Groundwater Modeling of Vashon – Maury Island

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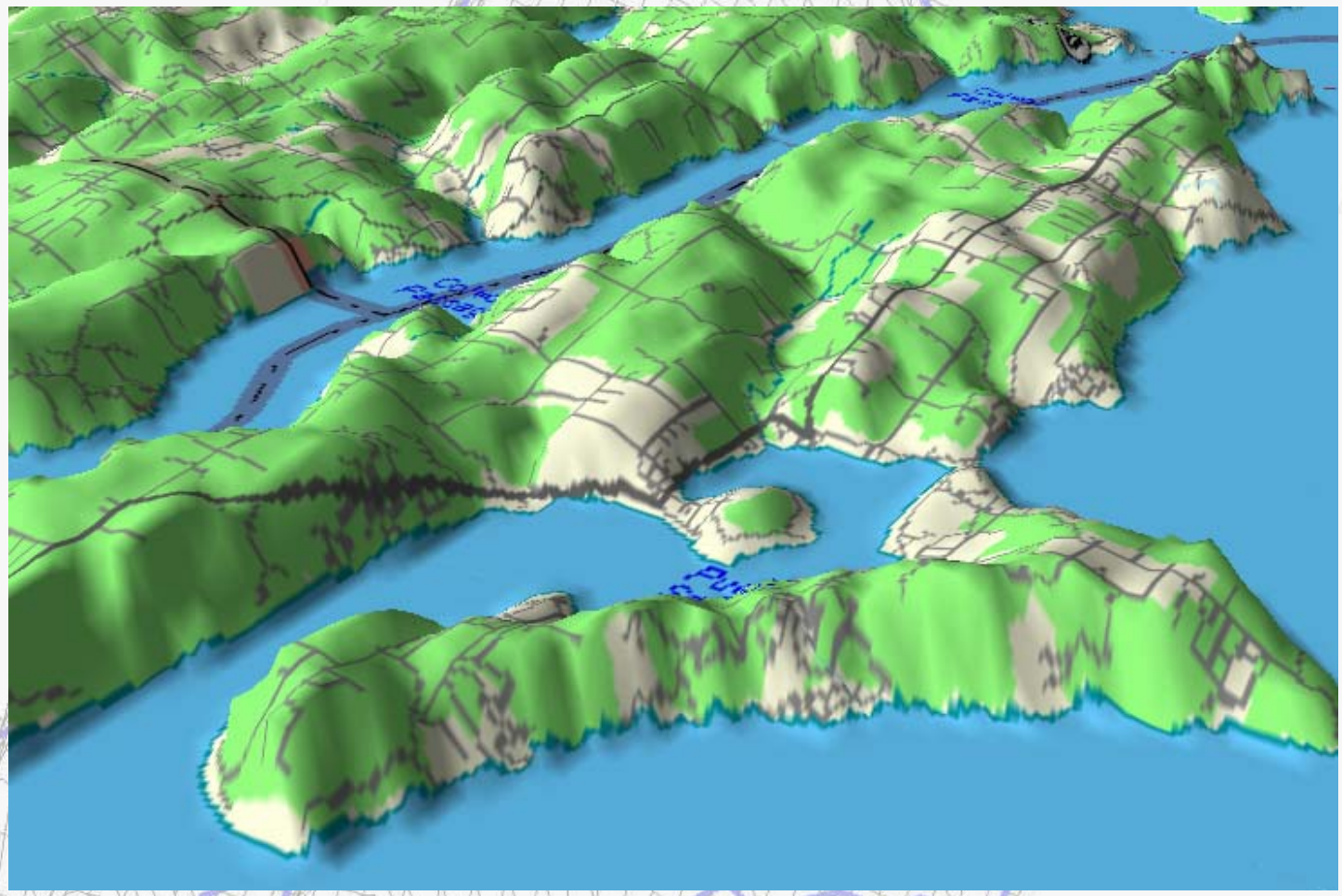
Outline of talk

- Purpose of modeling effort
- Context: part of *Water Resources Evaluation*
- Methods / Data Sources
- Difficulties / Solutions
- Applications / Next Steps

Purpose

- Previously only Island-wide “water balance” estimates
- Modeling is a test of the *state of our knowledge* of Island hydrogeology
- Phase I – not so much to “develop a product” as to “learn about data gaps”
- Example uses: monitoring well locations

Vashon – Maury Island (VMI)

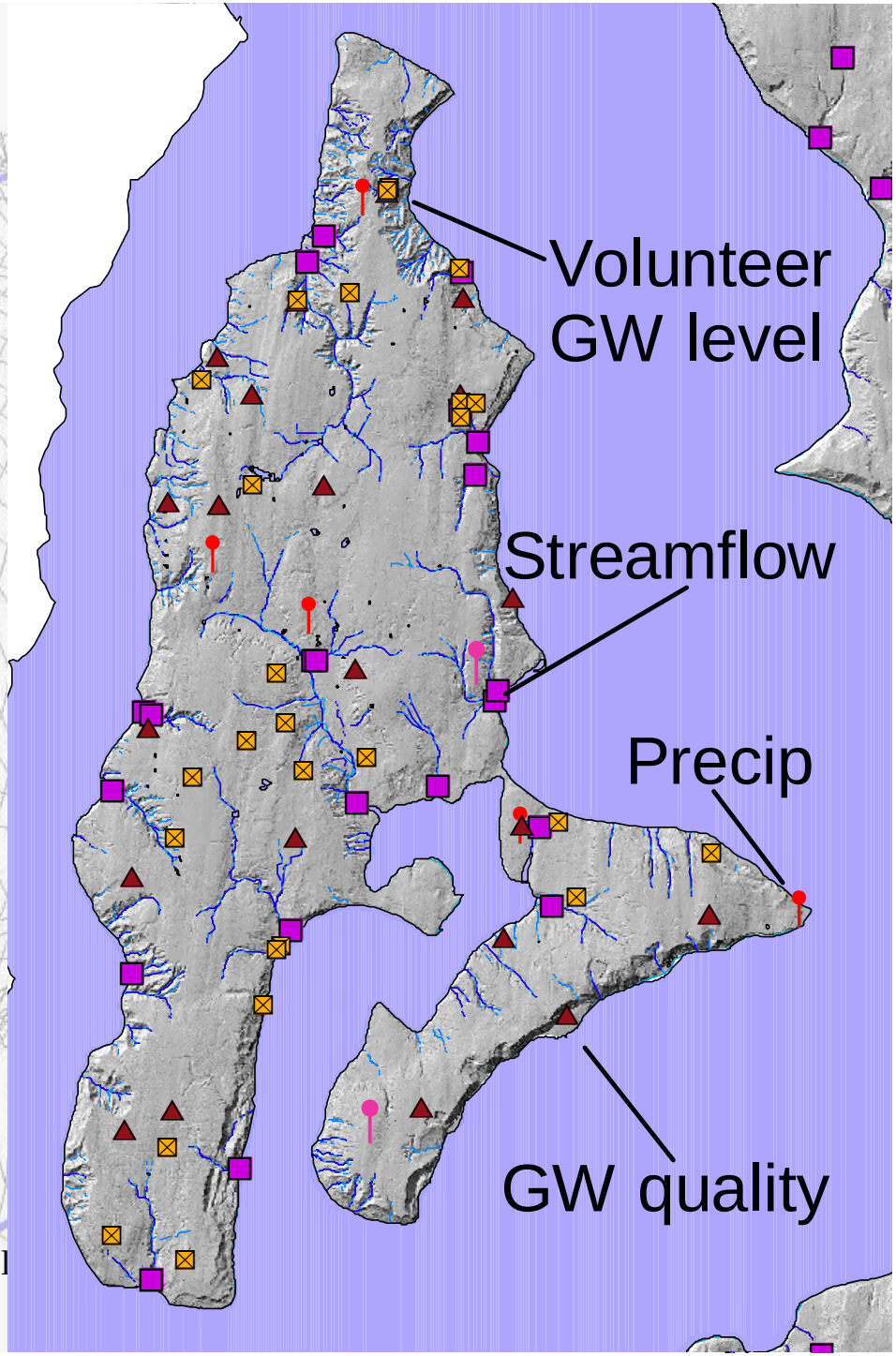


Context

- Water Resources Evaluation
  - Long-term investigation of Island hydrology
  - Besides model, other components:
    - Stream / precipitation gaging
    - Groundwater quality monitoring
    - GW level monitoring (including volunteers)
    - Monitoring well installation
- Developed in cooperation with RDP & VMI Groundwater Protection Committee

Monitoring
(part of WRE)

- WQ - 21 sites
- Streamflow: 3(+2) gages, 17-26 in baseflow survey
- Precip: 5 stations (+ volunteers)
- GW level: 26 volunteers, 8 on-going



What is GW Modeling?

(shocking, but this is Science Day)

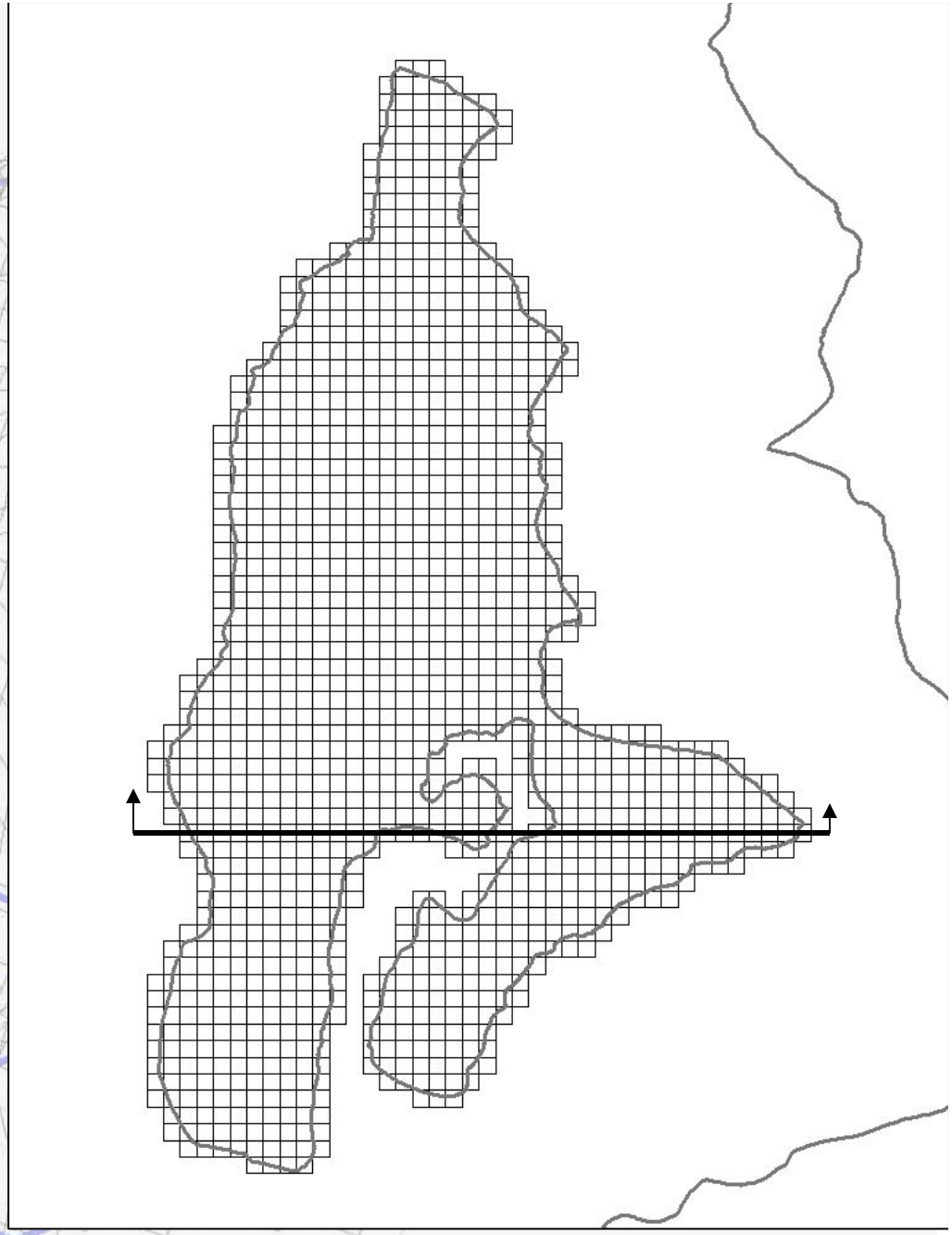
- *Finite Difference* solution of:
  - Darcy's equation: $\underline{v} = - K \underline{\nabla} h$
  - Continuity: $- \underline{\nabla} \cdot \underline{v} = \partial S / \partial t + Q$
- *Cells* (x,y,z) have *head* (h) as variable
- *Flows* from cell to cell calculated from:
  - Hydraulic conductivities in cells / layers
  - Differences in head (e.g., $h_{i,j,k} - h_{i,j,k+1}$)
  - Cell spacings (Δx, Δy, Δz)
  - Inflows / outflows (Q, boundary conditions)

Methods

- MODFLOW model, developed by USGS
  - "Visual MODFLOW" implementation by Waterloo Hydrologic Inc (WHI)
  - Preprocessing / postprocessing / graphics
- Modeling for *flow* only (in Phase I)
- Later phases
  - Surface water modeling / linked
  - Transient flow
  - Water quality transport

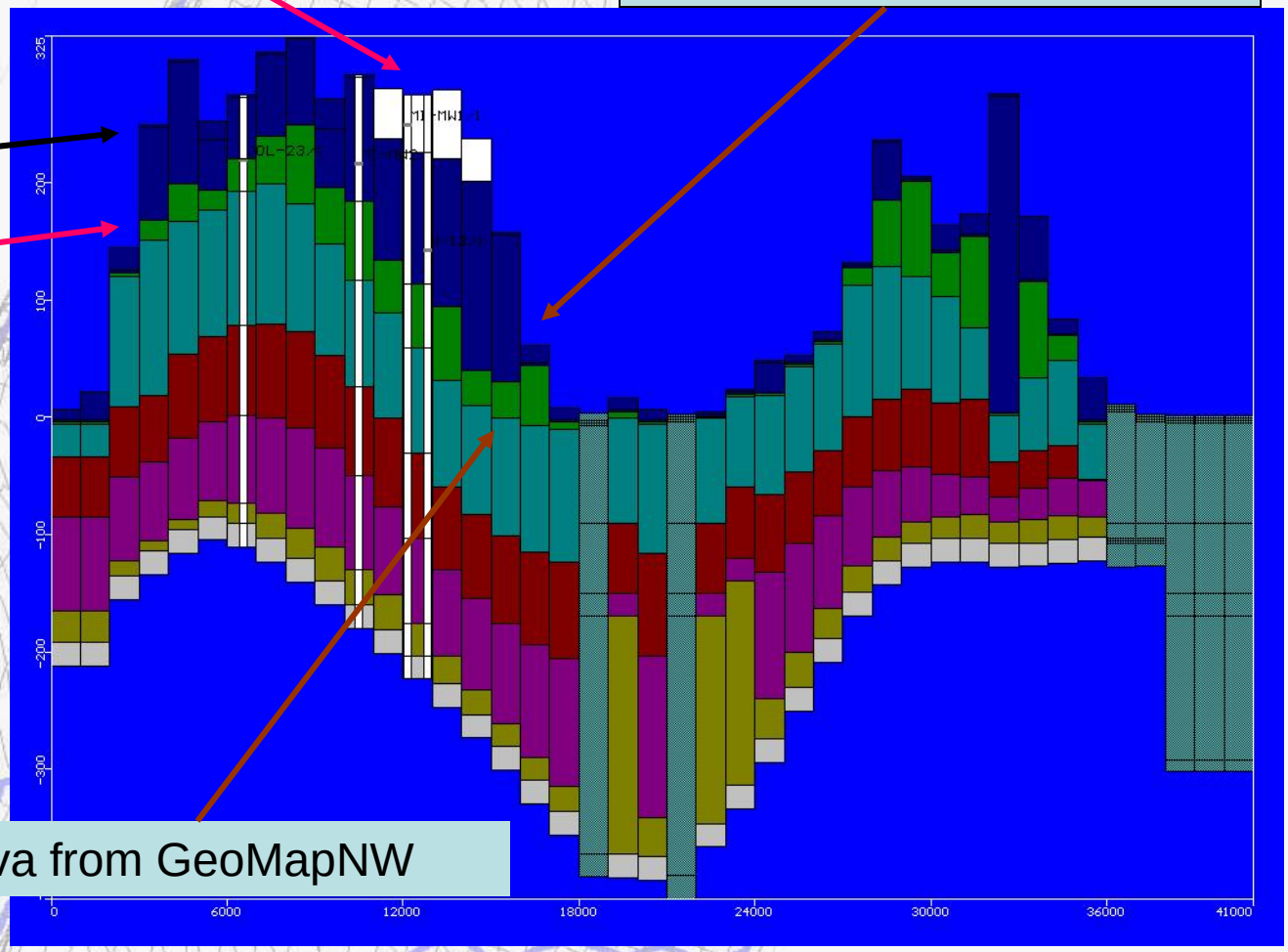
Grid

- 1000 ft squares
- N-S, E-W oriented
- 41 columns by 67 rows
- 1270 active cells per layer (out of 2747 possible)



Layers

- Qvr (aquifer)
- Qvt (aquitard)
- Qva
- Qpff
- Q(A)c
- Q(B)f
- Q(B)c



Data needs

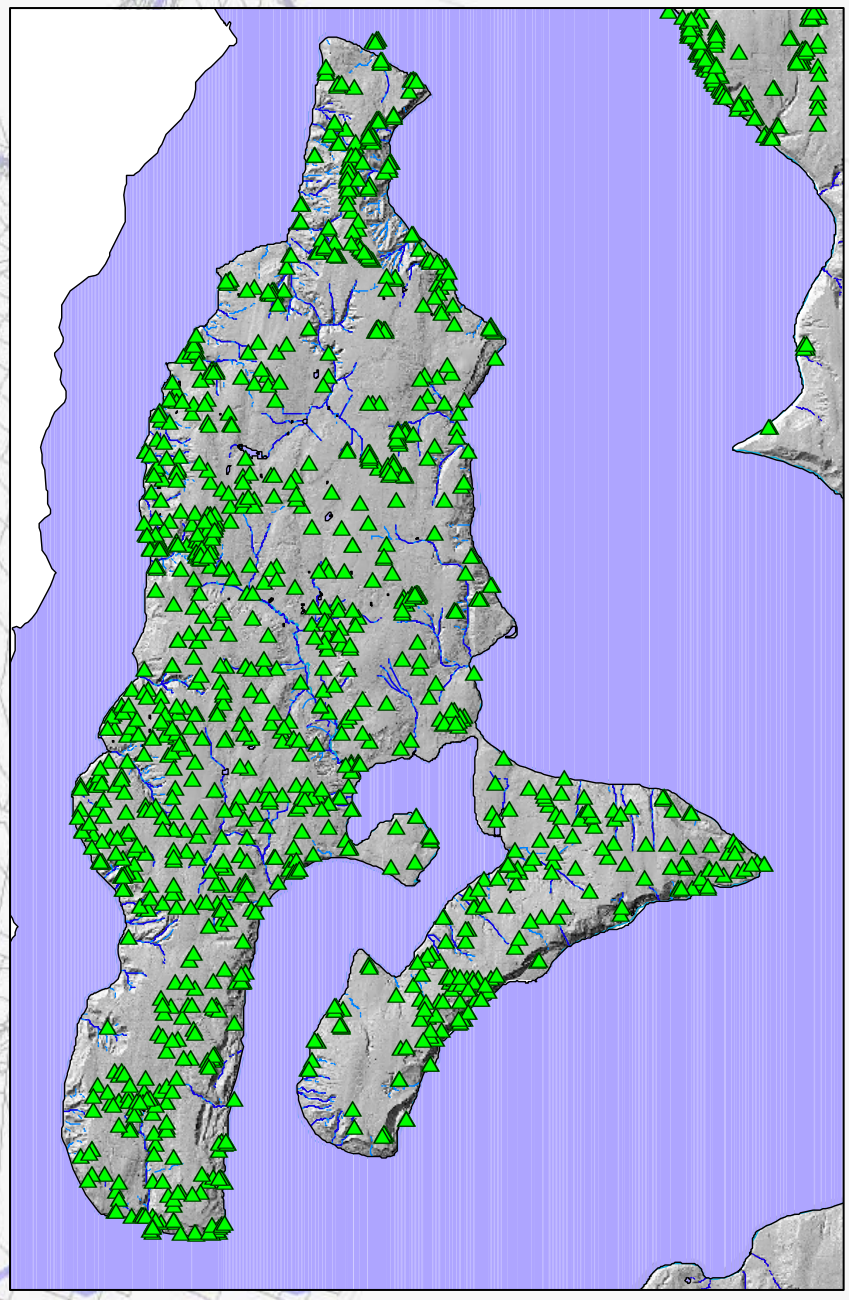
- *Discretization*: Layers / grid
  - Properties of Aquifers / Aquitards
  - *Steady state* time
- Stresses / *Boundary Conditions*
  - Pumping wells
  - Recharge
  - Rivers / streams
  - Springs / drains

Data Sources

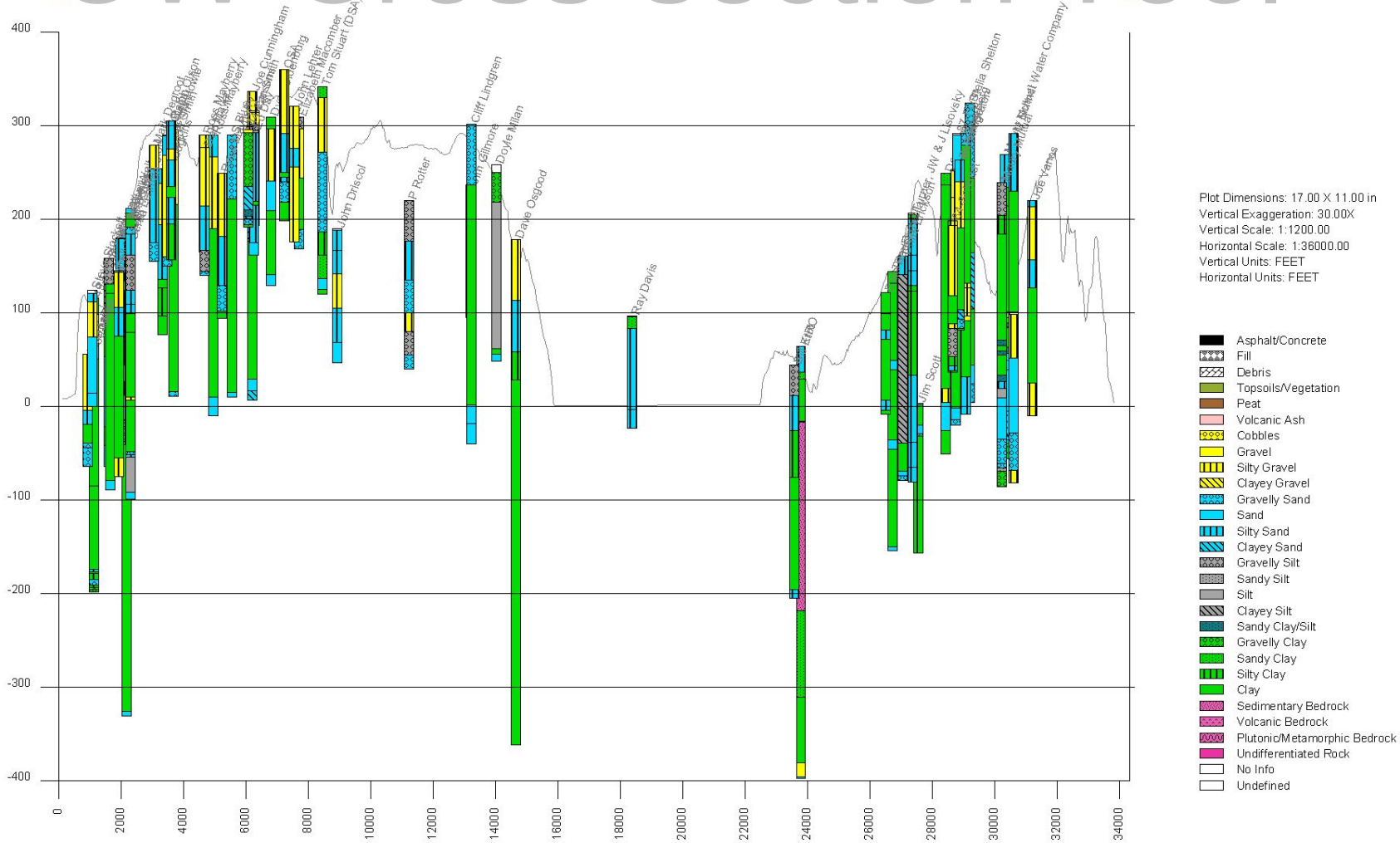
- Stratigraphy database by UW GeoMapNW (recall Science Seminar presentation by Kathy Troost, October 2004)
- Aquifer parameters: Purveyors, SWD (very little data: only 5 pumping tests, 13 slug tests), Ecology logs
- Pumping from purveyors (large systems)
- Monitoring data (GW levels, stream flow)

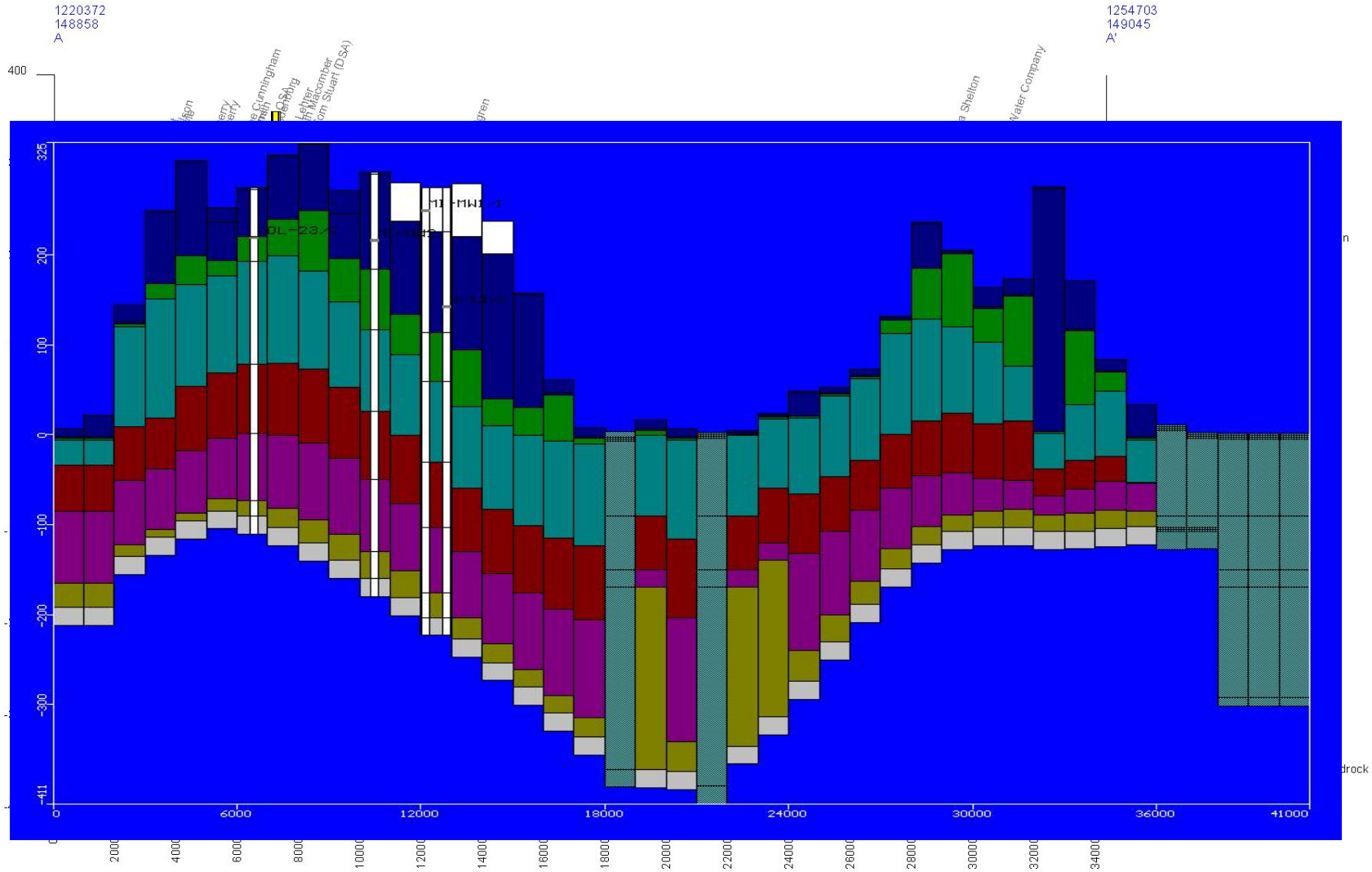
UW borehole logs

- Currently 1367 logs / exploration locations
  - (Receive updates)
- 6812 layer descriptions
- 948 water level locations



UW Cross-section Tool

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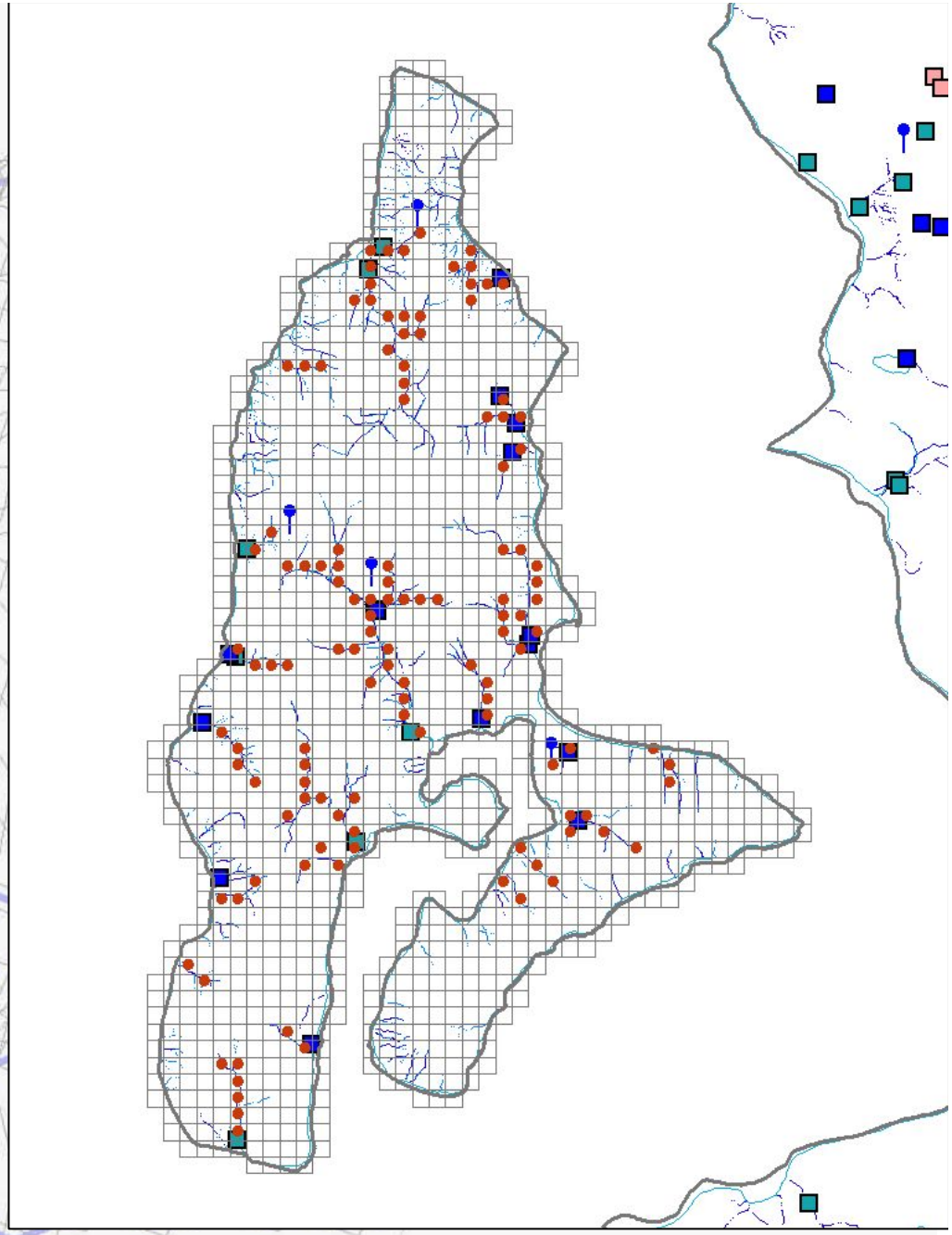
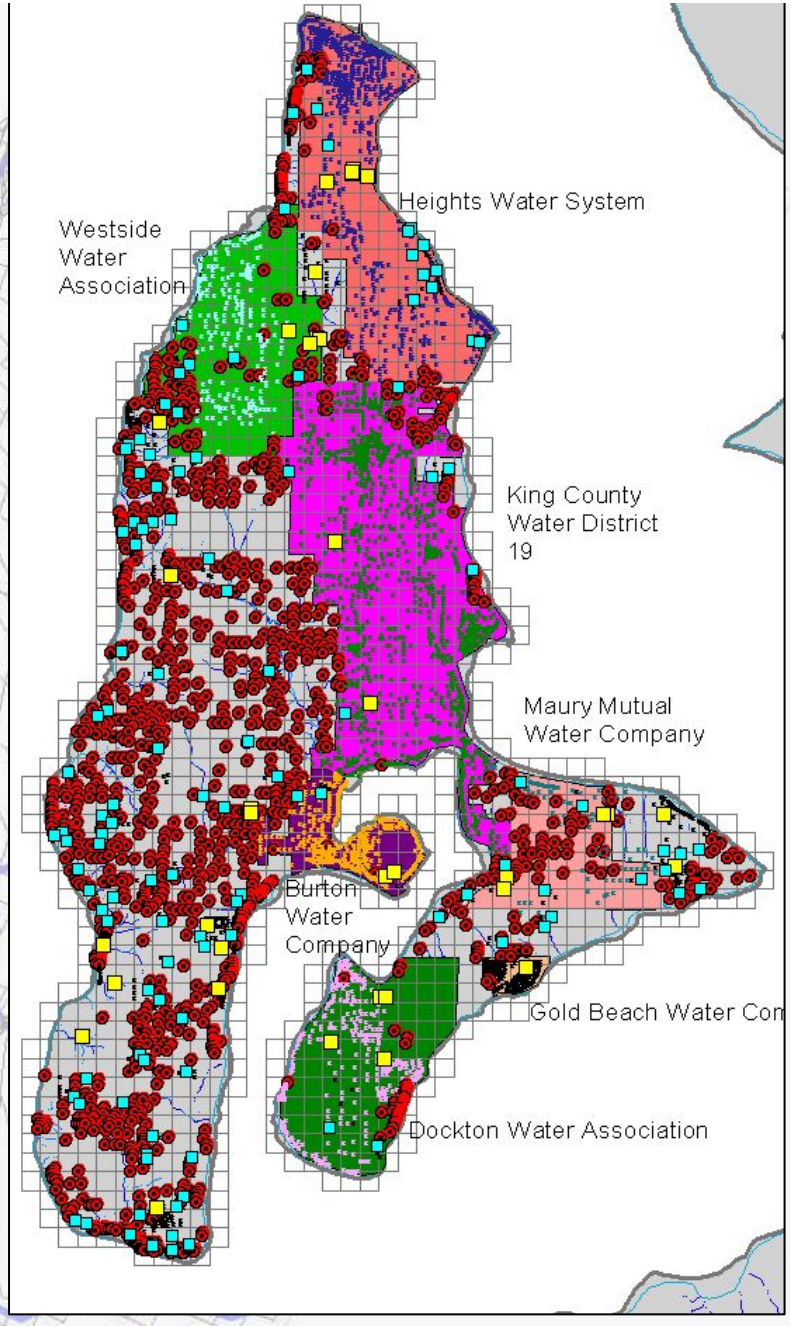
Streams

- “River” boundary conditions allow flow in/out between aquifer and stream
- Sum cell flows and compare with base flow measured



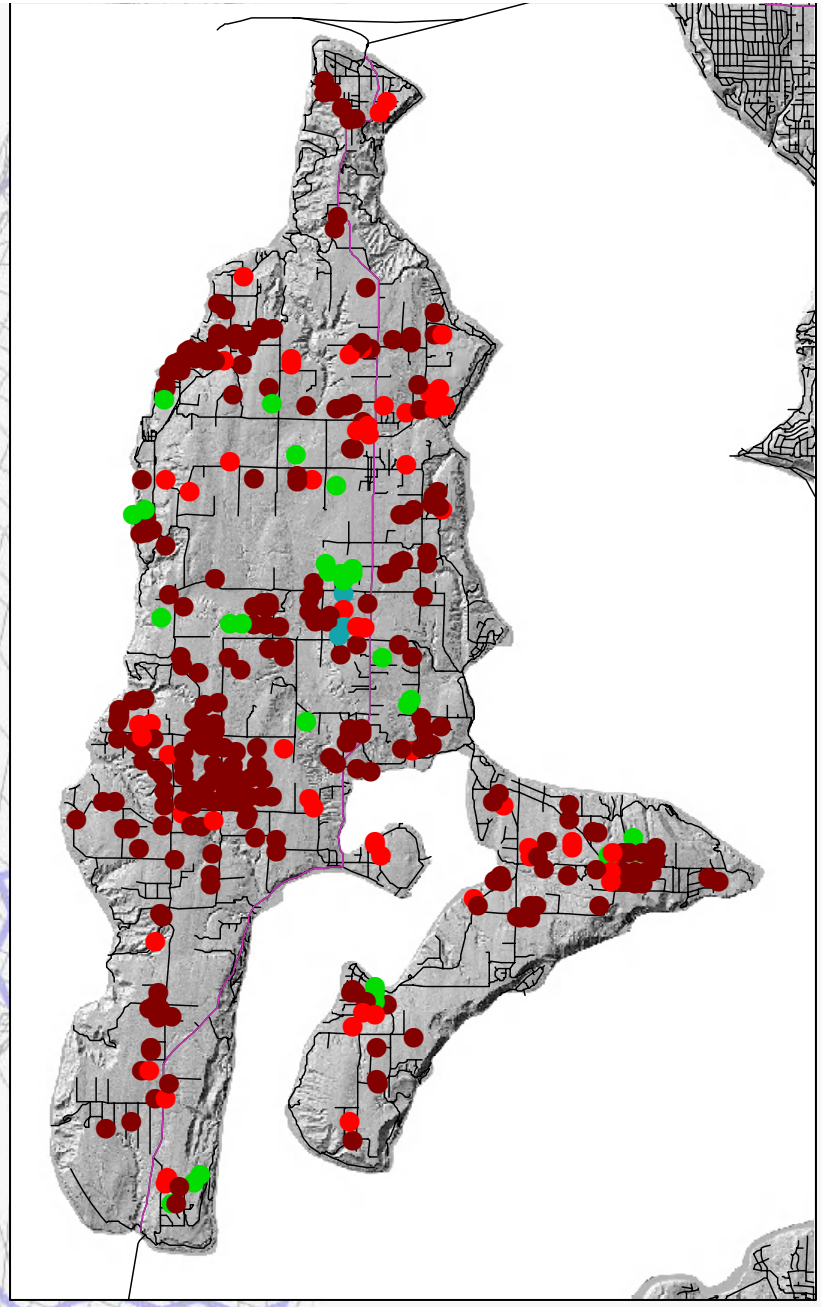
Difficulties / Solutions

- Individual wells
  - Where?
  - How much use?
- Agricultural water use
- Springs



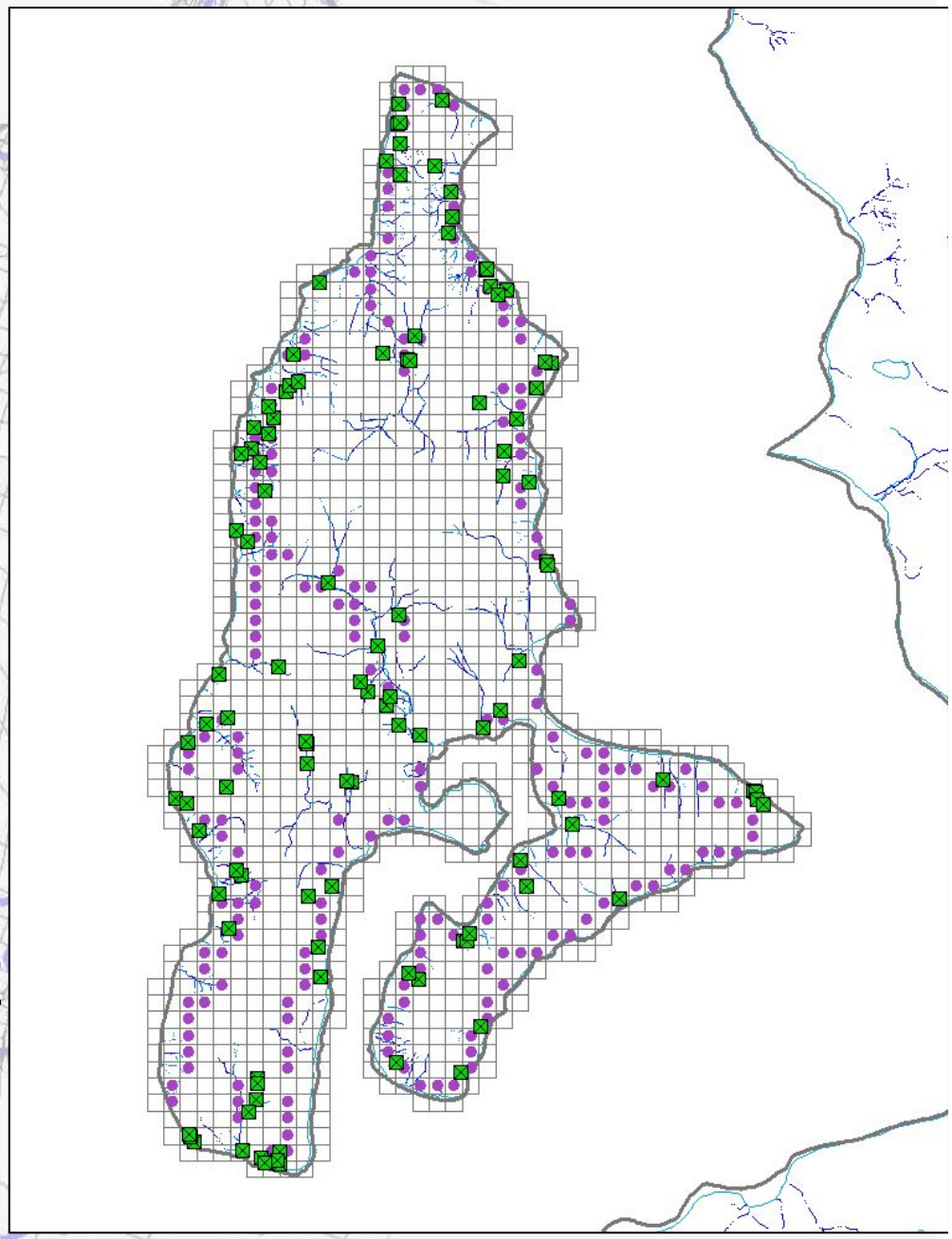
Ag water use

- Locations from WLRD Ag program, KCD
- Mostly for livestock
- Potential water use rates from NRCS
- Total ag use could be more than human use



Springs

- A major feature on VMI (e.g., some large systems use)
- No comprehensive mapping
- Include in model as “drain” BC (flow out only)



Applications

- Siting of Monitoring Wells
  - Anomalous water levels
  - Aquifer property investigation
  - Stratigraphic data gaps
  - WQ areas of concern
- Scenarios
- Basis for subsequent model phases
  - Finer mesh, more layers
  - Develop better data