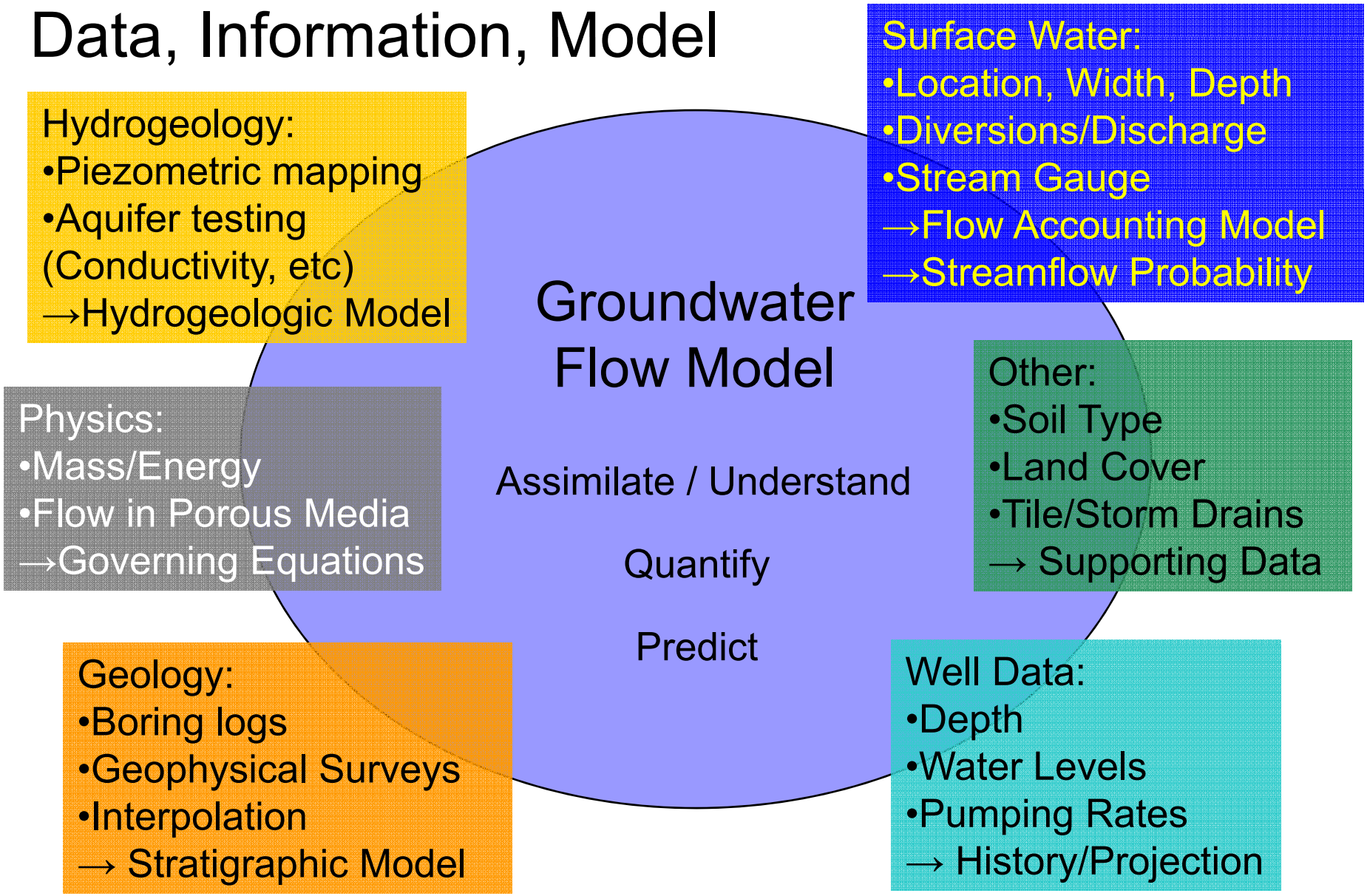
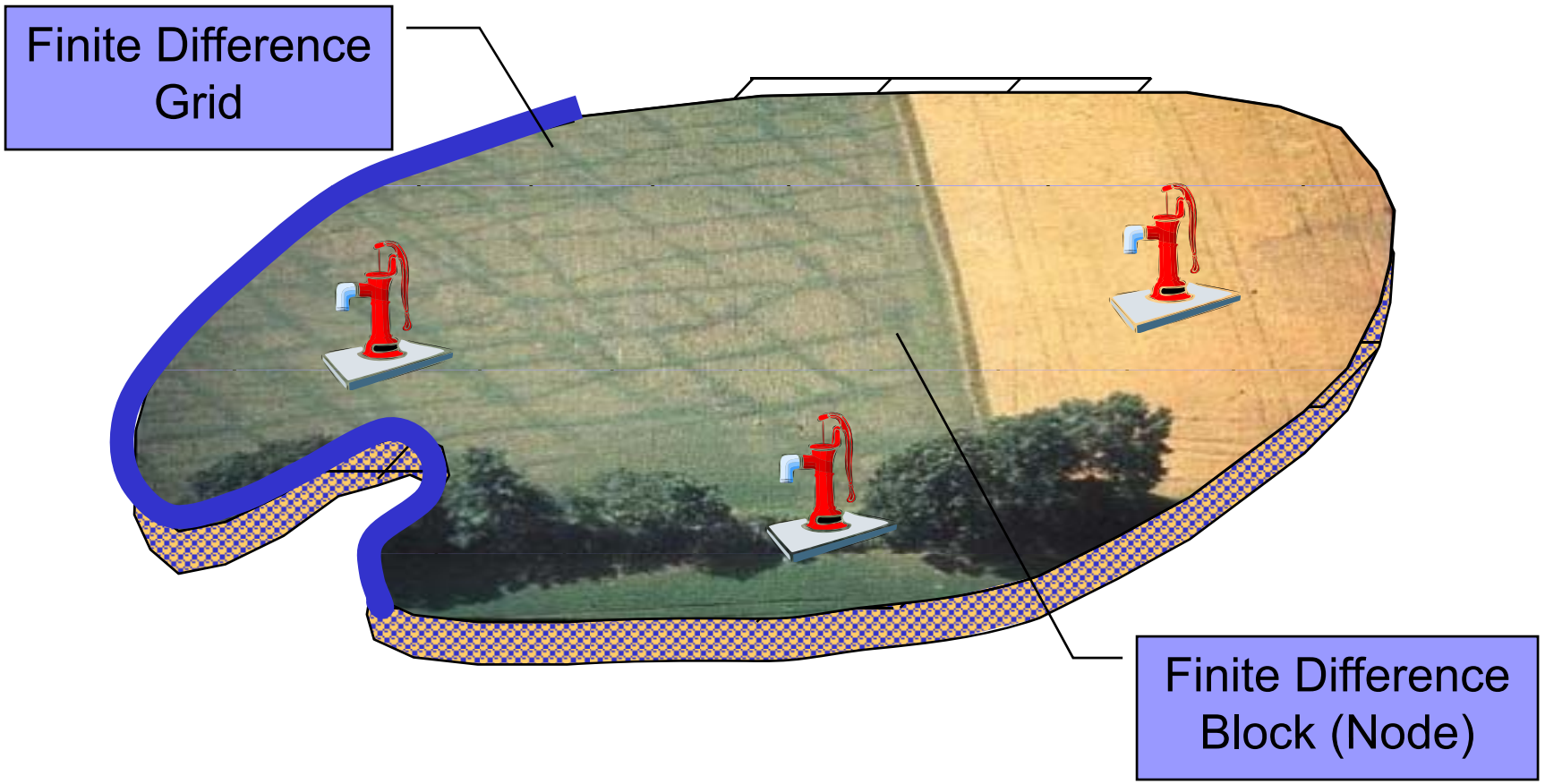
Groundwater Flow Modeling

Douglas D. Walker
Illinois State Water Survey
Illinois Department of Natural Resources

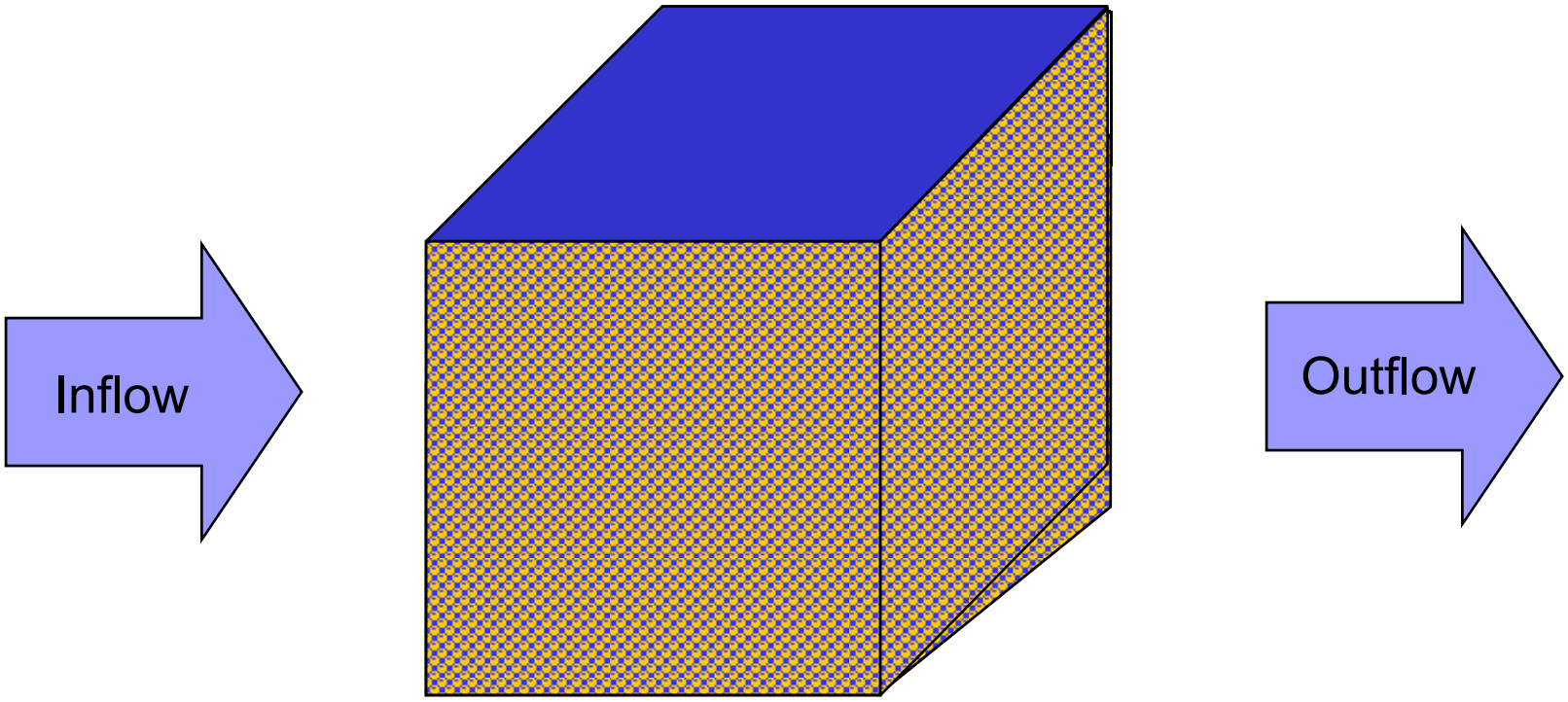
Data, Information, Model



Groundwater Flow Model

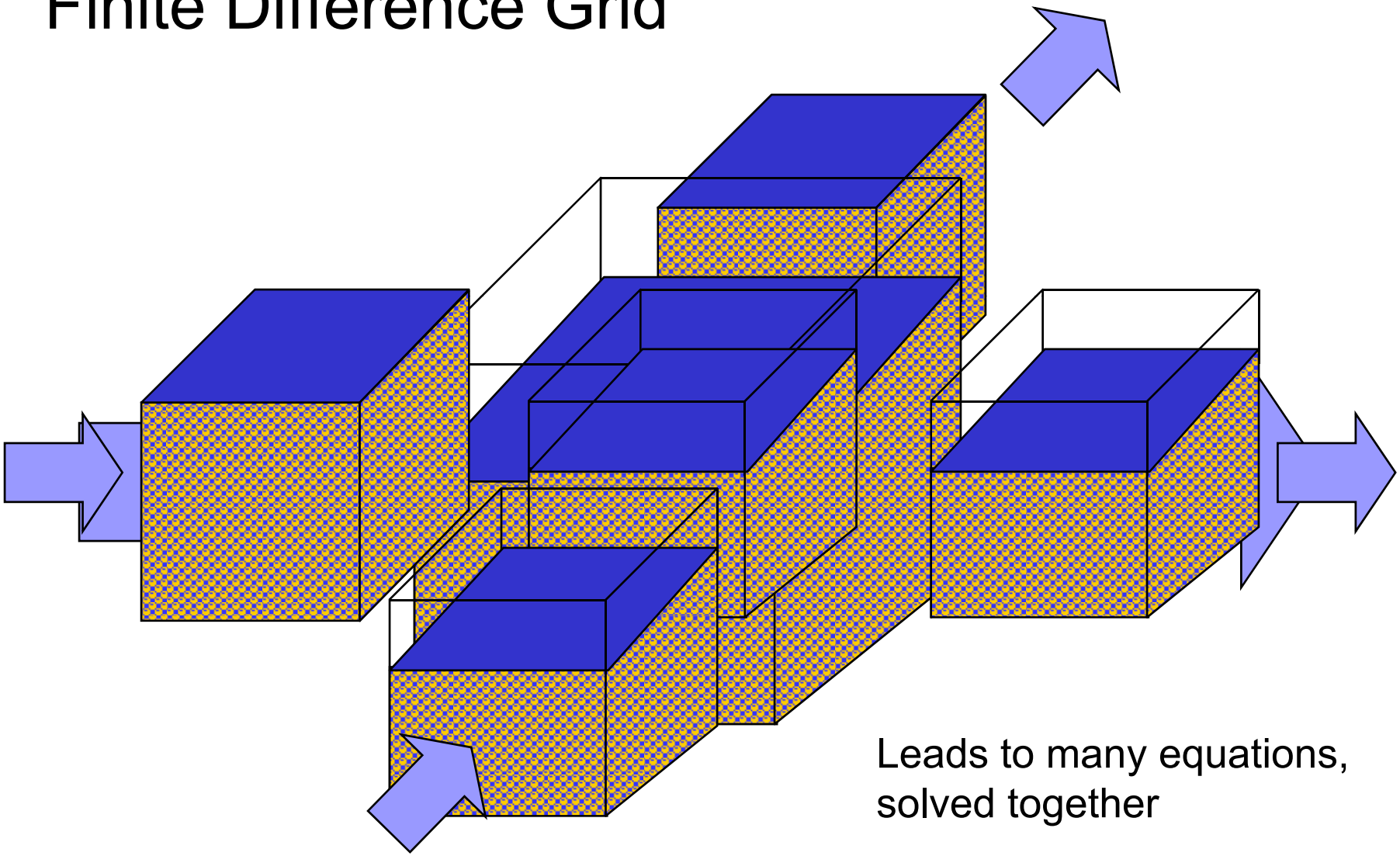


Finite Difference Block



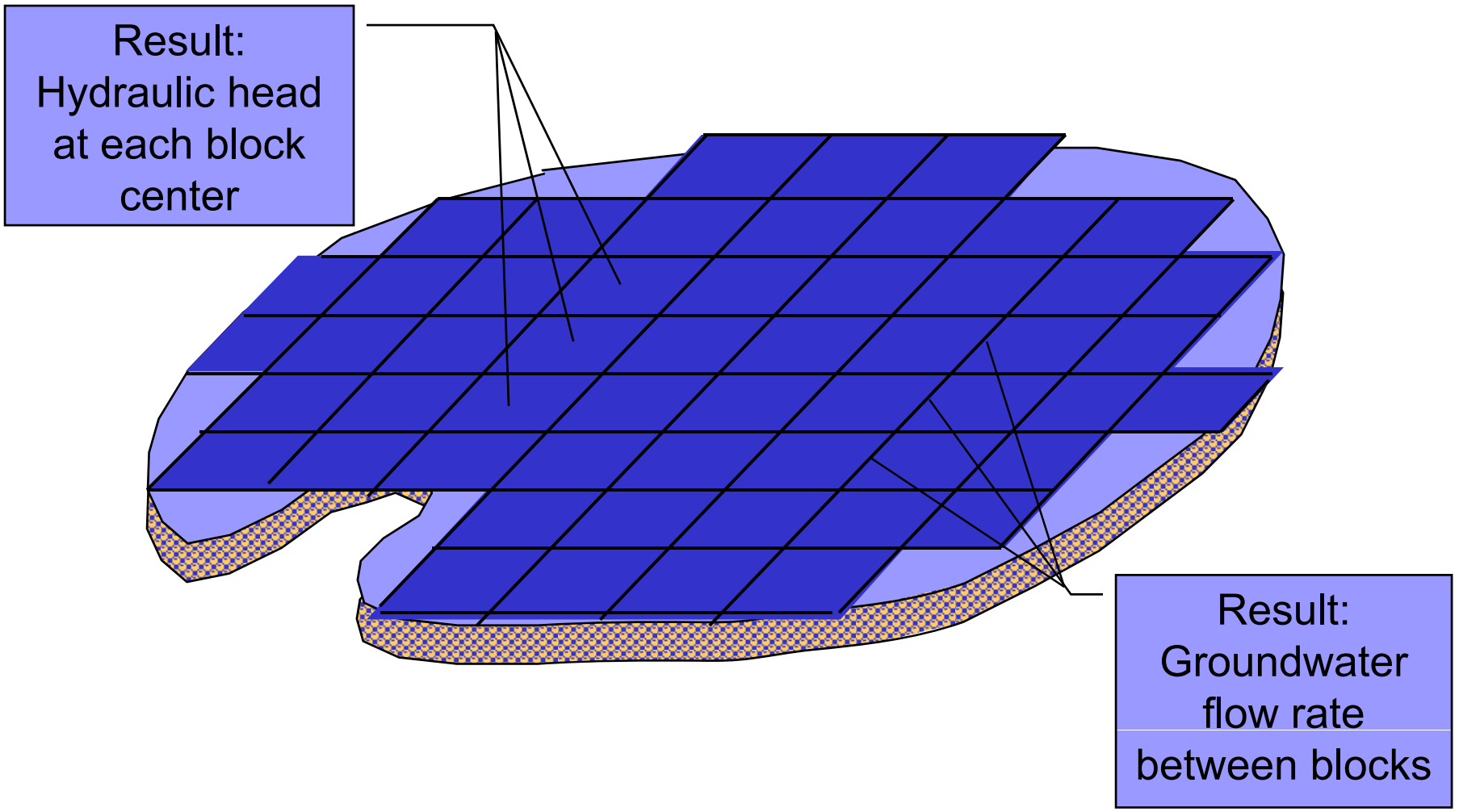
Inflow – Outflow = Change in Storage

Finite Difference Grid

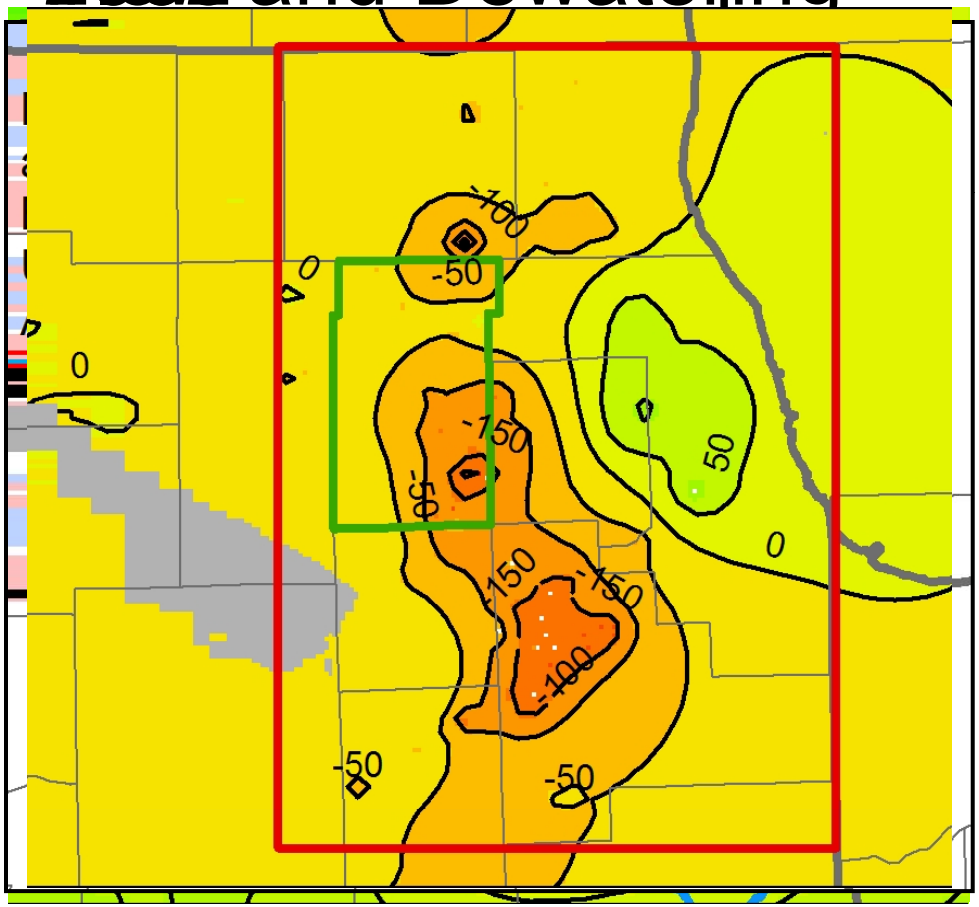


Leads to many equations, solved together

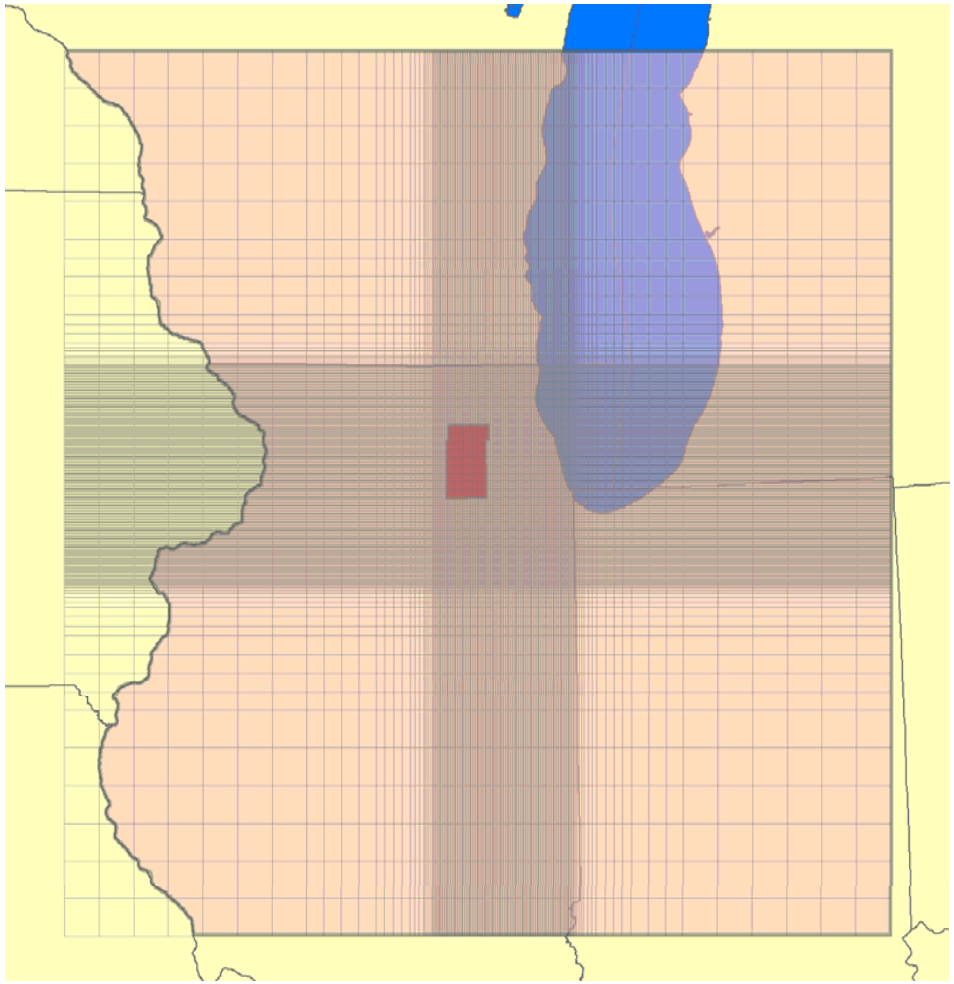
Groundwater Flow Model



Model Analyses



Groundwater Flow Model



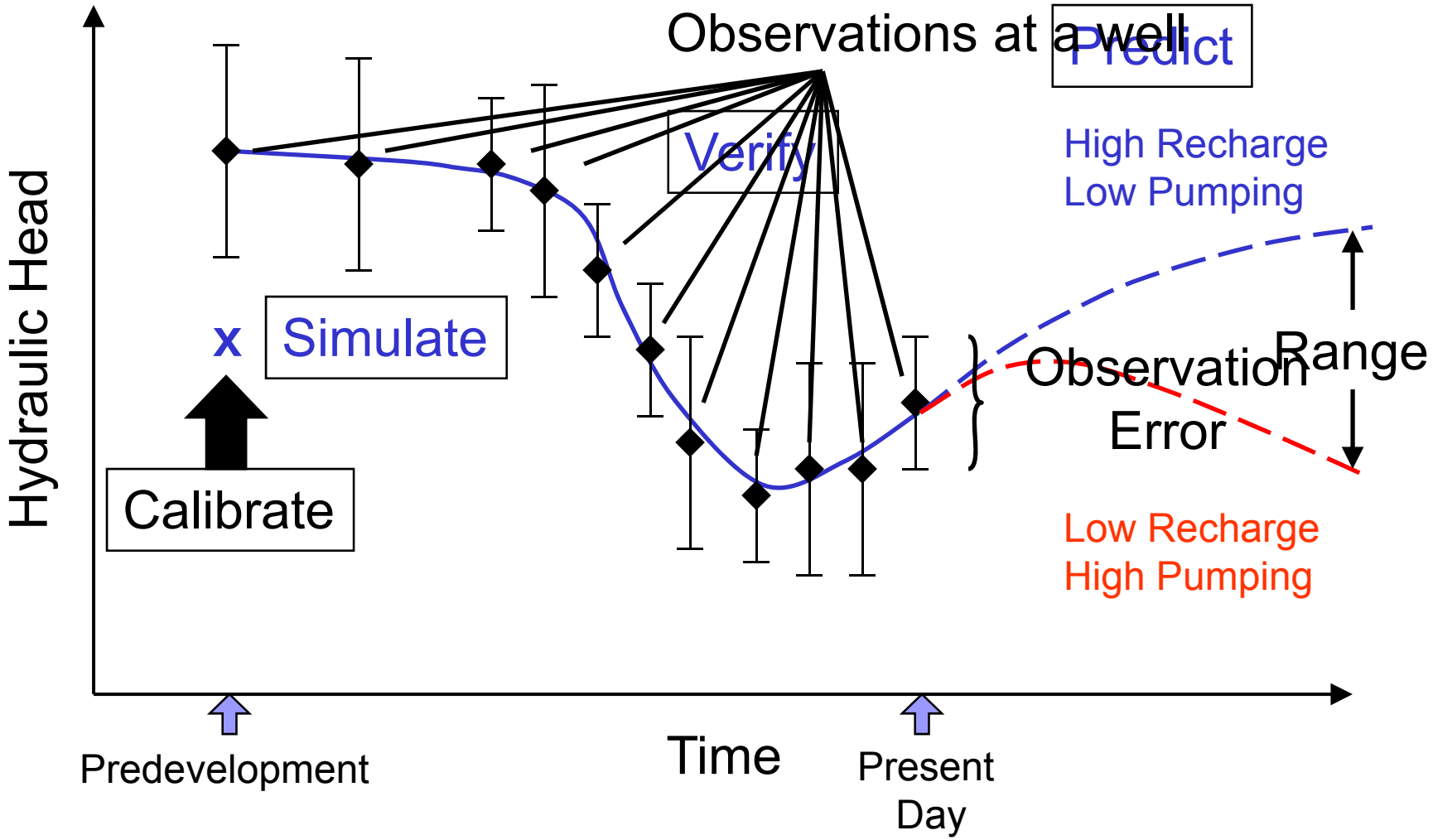
- Conceptual Model
  - Geology, hydrology, etc.
  - Organize/interpret data
- Mathematical Model
  - Physics → Governing equations
  - Boundaries/parameters
  - Yields water levels/flow rates
- Numerical Solution by Finite Difference Approach
  - Flexible, detailed representation of geology and hydrology
  - Many equations, parameters, data
  - Computer program MODFLOW
  - Output processed into head and flux maps, transient or steady-state

Groundwater Flow Model

The mathematical representation of a conceptual model of the aquifer, solved numerically on a computer to determine the distribution of hydraulic head and flows throughout the aquifer:

"The Model"

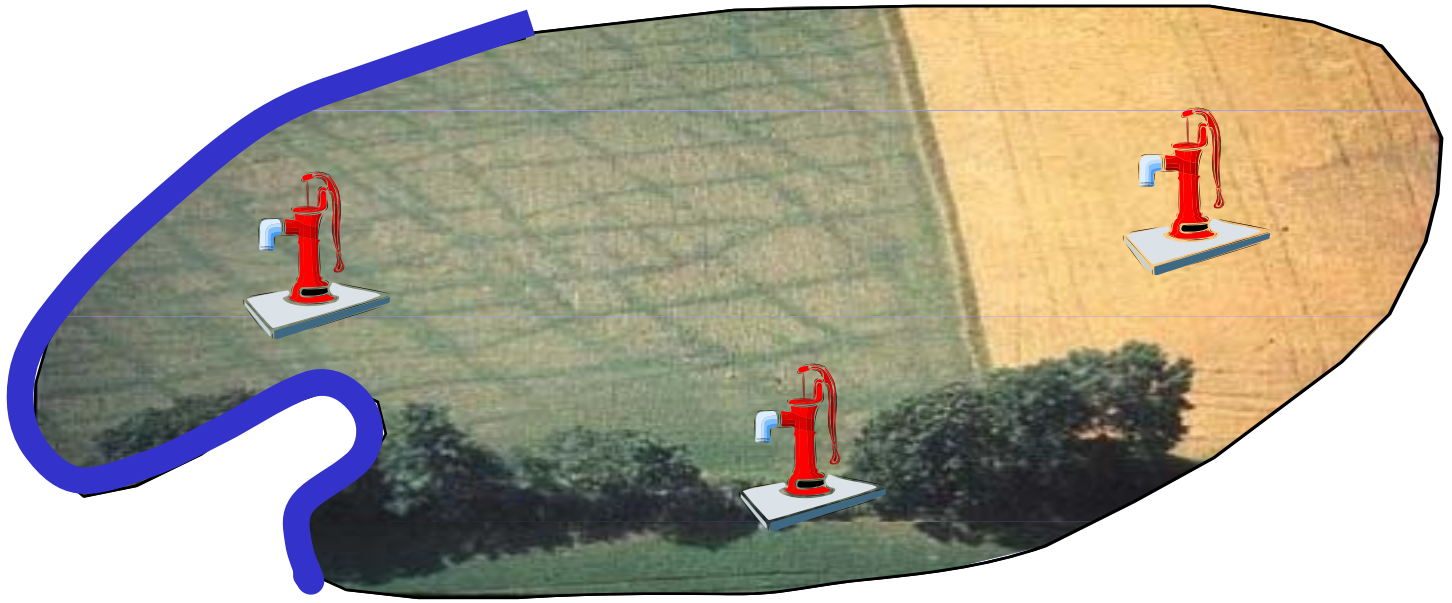
Model Confidence and Range of Results



Questions the Model Can Answer

Does pumping affect streamflow?

Where does the water come from?



Are additional measurements needed, and where?

What are the long-term effects of current pumping?

Additional Products of the Model

- Data sets and parameter values cross-checked for consistency.
- Framework for follow-up studies of greater detail
  - Wellfield design
  - Groundwater contamination
- Data, information, and results in GIS format.
- Baseline conditions for water management.

Defines the groundwater resource and adds to the scientific basis for water supply planning.

For this Study, Models on Two Scales:

Regional Model
Approx. 800,000 nodes
Min grid spacing 2,500 ft.
All aquifers

Local Model
Approx. 1.5 million nodes
Min grid spacing 660 ft.
Shallow aquifers only

For consistency and realism, the local model takes its boundary conditions from the regional model