Simulation of zones of contribution to wells at site GM–38, Naval Weapons Industrial Reserve Plant, Bethpage, New York

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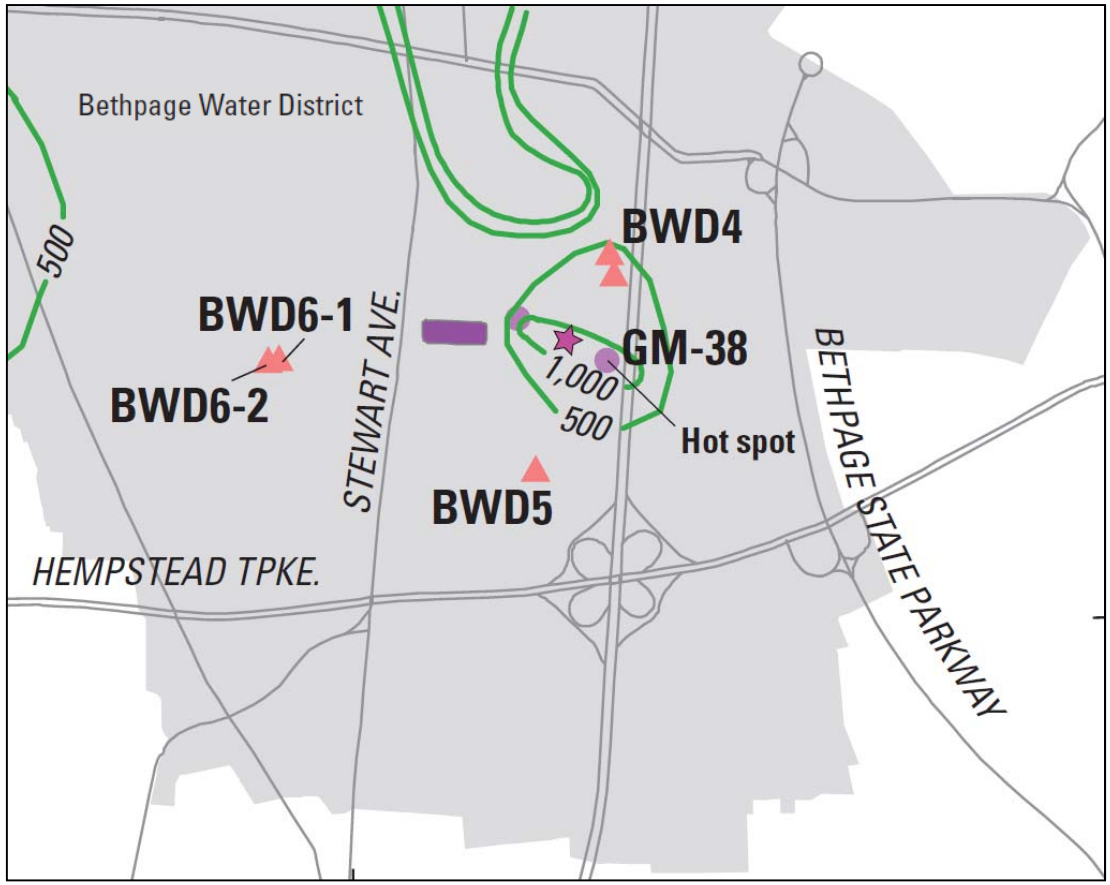
GENERAL FLOW DIRECTION



Recharge basin receiving GM-38 outflow

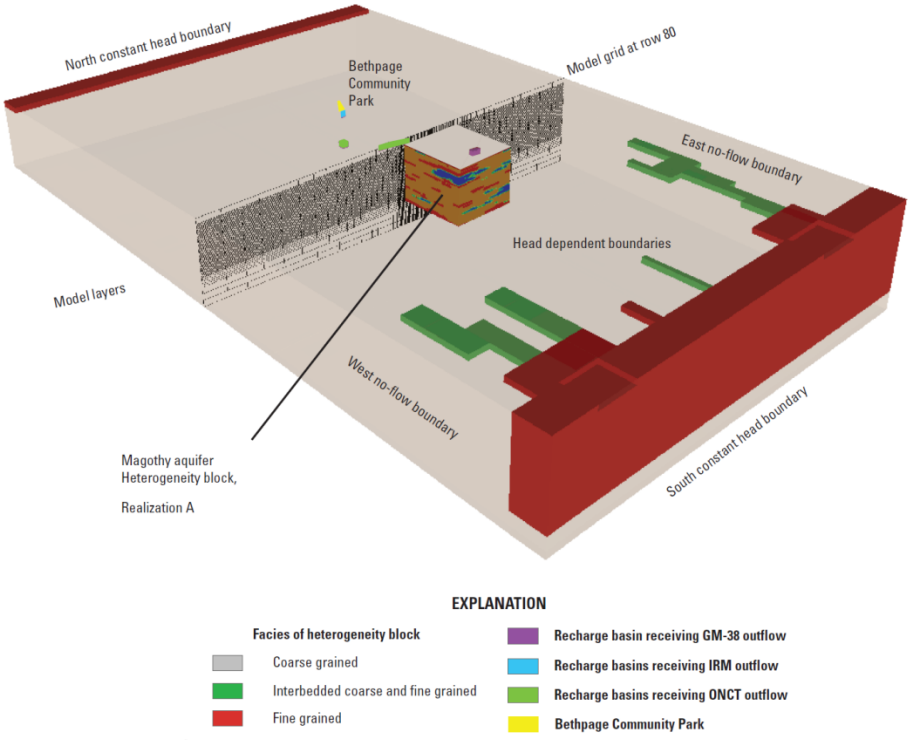
Line of equal total volatile organic compound concentration, in parts per billion (from ARCADIS, 2009)

Bethpage Water District (BWD) production wells

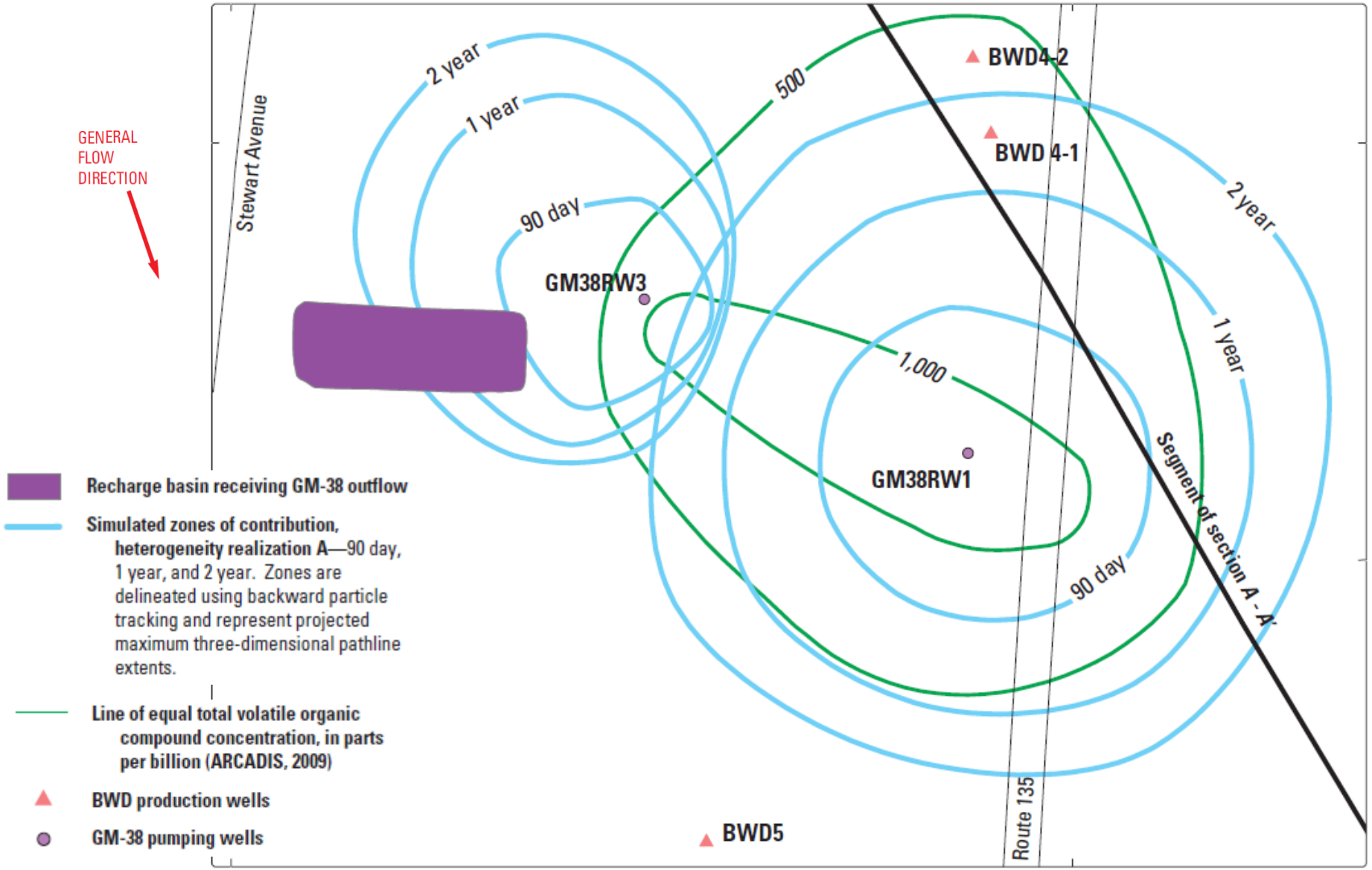
Active GM-38 pumping wells (RW1 and RW3)

Inactive GM-38 pumping wells (RW2)

MODFLOW variable grid spacing : map and block diagram



Baseline simulated capture zones: map



Study questions:

How does aquifer heterogeneity affect particle tracking delineations?

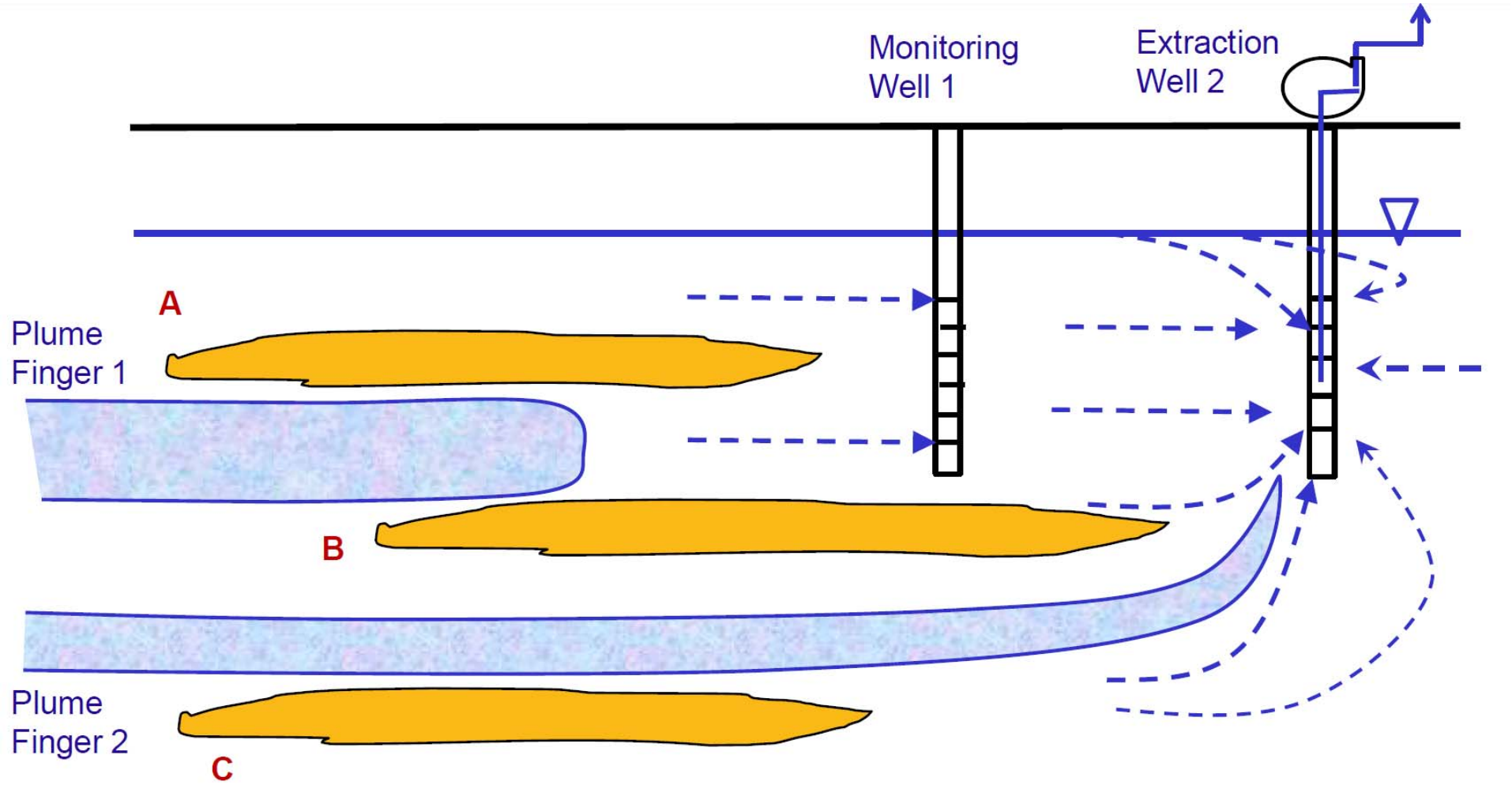
How do forward tracking and backward tracking methods compare?

How may the three GM38 pumping rates be optimized?

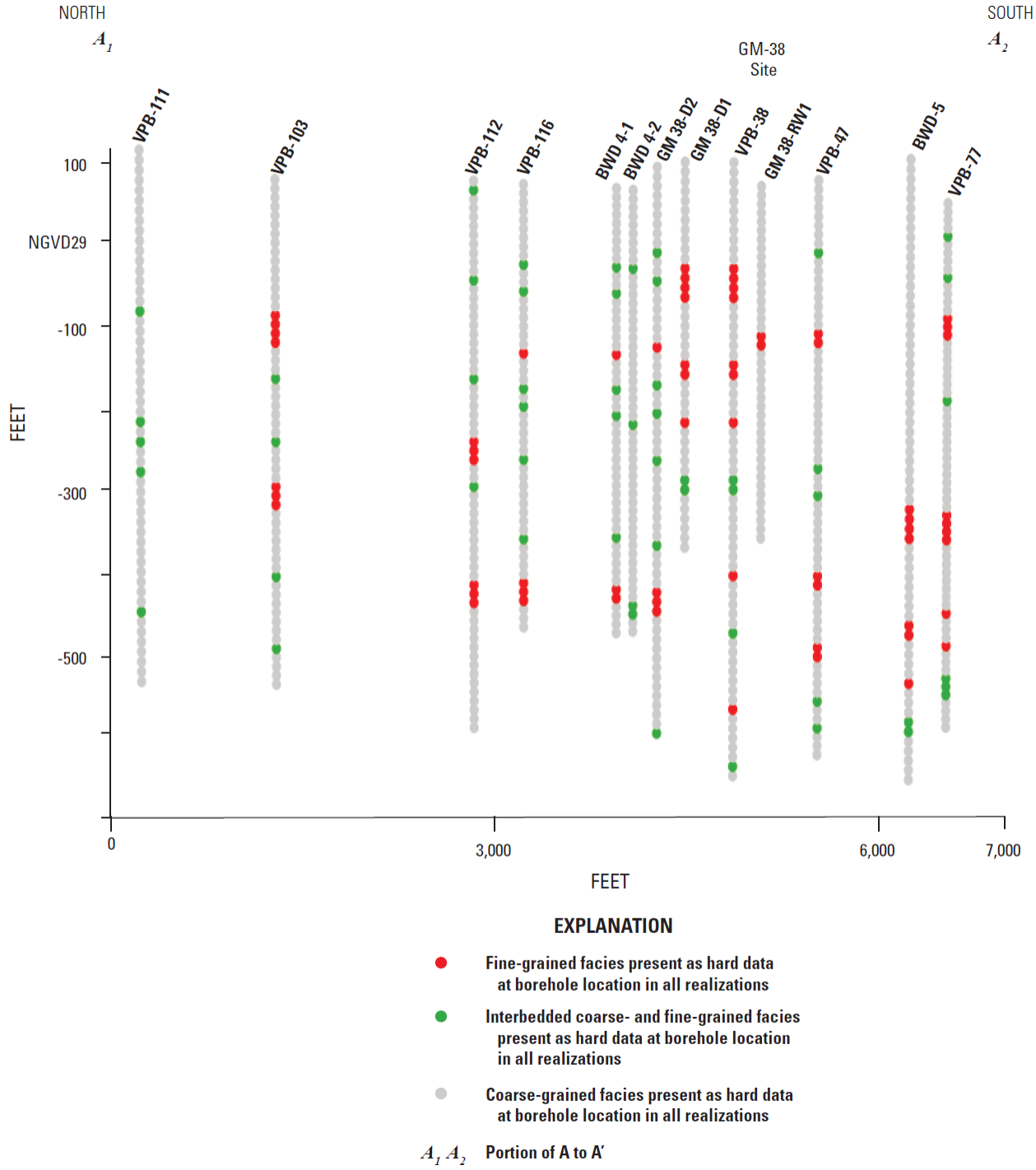
1. **Heterogeneity**
2. Forward tracking
3. Backward tracking
4. Conclusions

Navy conceptual model

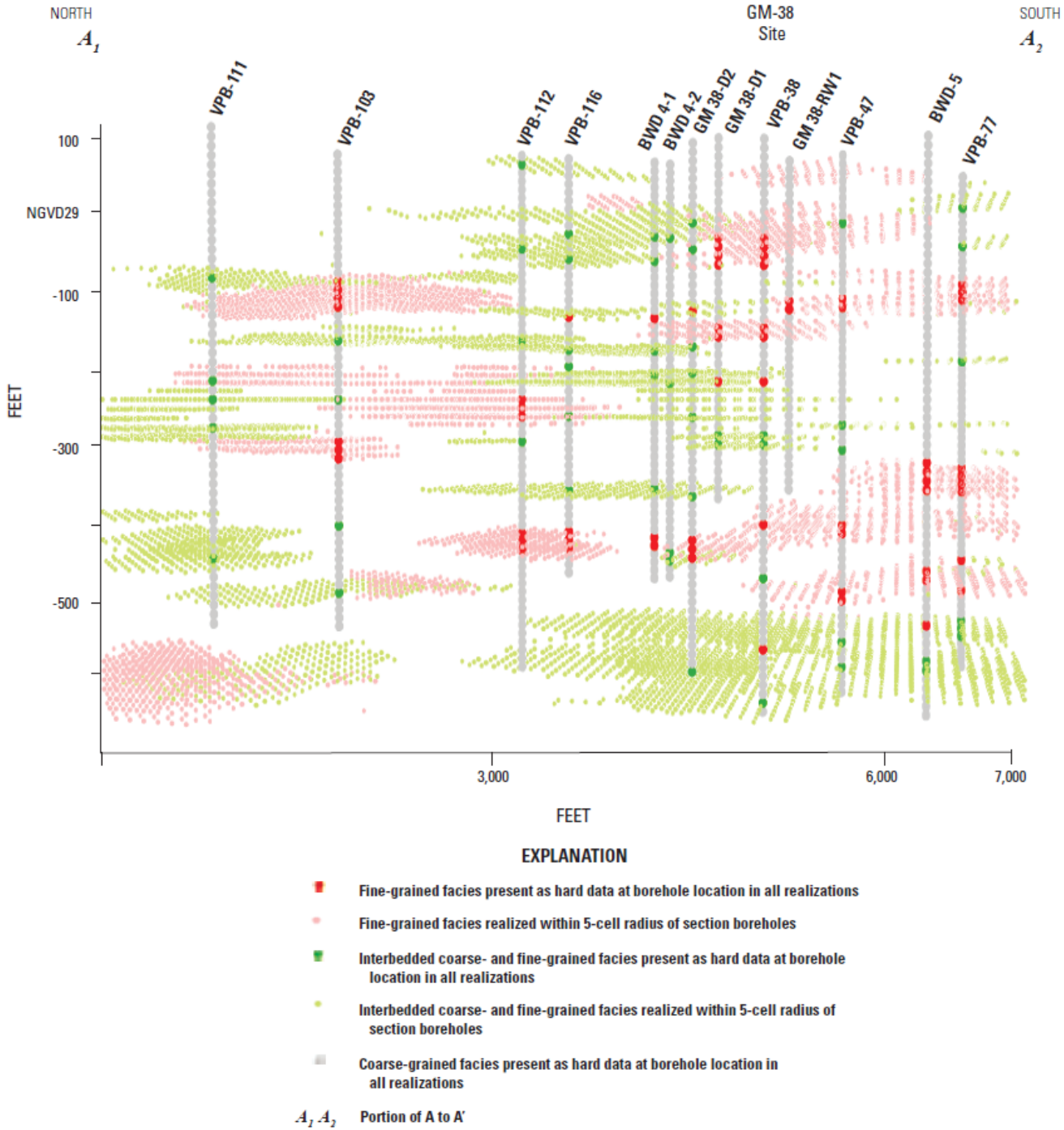
-subtle head differences observed



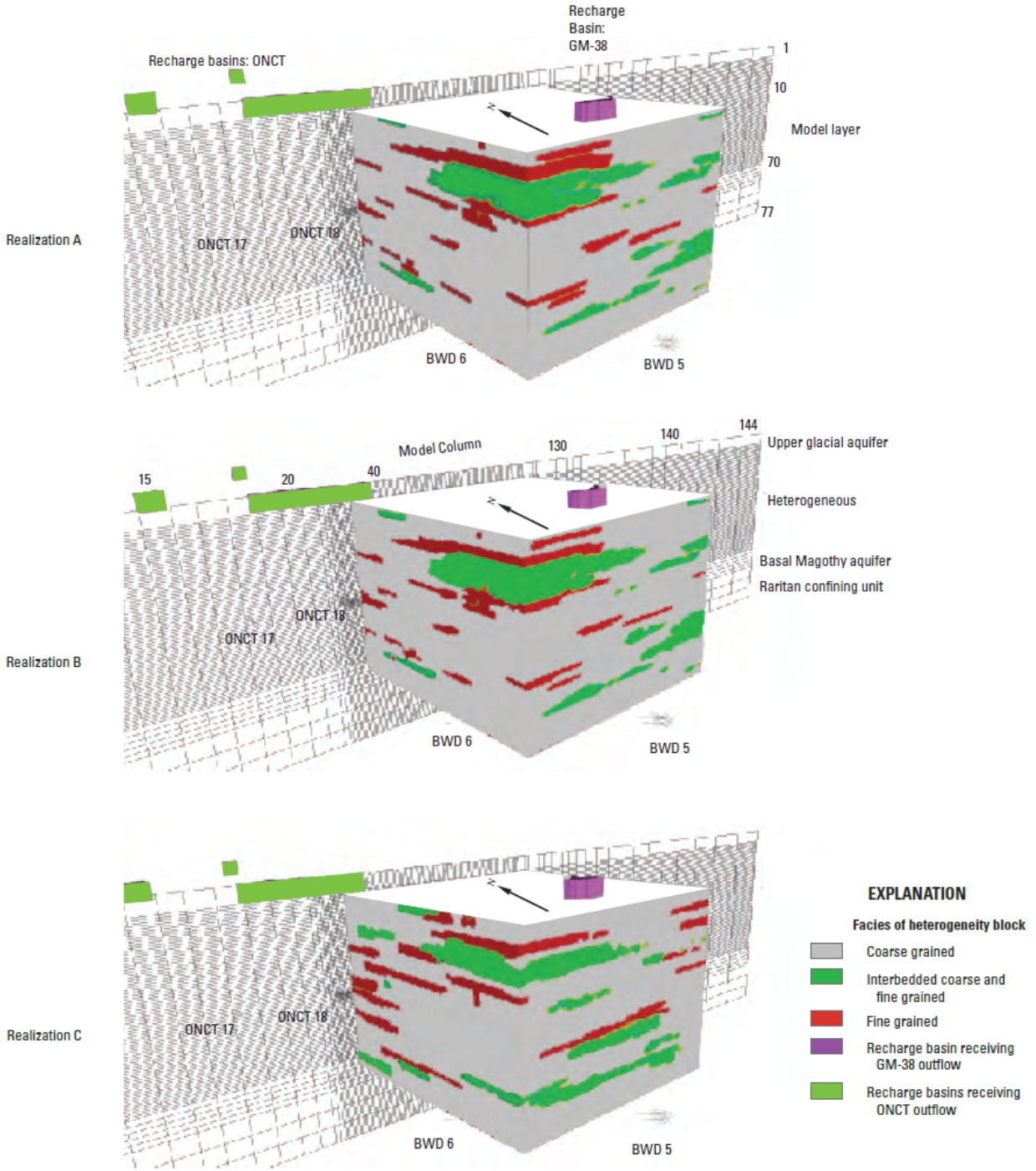
Hard data: section



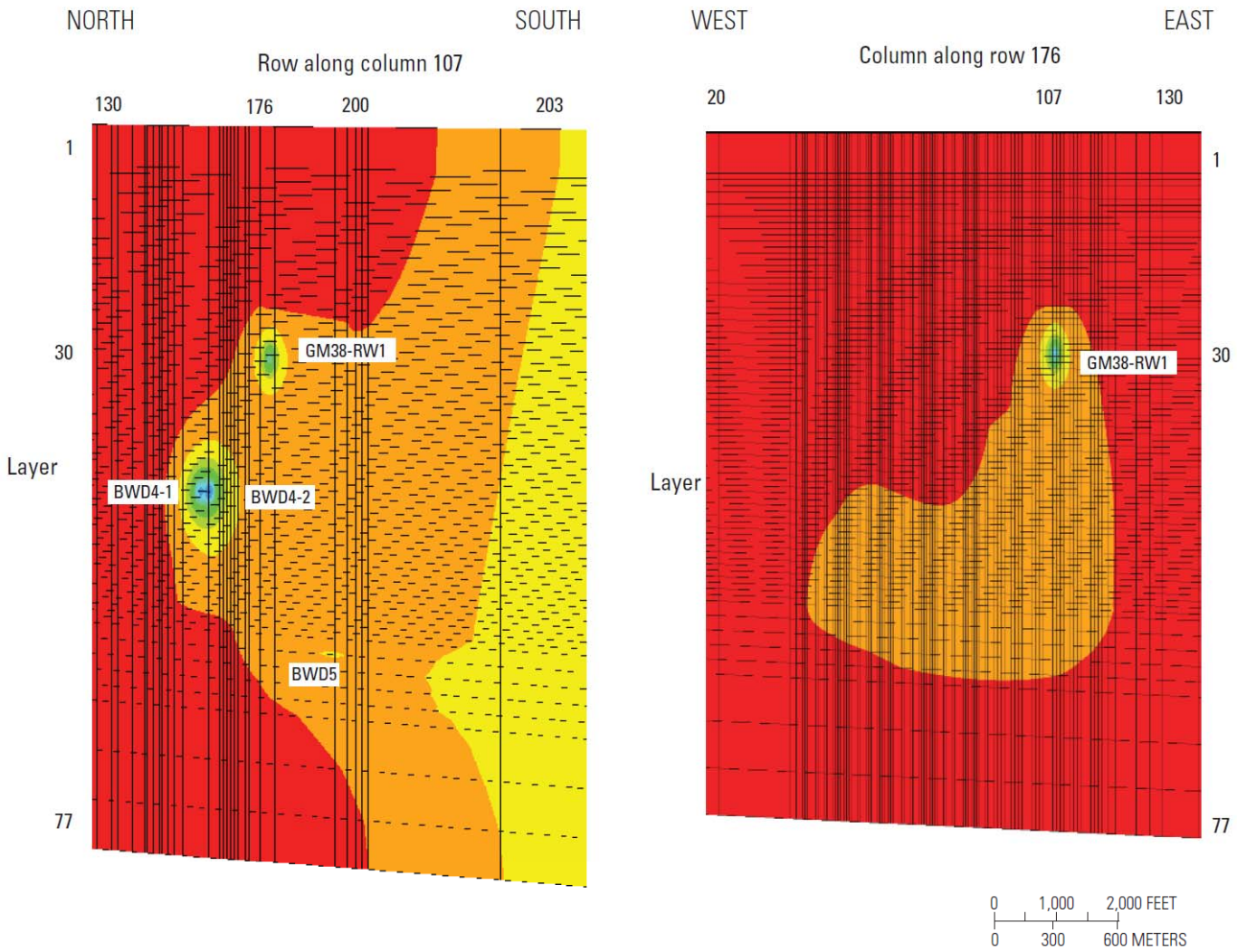
Realization: section



Alternate realizations: block series



Simulation: sections



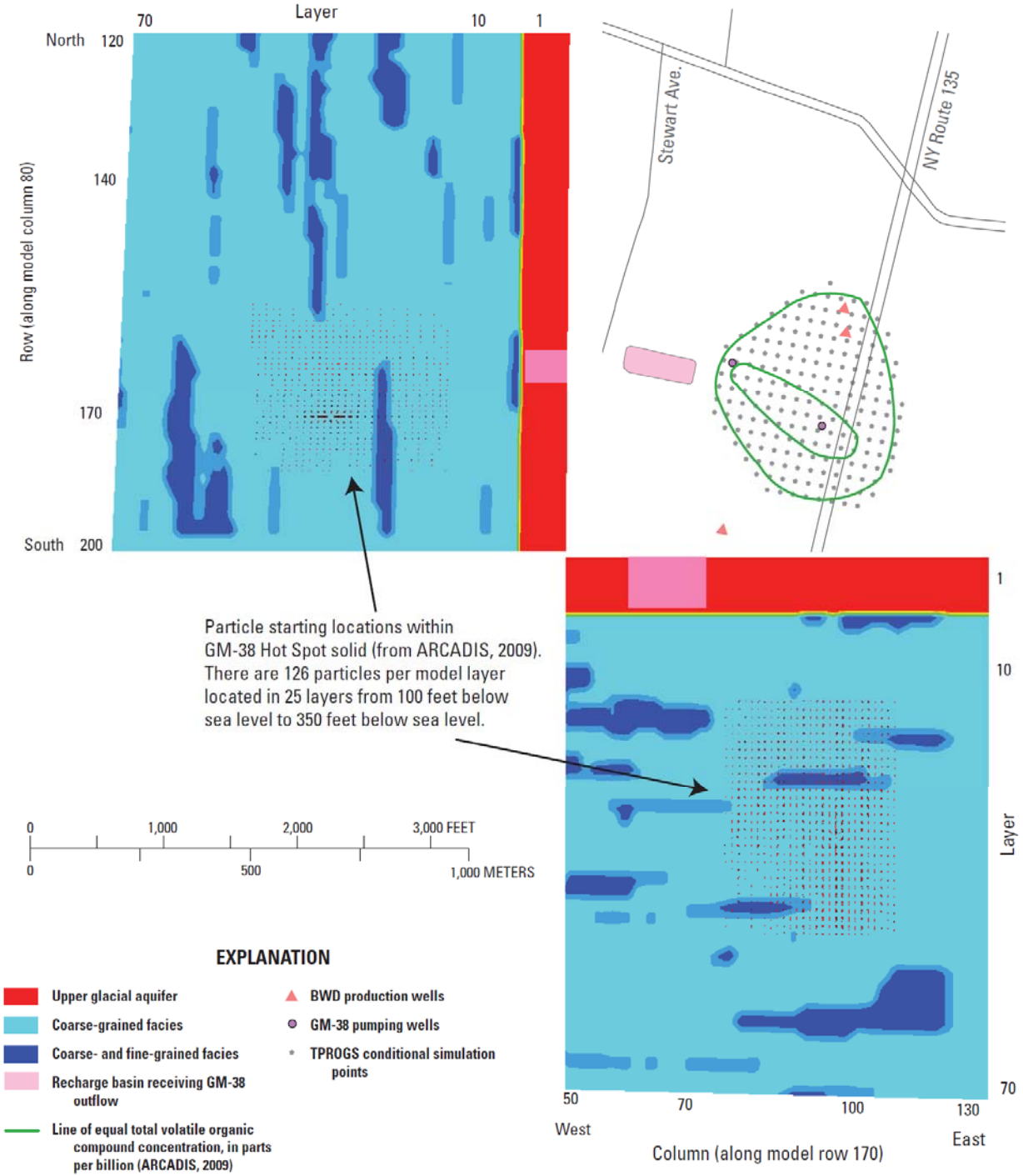
EXPLANATION

Simulated head, 3 foot color interval, steady-state present conditions, NGVD 29

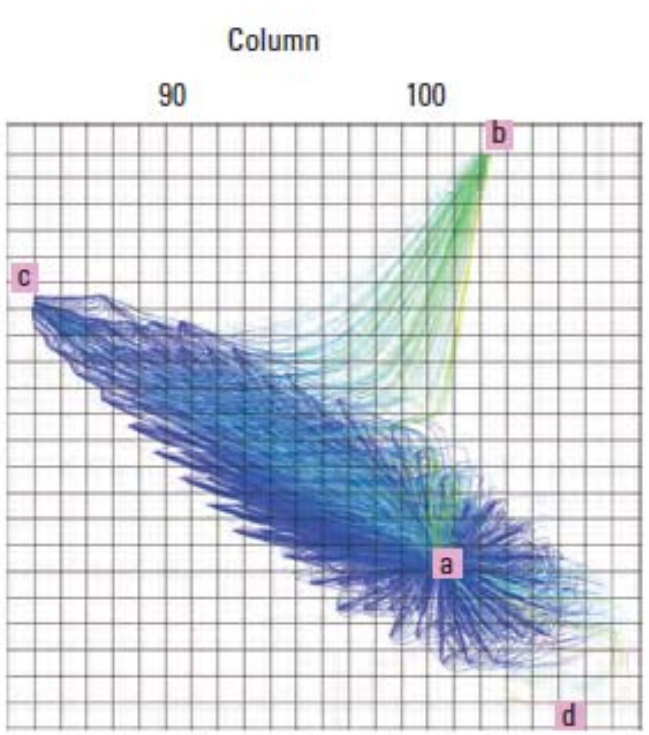
50 to > 47	41 to > 38	32 to > 29
47 to > 44	38 to > 35	29 to > 26
44 to > 41	35 to > 32	26 to > 23

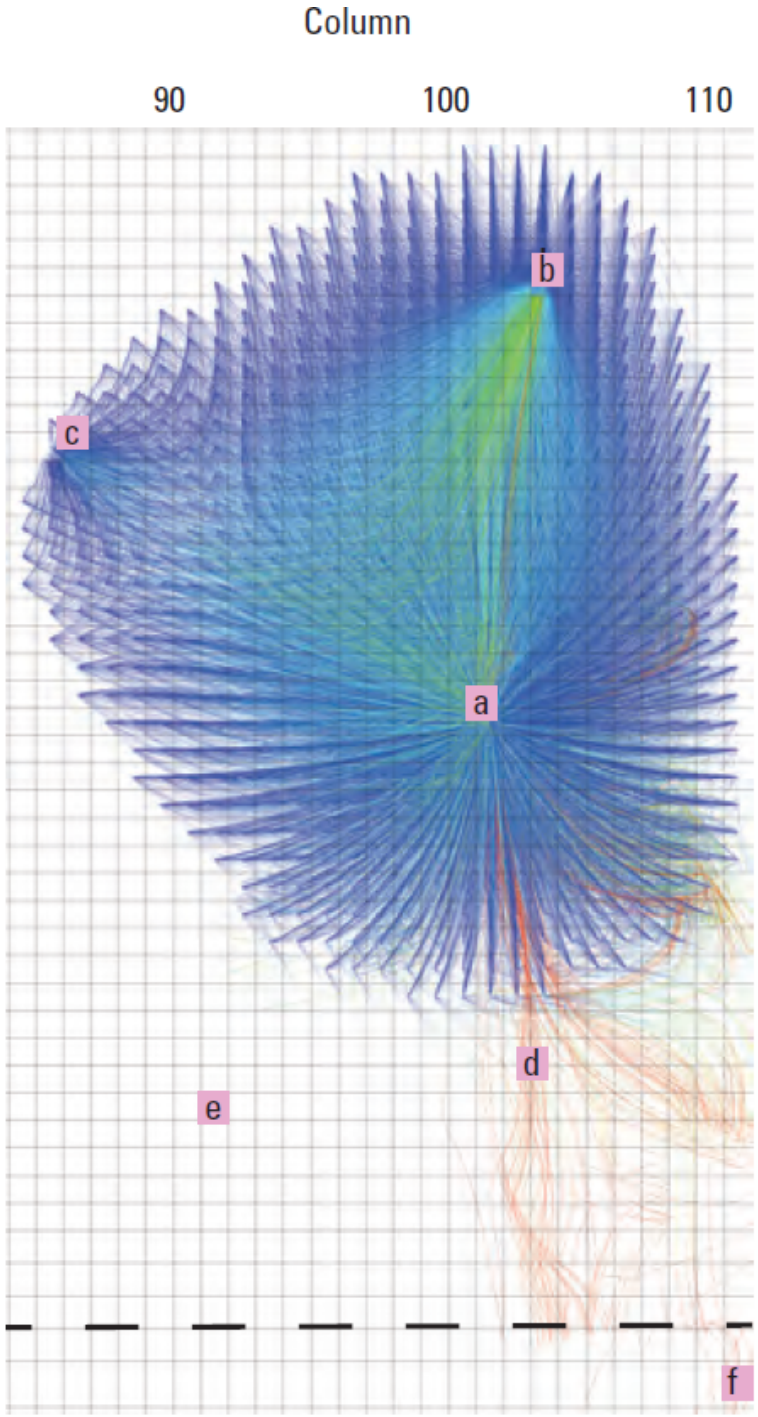
1. Heterogeneity
2. **Forward tracking**
3. Backward tracking
4. Conclusions

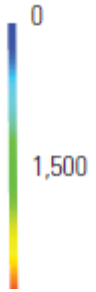
Plume cloud: foldout



Particle pathlines: map







Travel time from starting point at cell centers within 500 parts per billion TVOC contour (ARCADIS, 2009) to points of model discharge, days

a **GM38-RW1 pumping well**

b **BWD-4 pumping wells**

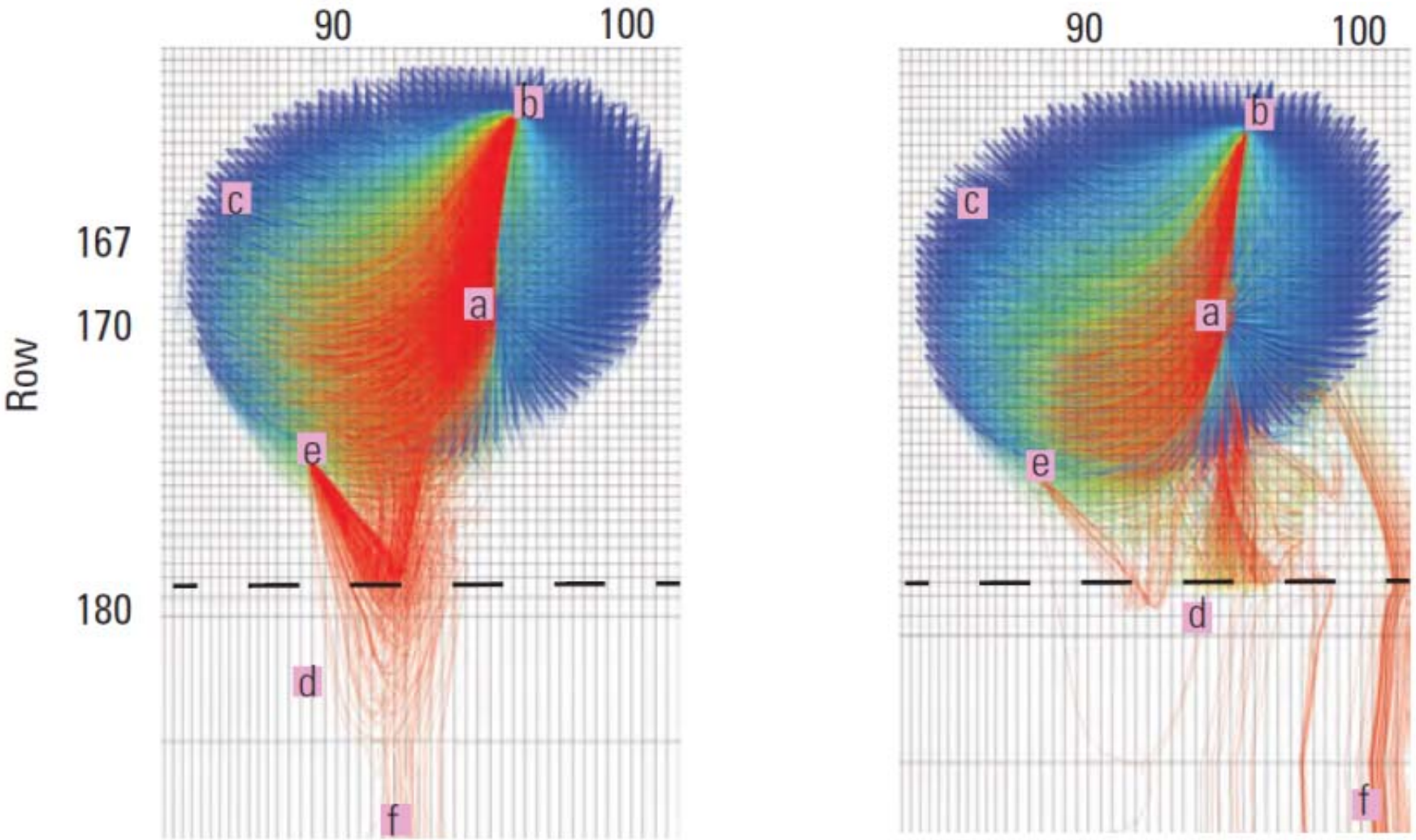
c **GM38-RW3 pumping well**

d **Stagnation points beyond the 500 parts per billion TVOC contour (ARCADIS, 2009)**

e **BWD-5 pumping well**

f **Pathlines that continue to constant head boundaries**

Alternative realizations and plume clouds:
maps

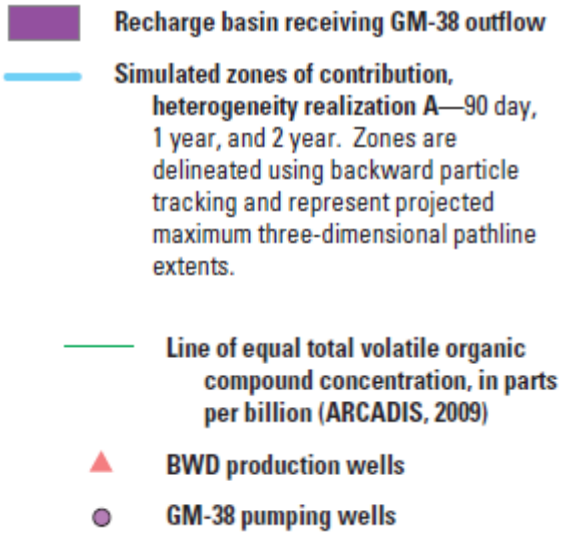


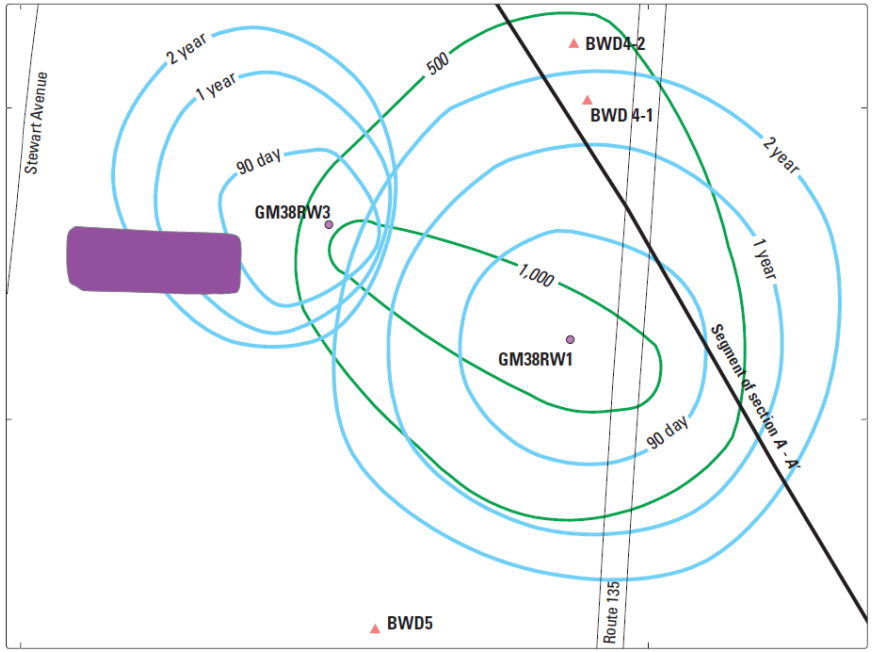
1. Heterogeneity
2. Forward tracking
3. **Backward tracking**
4. Conclusions

Capture zones:

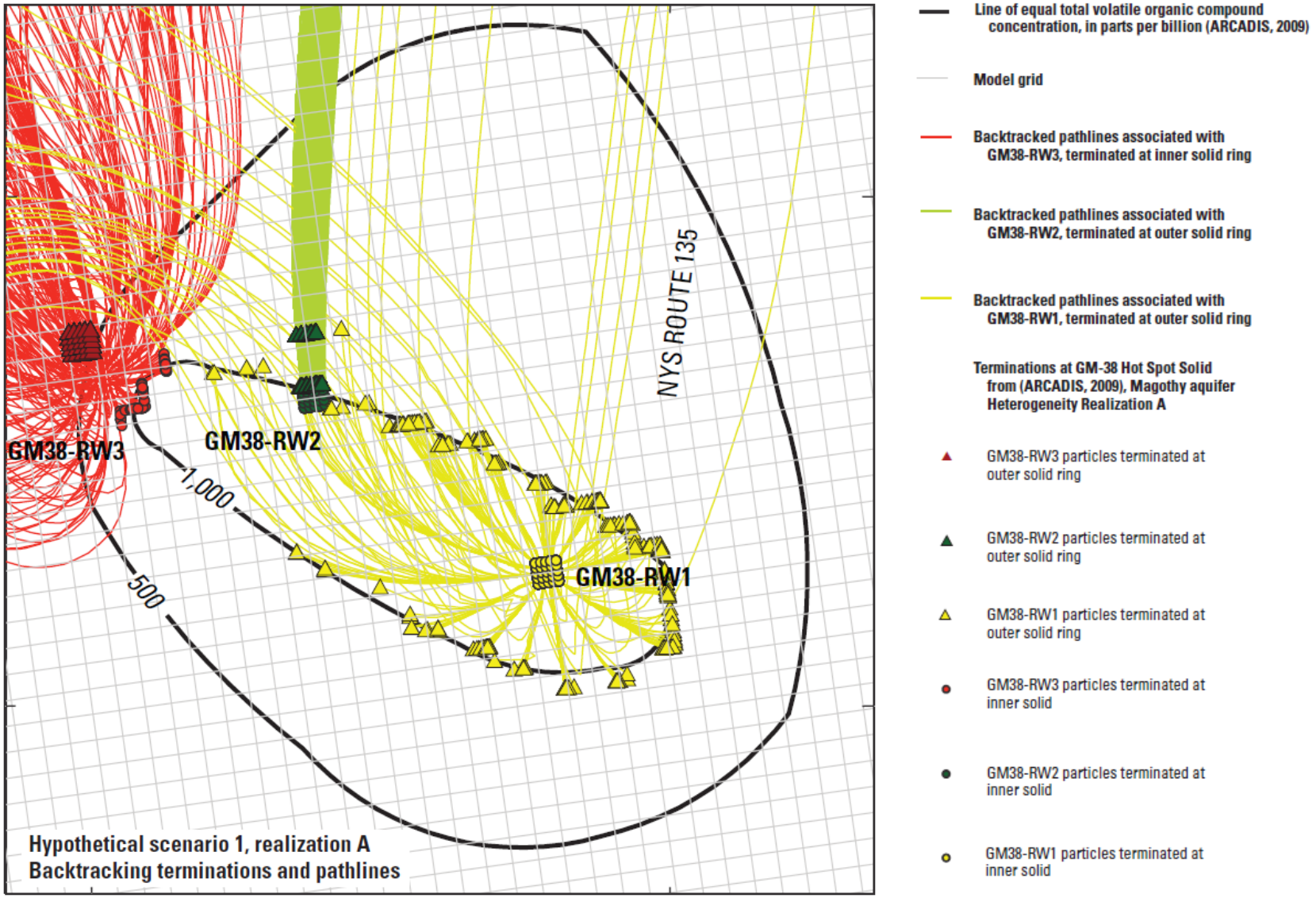
- Can show some information beyond the plume
- 2D drawing of maximum extent is simplification
- Technically no overlap

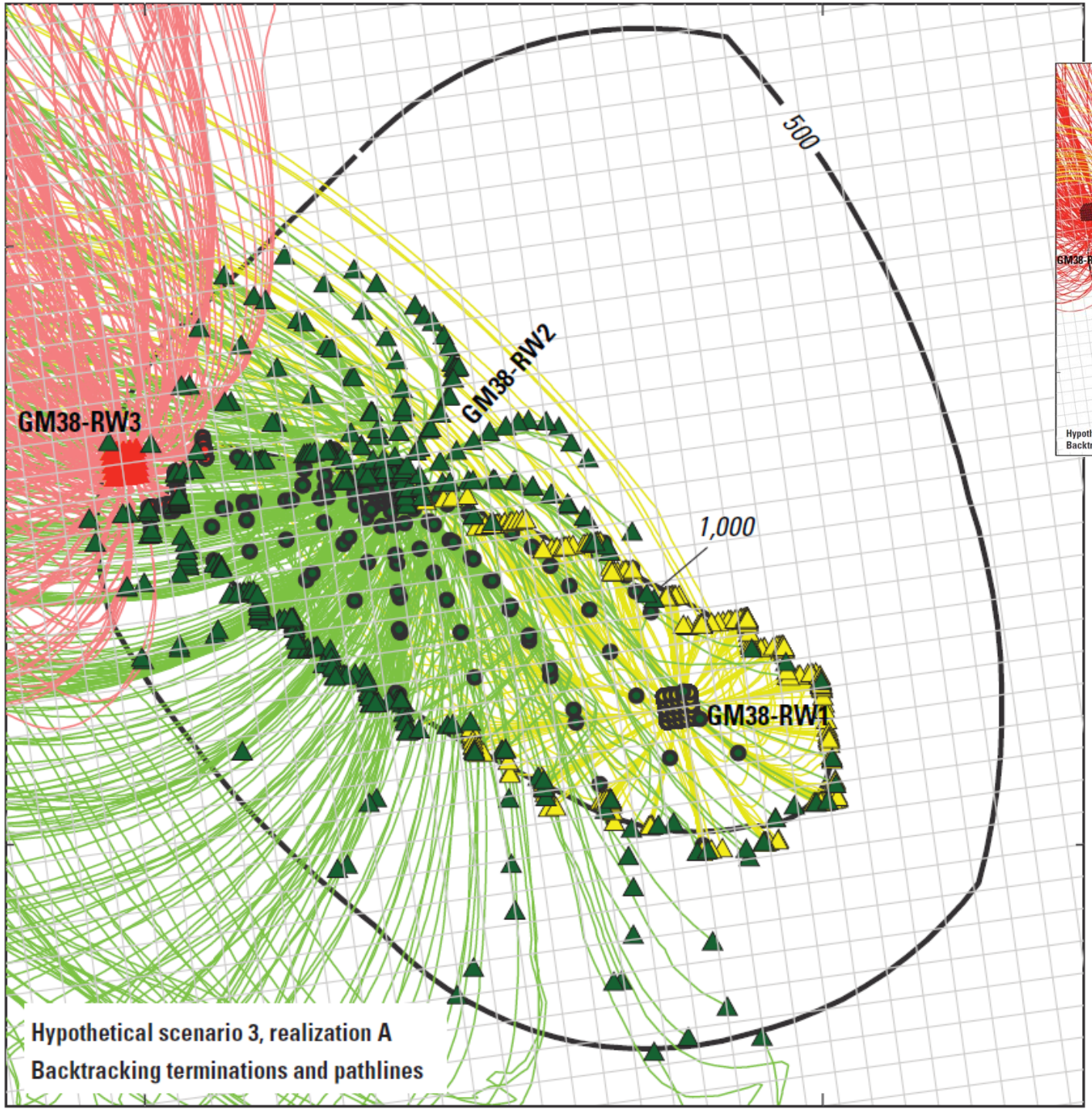
- Timing is arbitrary (*we also used approach of stopping particles at hot spot boundaries: MODPATH-OBS*)

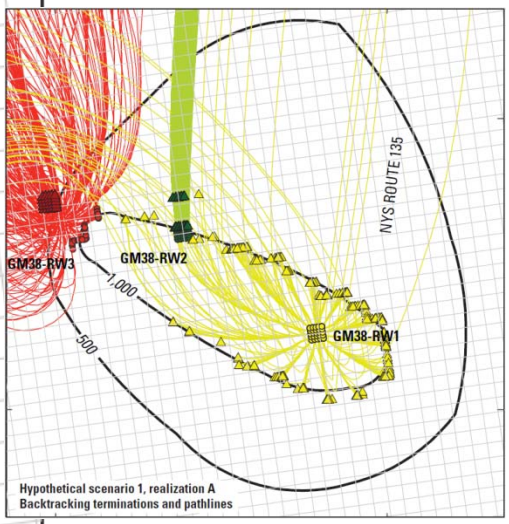




Pathline underflow and zone-intersection: map
-percentages (capture efficiency measures) are analyzed in report




500
GM38-RW3
GM38-RW2
1,000
GM38-RW1
Hypothetical scenario 3, realization A
Backtracking terminations and pathlines


NYS ROUTE 135
GM38-RW3
GM38-RW2
1,000
500
GM38-RW1
Hypothetical scenario 1, realization A
Backtracking terminations and pathlines

1. Heterogeneity
2. Forward tracking
3. Backward tracking
4. **Conclusions**

Study questions:

How does aquifer heterogeneity affect capture zone delineations?

- Probability model used to make alternative realizations of confining bed geometry from extensive VPB dataset

- structure reflected in simulated head distribution and MODFLOW parameter sensitivity analysis

- Structure makes a difference for plume tracking and well capture

- Only advection and head matching considered in study

Study questions:

How do forward tracking and backward tracking methods compare?

-forward represented fate of a plume cloud; did not show action upgradient

-backward represented hydraulics of capture throughout entire flow system

-MODPATHOBS software enhanced backtracking capability beyond typical capture zone approach

-both methods are affected by aquifer heterogeneity representation

Study questions:

How may the three GM38 pumping wells best be optimized and distributed?

-Scenarios of BWD4 shutdown and GM38-RW2 startup were considered

-Neither scenario improved capture efficiency

-In all scenarios, additional particles escape under the TCE hotspot

-Measures of underflow affected by heterogeneity realization

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