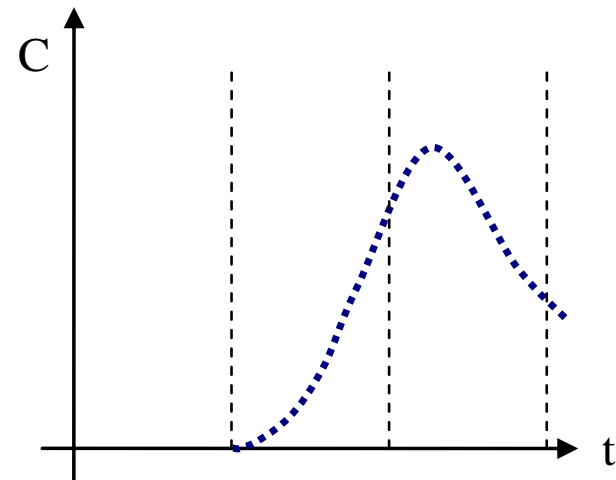
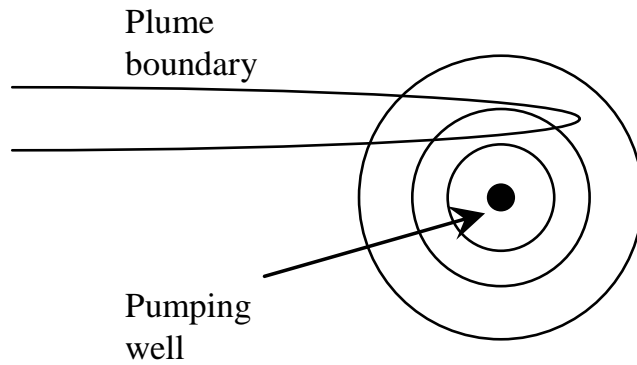
October 5-9, 1993

October 17-22, 2004 *October 18-22, 2004*

January 5-12, 2005

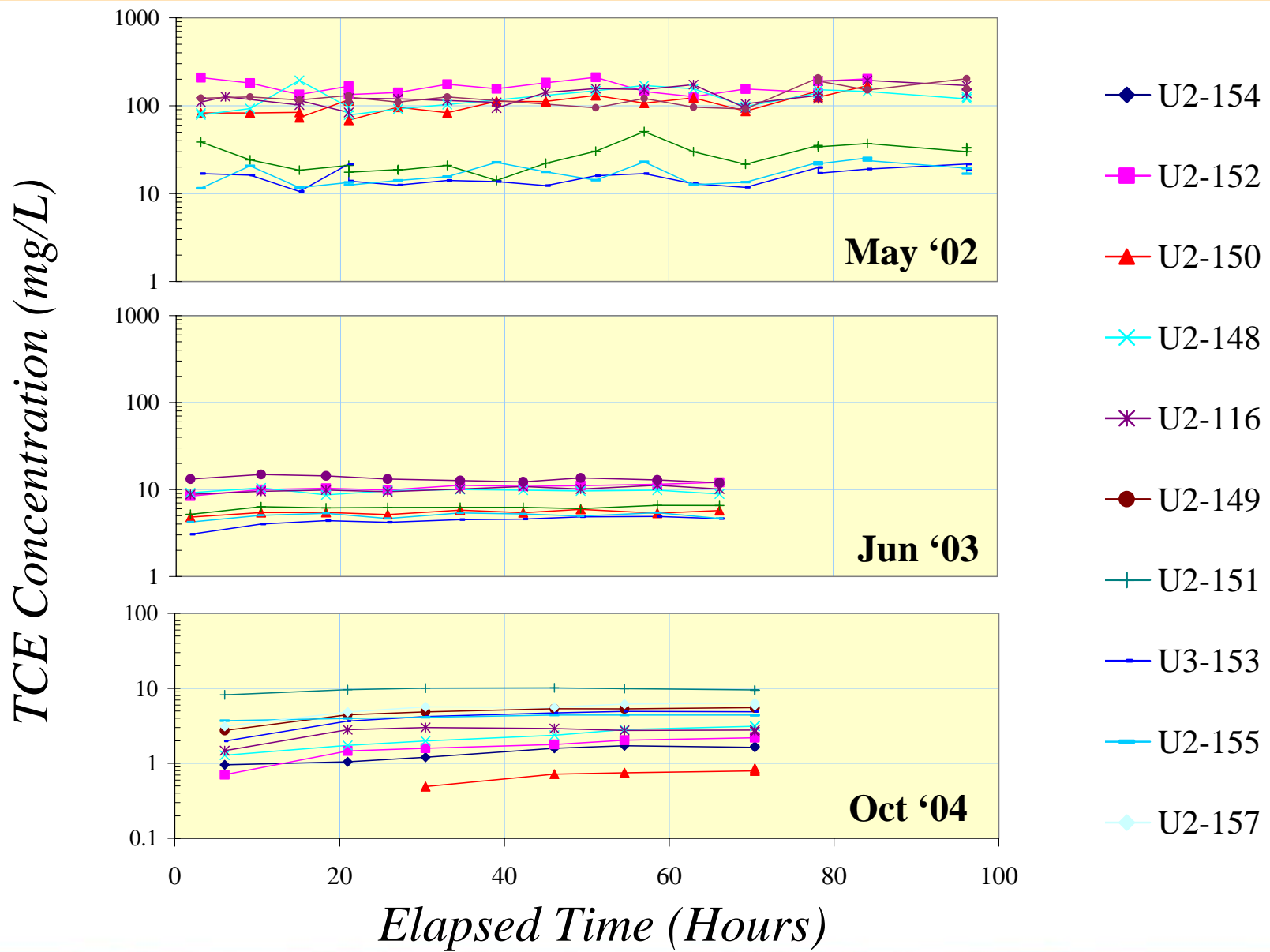
Source: [http://www.utahweather.org/UWC/utahs\\_climate/mega\\_storms.html](http://www.utahweather.org/UWC/utahs_climate/mega_storms.html)

# Interpretation of CT series



Adapted from Bockelmann et al. (2003)

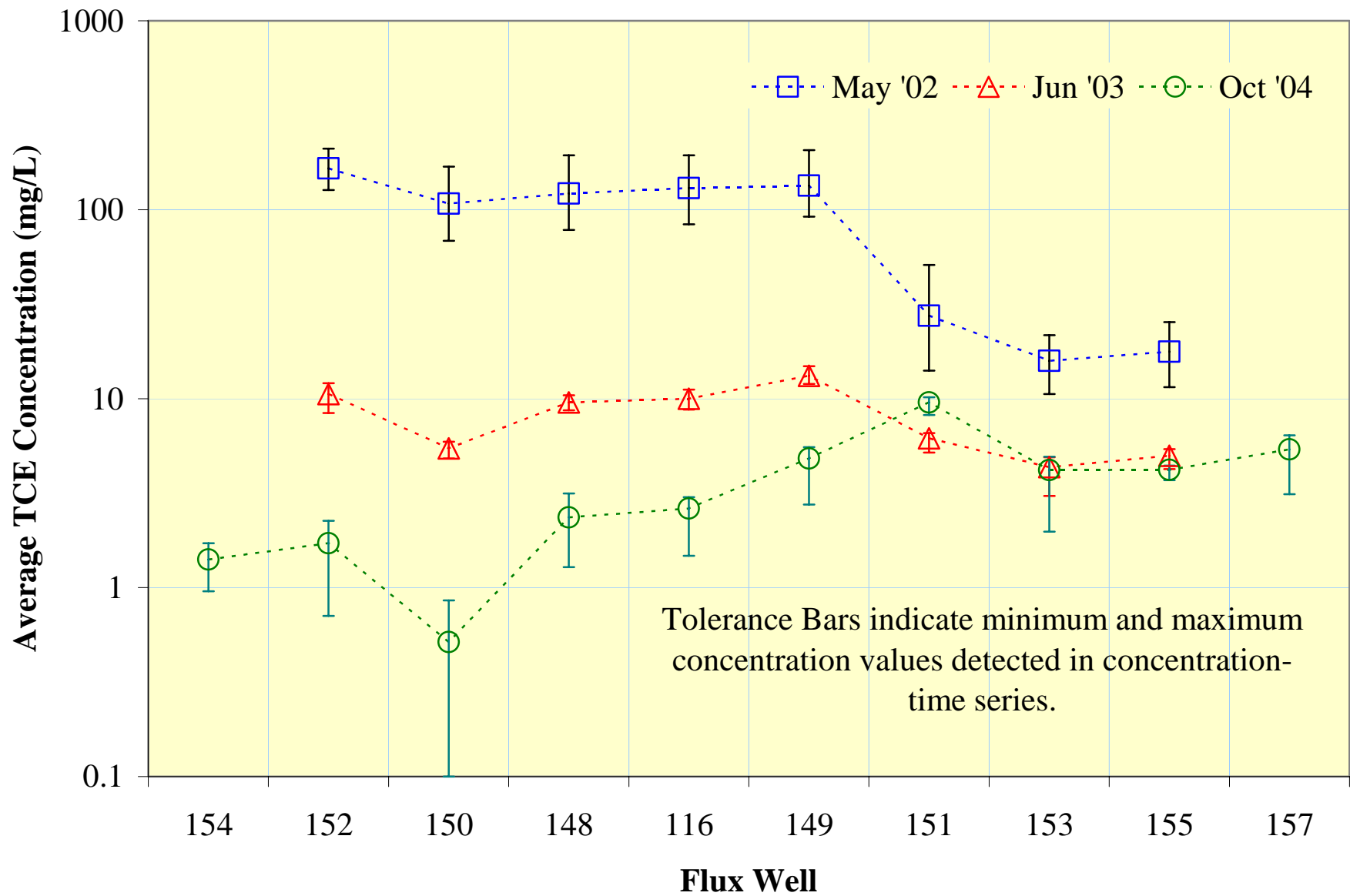
# TCE Concentration Time Series

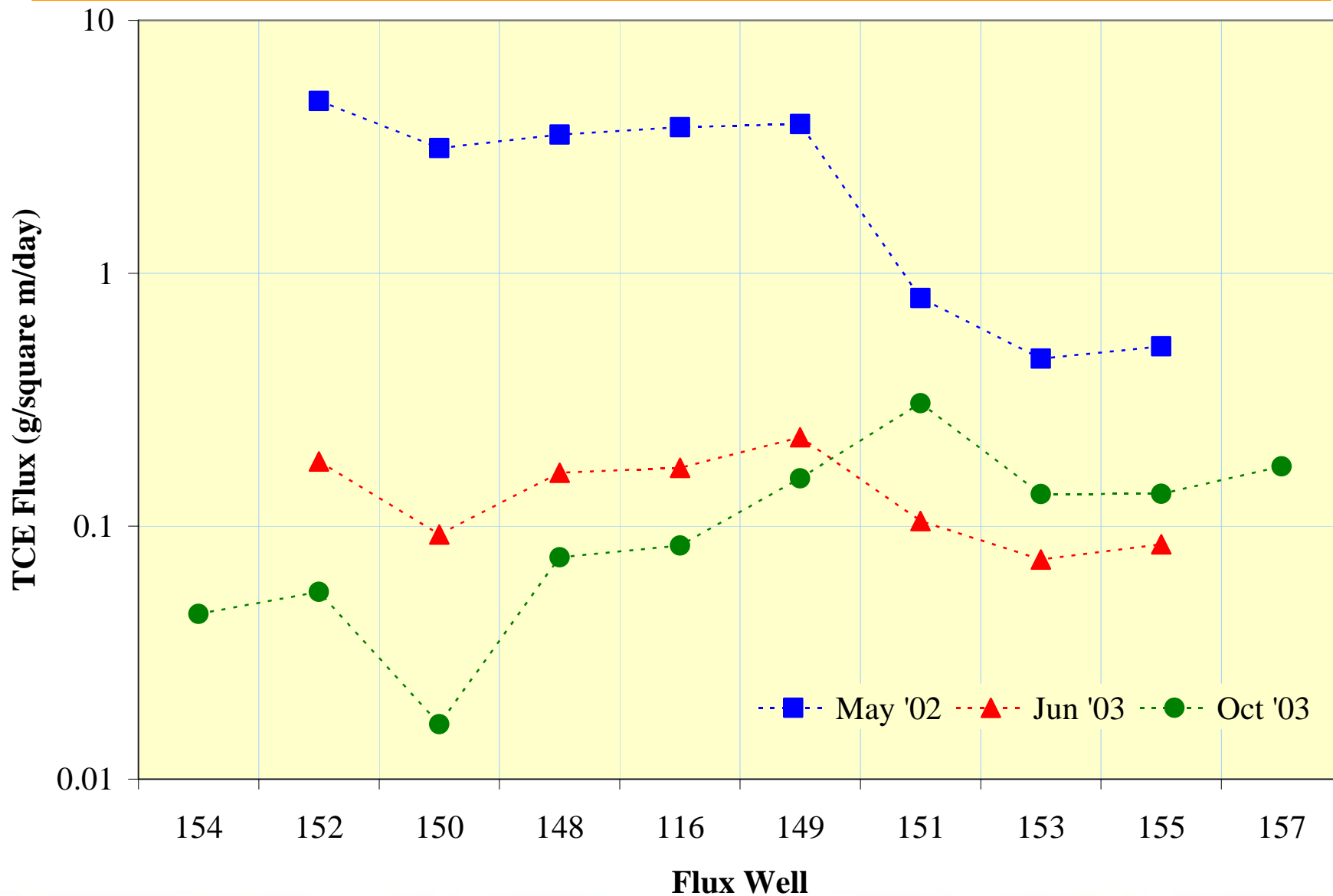


TCE Concentration (mg/L)

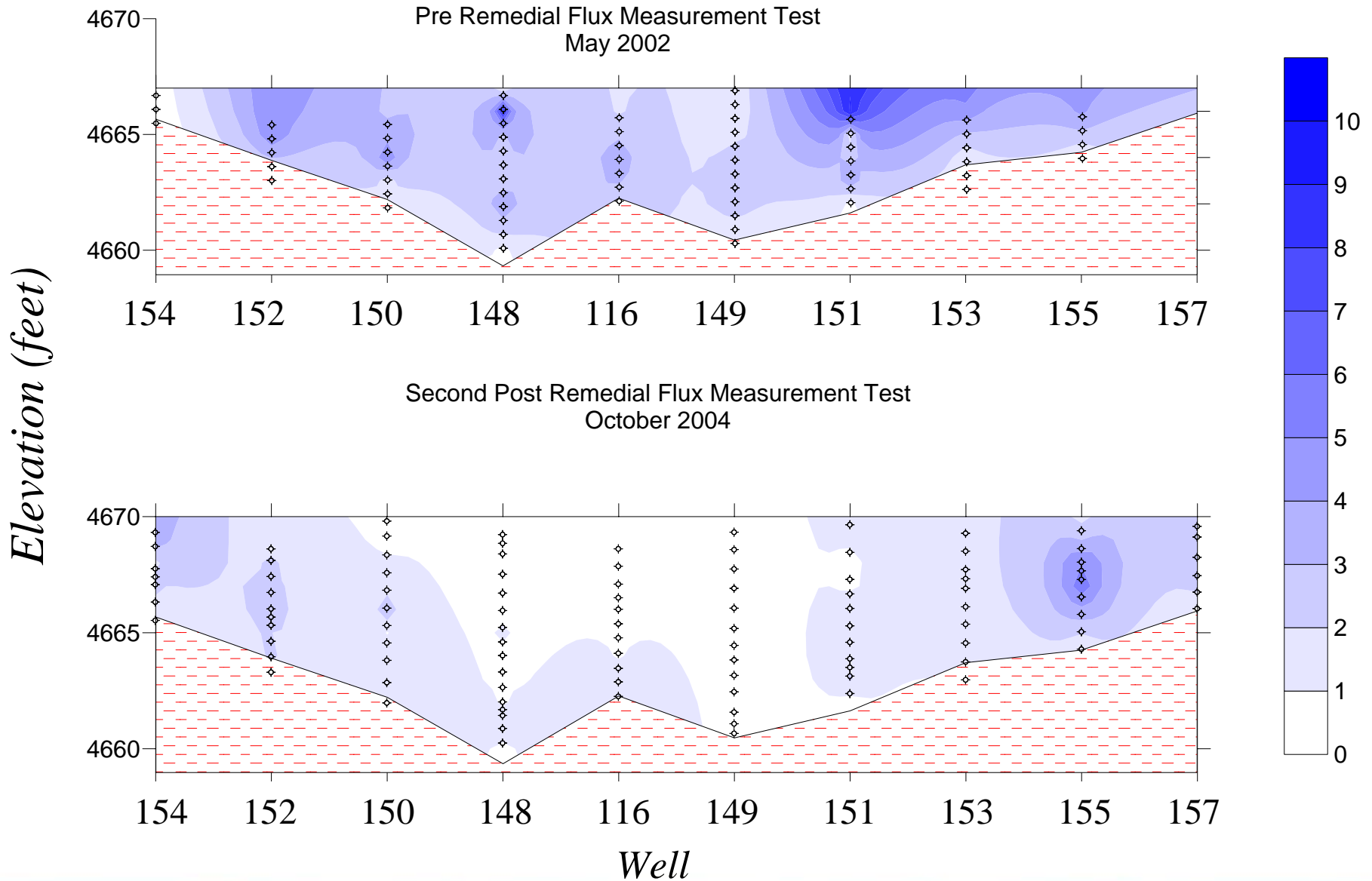
Elapsed Time (Hours)

# TCE Concentration Time Series - Summary

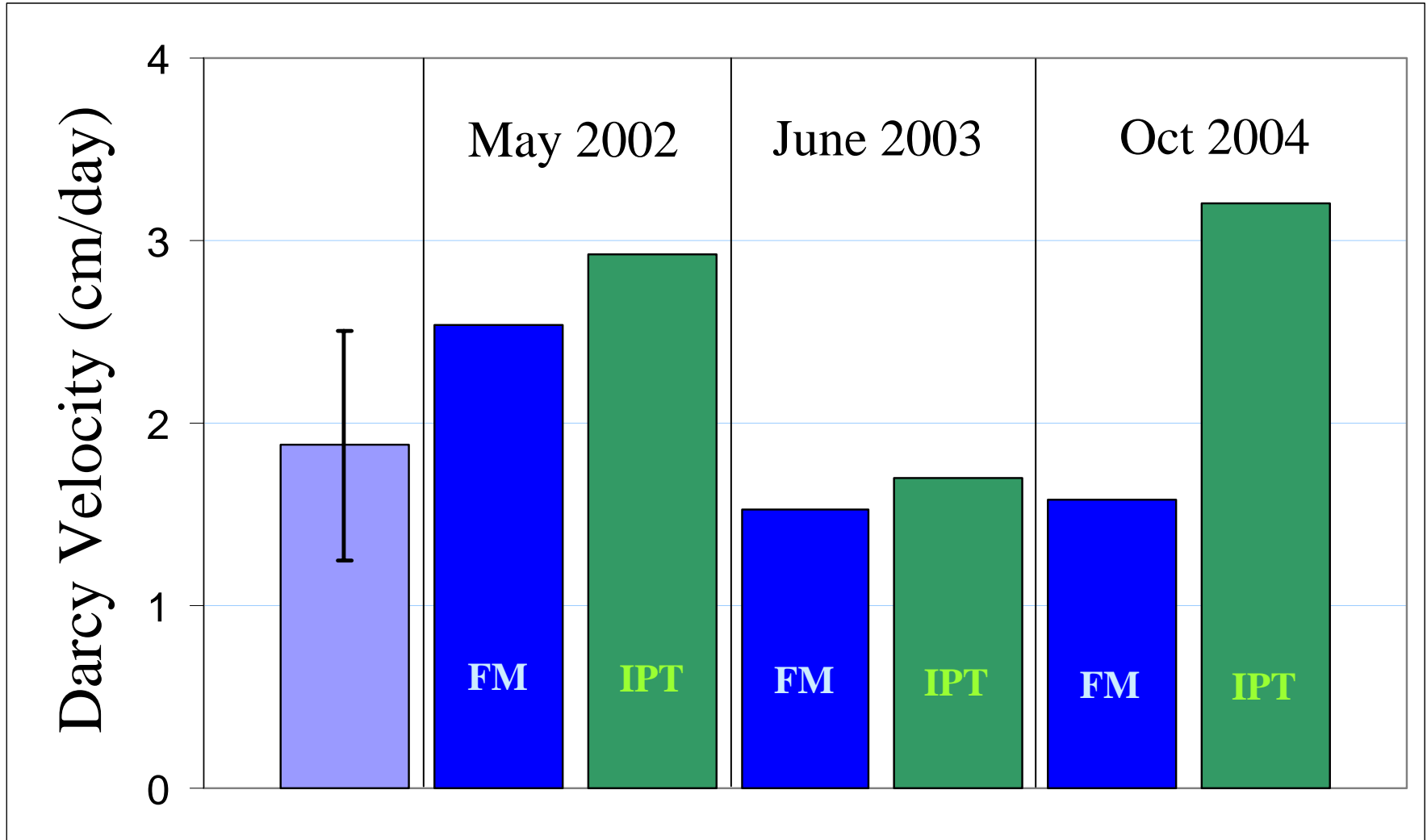




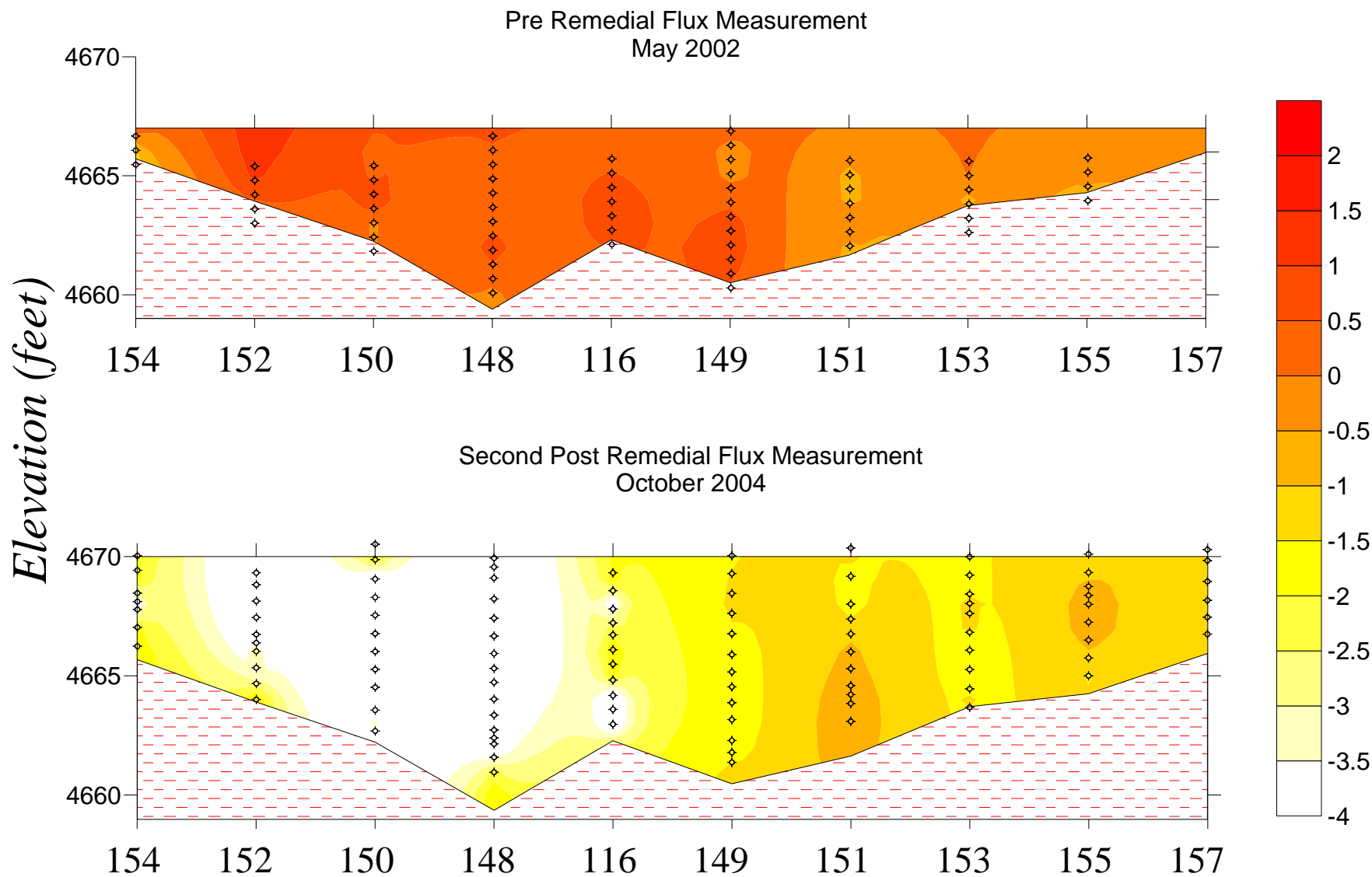
# Flux Meter - Darcy Velocity (cm/day)



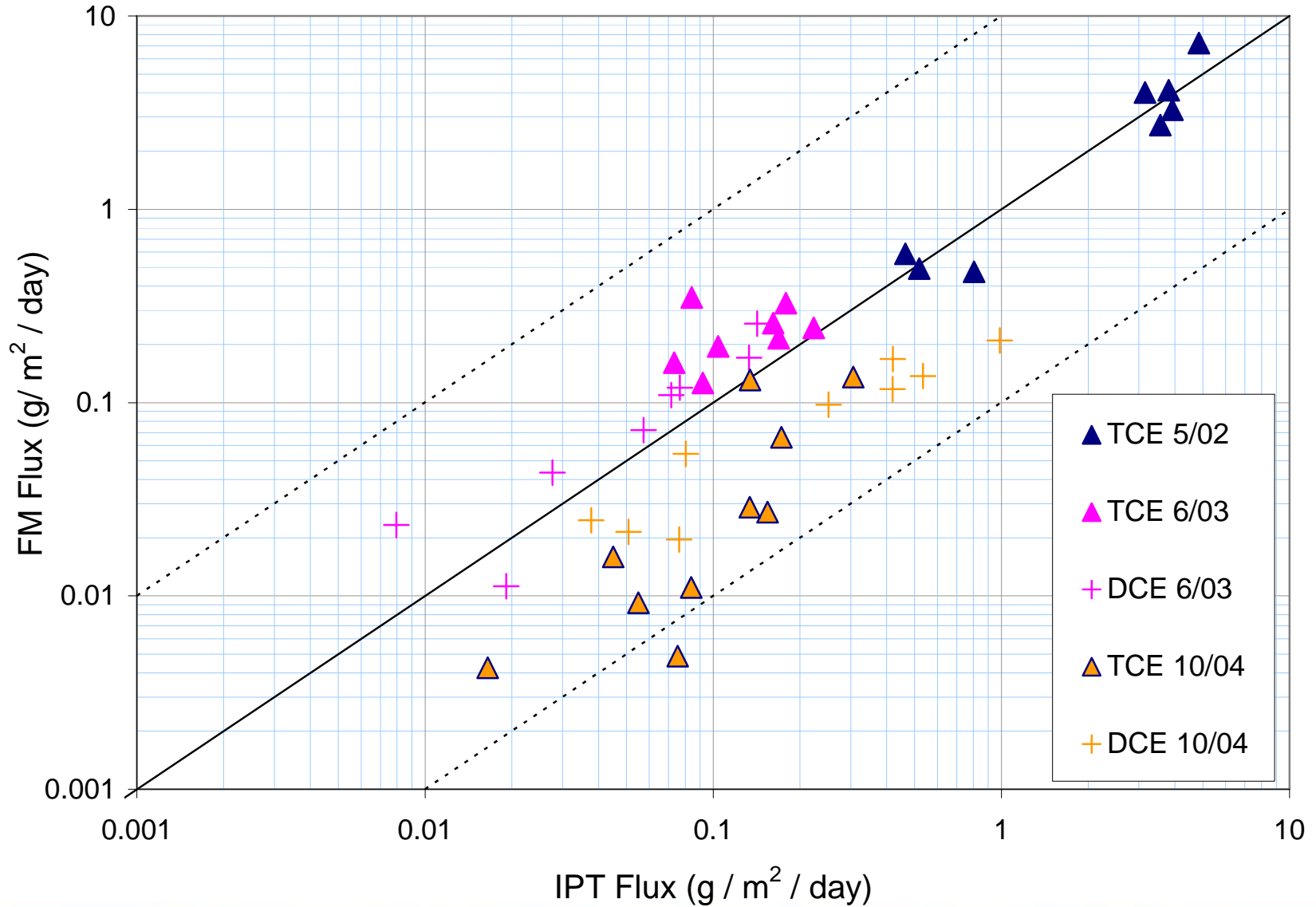
*Darcy Velocity Comparison*



# Flux Meter – Log TCE Flux (gram/square meter/day)



# Flux Comparison - Preliminary



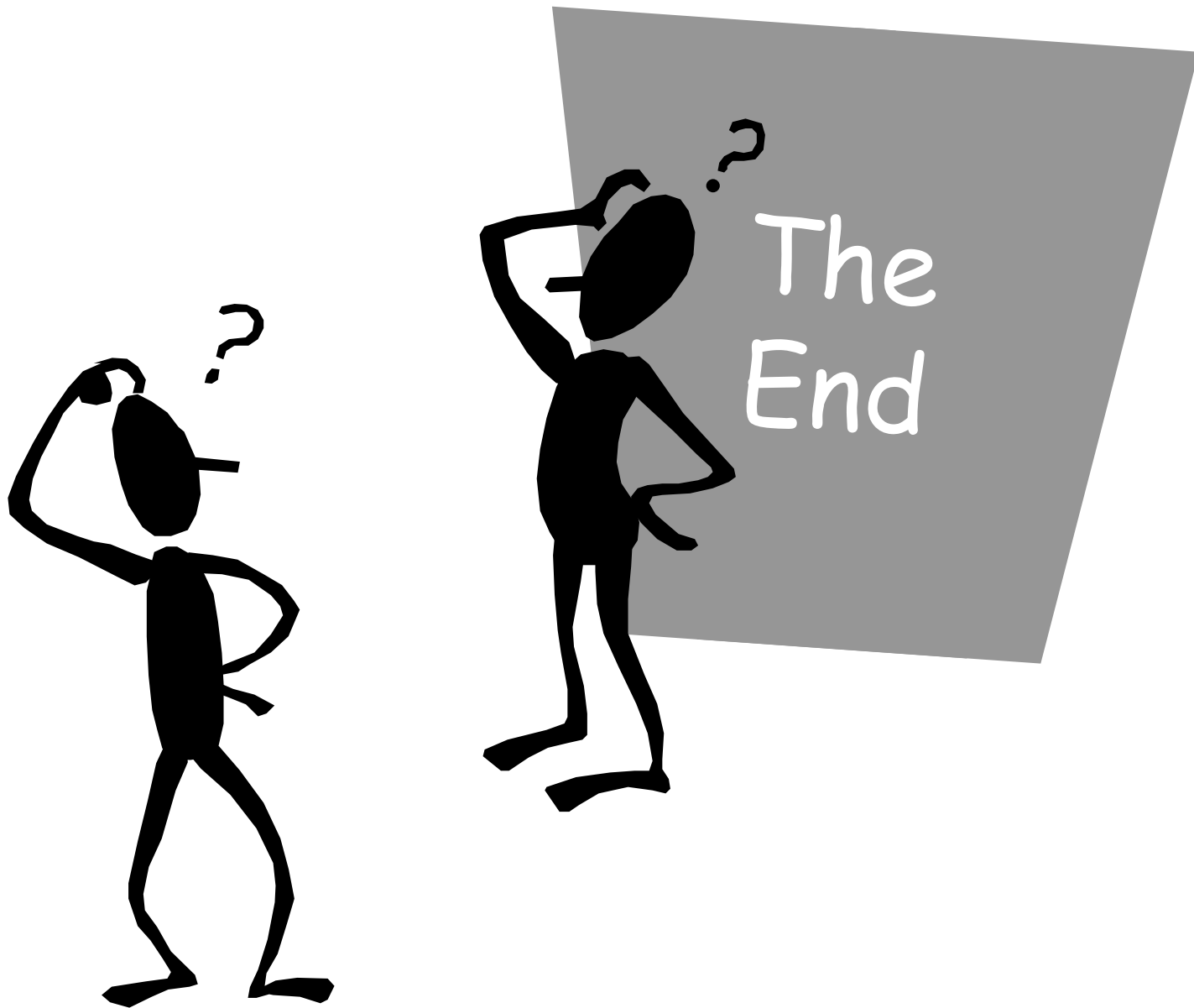
# Summary

- Pre- and Post-remedial flux is being used to assess DNAPL remedial performance at 4 sites
- Flux is being measured by two methods: FM & IPT
- Approximately an order of magnitude decrease in flux at Hill AFB
- Flux estimates based on flux meter and IPT methods to date are comparable

# Acknowledgements

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- Onsite Assistance
  - Hill AFB EMR/URS, Utah
  - LFR, Florida
  - US Army Corps of Engineers Seattle District/Fort Lewis Public Works, Washington
  - University of Waterloo, Canada
- Project Funding: Strategic Environmental Research and Development Program (SERDP)



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