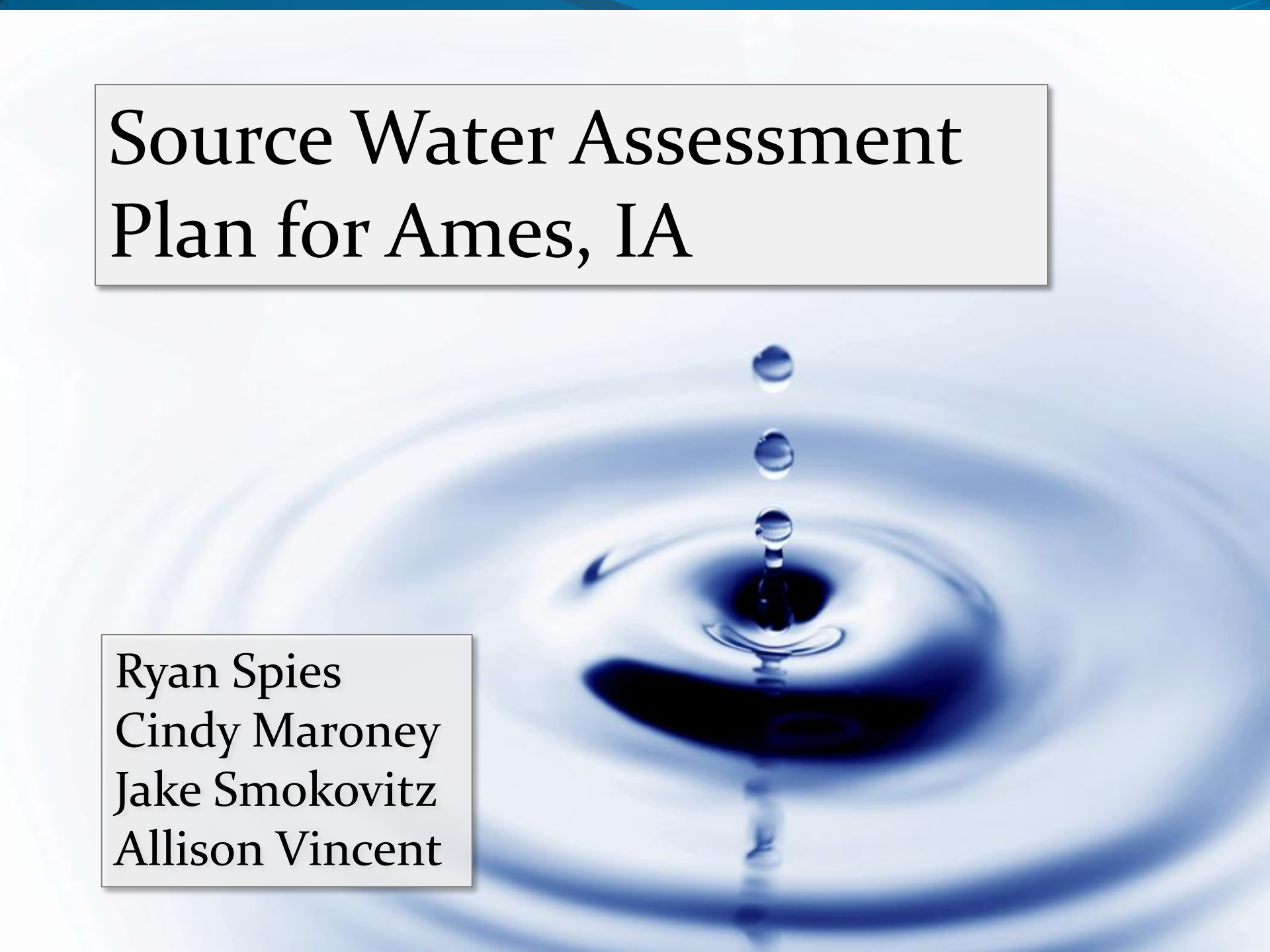
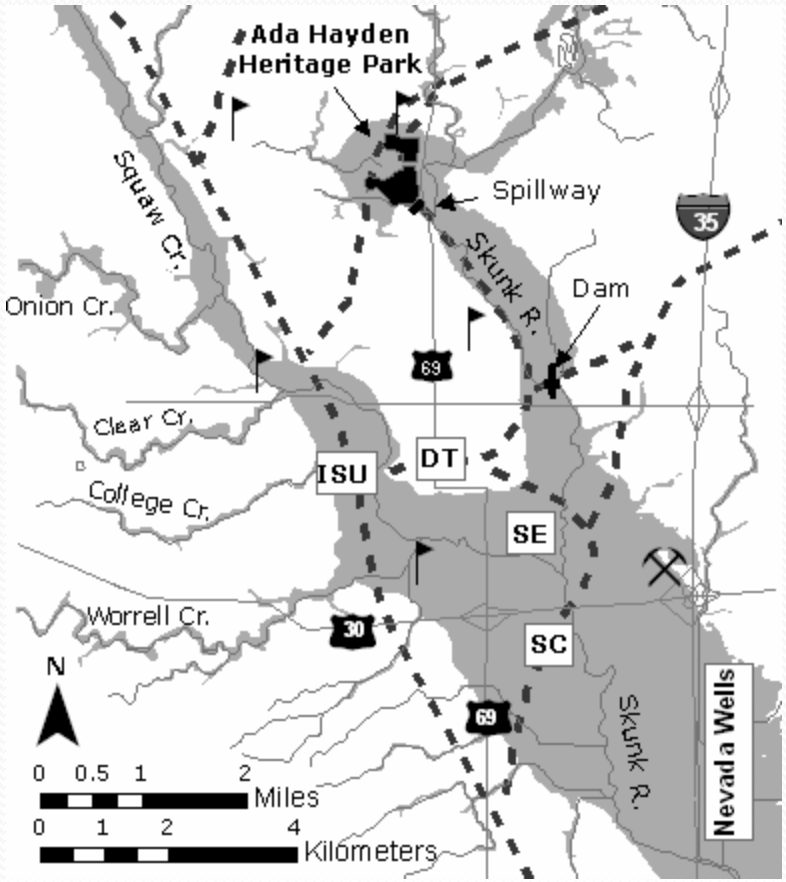
Source Water Assessment Plan for Ames, IA



Ryan Spies
Cindy Maroney
Jake Smokovitz
Allison Vincent

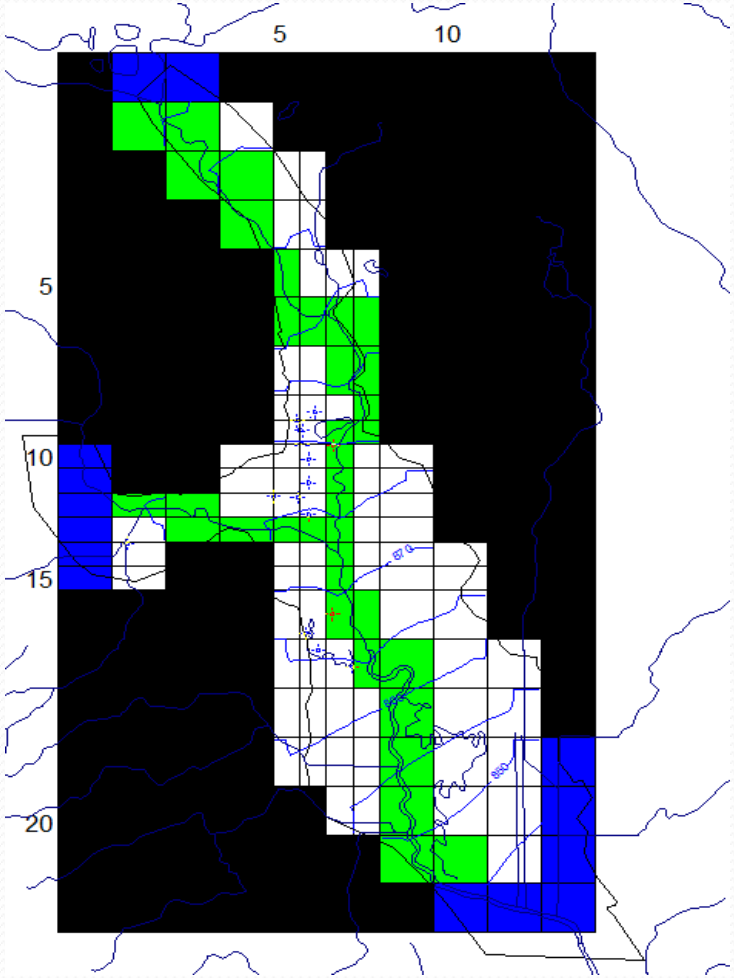
Introduction



- Conceptual Model
  - Unconfined aquifer
  - Alluvial silts and sands in upper 12-15 feet
  - Coarse sand and gravel to 100 ft
  - No interaction with area outside valley walls
  - No interaction with confined aquifer below

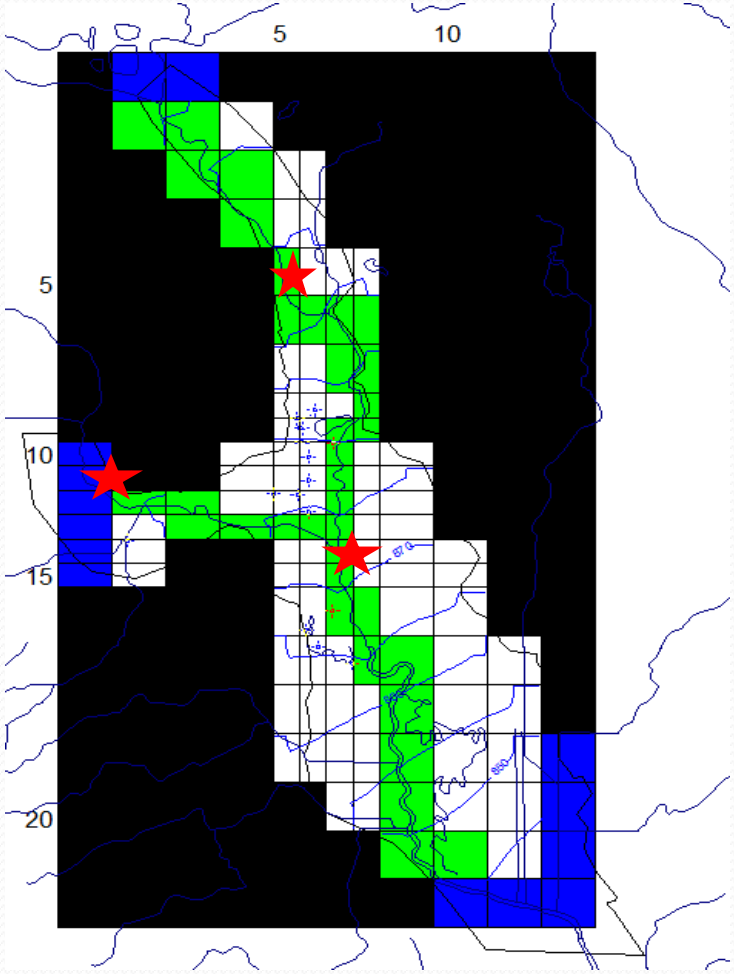
Description of Model

- Rows: 22
- Columns: 12
- Cells: 792 total
  - 264 per layer
  - Large cells 2000 ft^2
  - Small cells 1000 ft^2
- 3 Layers
  - 1. 920-835 Alluvium
  - 2. 835-817 Late WI Outwash
  - 3. 817-780 Pre-IL Outwash
- R= 0.002 ft/day
- K= 1.38 x 10^3 ft/day
- n_e = 0.25



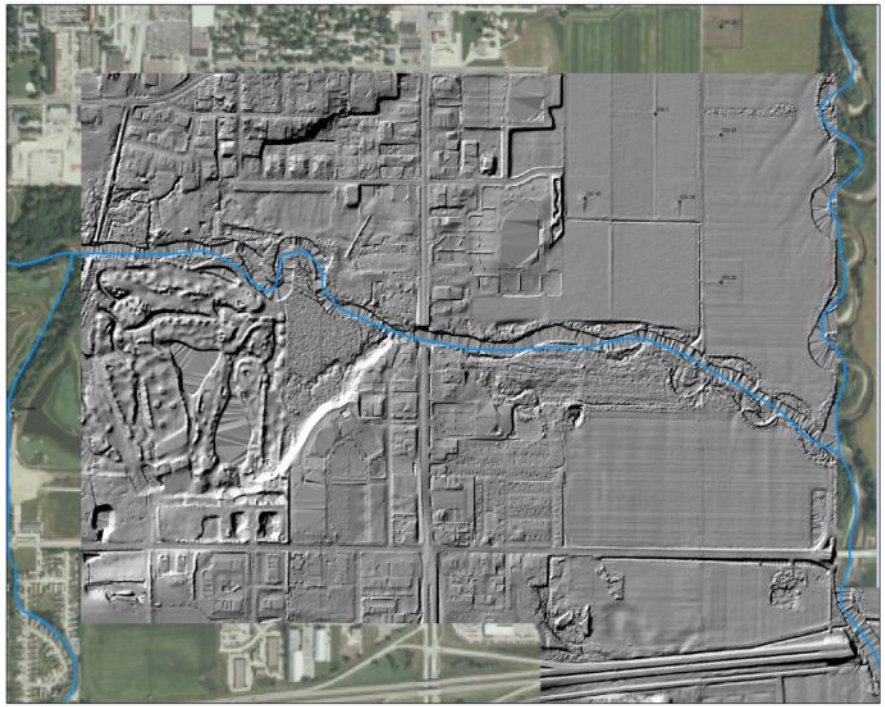
Description of Model

- Boundary Conditions
  - No flow
    - Used in every layer
  - Constant Head
    - Used in every layer
  - Head dependent cells
    - Squaw Creek- Stage = 2.5 ft deep
    - Skunk River (N) – Stage = 4.6 ft deep
    - Skunk River (S) – Stage = 11.6 ft deep



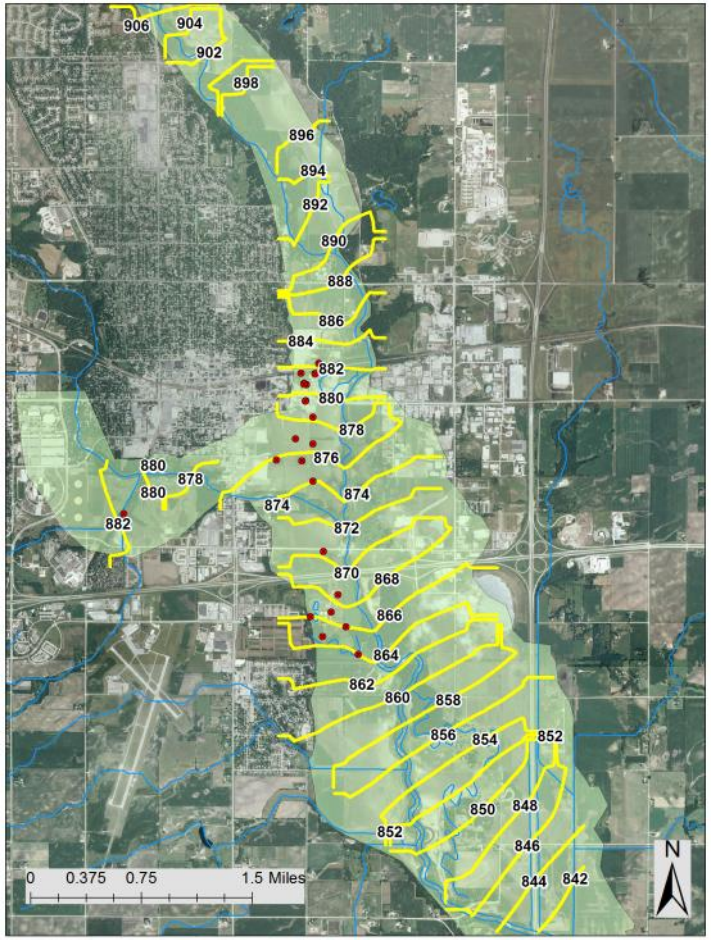
Description of Model

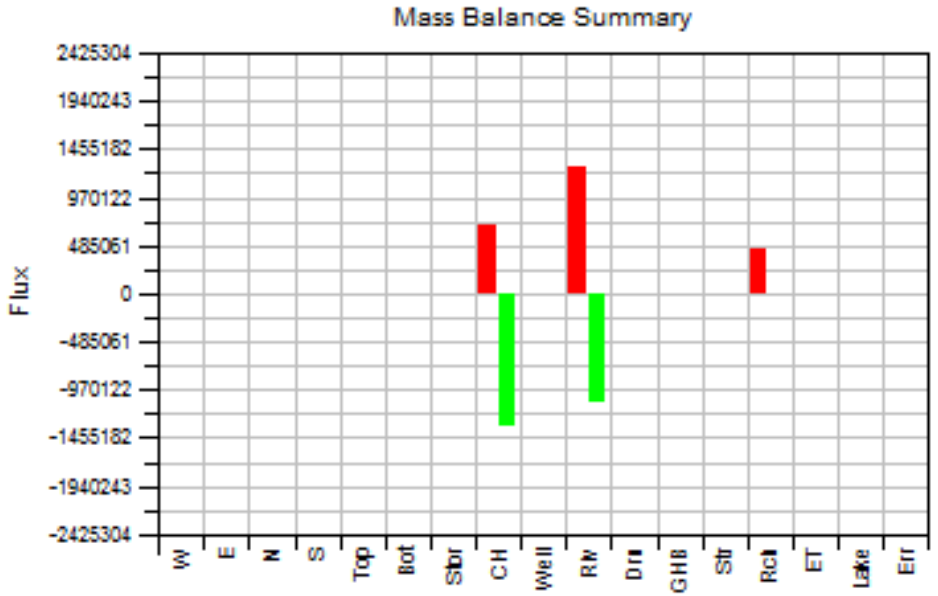
- River data
  - Annual average from 2008 used from USGS stream data
  - Conductance = 16.4 ft/day
  - Calculated slope- data between gages used
    - Squaw Creek = 0.0012
    - Skunk River = 0.0014



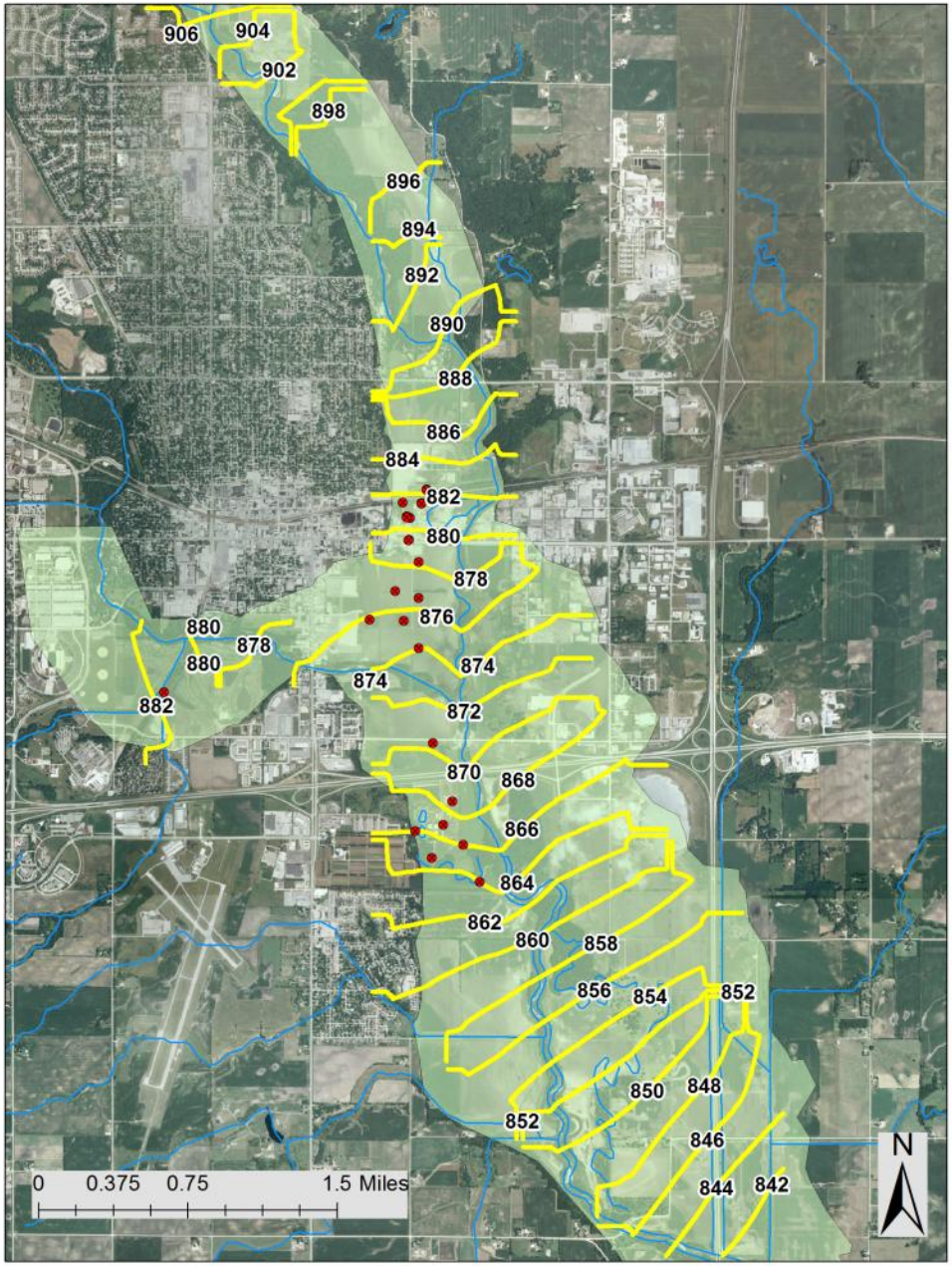
- An example LIDAR image we used to estimate stream width

Steady State Solution





Mass Balance Percent Error:
-0.08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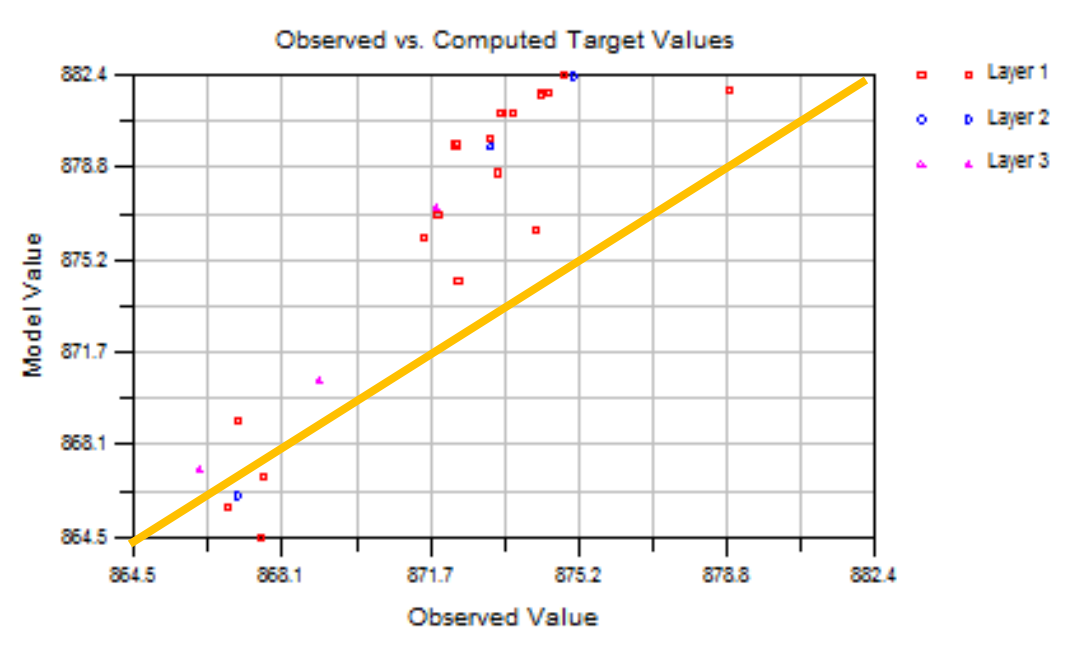
Steady State Solution

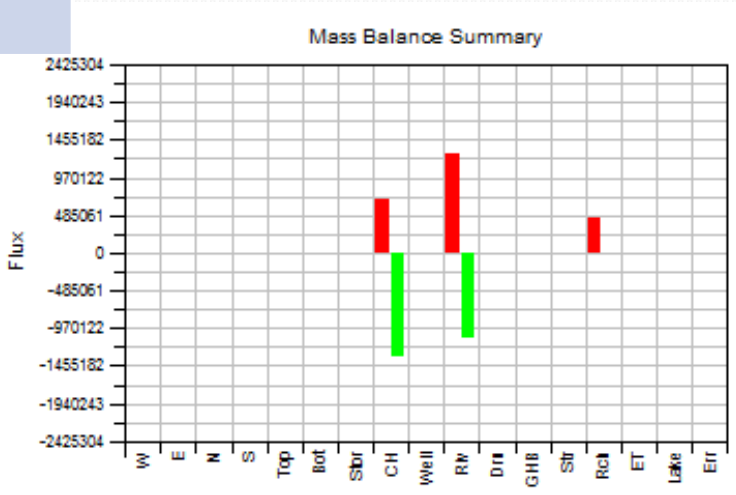
Absolute Residual Mean	**4.82**
Residual Sum of Squares	**7.75×10^2**
K_z1	13.8 ft/day
$K_{xy}2$	1,380 ft/day
$K_{xy}3$	1,380 ft/day
K_z1	1.38 ft/day
K_z2	1.38 ft/day
K_z1	1.38 ft/day
River Conductance	16.4 ft/day



Steady State Solution

SOURCE	INFLOW ft^3/day	OUTFLOW ft^3/day	Flux
Wells	0.0	0.0	
Constant Head	679,944.1	1,335,838.1	655,894 Out of Model
River	1,287,359.6	1,089,465.6	-197,894 GW
Recharge	456,000	0.0	
TOTAL	**2,423,303.7**	**2,425,303.8**	**0.08%Error**

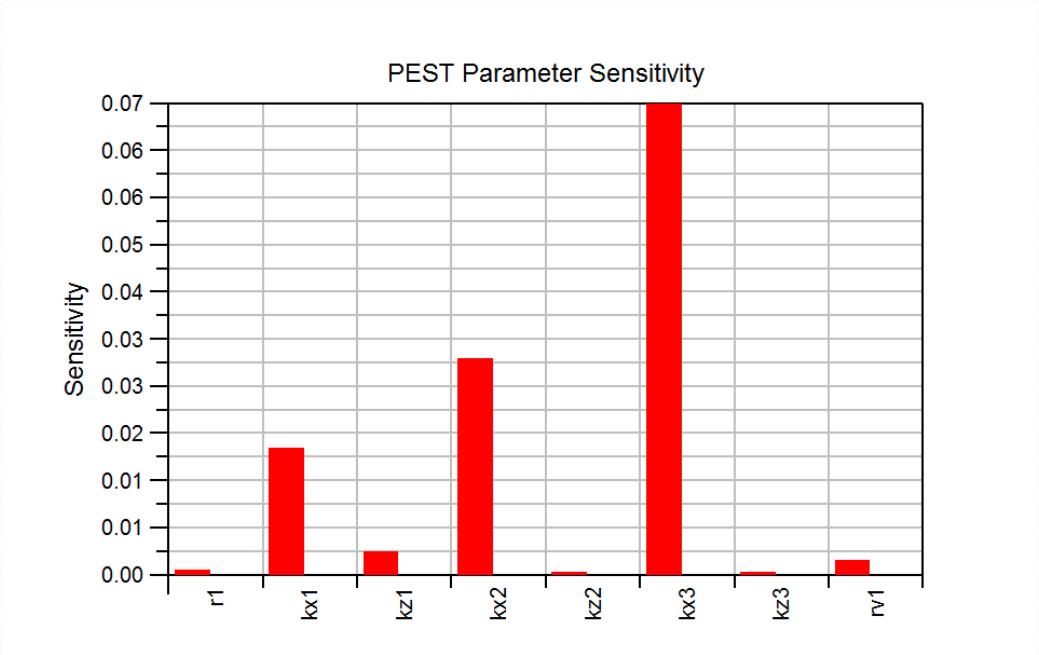
~2000 ft^3/day excess



Run	MAD	RSS	Parameters K(ft/d)
1	4.92	$8.36x10^2$	K_{xyz} = 1,380
2	5.18	$9.21x10^2$	K_{xyz} = 138
3	4.79	$7.71x10^2$	K_{xyz} = 13,800
4	4.92	$8.36x10^2$	K_x = 1,380, K_z = 138
5	F	F	K_r = 1.64 (All Reaches) K_{xyz} = 1,380
6	4.91	$8.32x10^2$	K_r = 16.4 (All Reaches), $K_{xyz}1$ = 138
7	4.93	$8.41x10^2$	K_{xyz} 2 = 138
8	F	F	K_{xyz} 2 = 1,380, K_r = 8.2 (All Reaches)
9	4.91	$8.25x10^2$	K_z1 = 1.38, $K_{xy}1$ = 1,380
10	4.9	$8.23x10^2$	K_z2,3 = 1.38
11	4.75	$7.51x10^2$	$K_{xy}1$ = 13.8, k_z1 = 1.38
12	7.65	$1.8x10^3$	K_{xy} 2,3 = 13.8, K_z 2,3 = 1.38
13	5.33	$9.15x10^2$	K_{xy} 2,3 = 1,380, K_z 2,3 = 1.38
14	5.33	$9.15x10^2$	K_r1 = 17
15	6.73	$1.23x10^3$	K_r1 = 16.4, K_r3 = 17
16	6.73	$1.23x10^3$	K_r3 = 17
17	6.13	$1.06x10^3$	K_r3 = 16.4, K_z1 = 0.138

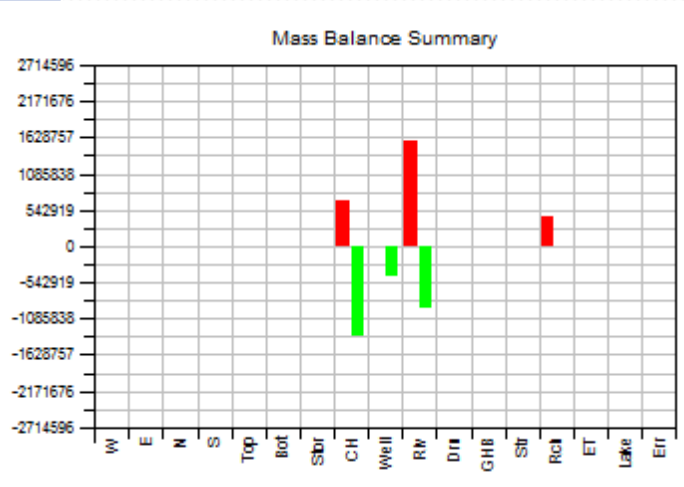
Steady State Solution

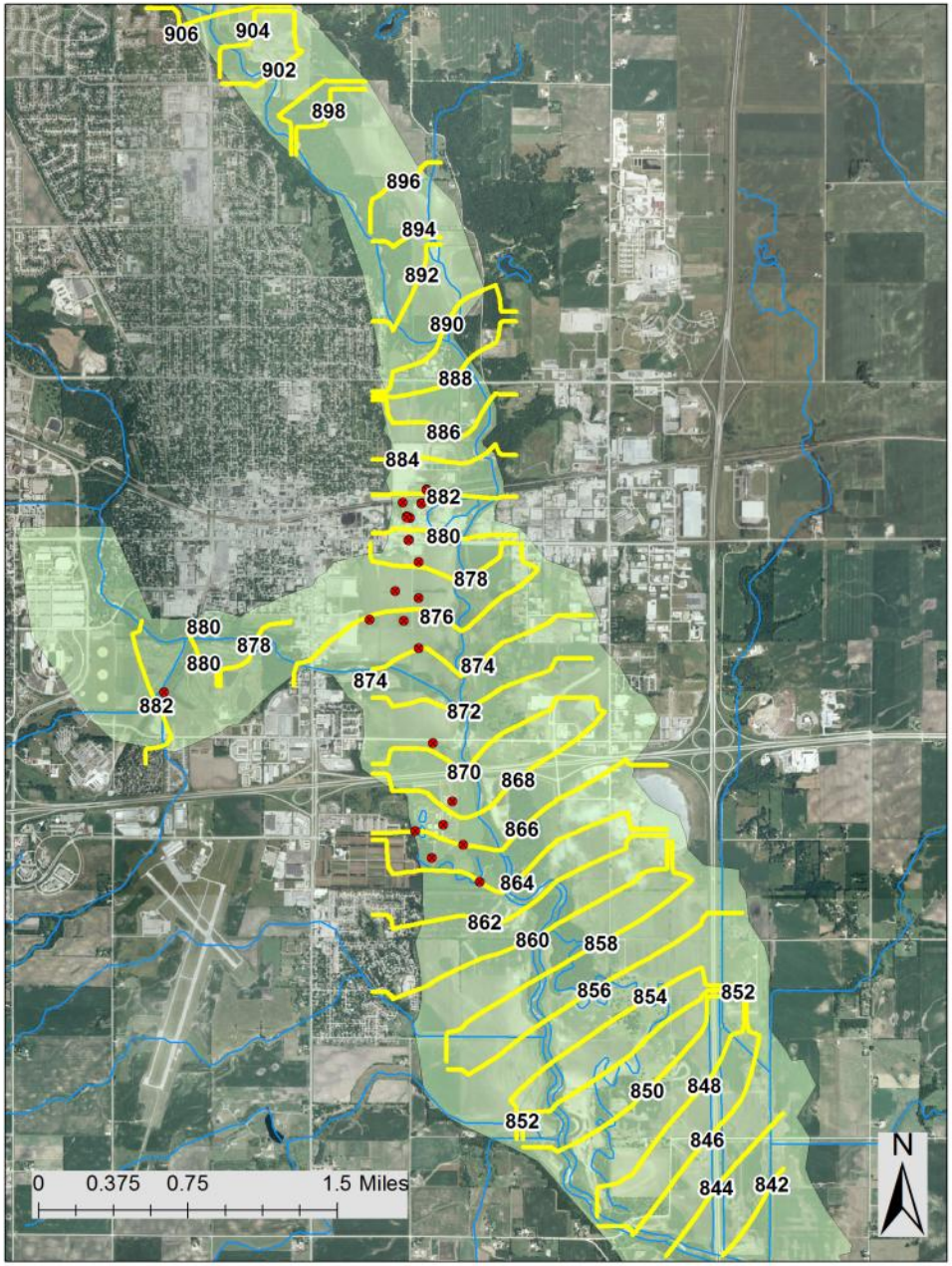
- Manual calibration did not yield a good solution
- PEST showed us that all parameters were insensitive



Pumping Simulation

SOURCE	INFLOW ft^3/day	OUTFLOW ft^3/day	Induced Effects
Wells	0.00	464,181.6	
Constant Head	688,455.7	1,332,718.9	644,263.2 Out of model
River	1,568,110.8	917,694.9	-650,415.9 GW
Recharge	456,000	0.00	
TOTAL	**2,712,566.5**	**2,714,595.4**	**0.07%Error**

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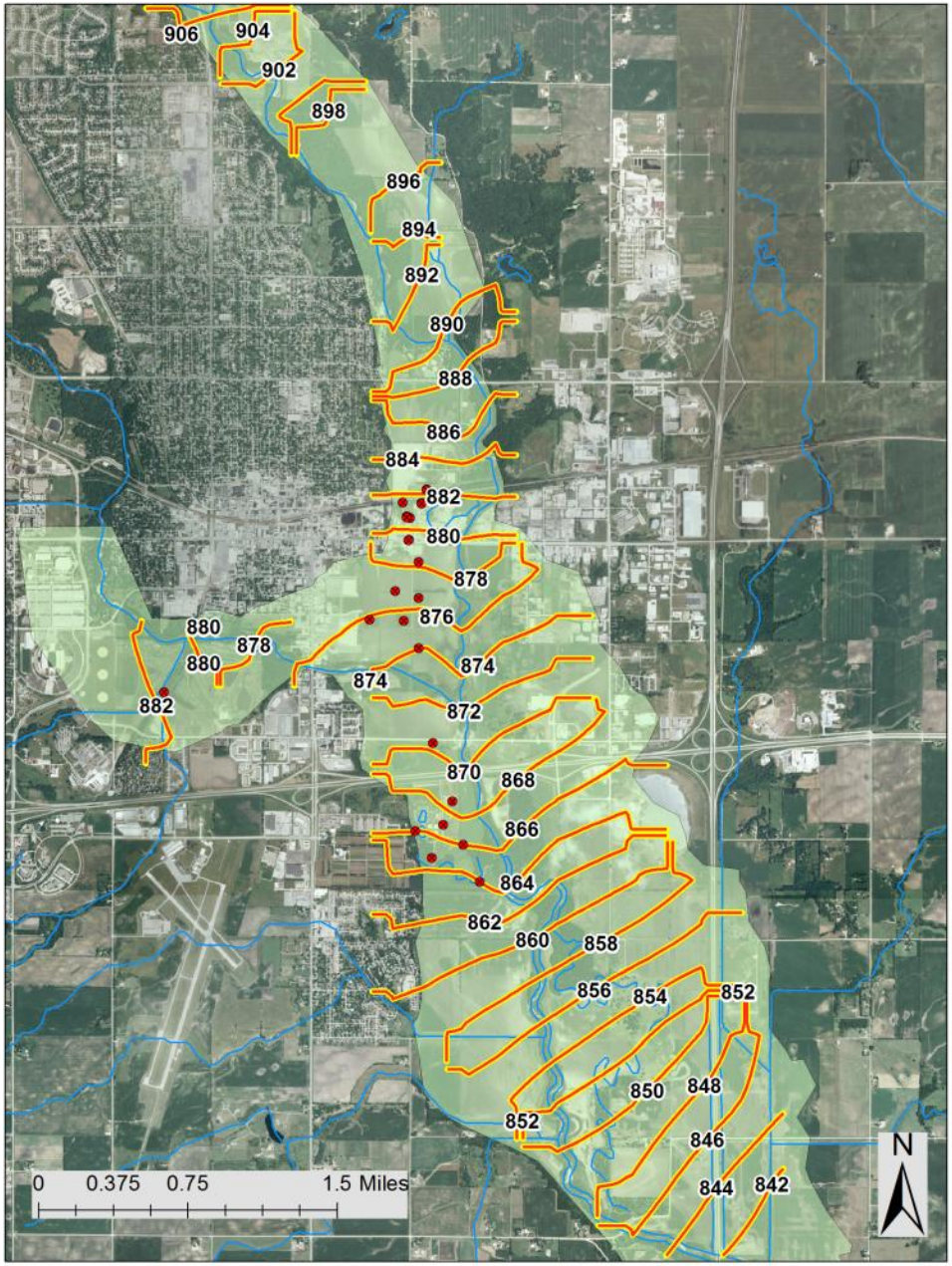
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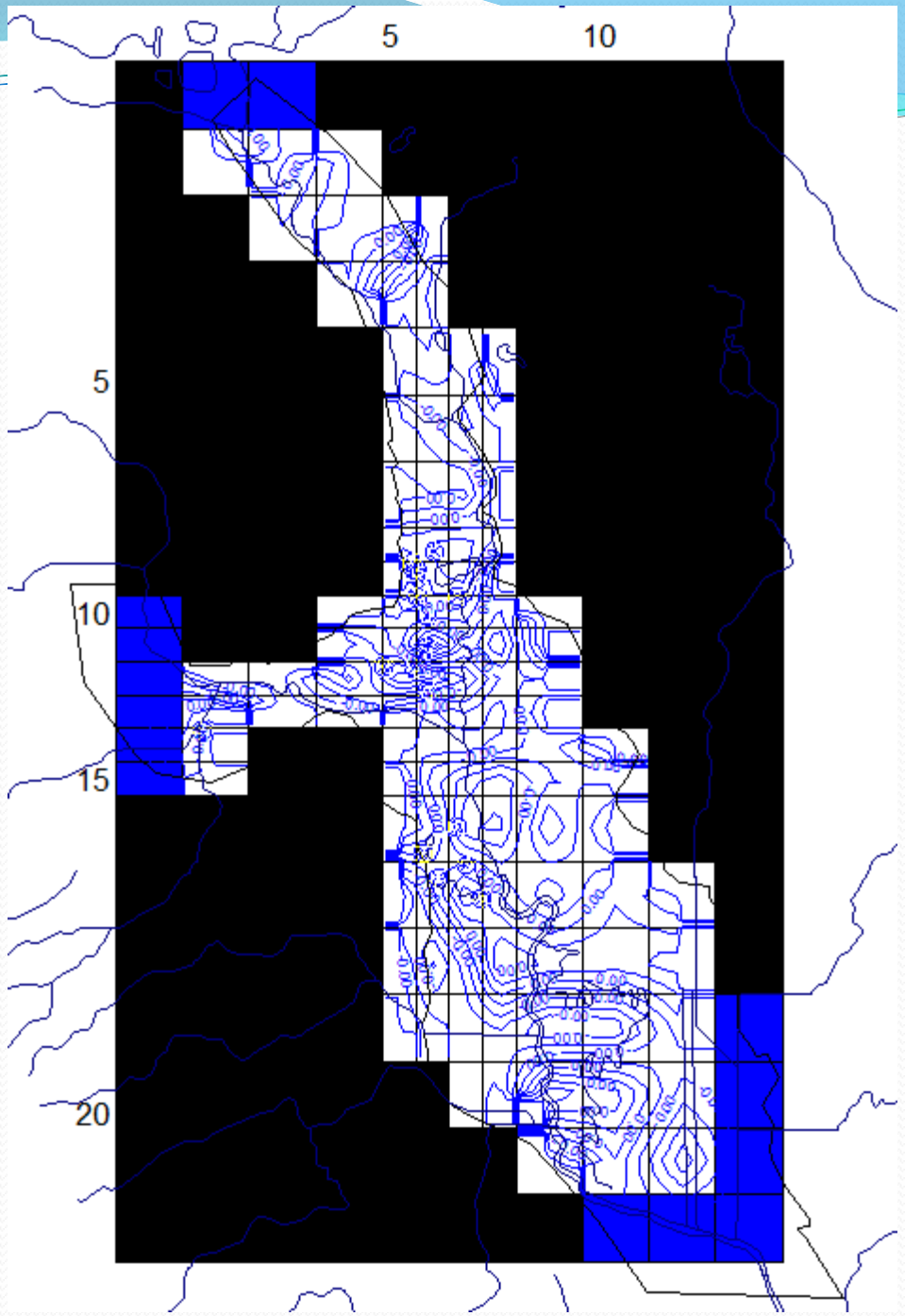
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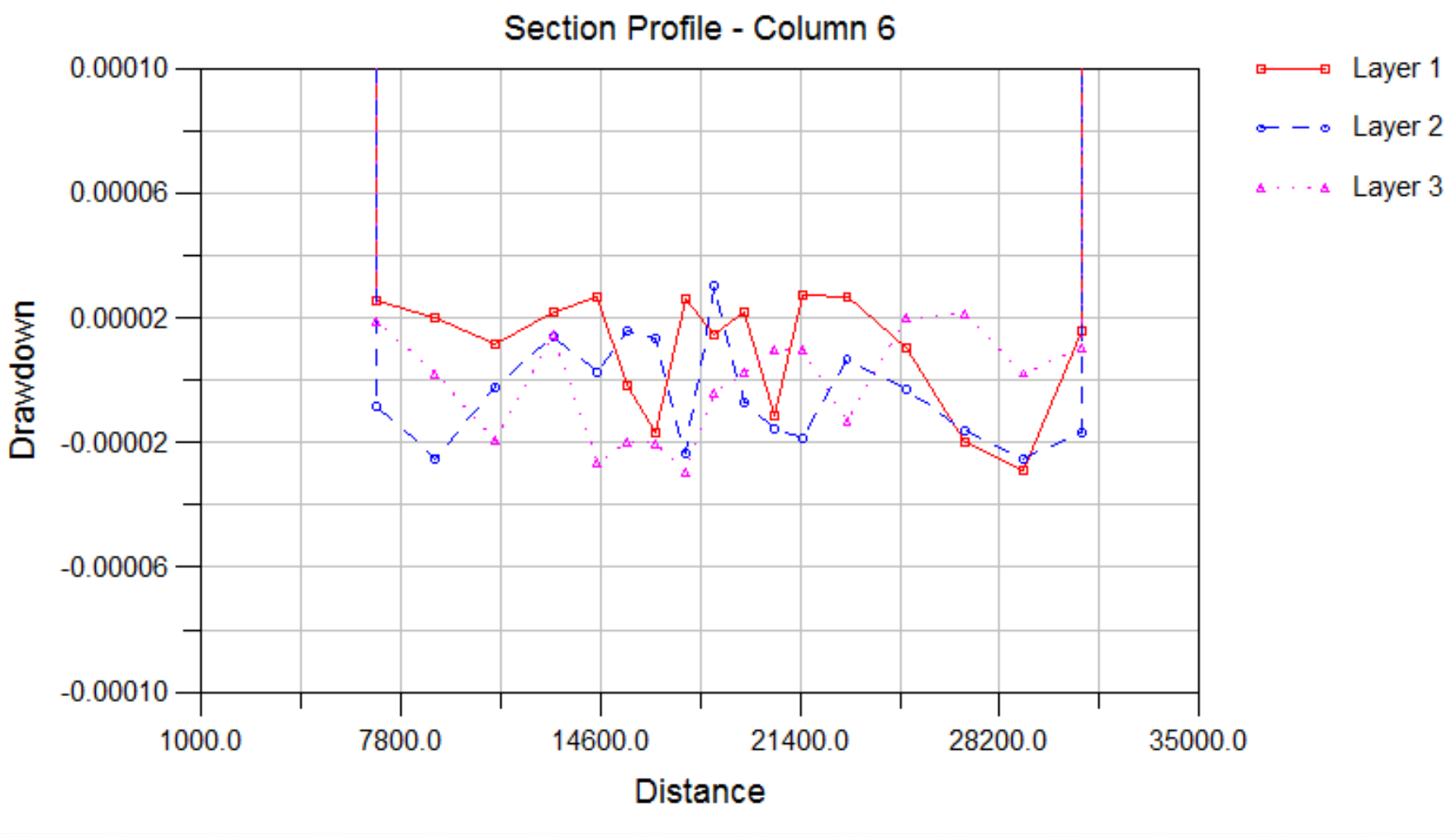
Section Profile - Column 6
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Drawdown
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14600.0
21400.0
28200.0
35000.0
Distance
Layer 1
Layer 2
Layer 3

Steady State

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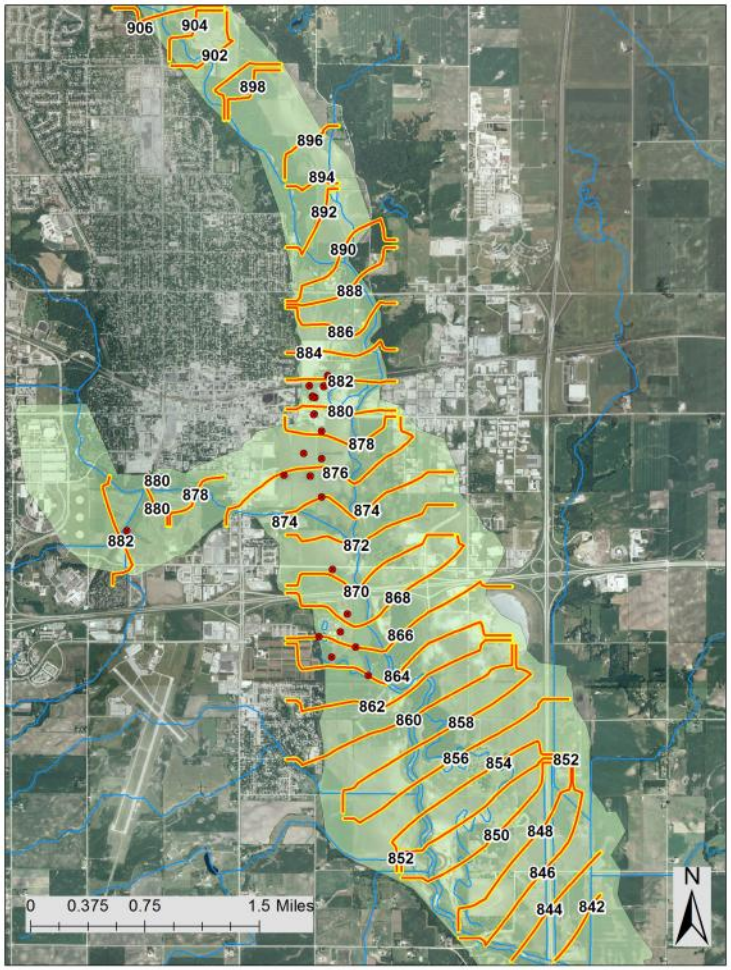
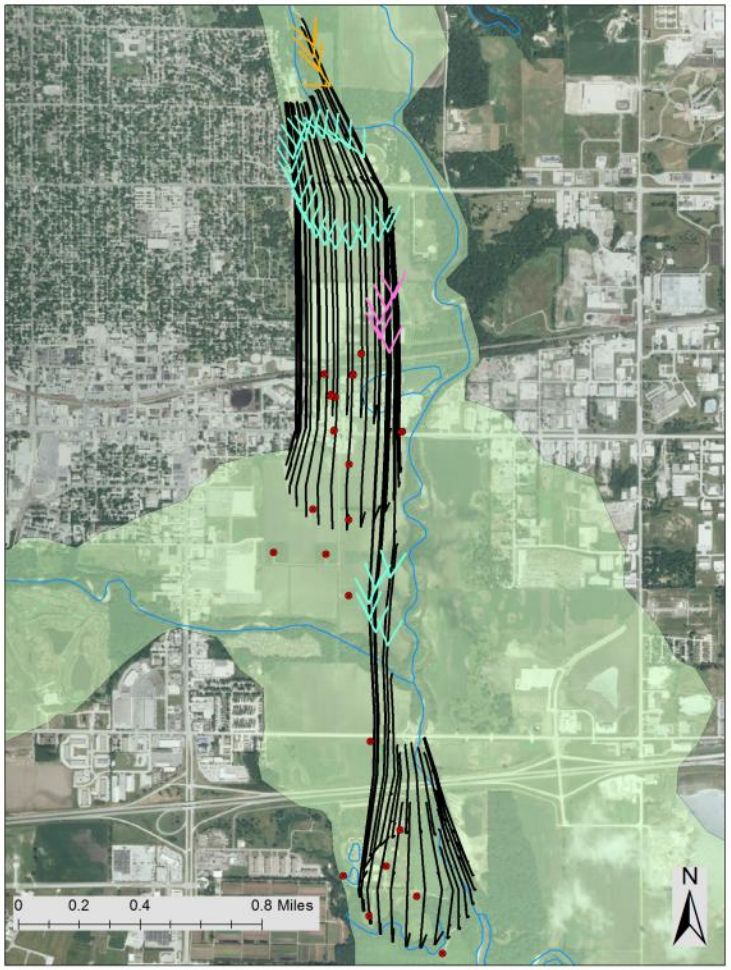
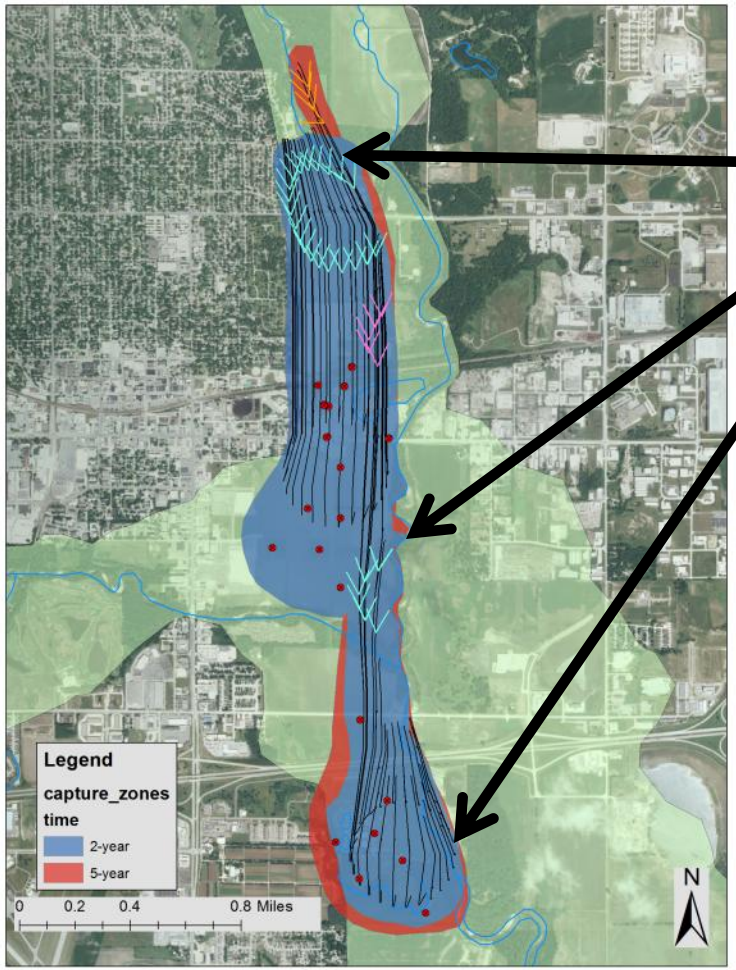
Particle Tracking

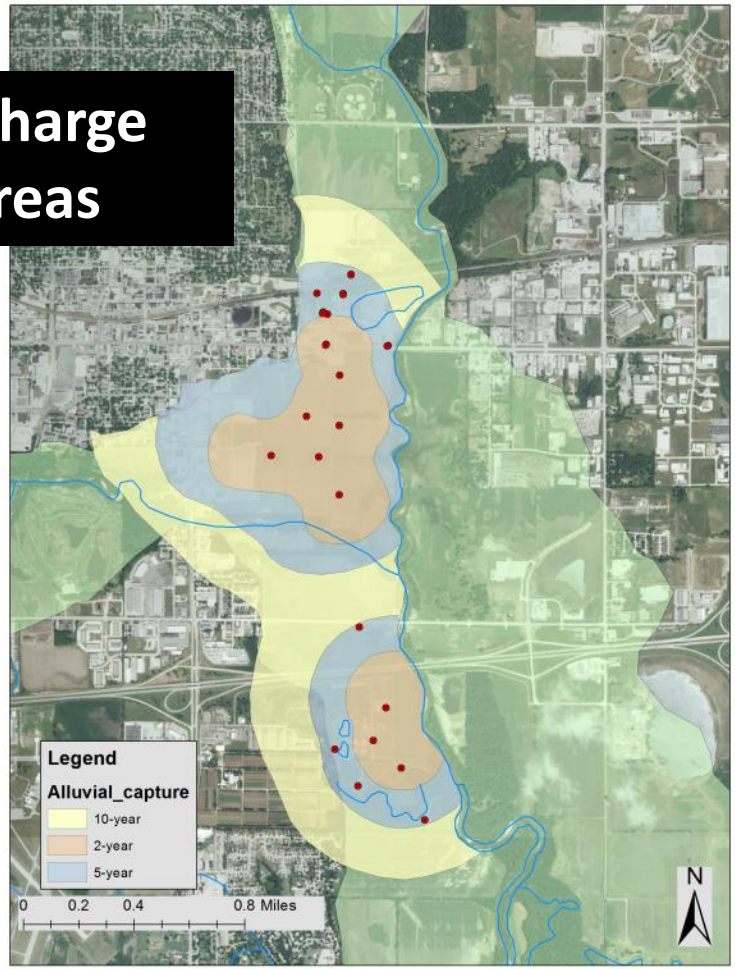




Capture Zones



Recharge Areas



Conclusion

- Stoic Model – insensitive to changes in parameters
- Very Small Drawdown
- Capture zones reflected river influence
  - Simple model → not effective capture zones
  - Complexity needed to further delineate zones
- River to GW - ~24% of incoming water (pumping)
  - Protect river water quality just as important as surface
- Our model not ready for the City of Ames