Influence of managed recharge on water quality and quantity in the South Platte River Basin

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USDA-NRI

Colorado State University

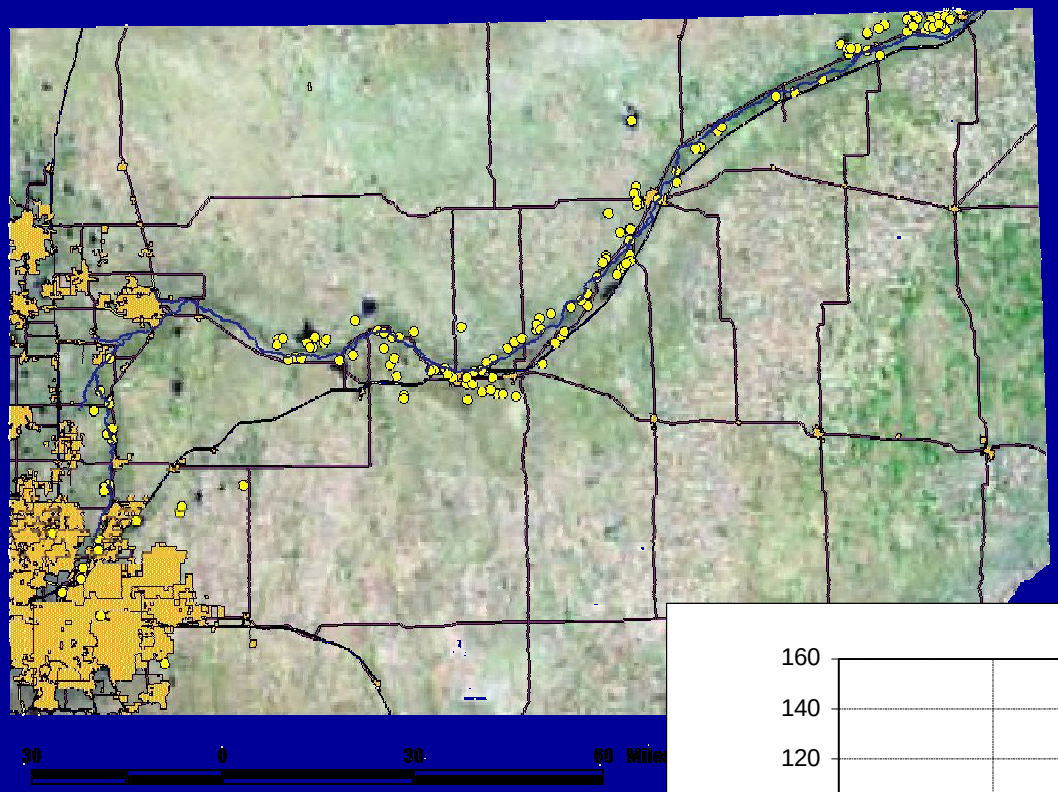
COLORADO DIVISION OF WILDLIFE

What is streamflow augmentation using managed recharge?

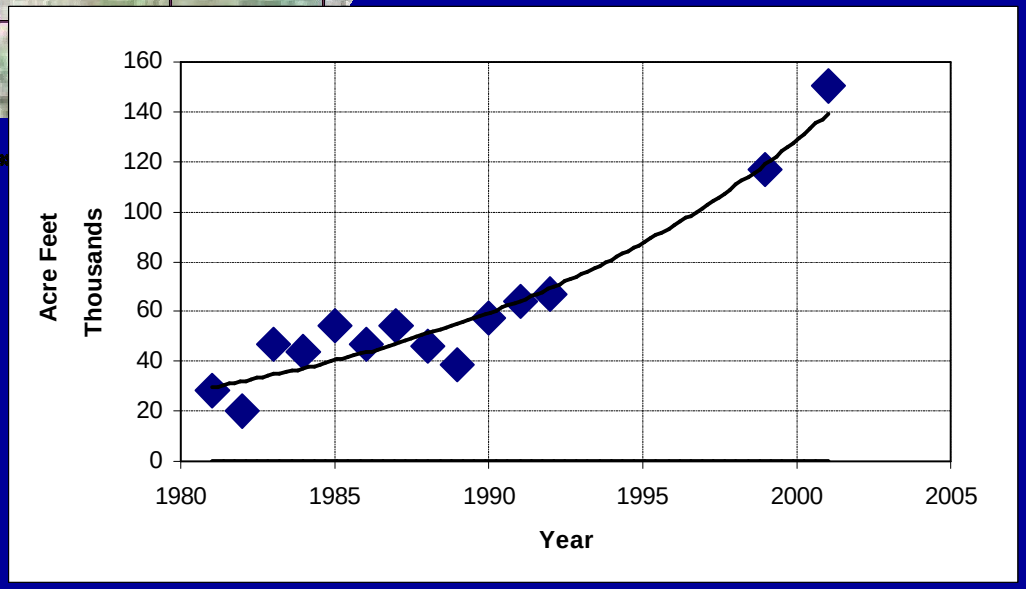
Colorado Water Law is based on the Prior Appropriation Doctrine, “first in time, first in right”. During the irrigation season, surface flows in the lower South Platte have long been appropriated.

Managed recharge is a form of conjunctive water management used for streamflow augmentation to meet water rights demands. Water is diverted from the river during low-demand periods, pumped to recharge ponds where it infiltrates and returns to the river at later critical high-demand periods, thus retiming flows, and allowing junior well owners to pump without harming senior water rights.

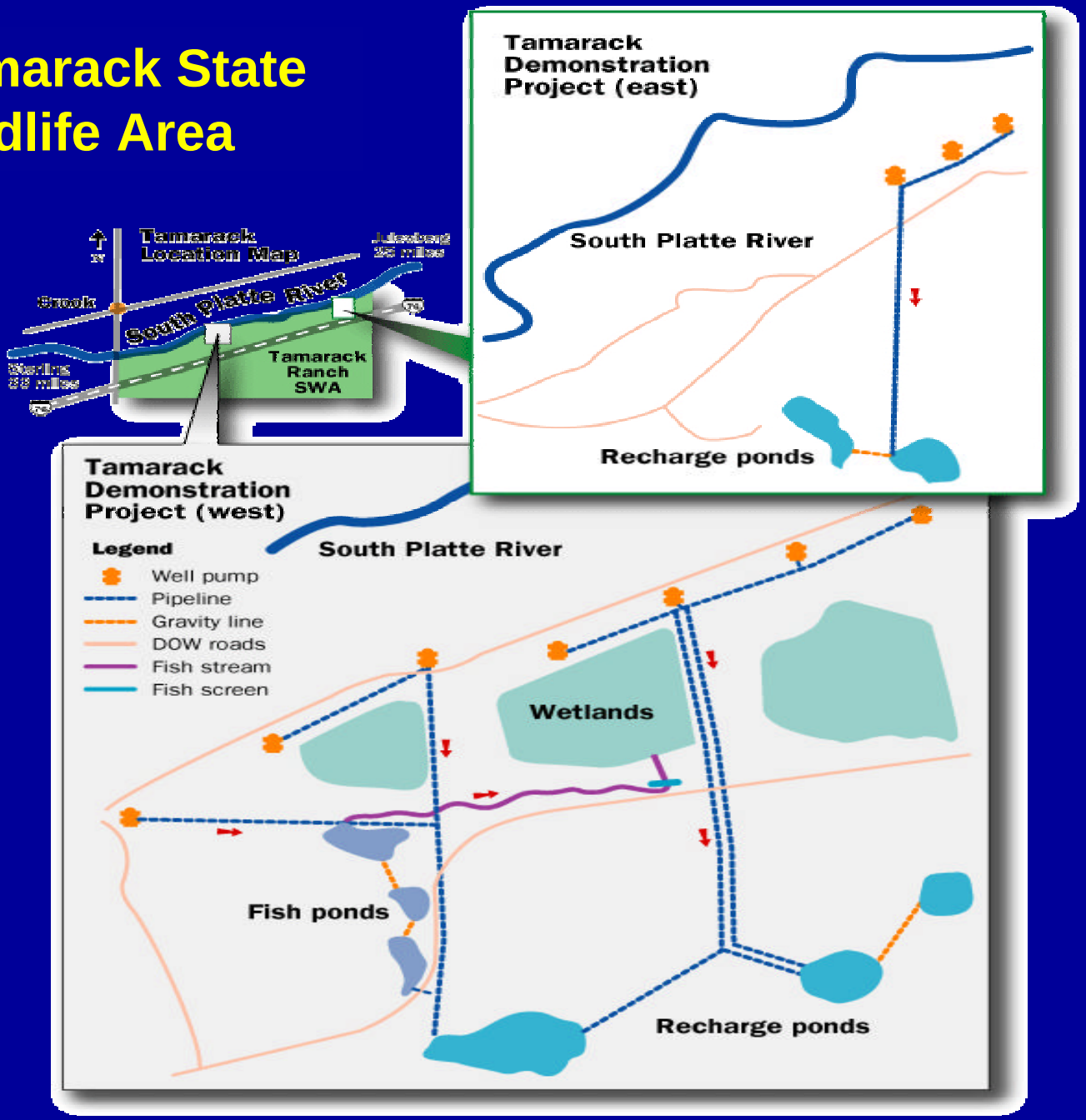
Recharge Sites

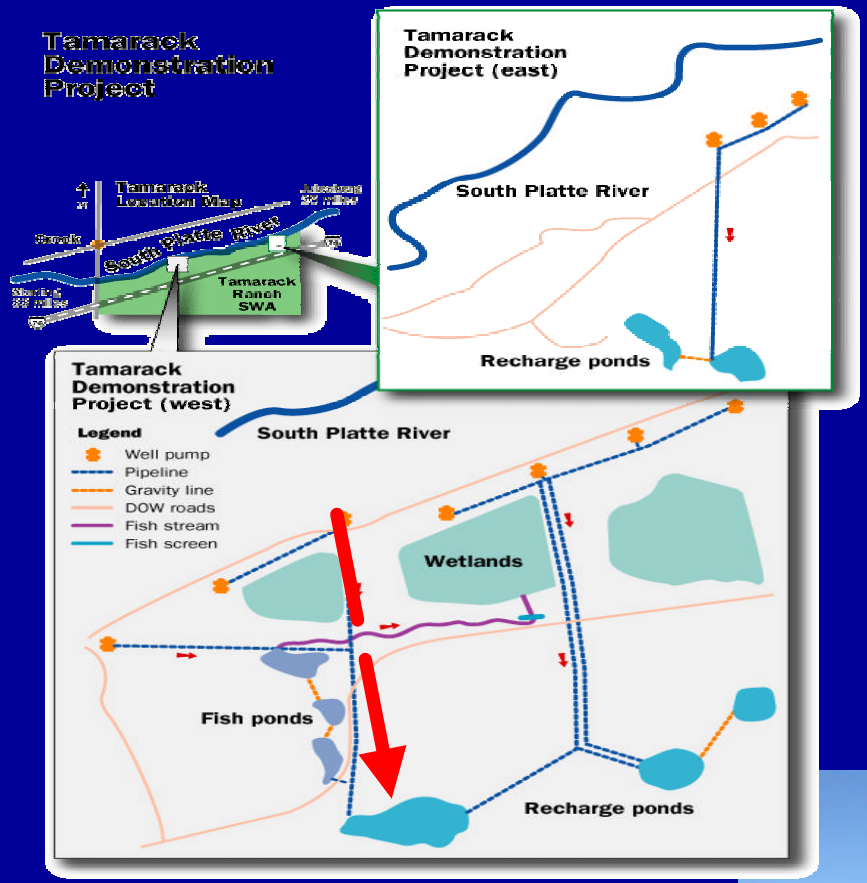


Acre Feet of recharge in the South Platte from 1980-2001

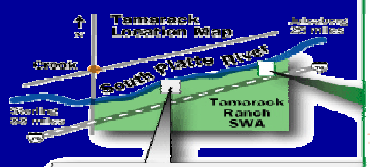


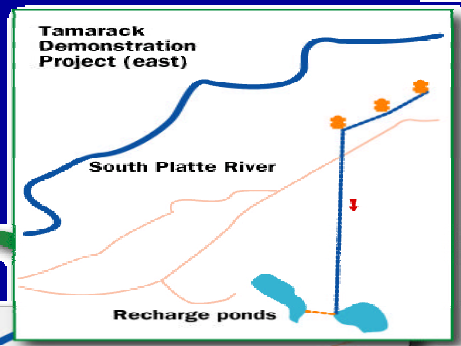
Tamarack State Wildlife Area

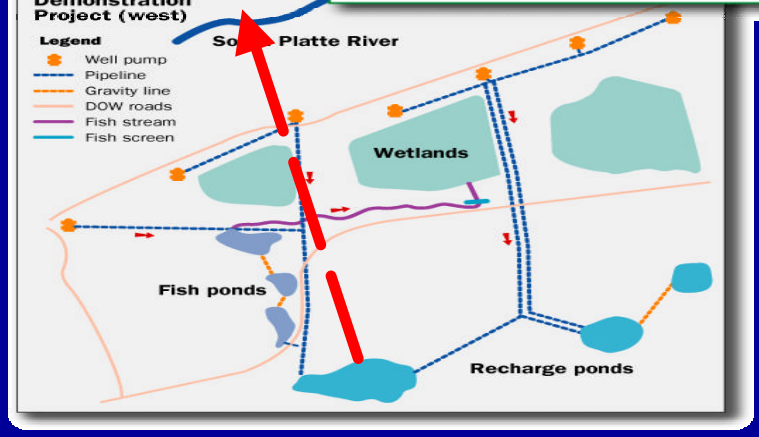




<u>October-March</u>
Water is pumped from alluvial aquifer near the river and piped to recharge ponds







April-Sept

Recharge water returns to river during low-flow, high demand periods

Tamarack Recharge Project

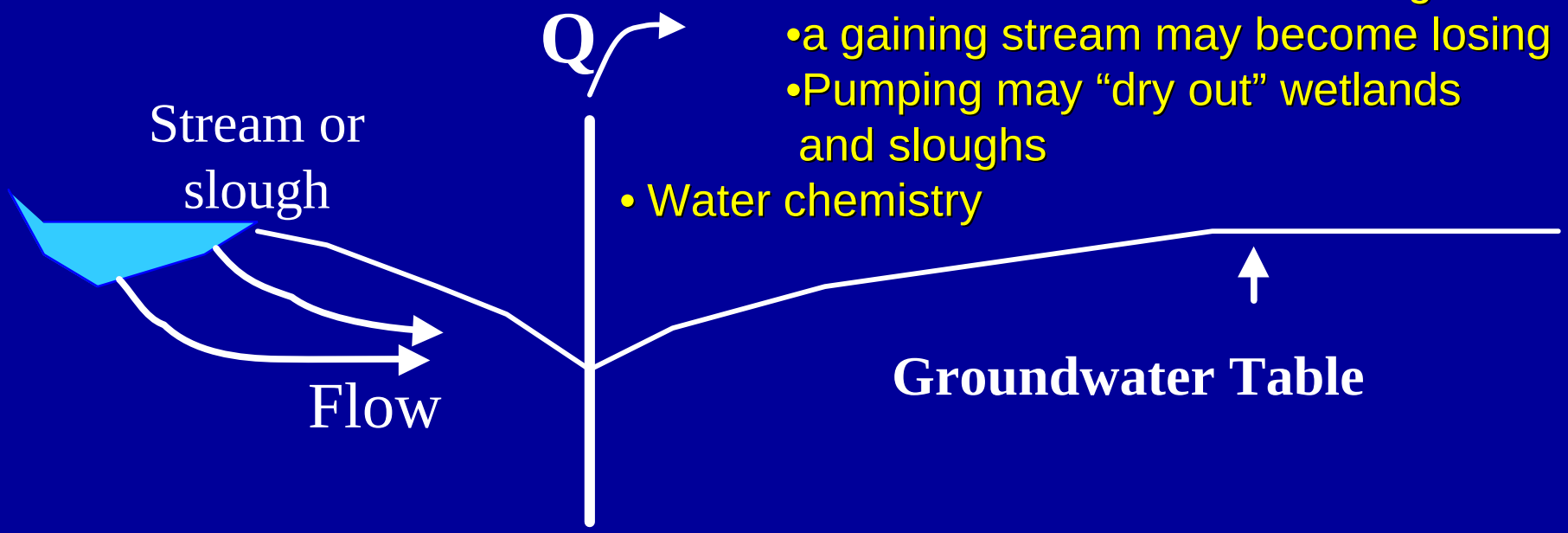
- Platte River Basin Endangered Species Cooperative Agreement to Provide Water in Platte River for Endangered Species in Nebraska; Goal of augmenting river flows by 27,000 acre-ft annually

- Located at CDOW Tamarack Ranch State Wildlife Area; must meet CDOW habitat objectives

Augmentation will tend to "smooth" river hydrograph, ie The "flashiness" of the hydrograph will be moderated

Impacts of Pumping on River, Sloughs, Wetlands and on-site hydrology

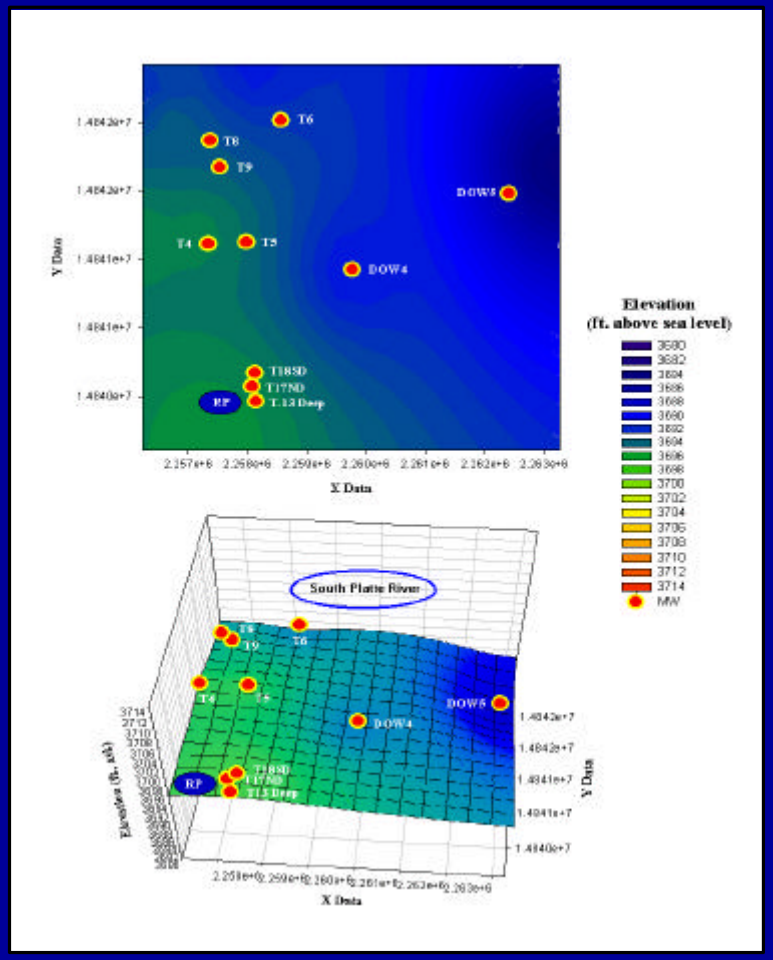
- Groundwater-surface water interchange
  - a gaining stream may become losing
  - Pumping may "dry out" wetlands and sloughs
- Water chemistry

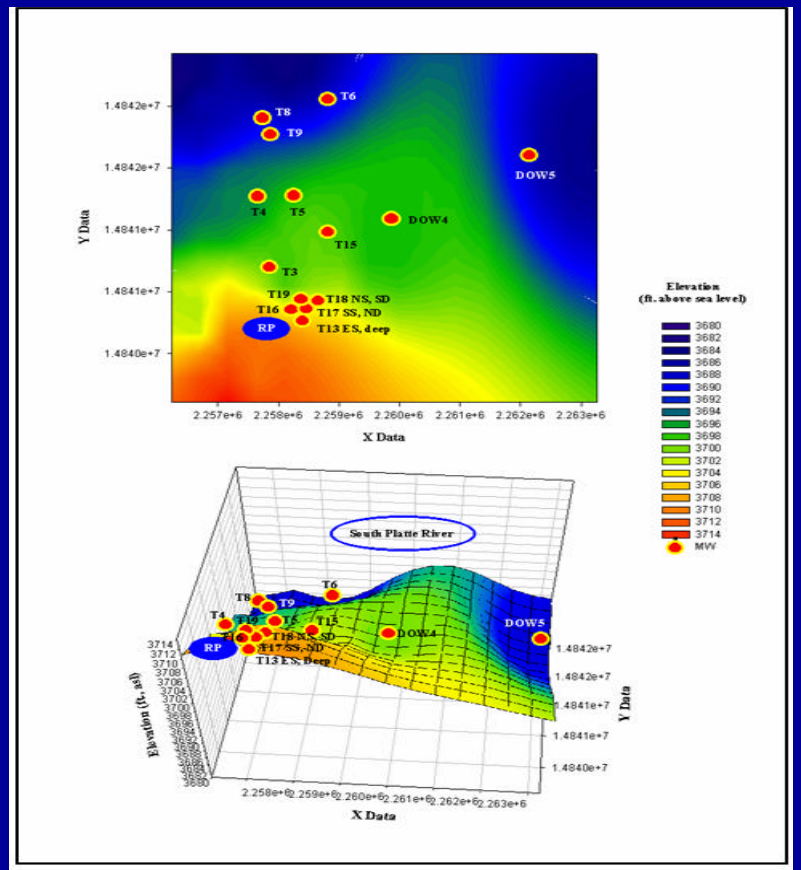


NRI PROJECT GOALS:

- Model groundwater flow and chemical transport
- Define site hydrology (geophysics, well monitoring, tracer studies)
- Characterize water quality in the recharge ponds, river, backwater sloughs and alluvium,
- Evaluate SDF Method and recharge systems/management to meet both stream flow augmentation and habitat objectives

model groundwater flow and chemical transport





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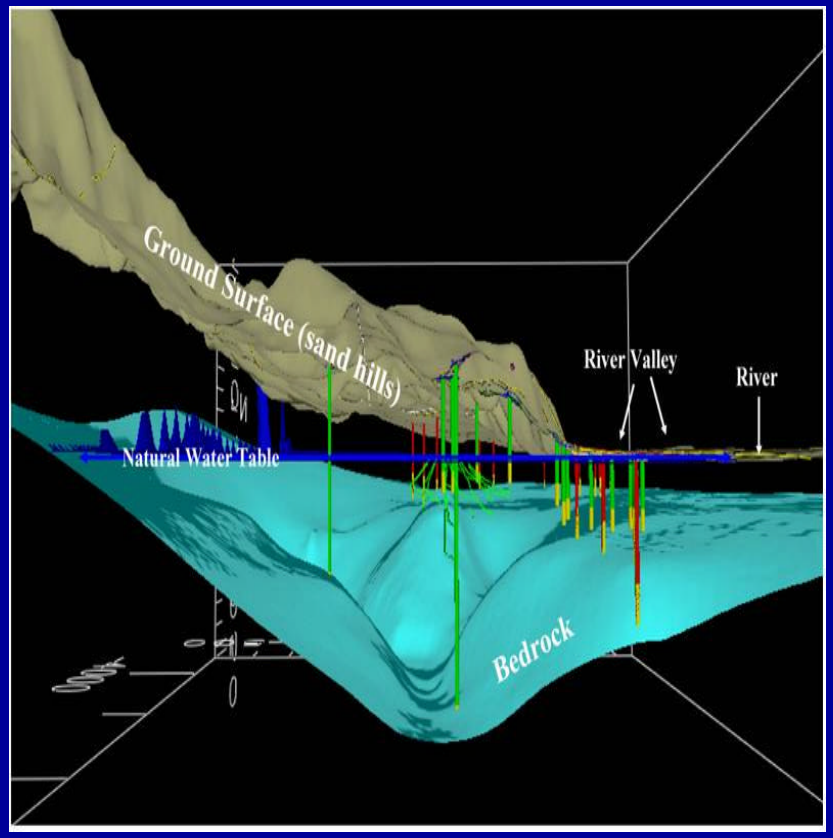
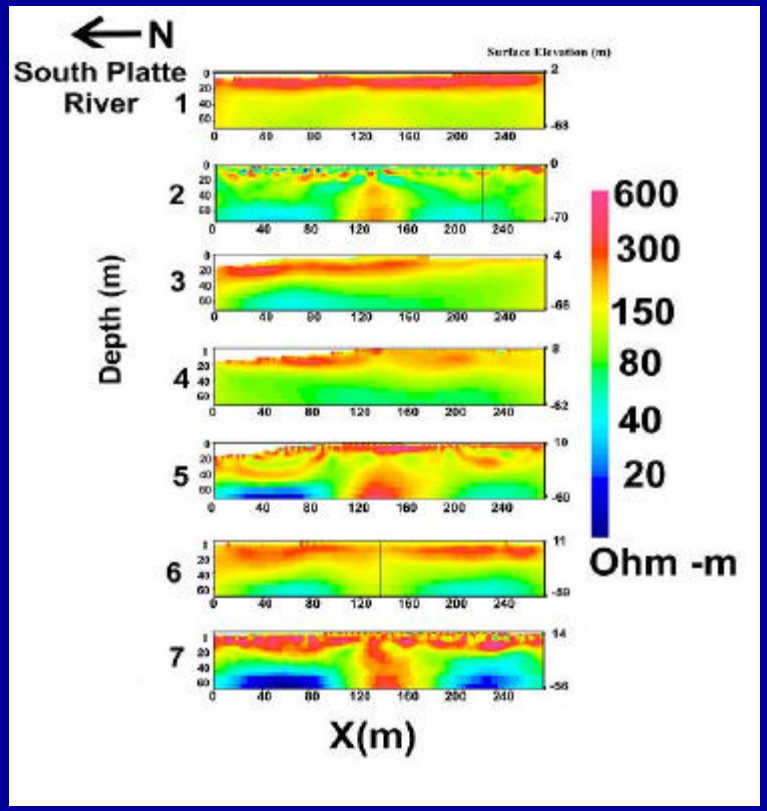
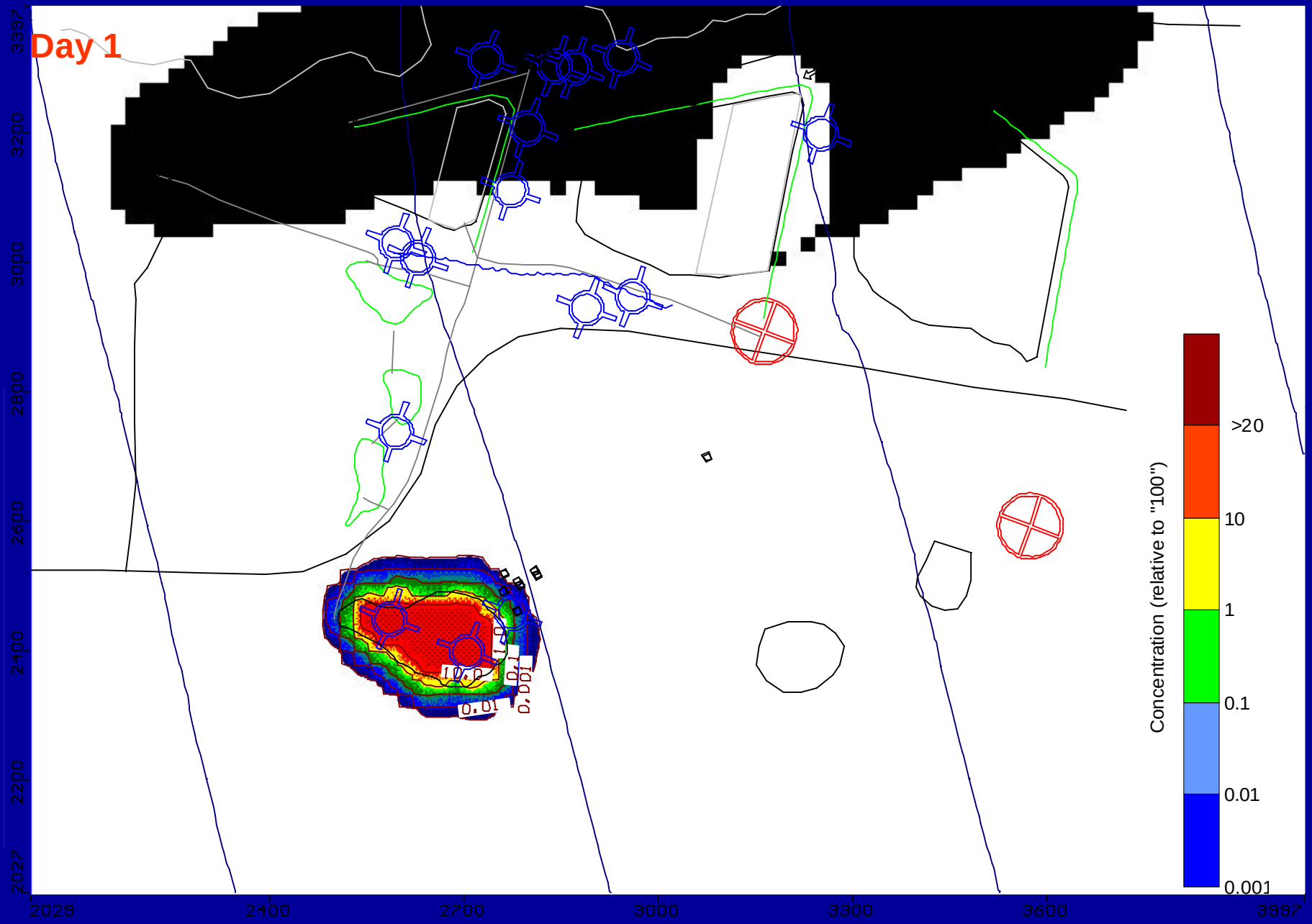




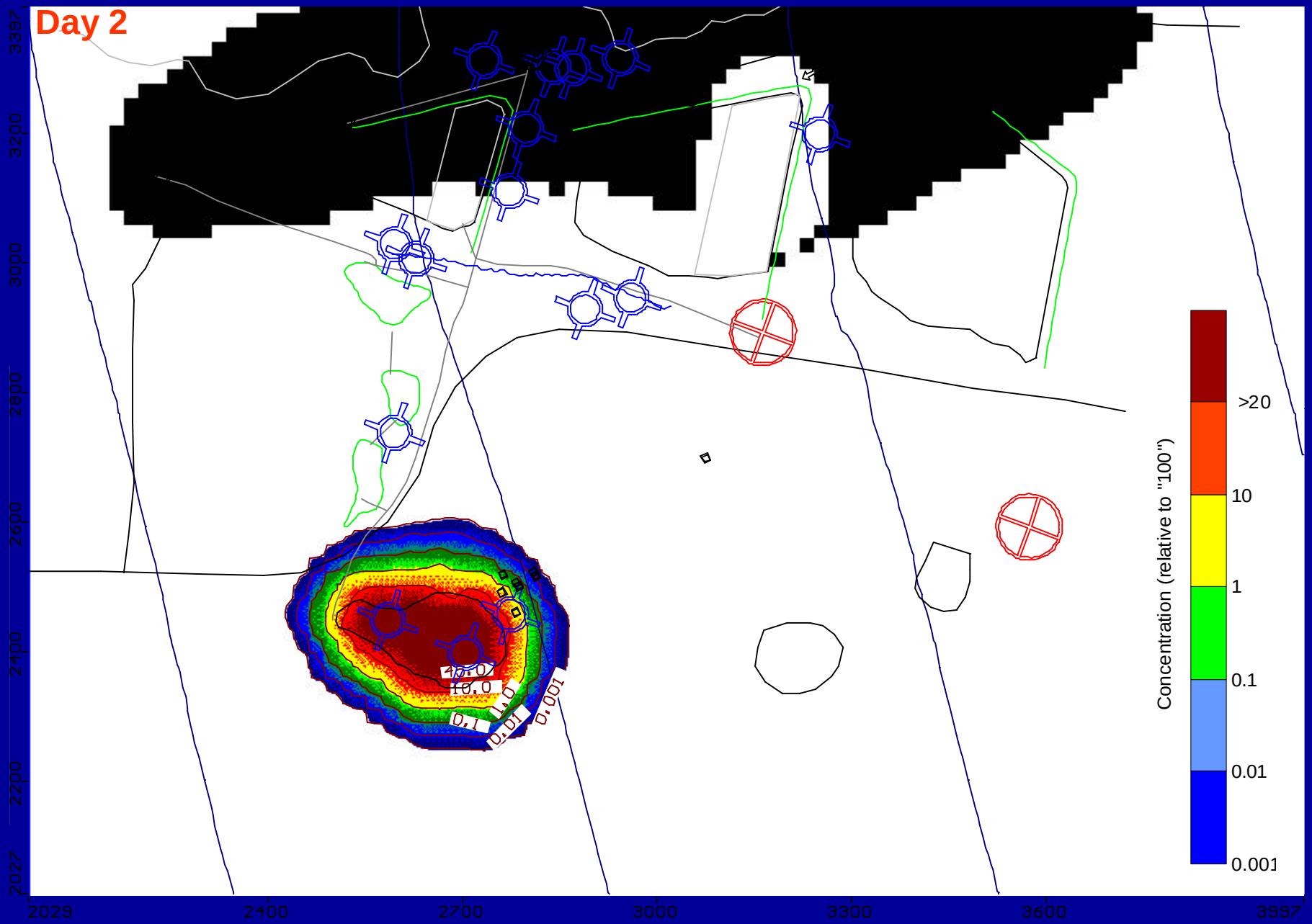
Tracer Study: SF_6 injected

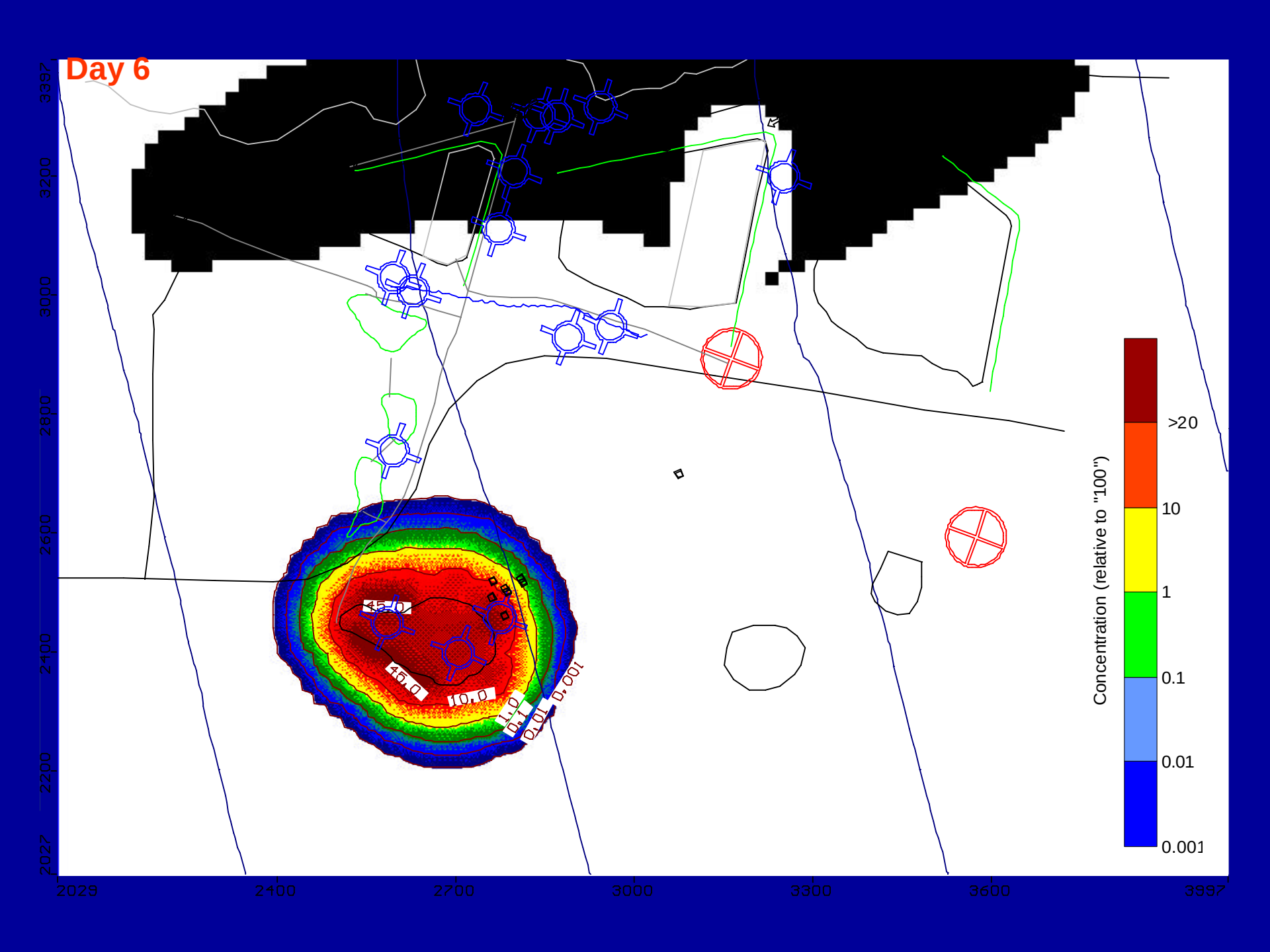
Bubbled into the pond for 5 days, Tagged ~ 20,000 m^3/day

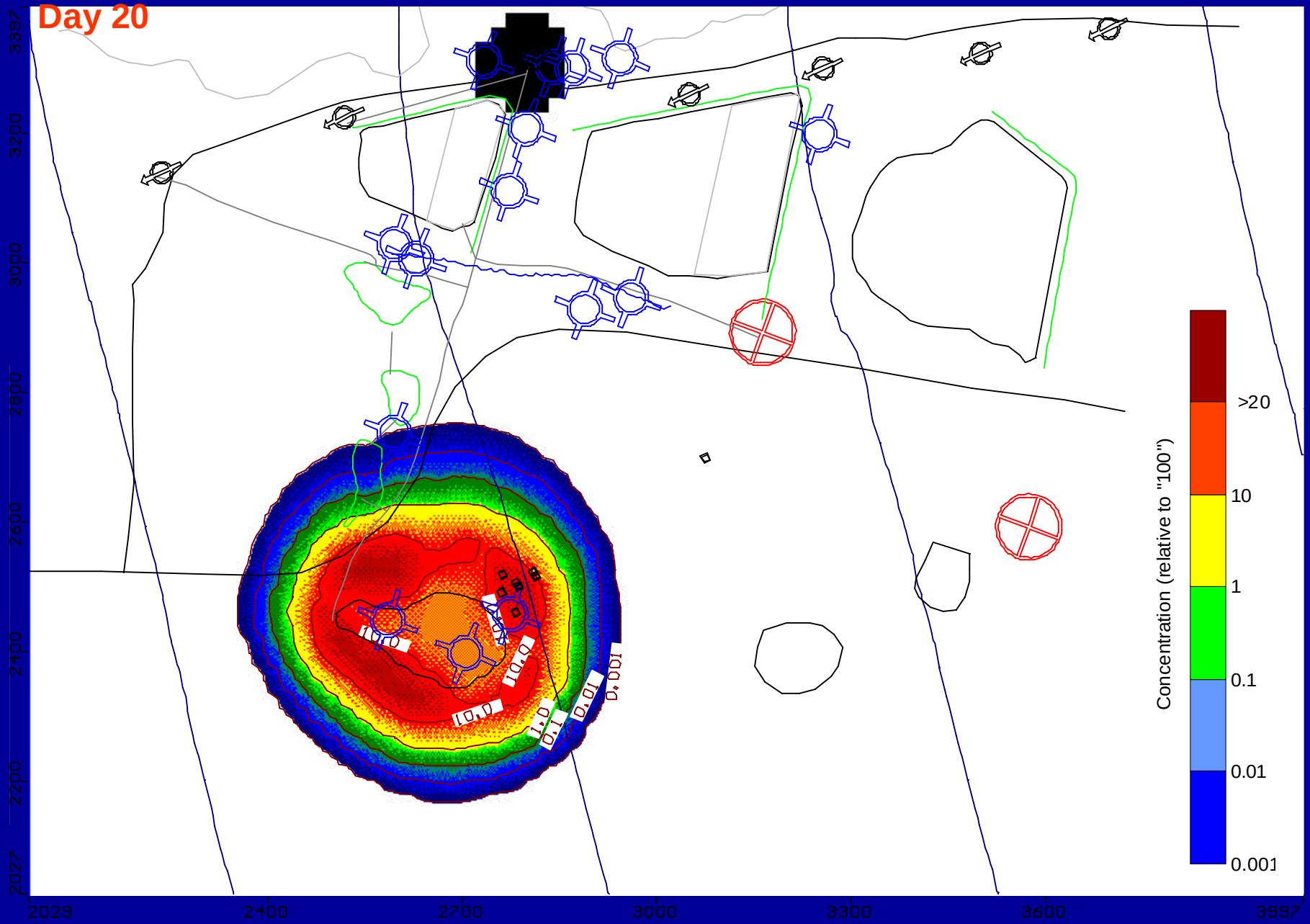
injected in March, 2004,Sampling for almost 2 years

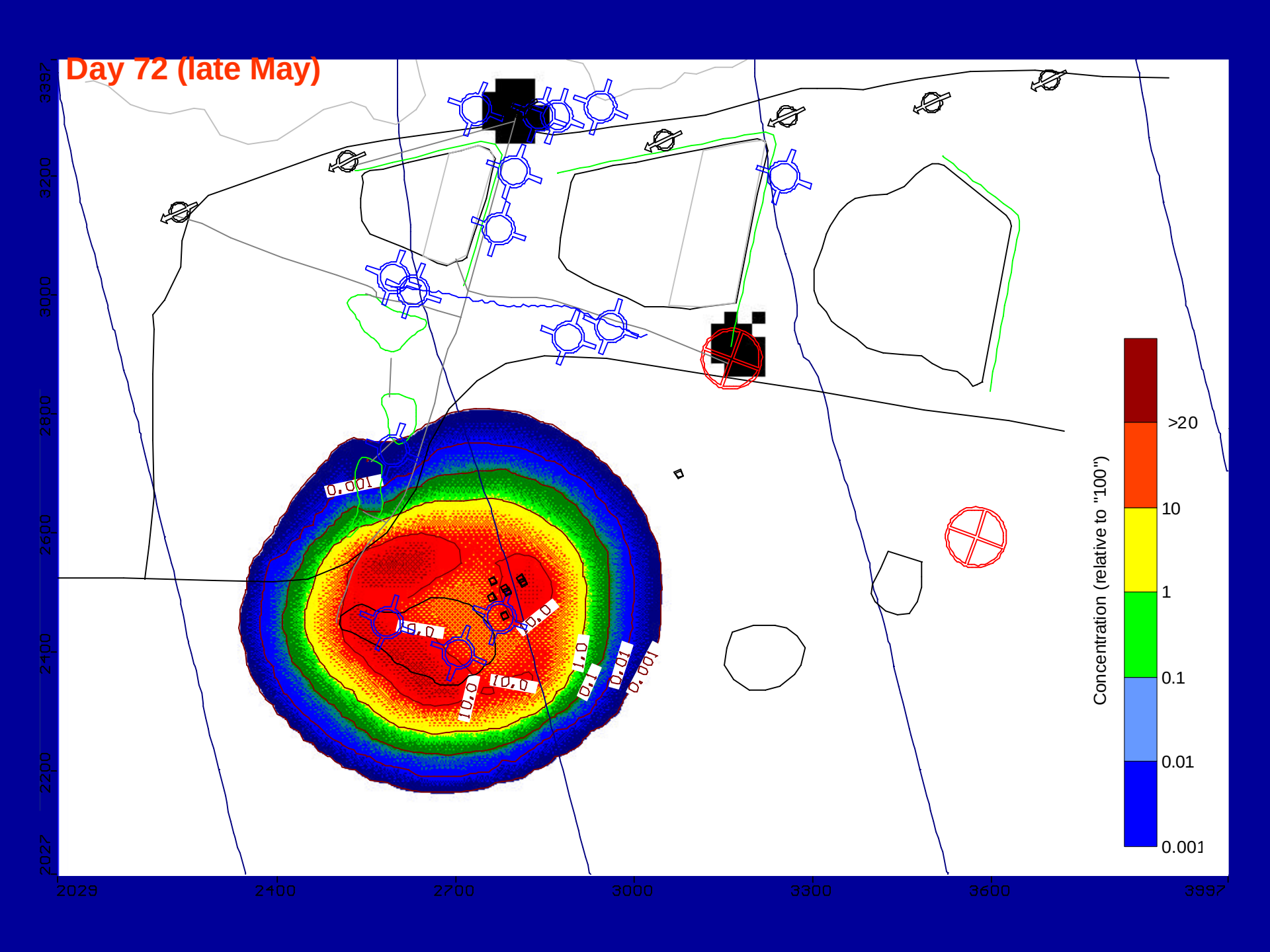


Evaluate SDF Method


Day 2
Concentration (relative to "100")
>20
10
1
0.1
0.01
0.001
40.0
10.0
1.0
0.1
0.01
0.001
2029
2400
2700
3000
3300
3600
3997
2027
2200
2400
2600
2800
3000
3200
3397

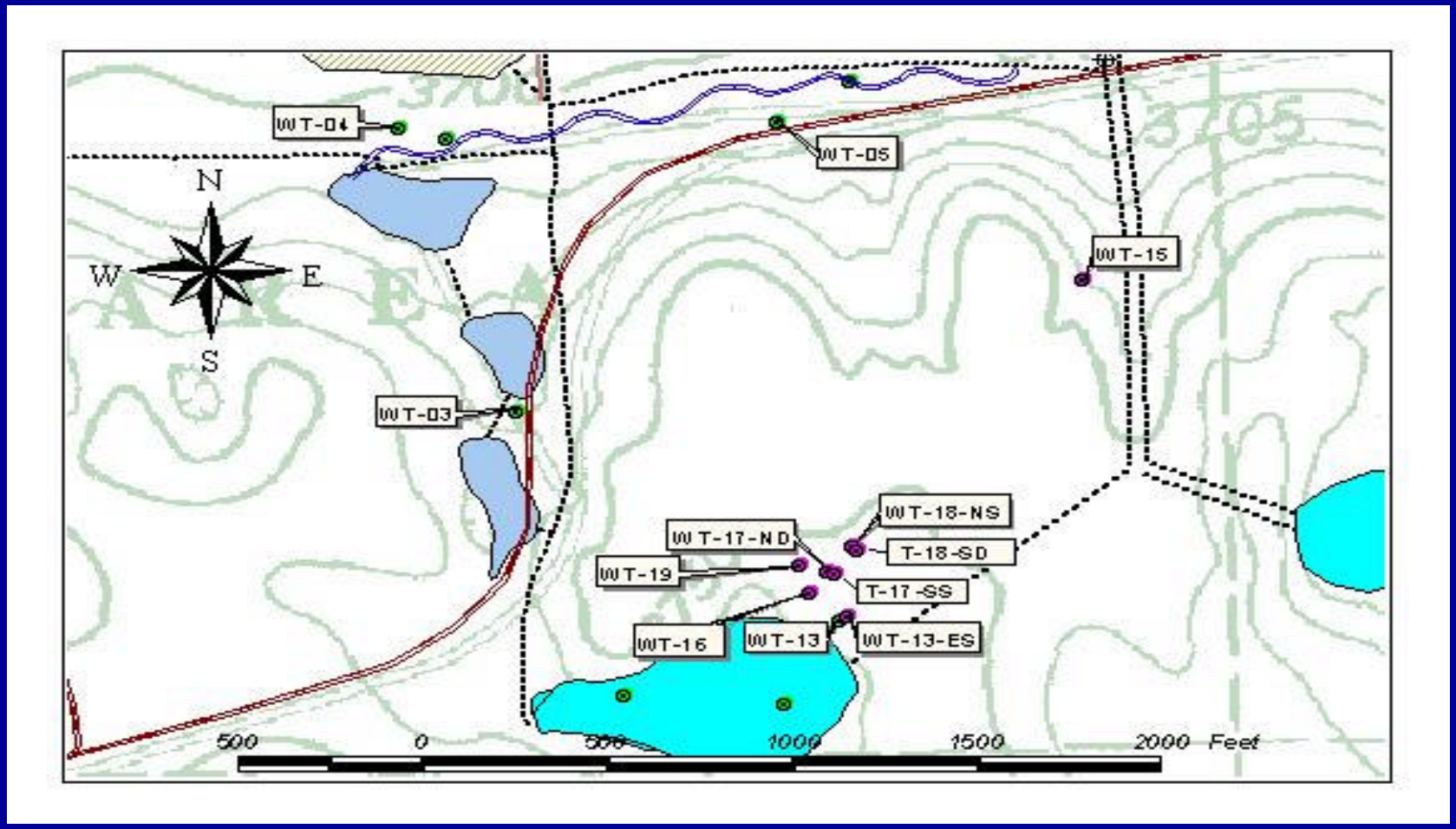

Day 6
3397
3200
3000
2800
2600
2400
2200
2027
2029
2400
2700
3000
3300
3600
3997
45.0
45.0
10.0
1.0
0.1
0.01
0.001
Concentration (relative to "100")
>20
10
1
0.1
0.01
0.001


Day 20
Concentration (relative to "100")
>20
10
1
0.1
0.01
0.001
2029
2400
2700
3000
3300
3600
3997
2027
2200
2400
2600
2800
3000
3200
3397

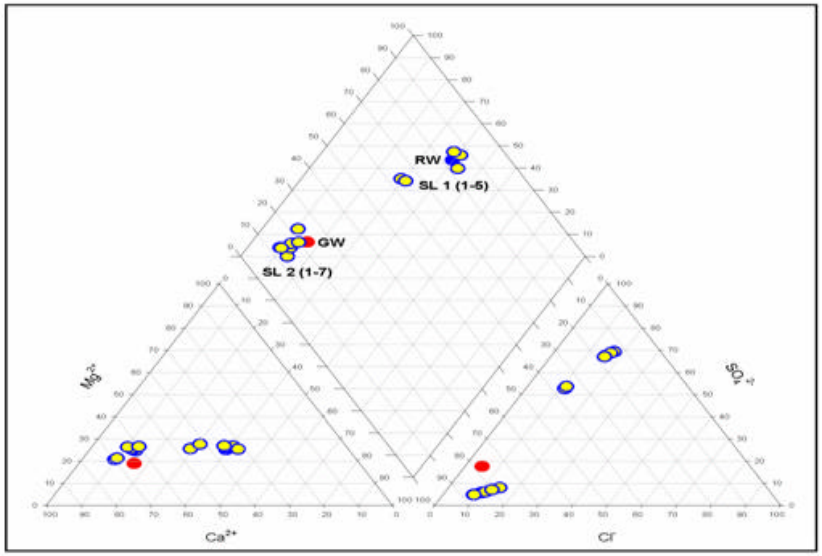


Day 72 (late May)
Concentration (relative to "100")
>20
10
1
0.1
0.01
0.001
2029
2400
2700
3000
3300
3600
3997
2027
2200
2400
2600
2800
3000
3200
3397

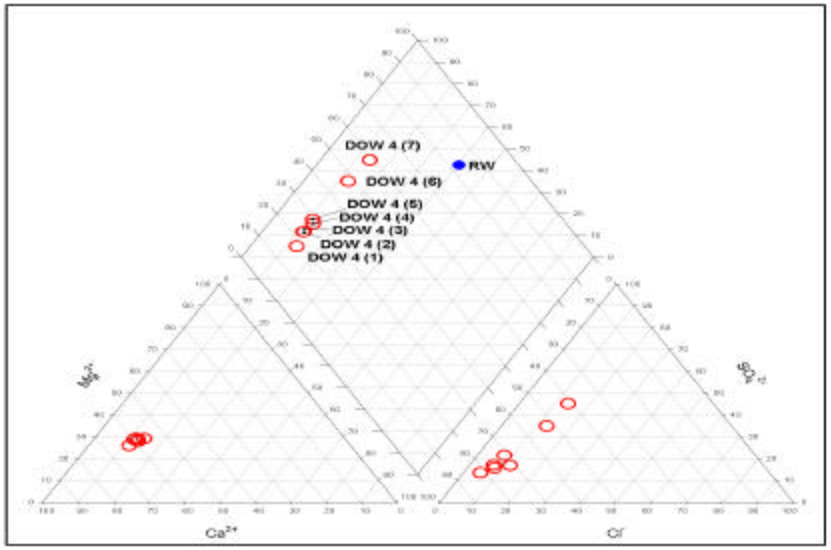
characterize water quality in the recharge ponds, river, wetlands, backwater sloughs and alluvium,



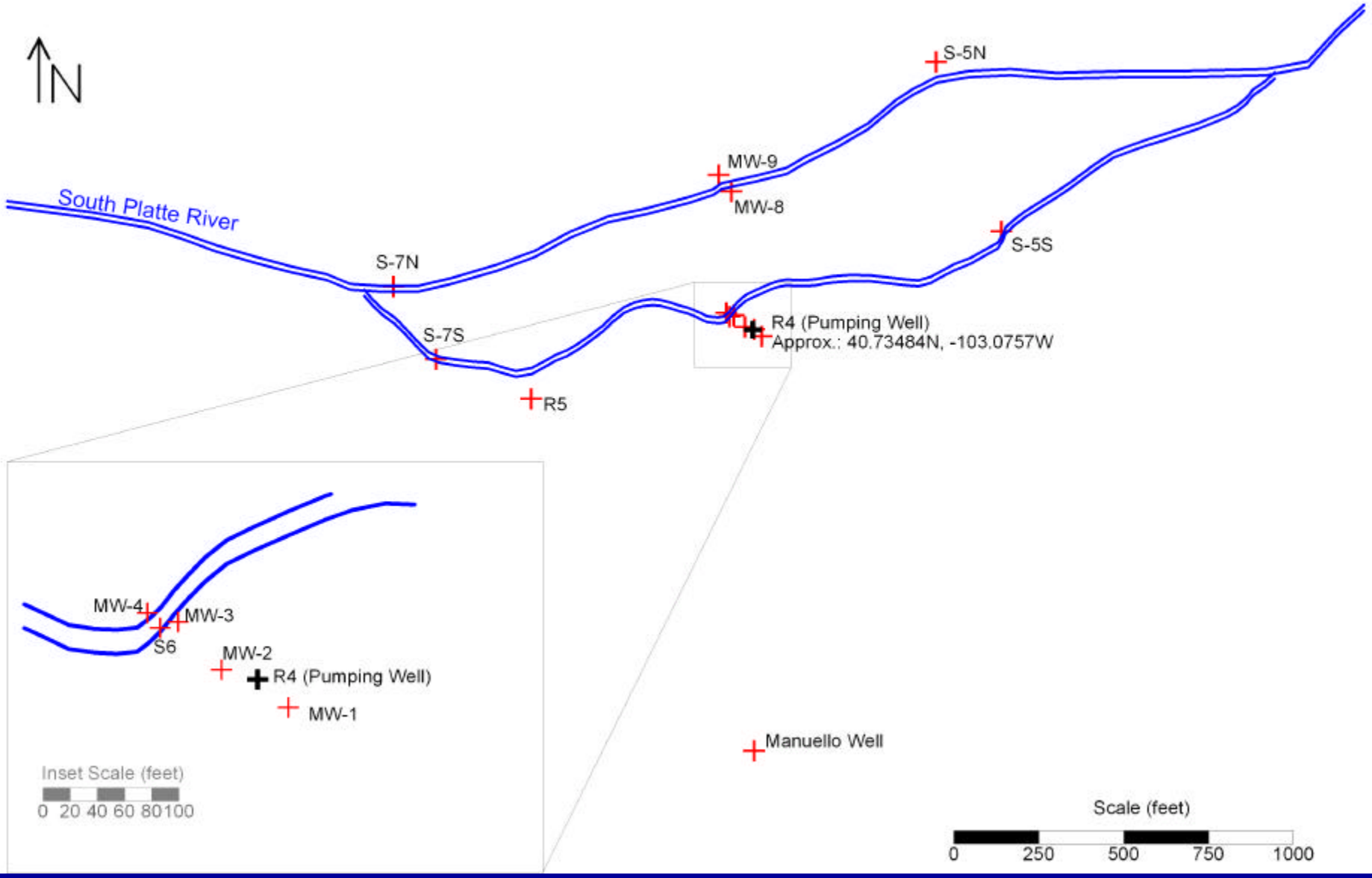
- **Monitor Spatial and Temporal Variations in Water Quality Parameters – NO^-, SO_4^{2-}, pH, DO,Temperature, Hardness, EC (sloughs, river, alluvium, pumped water, recharge ponds)**



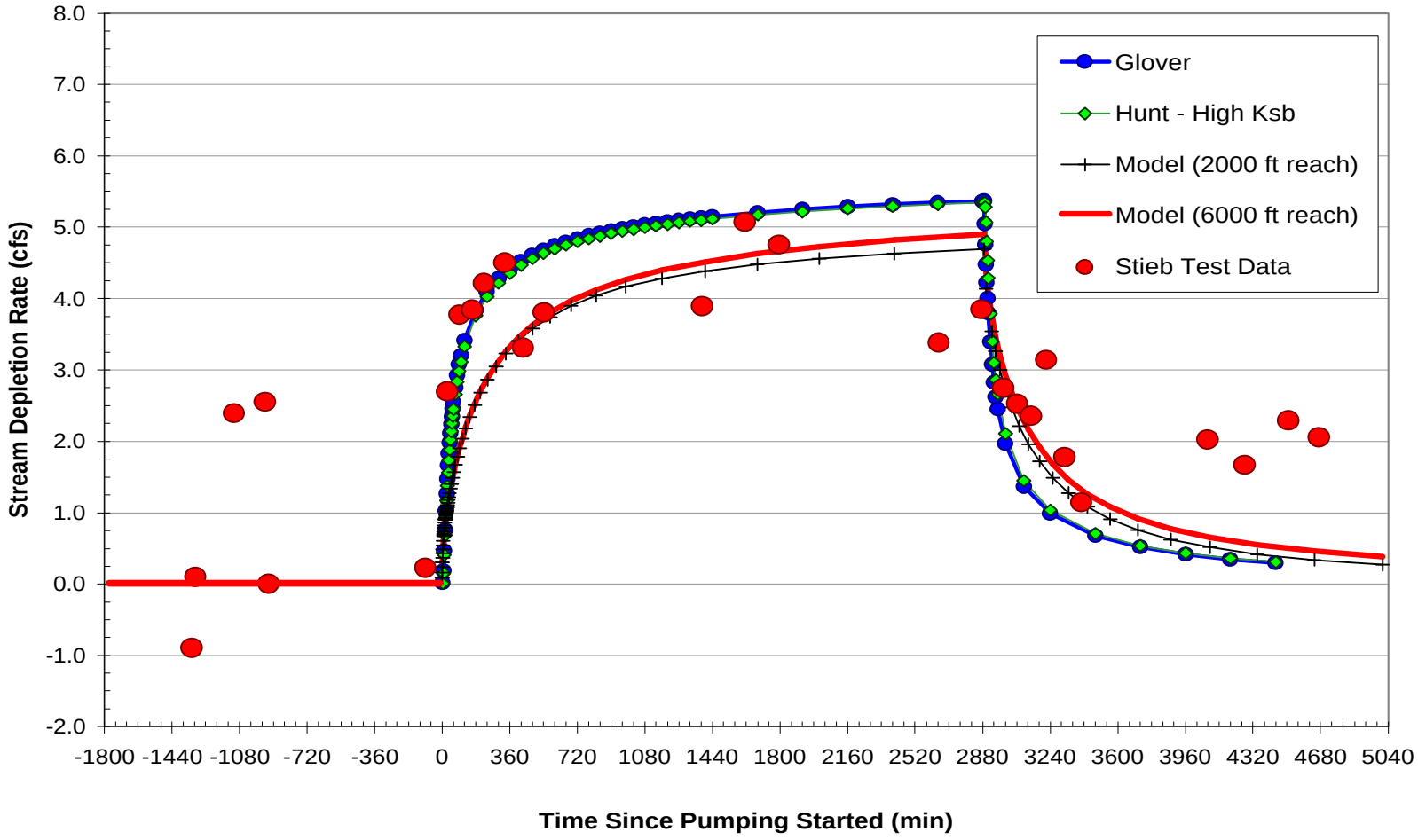
This plot shows backwater slough 1 is river dominated, whereas slough 2 is predominantly fed by a groundwater source.



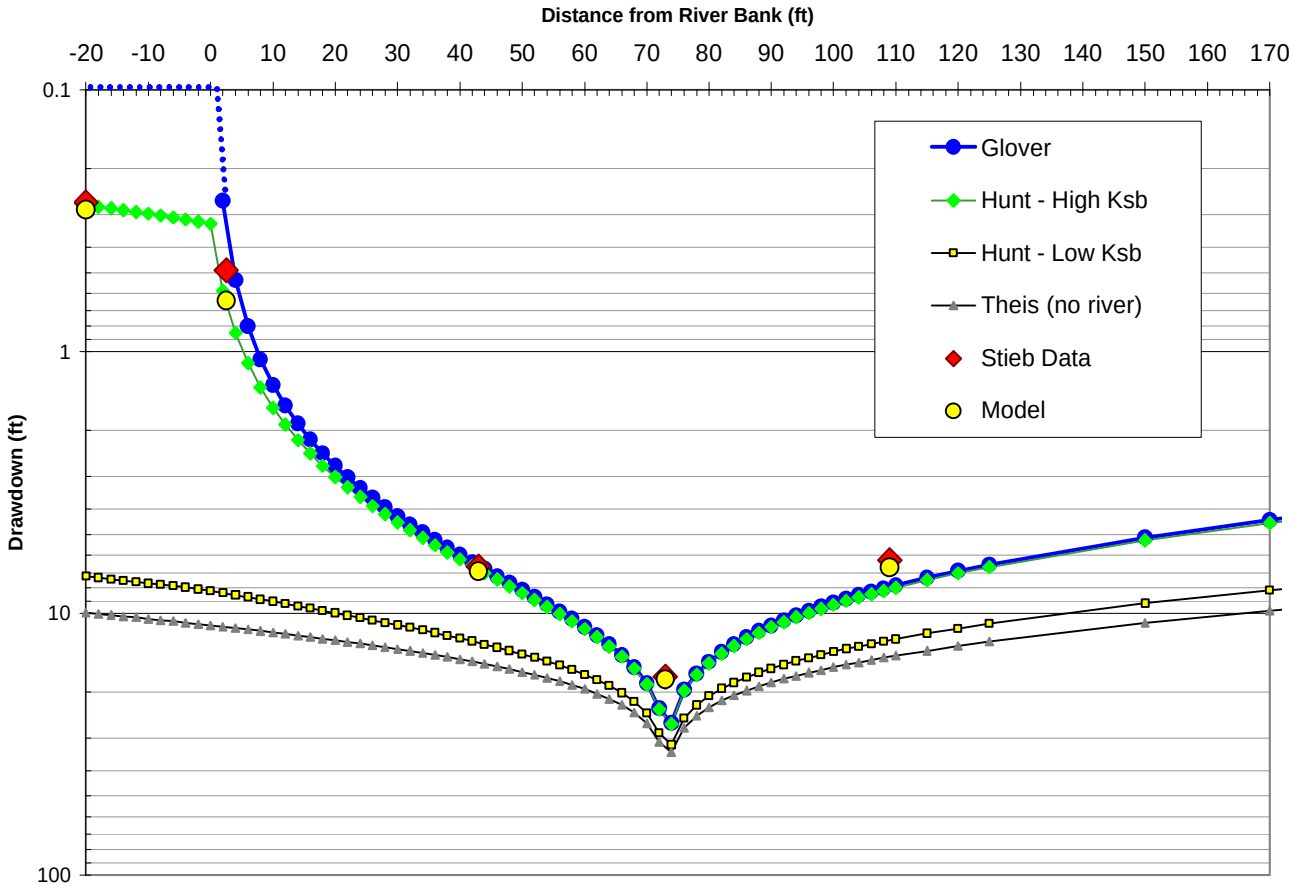
DOW 4 shows signs of mixing with the river water source.


N
S-5N
MW-9
MW-8
South Platte River
S-5S
S-7N
R4 (Pumping Well)
Approx.: 40.73484N, -103.0757W
S-7S
R5
MW-4
MW-3
S6
MW-2
R4 (Pumping Well)
MW-1
Inset Scale (feet)
0 20 40 60 80100
Manuello Well
Scale (feet)
0 250 500 750 1000

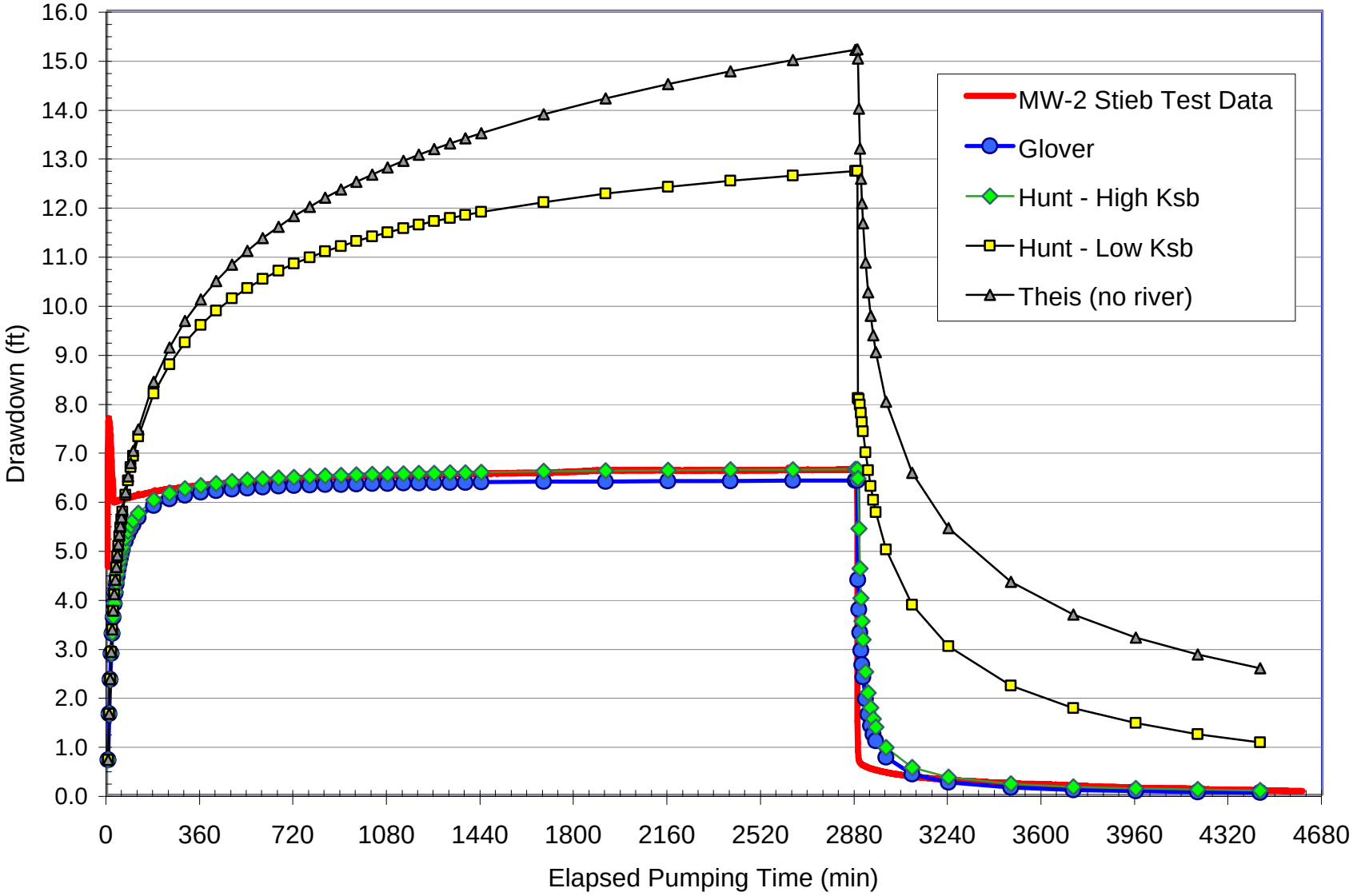
Stream Depletion, Stieb Stream-Aquifer Performance Test



Drawdown vs. Distance, Stieb Stream-Aquifer Performance Test



Drawdown vs. Time , Stieb Stream-Aquifer Performance Test



General Results

- Three years of data collection, modeling and field tests, as part of the NRI project, have improved our understanding of stream augmentation as a water management option.

- Results of this project are currently contributing to Three-State Agreement, management of CDOW Tamarack Ranch Recharge Project and well permit applications filed in response to SB73.

- SDF method seems to be a reasonable method to predict stream augmentation if it is used correctly (e.g. boundary effects).

- Analytical equations (Hunt, Glover) compare well to field data of stream depletion for a very permeable, wide, shallow stream.

- water chemistry in the alluvial groundwater due to the pumping/recharge system is changing with time

- A large, well calibrated numerical groundwater was built and verified using steady state and transient heads as well as water quality data.

Thank you

I'd like to acknowledge the following for their support of this project

USDA-NRI

CDOW

NCWCD

SPLRG