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

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NAVFAC

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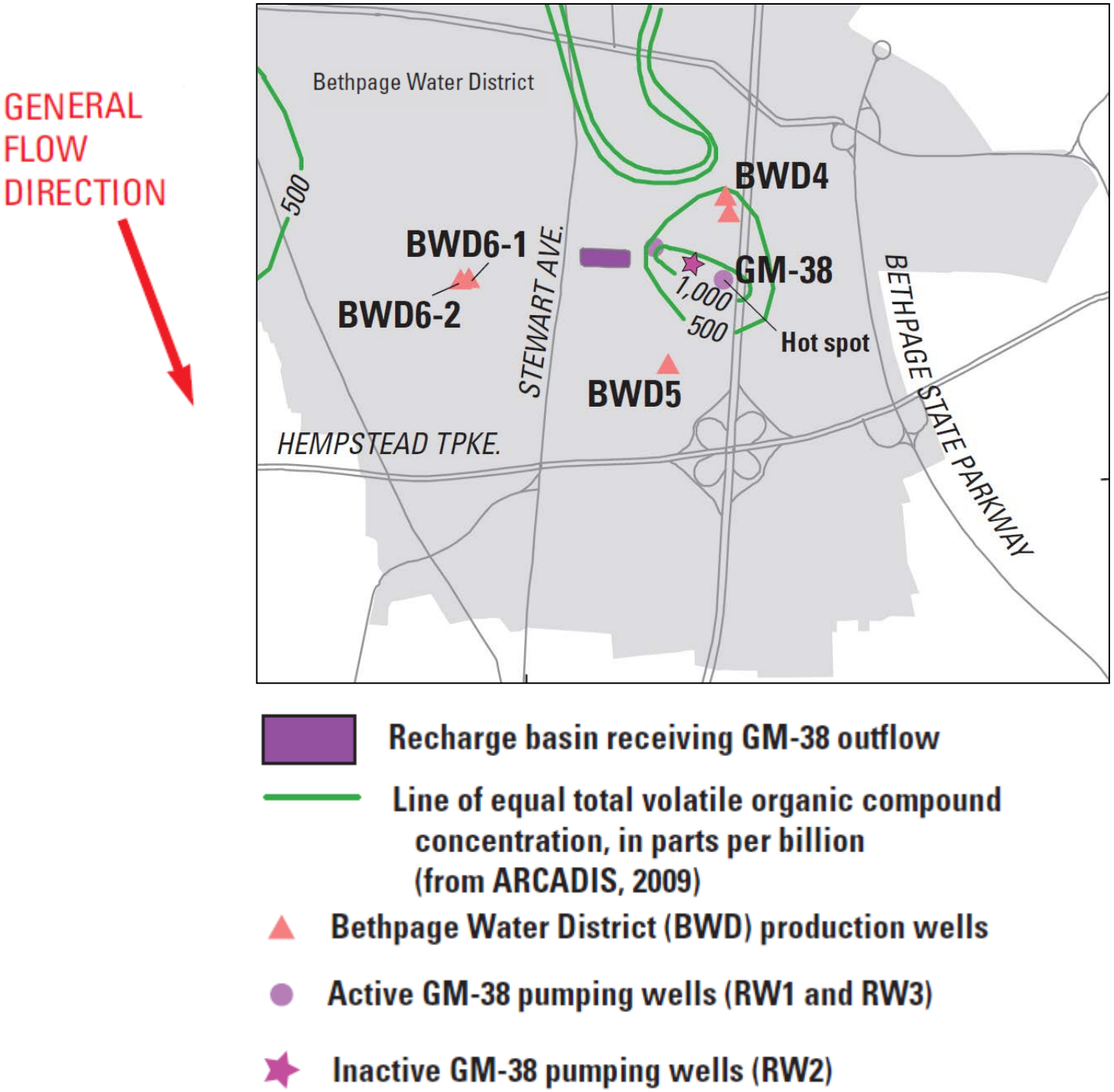
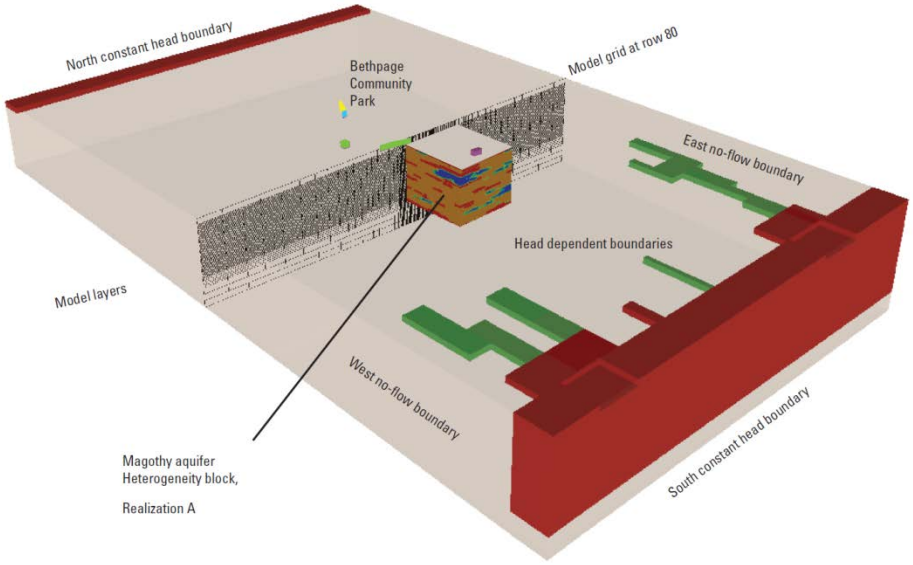
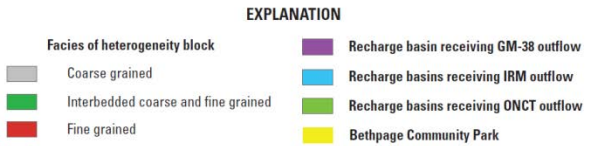
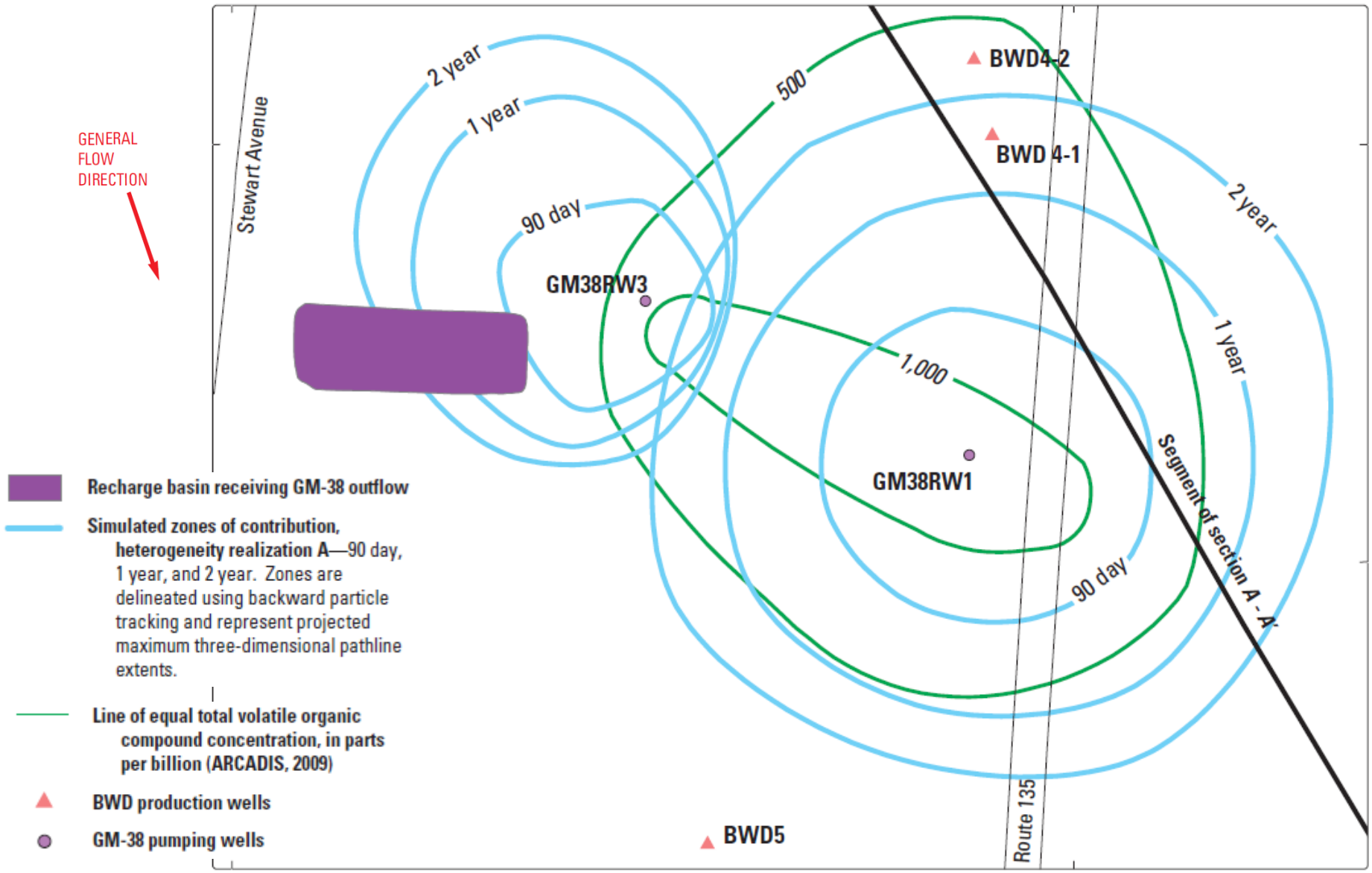

GENERAL
FLOW
DIRECTION
Bethpage Water District
500
BWD6-1
BWD6-2
STEWART AVE.
BWD4
GM-38
1,000
500
Hot spot
BWD5
HEMPSTEAD TPKE.
BETHPAGE STATE PARKWAY
Recharge basin receiving GM-38 outflow
Line of equal total volatile organic compound concentration, in parts per billion (from ARCADIS, 2009)
Bethpage 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?

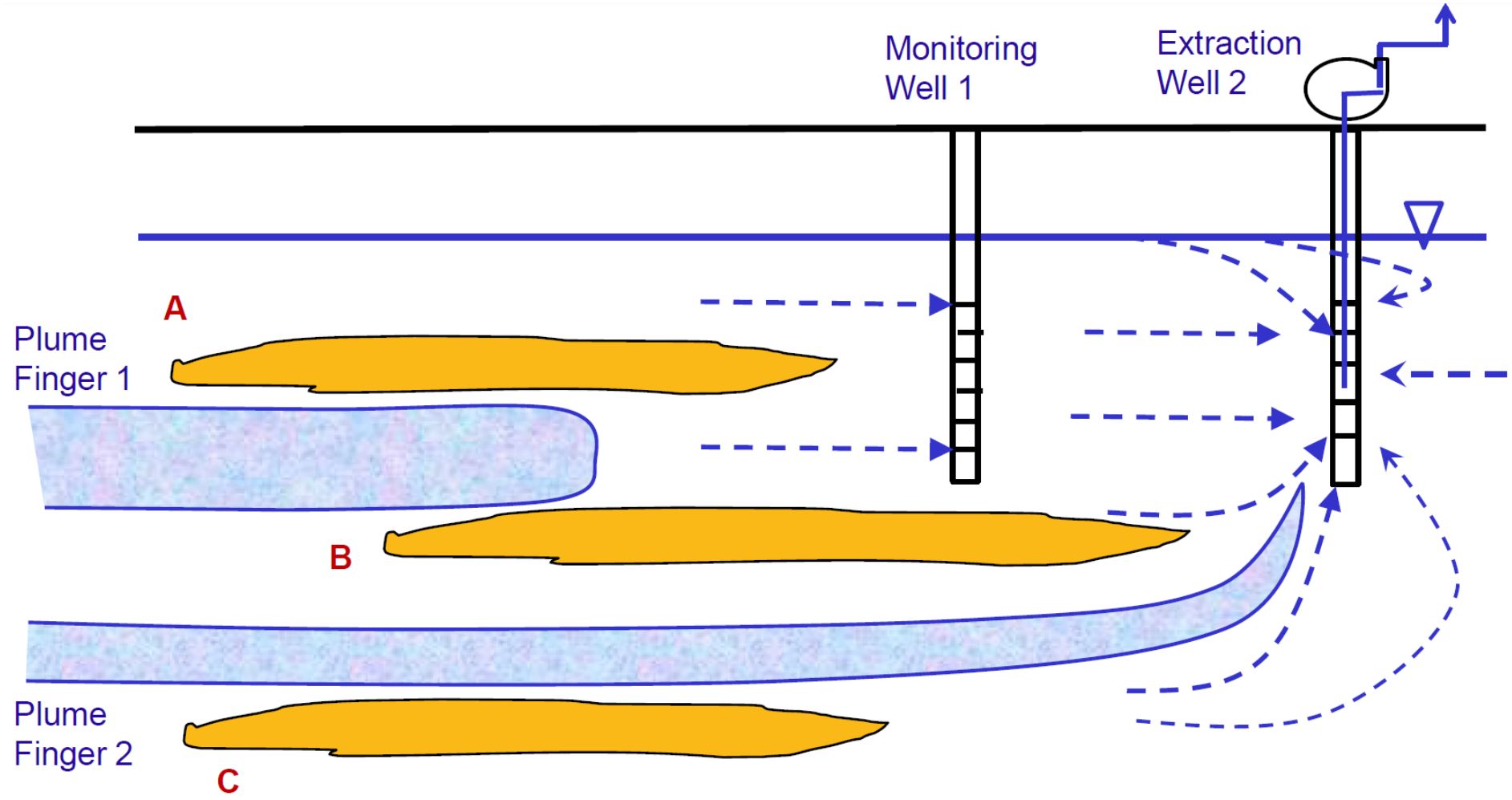
How do forward tracking and backward tracking methods compare?

How may the three GM38 pumping rates be optimized?

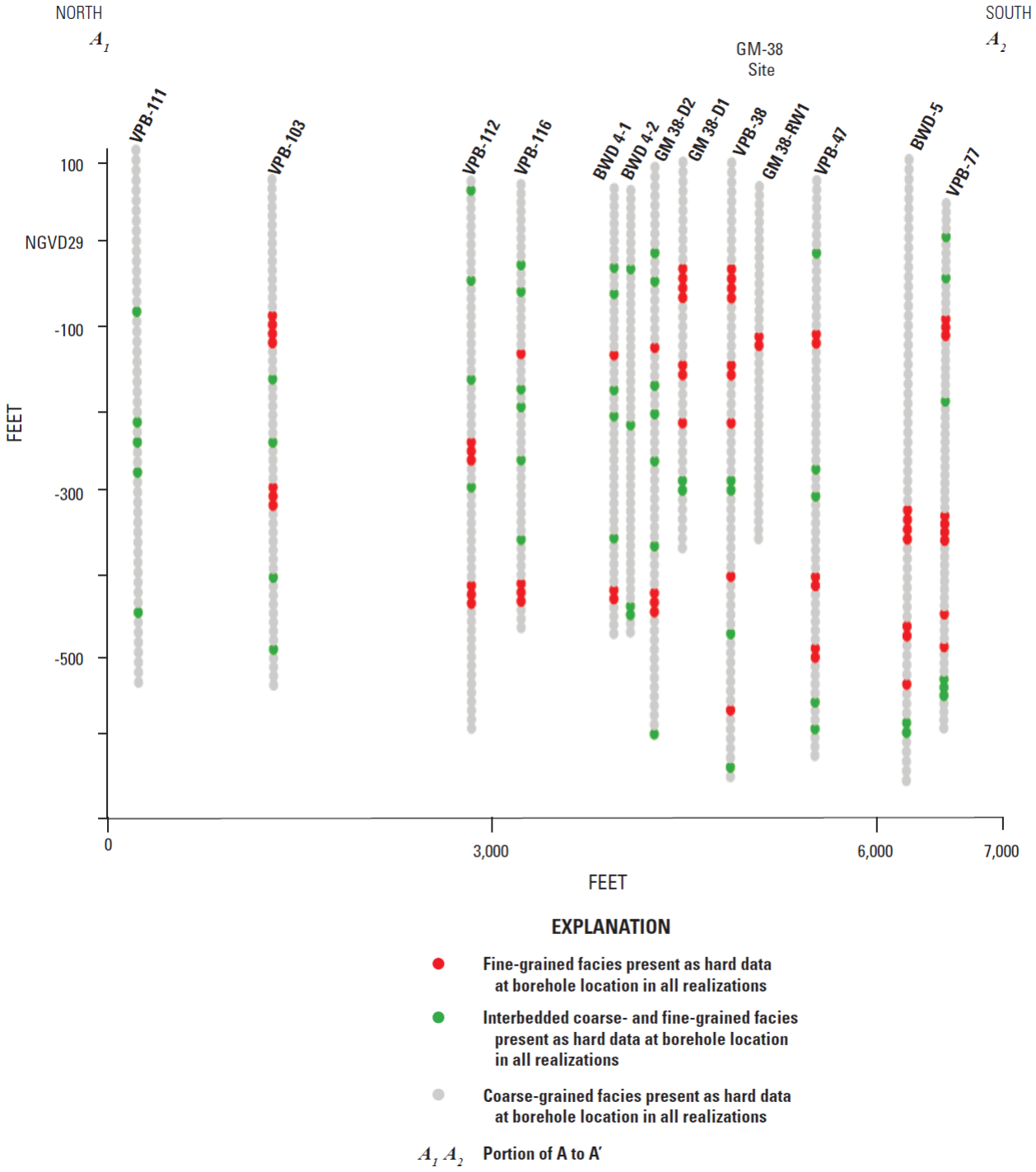
1. **Heterogeneity**
2. Forward tracking
3. Backward tracking
4. Conclusions

Navy conceptual model

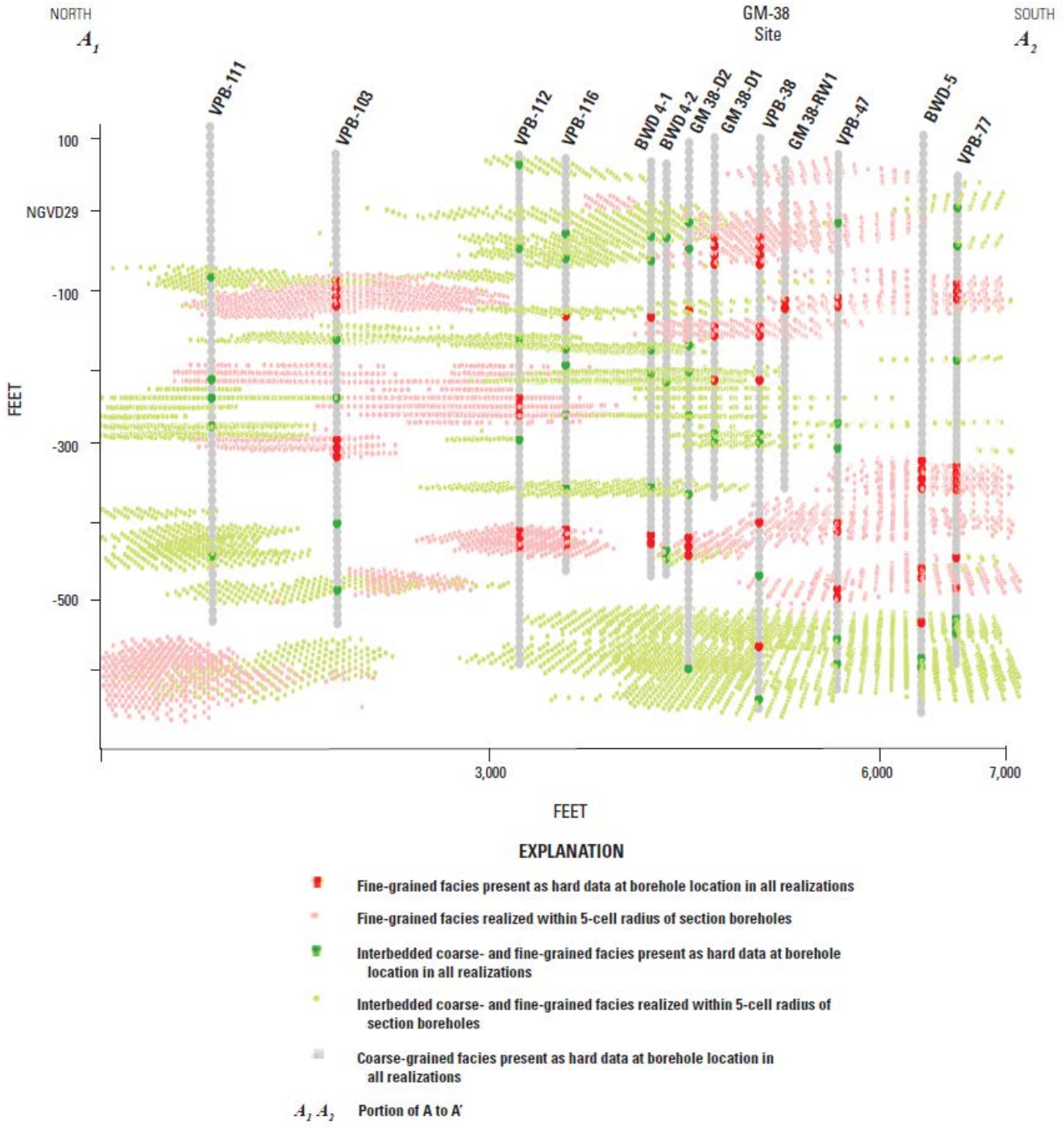
-subtle head differences observed



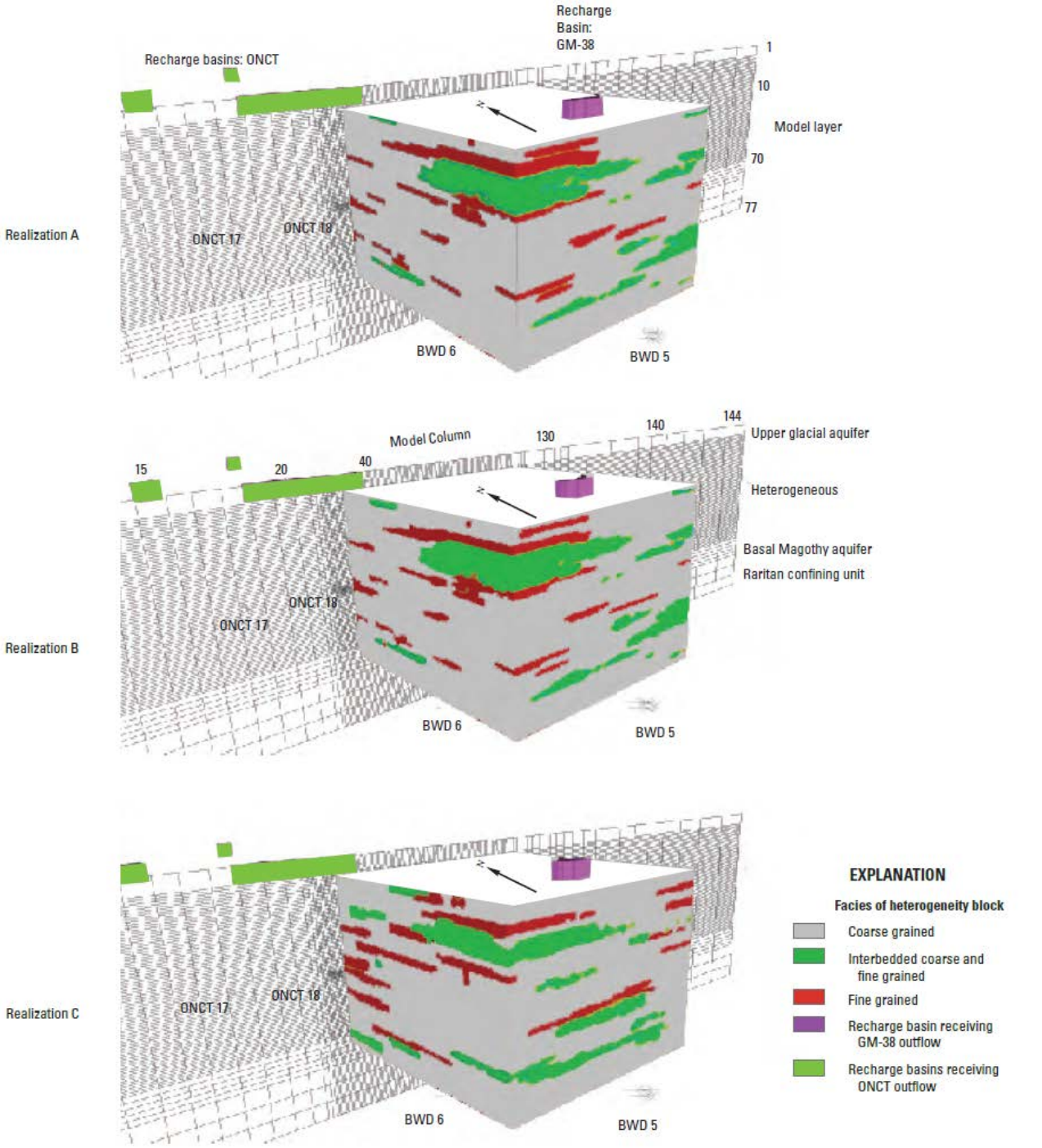
Hard data: section



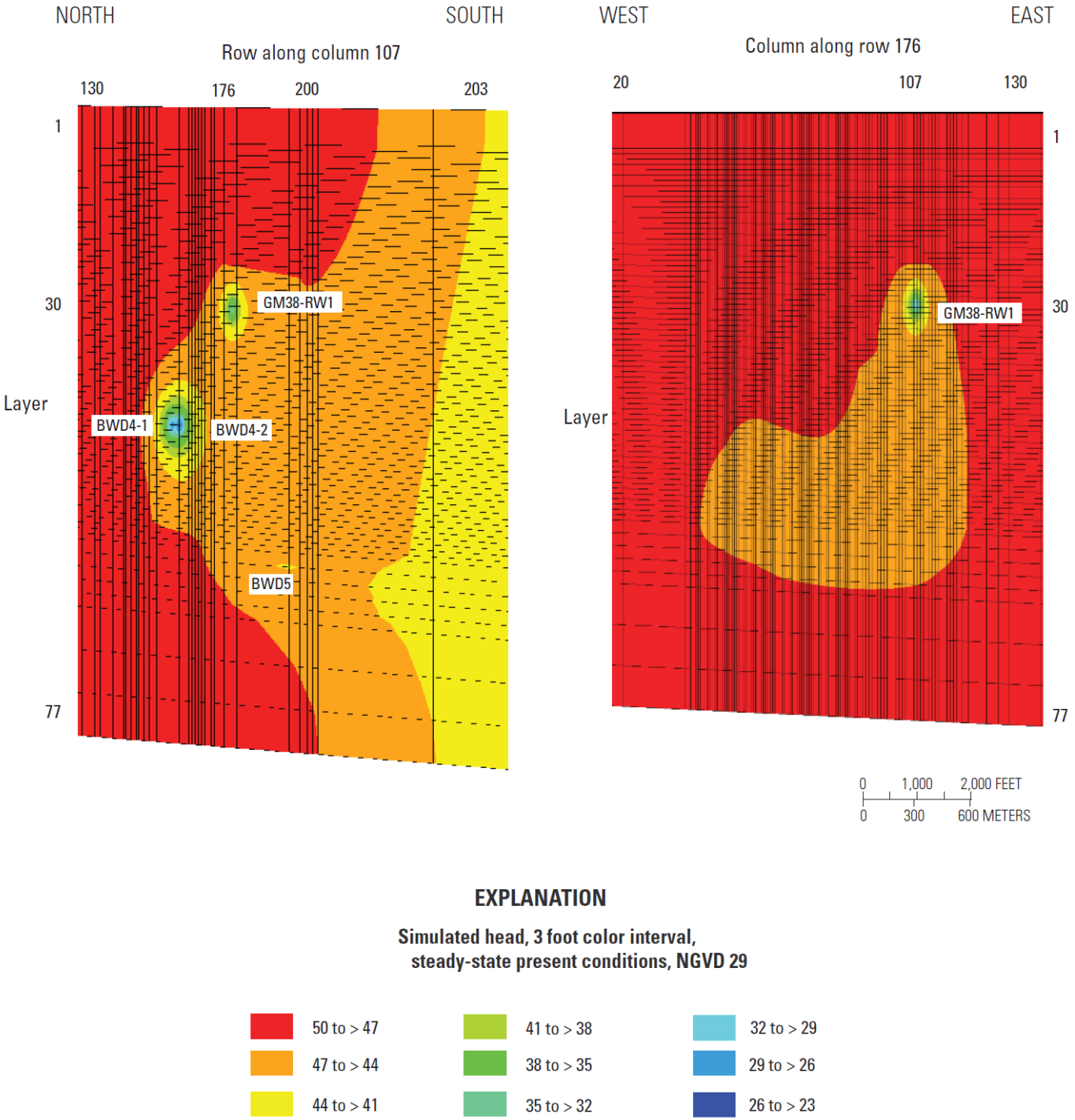
Realization: section



Alternate realizations: block series

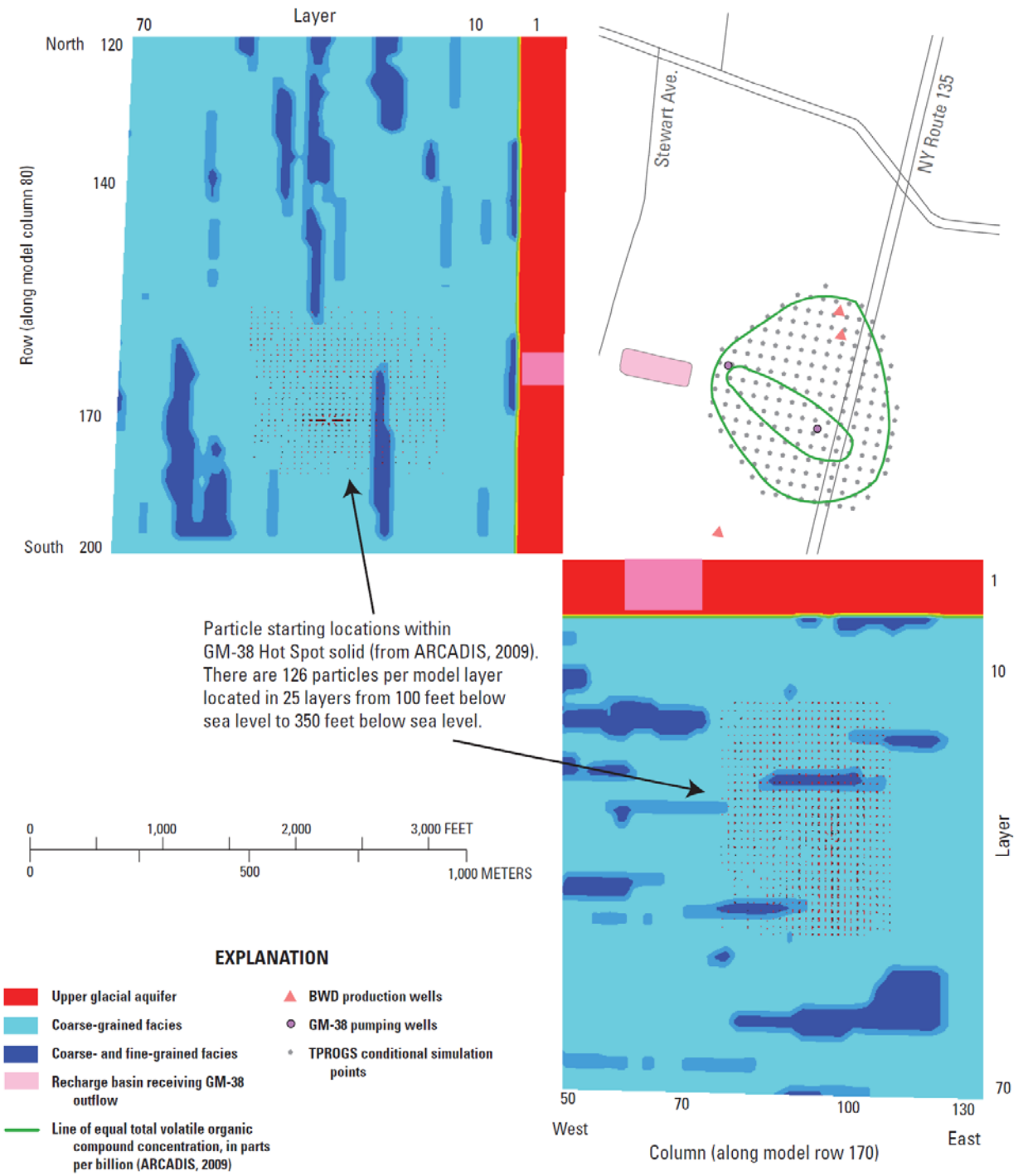


Simulation: sections

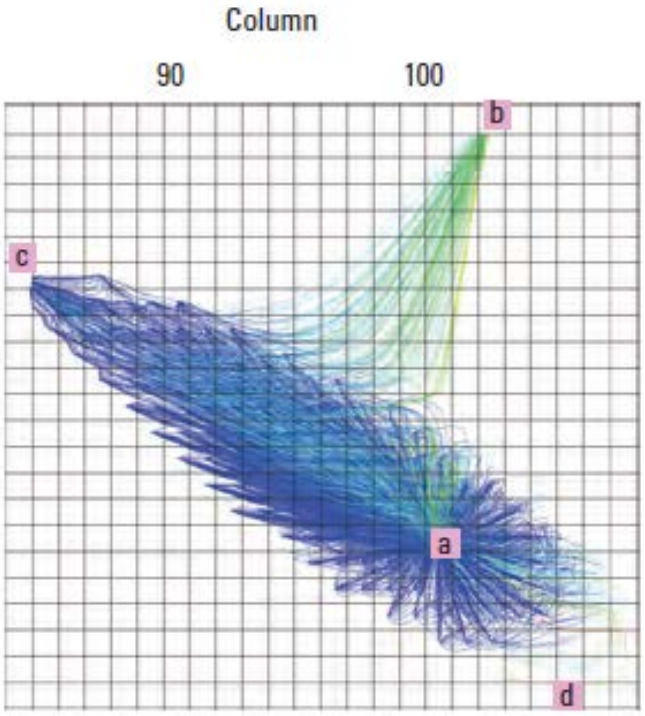


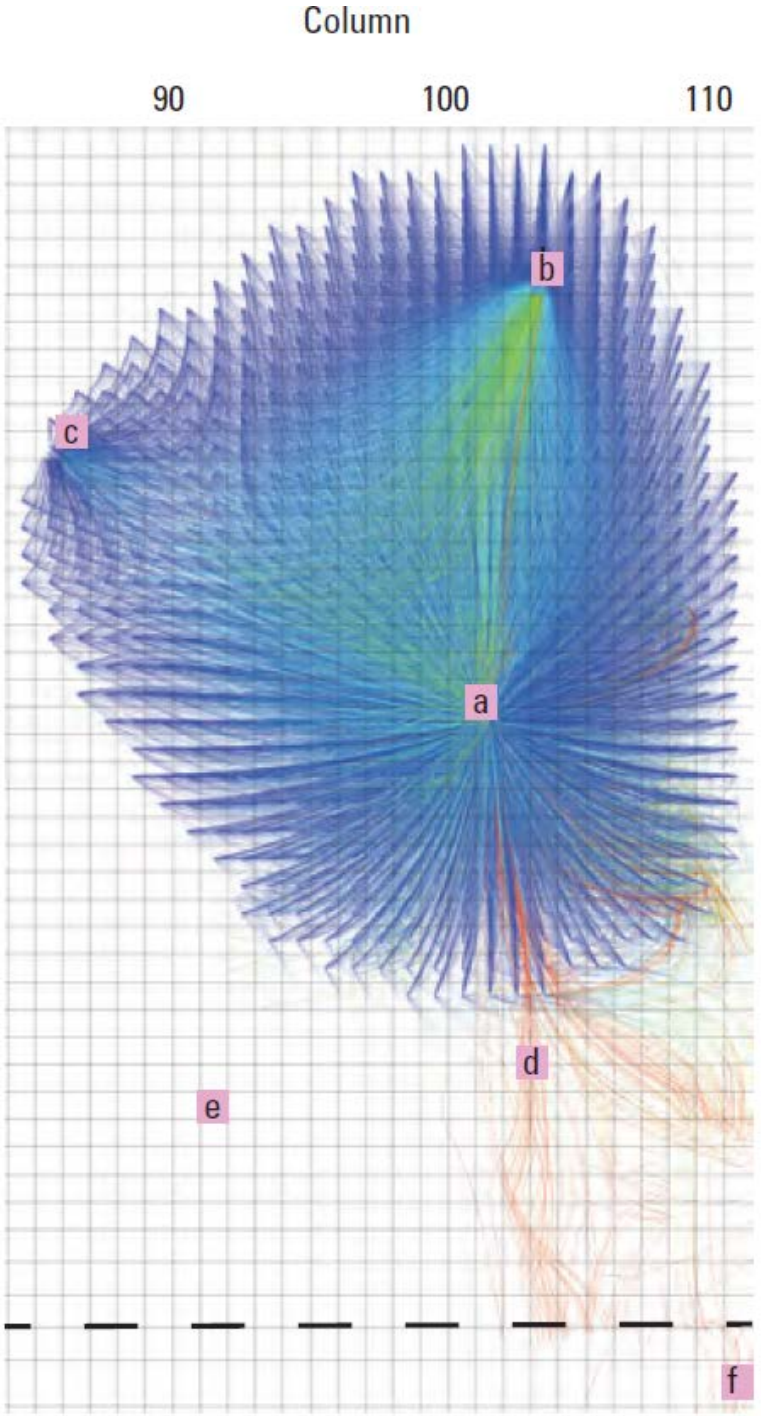
1. Heterogeneity
2. **Forward tracking**
3. Backward tracking
4. Conclusions

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

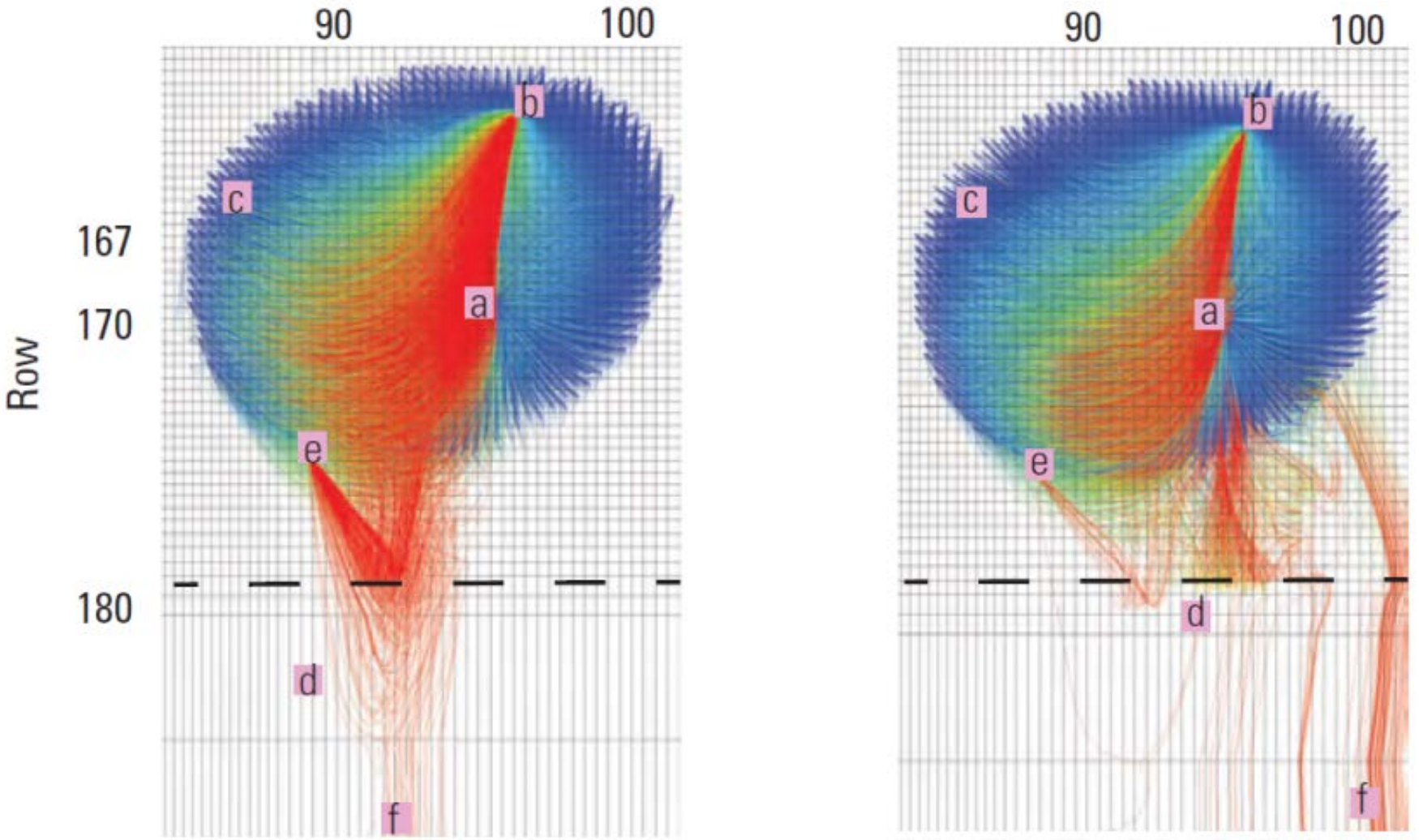
c GM38-RW3 pumping well

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

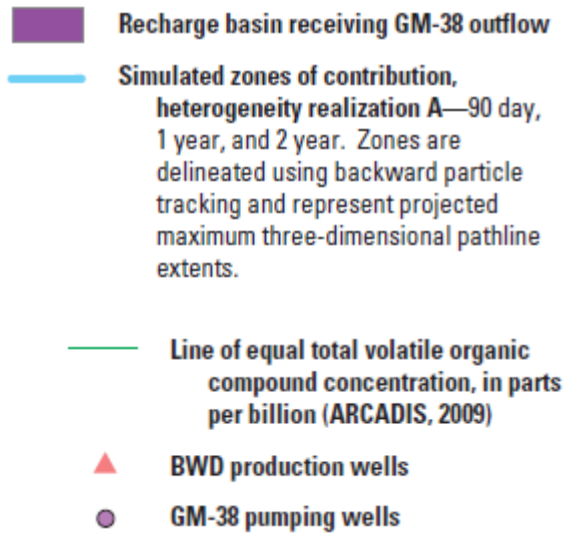


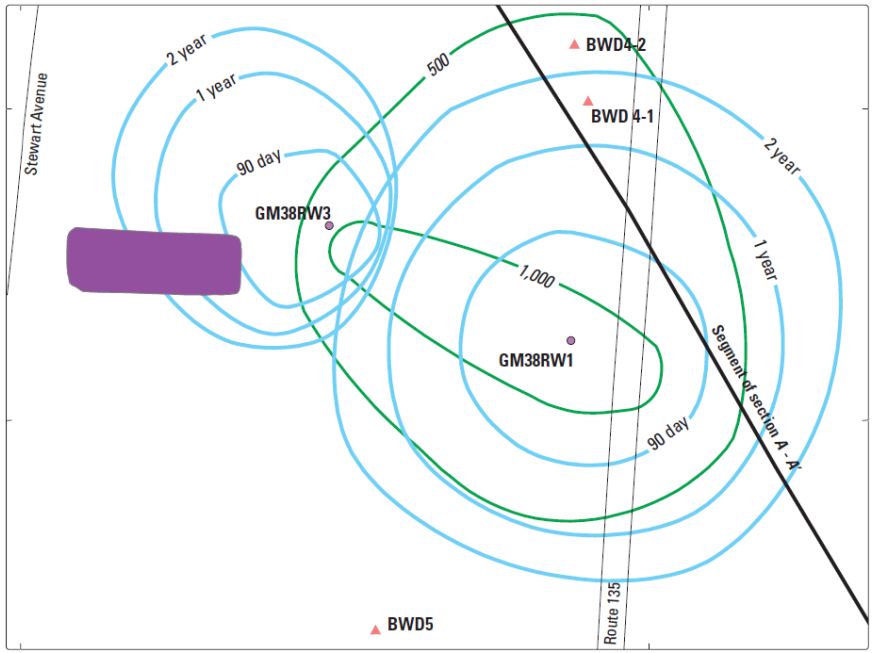
1. Heterogeneity
2. Forward tracking
3. **Backward tracking**
4. Conclusions

Capture zones:

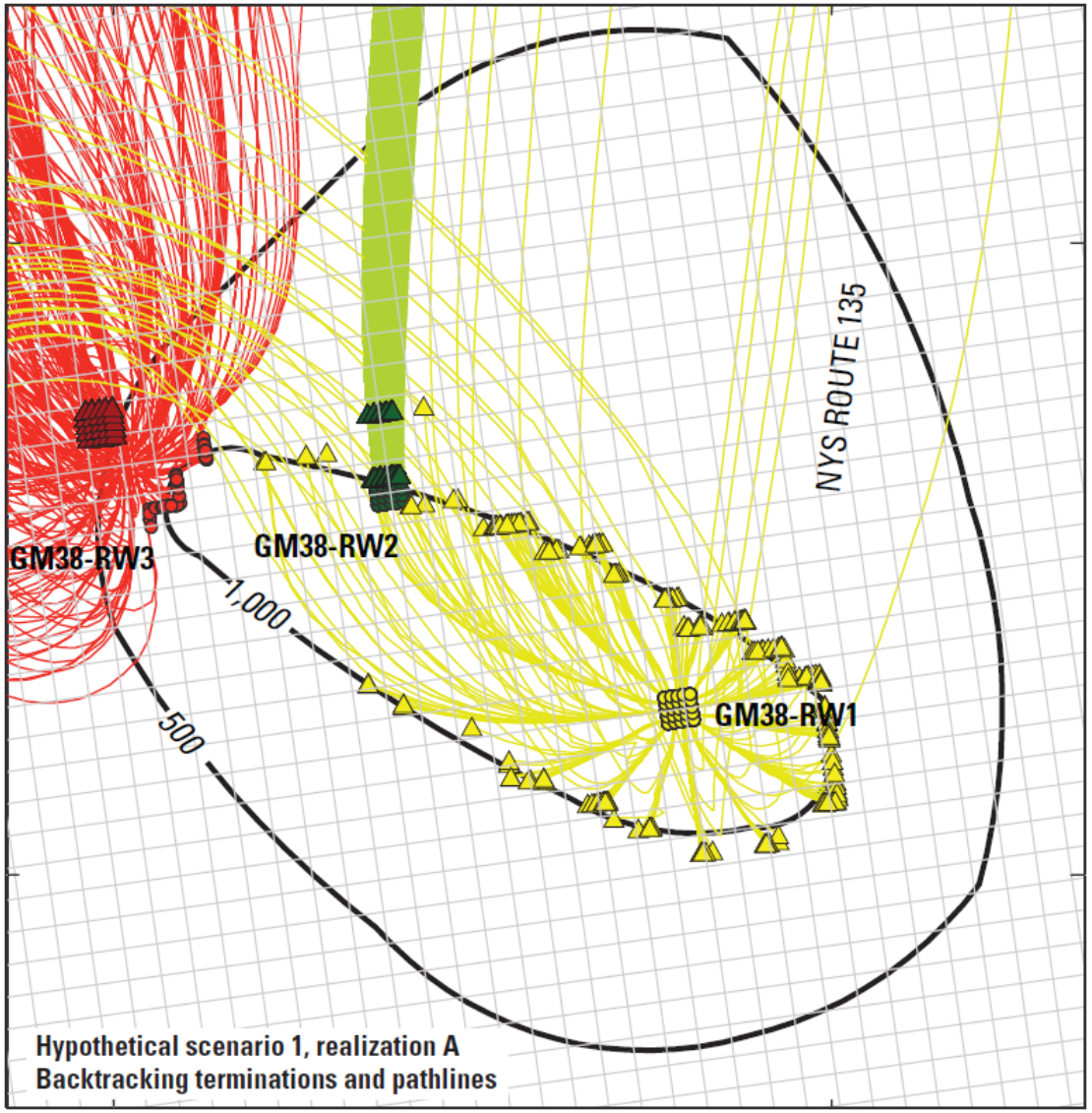
- Can show some information beyond the plume
- 2D drawing of maximum extent is simplification
- Technically no overlap

- 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



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

Model grid

Backtracked pathlines associated with GM38-RW3, terminated at inner solid ring

Backtracked pathlines associated with GM38-RW2, terminated at outer solid ring

Backtracked pathlines associated with GM38-RW1, terminated at outer solid ring

Terminations at GM-38 Hot Spot Solid from (ARCADIS, 2009), Magothy aquifer Heterogeneity Realization A

GM38-RW3 particles terminated at outer solid ring

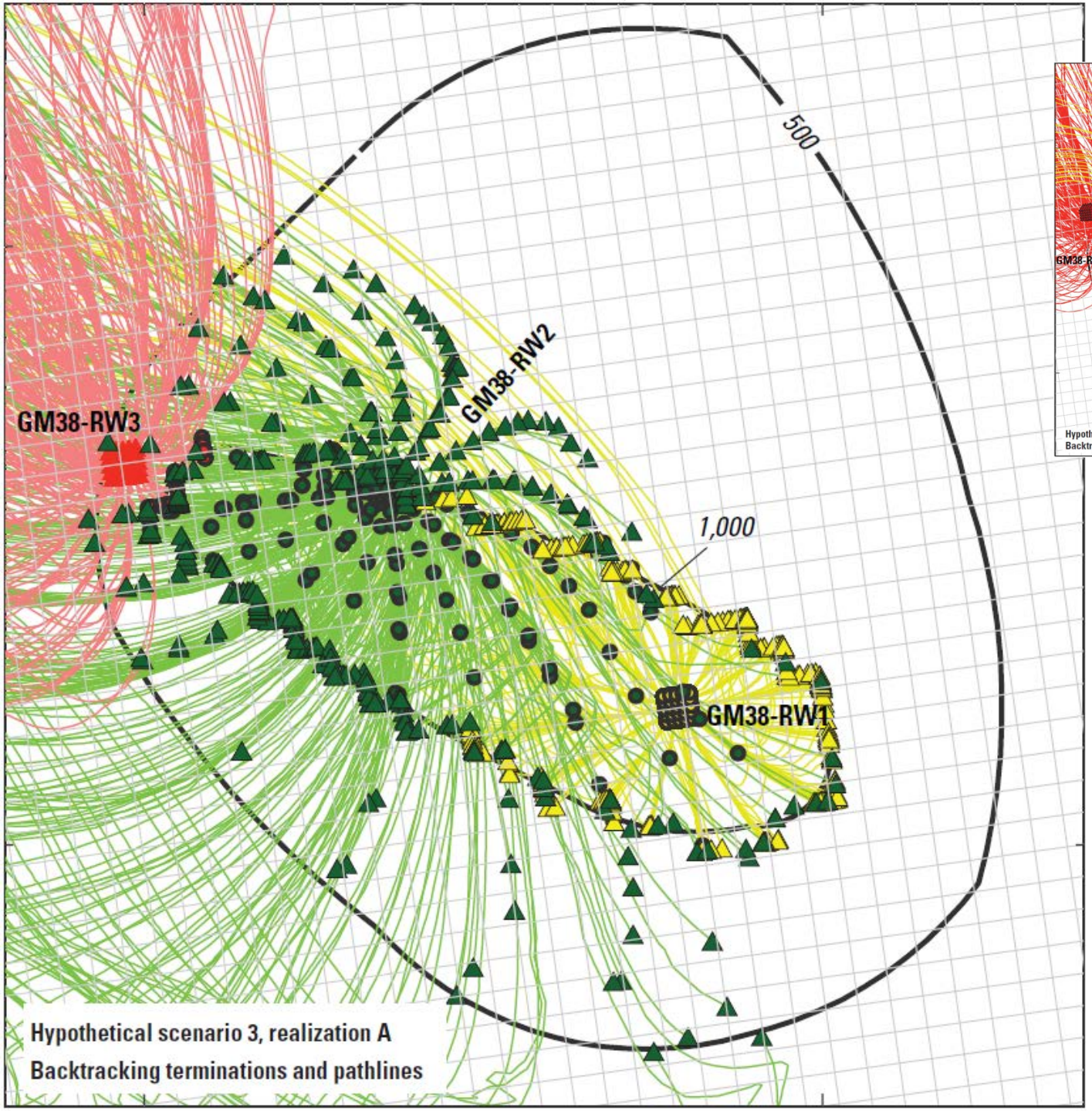
GM38-RW2 particles terminated at outer solid ring

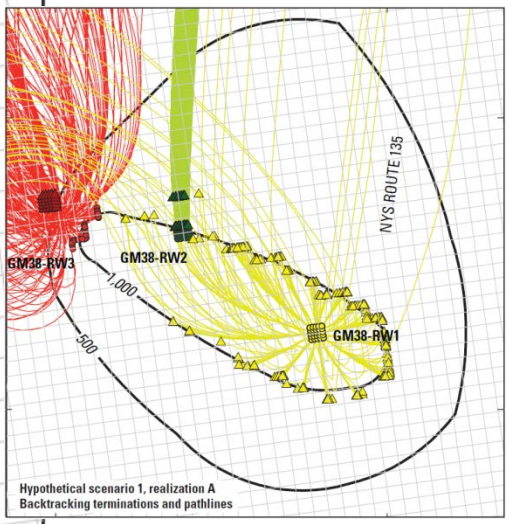
GM38-RW1 particles terminated at outer solid ring

GM38-RW3 particles terminated at inner solid

GM38-RW2 particles terminated at inner solid

GM38-RW1 particles terminated at inner solid


500
GM38-RW2
GM38-RW3
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