Resource Assessment

West Virginia Water Resources Training Workshops

Presented by the Interstate Commission on the Potomac River Basin

Sponsored by the West Virginia Department of Environmental Protection

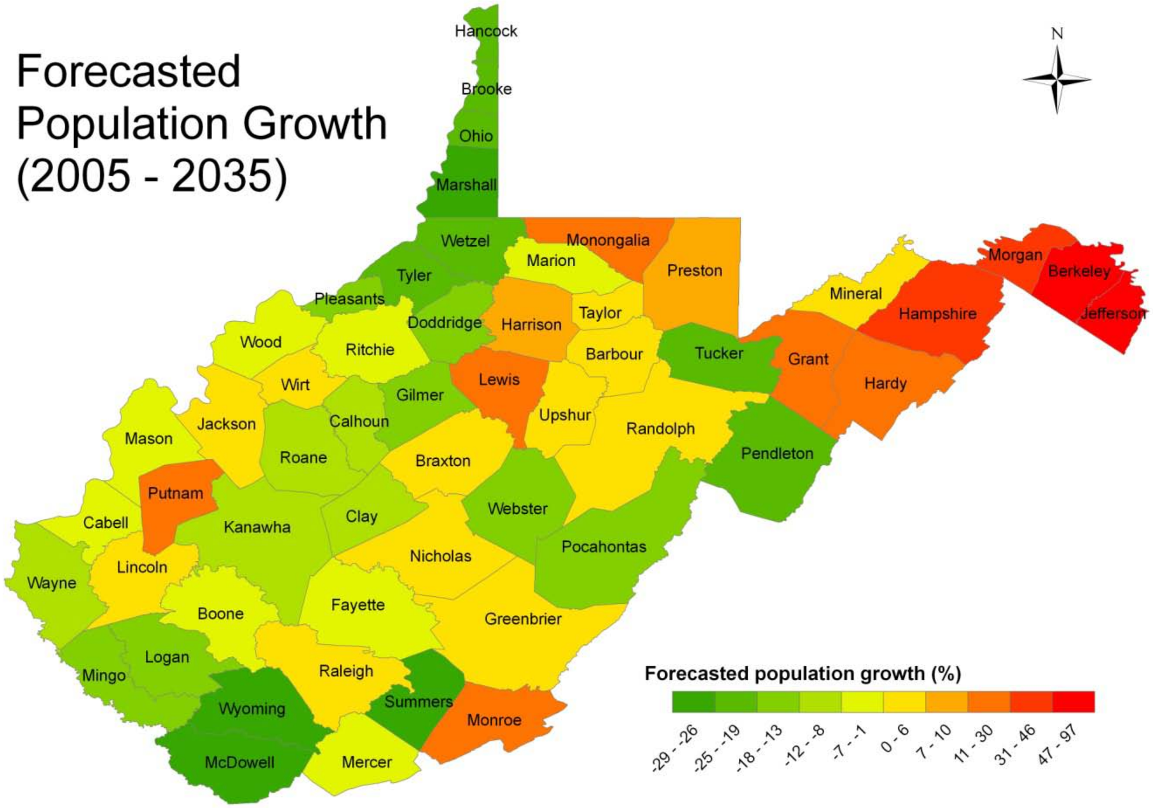
With funding from the American Reinvestment & Recovery Act

Outline

- Water availability: why worry? who cares?
- Safe yield
- Watershed water budgets
- Risk-based approach

Why worry about availability?

- Forecasted population growth
- Industrial growth
- Contaminated sources
- Desire to extend public supply to self-served population



Derived from Cristiadi, 2009

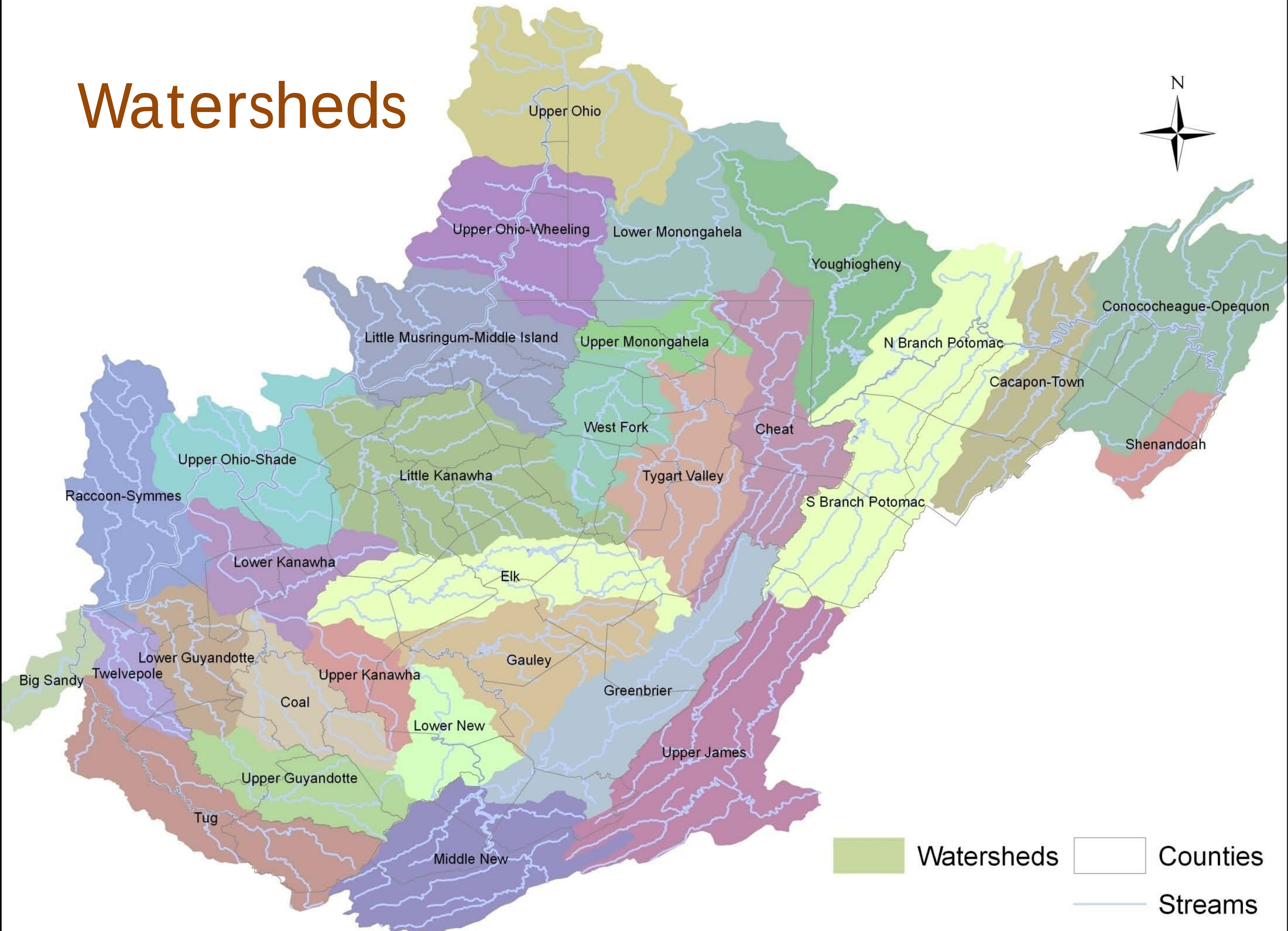
Who worries about availability?

- Individual water providers
  - Municipalities, PSDs, self-served industries, …
  - Focus on local resources - evaluate and develop
    - Wells
    - Streams
    - Impoundments (reservoirs or natural lakes)
  - Need technical evaluations of individual sources to determine safe yield of reservoir, best locations for wells, …
- Regional entities
  - Counties, states, regional commissions
  - Focus on watersheds – surface water & ground water as a single resource
  - Planning based on use & availability by watershed

Safe Yield & WV Planning

- **West Virginia's State Water Resources Management Plan**: the state shall develop "An inventory of the surface water resources of each region of this state, including an identification of the boundaries of significant watersheds and an estimate of the safe yield of such sources for consumptive and nonconsumptive uses during periods of normal conditions and drought."

Watersheds



N
Upper Ohio
Upper Ohio-Wheeling
Lower Monongahela
Youghiogheny
Conococheague-Opequon
Little Musringum-Middle Island
Upper Monongahela
N Branch Potomac
Cacapon-Town
West Fork
Cheat
Shenandoah
Upper Ohio-Shade
Little Kanawha
Tygart Valley
S Branch Potomac
Raccoon-Symmes
Lower Kanawha
Elk
Lower Guyandotte
Twelvepole
Big Sandy
Upper Kanawha
Gauley
Greenbrier
Coal
Lower New
Upper James
Upper Guyandotte
Tug
Middle New
Watersheds
Counties
Streams

Definitions

- *Safe yield* (standard definition): the maximum sustainable withdrawal that can be made continuously from a water source
  - For surface water sources: based on historic flow data/drought of record
  - For wells: based on estimate of average ground water recharge
- *Consumptive use*: The amount of water withdrawn that is not returned to the same water body
  - Due to evaporation, incorporation into products or crops, consumptive by humans or livestock
- *Drought of record*: worst event for which hydrologic records exist
  - For Potomac & Ohio River basins: summer 1930 – spring 1931
  - In West Virginia in July-August, 1930, annual precip was 59% of average, 2-month precip was 48% of average

Safe Yield – Limitations of Standard Definition

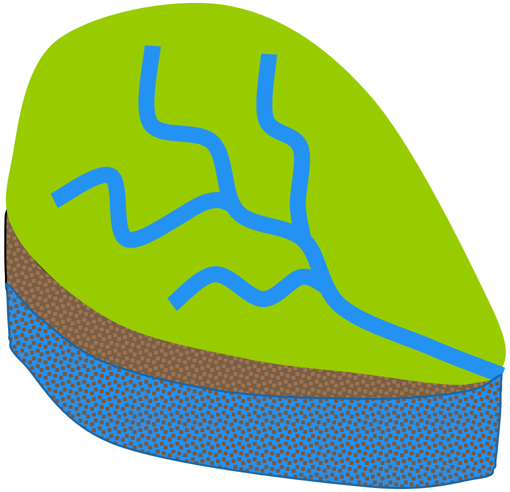
- Need to add to qualification: "… while preserving the source's aquatic habitat"
- Connotes "safety", and gives no indication of risk
  - For surface water – results based on drought of record may be too conservative
  - For ground water – results based on annual may be not be conservative enough – misses risk of summertime low flows
- Doesn't consider cumulative impact of consumptive use

Safe Yield – Simple Stream Example

- Happy Hollow, WV:
  - Currently uses 0.5 mgd
  - Projects demand of 0.8 mgd in 2030
- The municipal water source is Bubbly Brook, and USGS records show:
  - Annual mean flow = 15 cfs (15 cfs x 0.65 = 9.7 mgd)
  - August mean flow = 7 cfs (7 cfs x 0.65 = 4.5 mgd)
  - Lowest recorded flow was 1 cfs (1 x 0.65 = 0.65) mgd on Oct 15, 1930
- Safe yield analysis indicates that an additional water source must be developed

Bubbly Brook safe yield = 0.65 mgd

Safe Yield – Groundwater Example



Standard calculation based on annual average recharge:

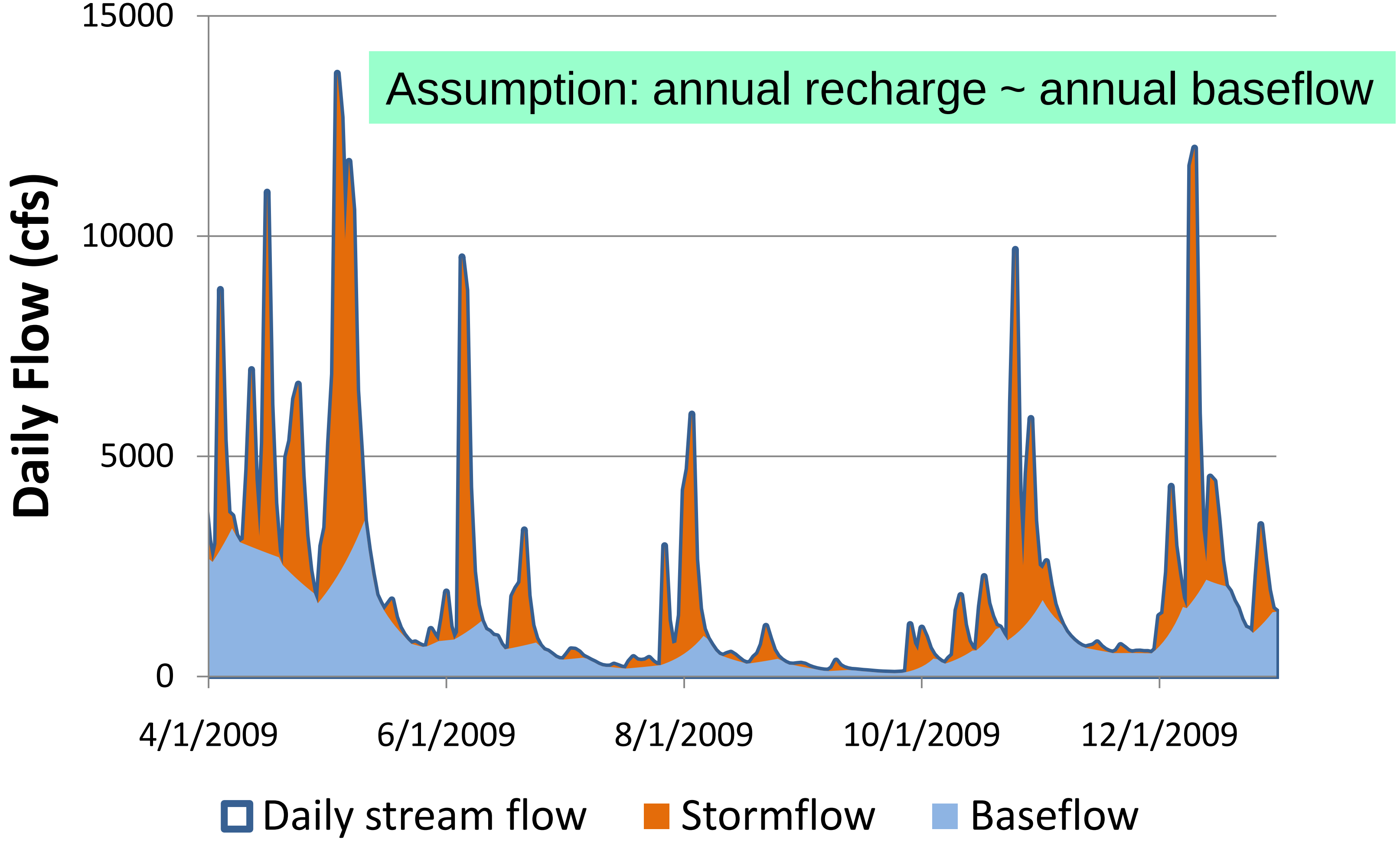
- Use long-term record of daily stream flow
- Compute average annual baseflow using "hydrograph separation"
- Assumption: baseflow ~ recharge

Typical annual average recharge for Mid-Atlantic bedrock aquifer/stream systems:

8 inches/year ~ 600 gpd/acre*

*Caution: may not capture risk of seasonal low flows – see seasonal variability slide

Hydrographic Separation – Cheat River



Estimates from USGS program “PART”

Surface Water & Ground Water – a Shared Resource

- Groundwater flow paths tend to mimic topography
- Recharge within a watershed is shared: available for well withdrawals & discharge to streams

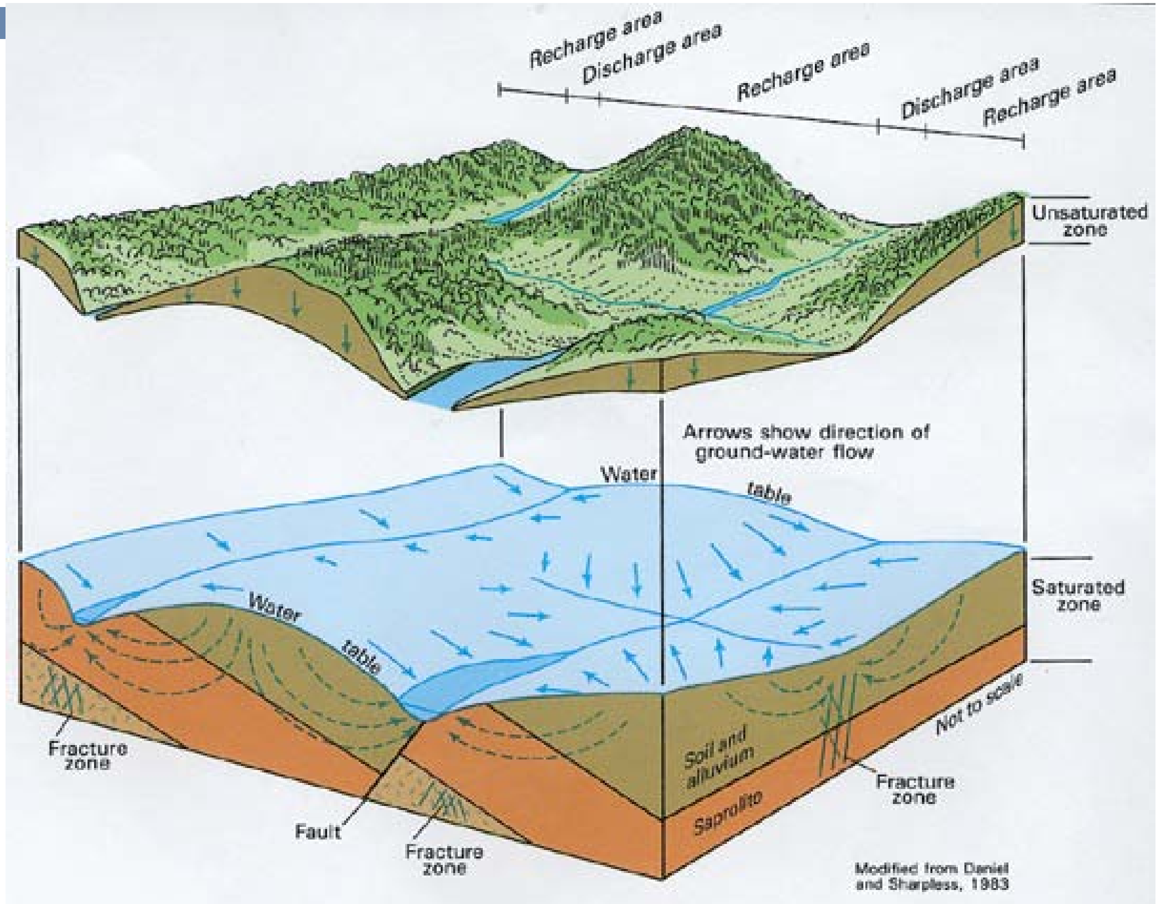
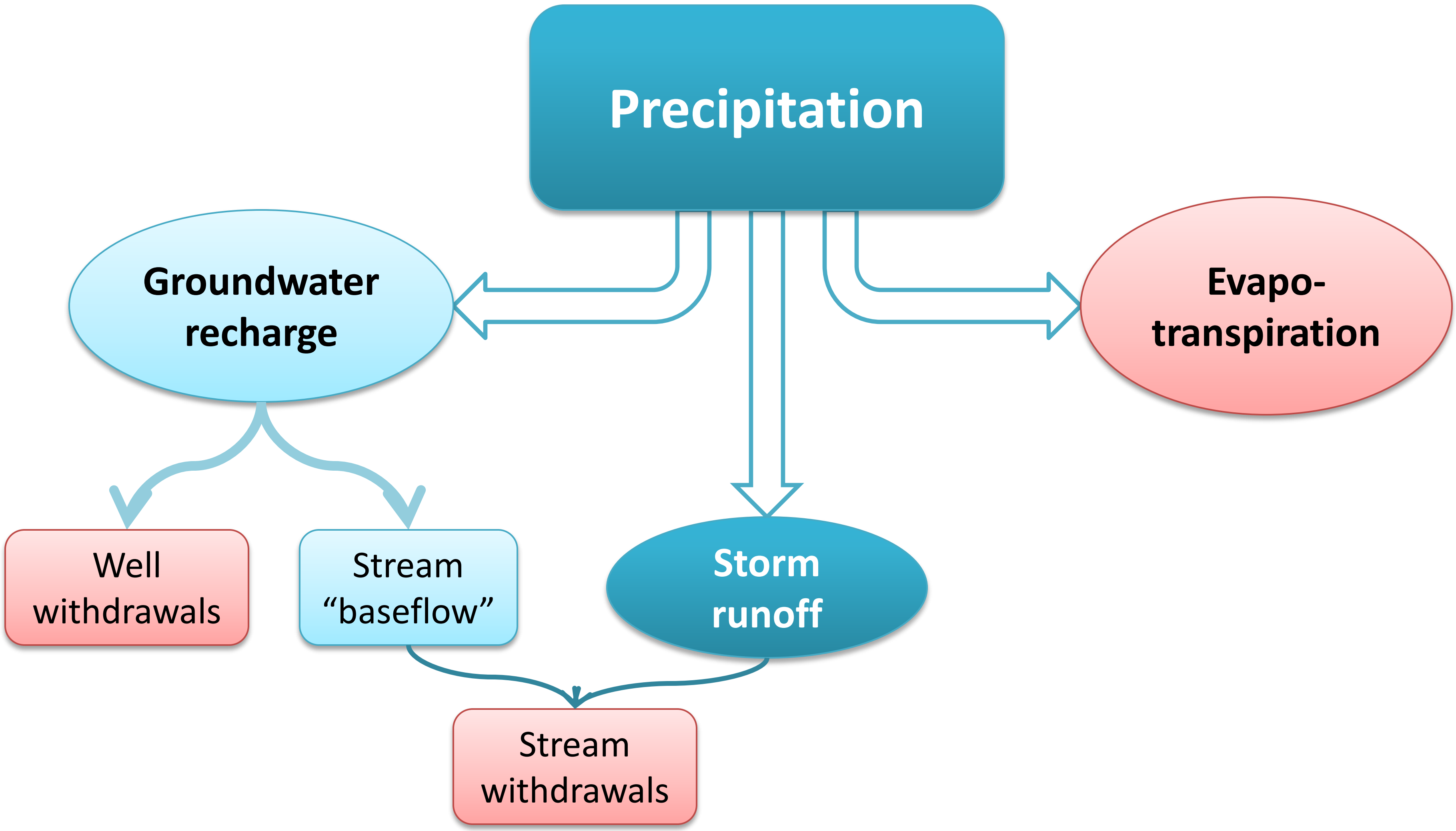


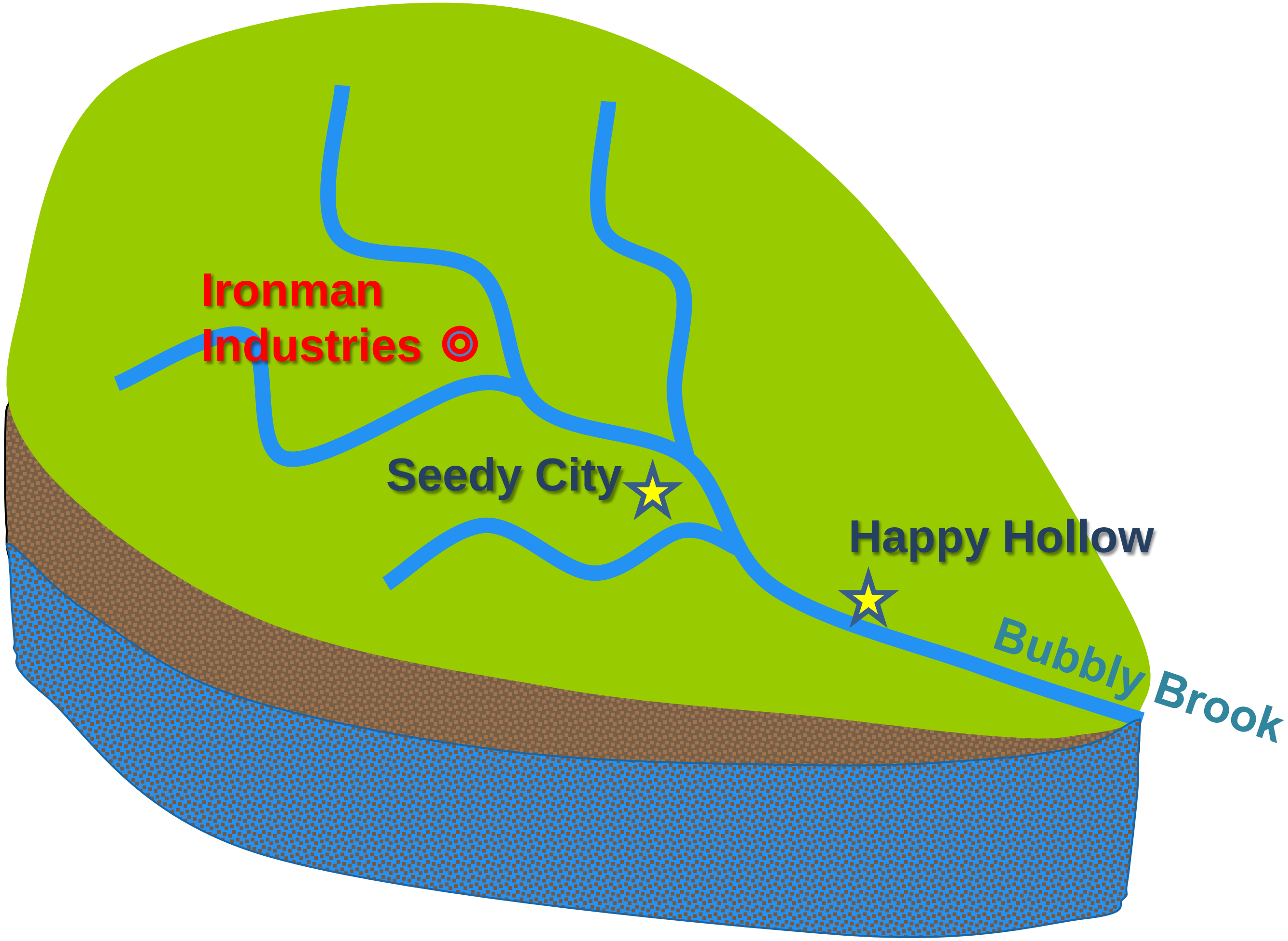
Figure 92. *Ground water percolates downward through the unsaturated zone (shown lifted up) to the water table, then moves laterally to discharge points. In the bedrock, the water is channeled through fractures.*

Figure from USGS, Groundwater Atlas of the United States, at pubs.usgs.gov/ha/ha730/ch_g/G-text8.html

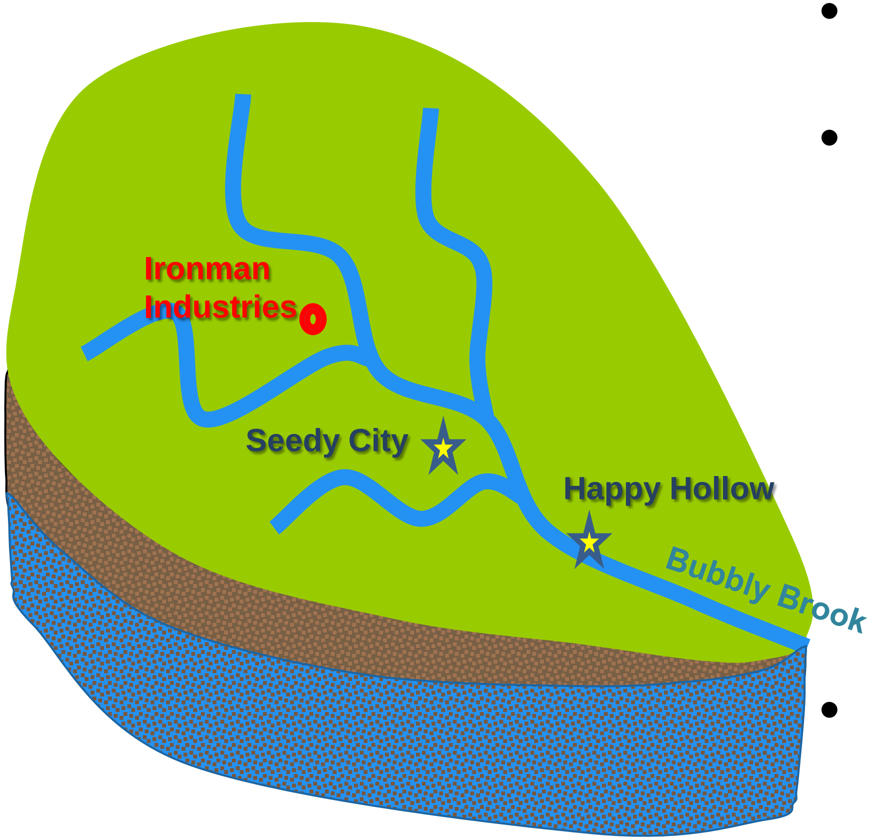
Watershed Water Budgets



Watershed Water Budgets



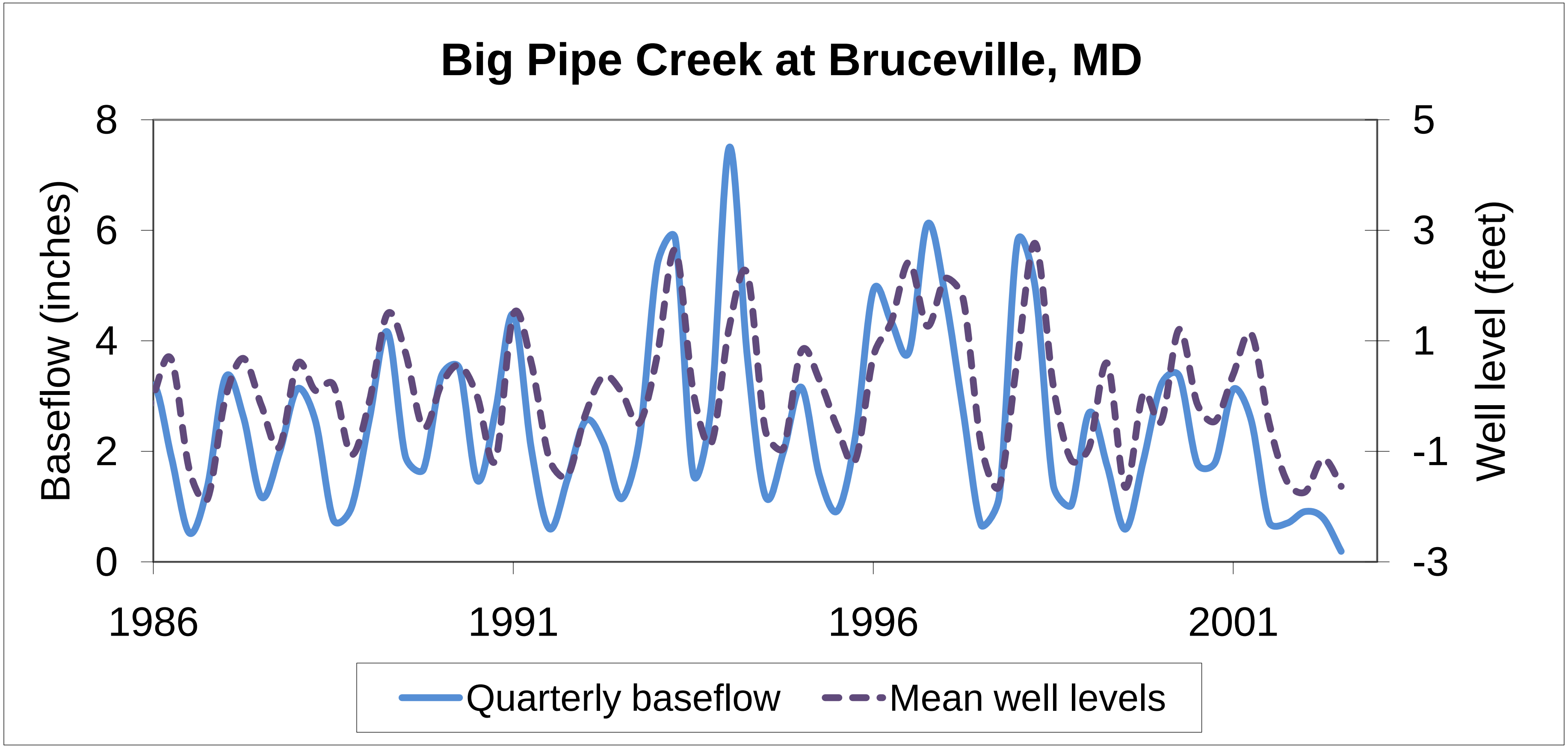
Watershed Water Budgets



- Especially important in fractured bedrock environments
- Surface water and ground water: a shared resource for diverse set of users:
  - Municipal, industrial, & agricultural well owners
  - Individual residential wells
  - Municipalities, industries, & farmers relying on surface water withdrawals
  - Aquatic ecosystems relying on adequate in-stream flow
- Takes into account total consumptive use within a watershed
- Possible to do seasonal as well as annual water budgets

Seasonal Variability

- In our region, stream baseflow and aquifer levels lowest in summertime
- Season water budgets better at capturing risk of summertime shortages



Example of Seasonal Estimates from Maryland Study

Annual water budget

- Based on estimates of annual recharge
- Assumes no annual change in storage

Seasonal water budget

- Based on estimates of recharge and recession
- Estimates seasonal changes in storage

	Annual Recharge (gpd/acre)	Seasonal Summer recharge + summer storage (gpd/acre)		
Station	1 in 20 year	Median	1 in 10-year	1 in 20 year
Catoctin Creek (01637500)	350	210	65	60
Upper Monocacy River (01639000)	230	120	42	30
Big Pipe Creek (01639500)	350	460	190	150
Bennett Creek (01643500)	390	420	220	160

Risk-Based Approach

- Water suppliers want to minimize risk of shortages
- Zero risk?

Planning involves risk tradeoffs, whether explicit or not

Tradeoffs

- What's the probability of different drought stages?
- Is there a drought management plan with conservation and water use restrictions?
- What are the impacts/costs of shortages?

Resources

- Ground Water and Surface Water: A Single Resource, by T.C. Winter, J.W. Harvey, O.L. Franke, and W.M. Alley, 1998. USGS Circular 1139, online at http://pubs.usgs.gov/circ/circ1139/.
- USGS Water Science Center in Leestown, WV, http://wv.usgs.gov/.
- WVU Water Resource Institute, http://wvwri.nrcce.wvu.edu/.
- Canaan Valley Institute, http://www.canaanvi.org.