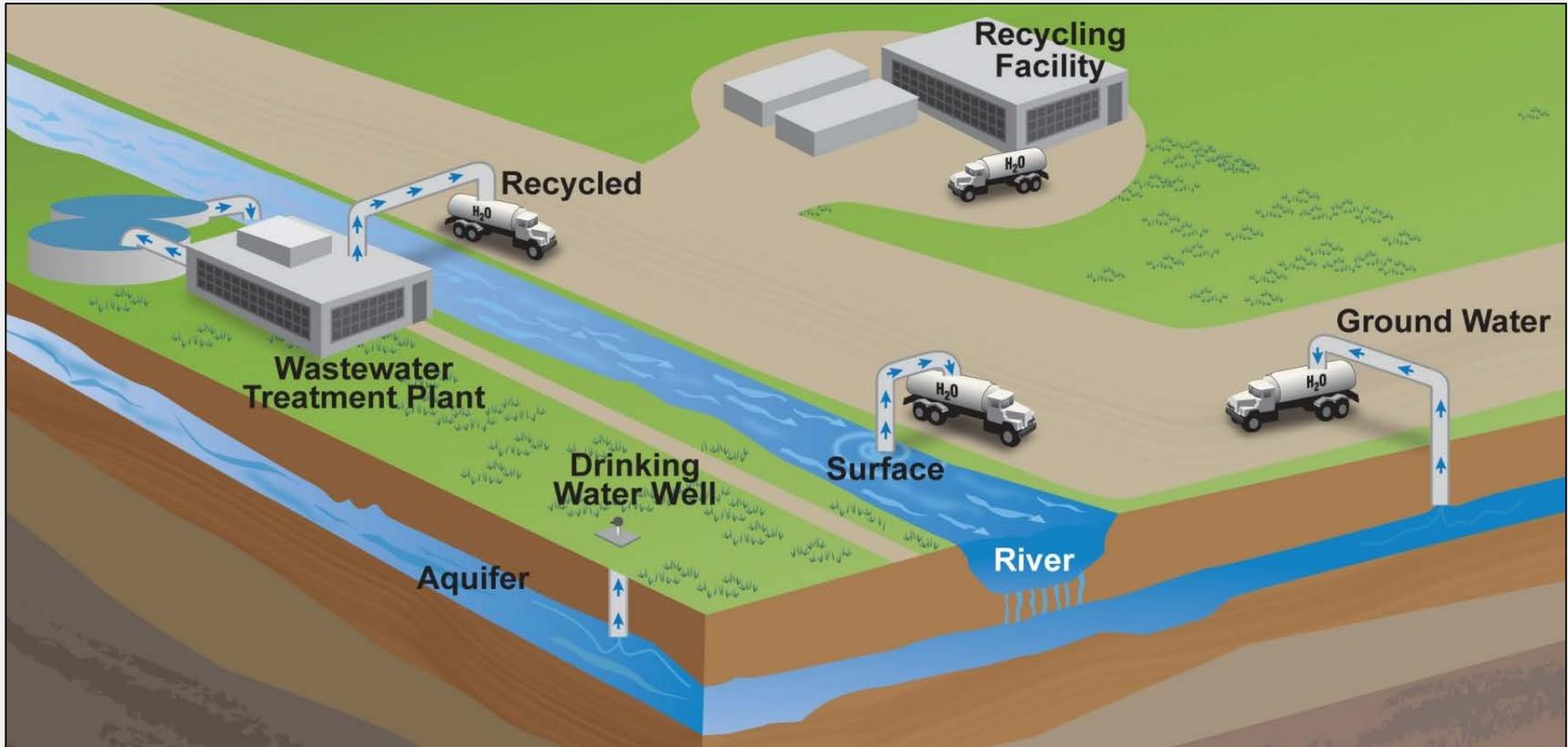


Water Acquisition

Jennifer Orme-Zavaleta, PhD



Water Acquisition



What are the possible impacts of large volume water withdrawals from ground and surface water on drinking water resources?

Charge Questions #1-3

Water Availability

- What **spatial and temporal** scales should be considered for this analysis to best characterize the impacts, if any, on the **availability** of water used as a source of drinking water.

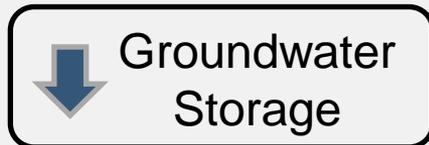
Water Quality

- What **spatial and temporal** scales should be considered for this analysis to best characterize the impacts, if any, on the **quality*** of water used as a source of drinking water?
- What are the most important **water quality** characteristics that should be considered?

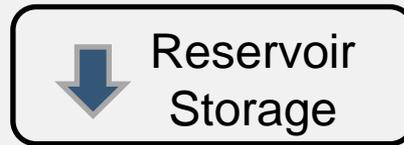
Activity – Stressor/Pathway – Impact



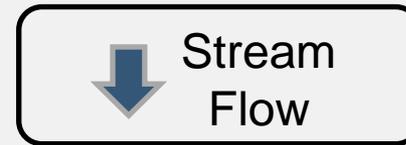
Consumptive Use



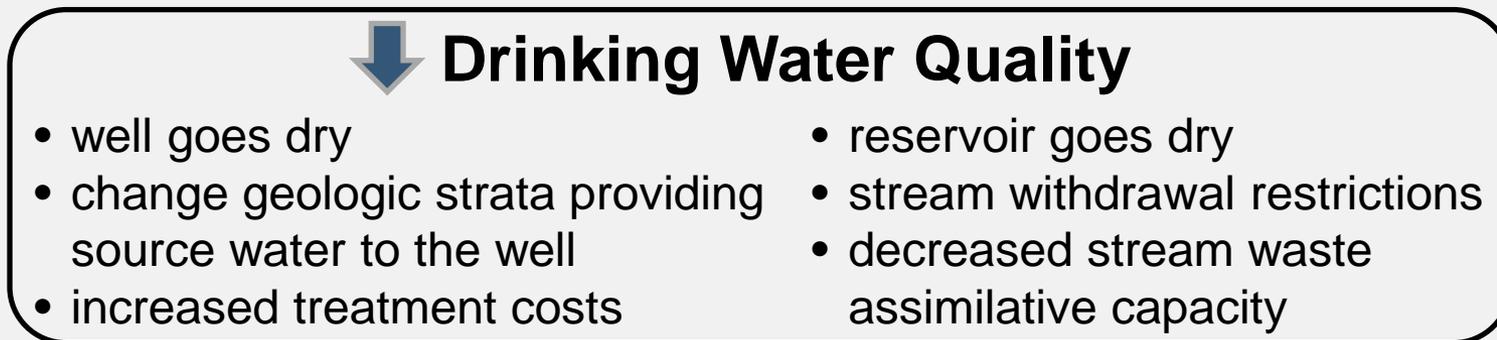
Low water table



Low stage



Increase pollutant concentrations



Activity

Stressor,
Pathway

↓ Impact

Consideration of Scale: National Estimates



**1.5×10^{14}
gallons**

USGS estimated
national water use
in 2005

**1.5×10^{12}
gallons**

USGS estimated
national water use
for Mining and Oil
and Gas in 2005

~1% of total

**$7-14 \times 10^9$
gallons**

EPA estimate of
water used for
hydraulic fracturing
in 2009-2010

<0.1% of
total in 2005

**Impacts of water withdrawals for hydraulic
fracturing may not be visible at the national level**

Consideration of Scale: State Estimates

- Volume of water withdrawals may vary by state
- Potential impacts may depend on
 - Scale and distribution of hydraulic fracturing operations
 - Local geology
 - Local hydrology and water needs

	COLORADO	PENNSYLVANIA
Total number of wells drilled in 2010	2,753	1,386
Estimated water use per well in 2010 (million gallons)	1.7	5
Estimated total water use for hydraulic fracturing in 2010 (million gallons)	4,700	6,900
Compared to total state water use in 2005	0.09%	0.2%

**Impacts of water withdrawals for hydraulic
fracturing may not be visible at the state level**

Research Questions and Projects

What are the possible impacts of large volume water withdrawals from ground and surface waters on drinking water resources?

Secondary Research Questions

How much water is used in hydraulic fracturing operations, and what are the sources of this water?

How might water withdrawals affect short- and long- term water availability in an area with hydraulic fracturing activity?

What are the possible impacts of water withdrawals for hydraulic fracturing operations on local water quality?

Research Projects

Literature Review

Service Company Analysis

Well File Review

FracFocus Analysis

Water Availability Modeling

Analysis of Existing Data

Scenario Evaluations

Water Availability Modeling

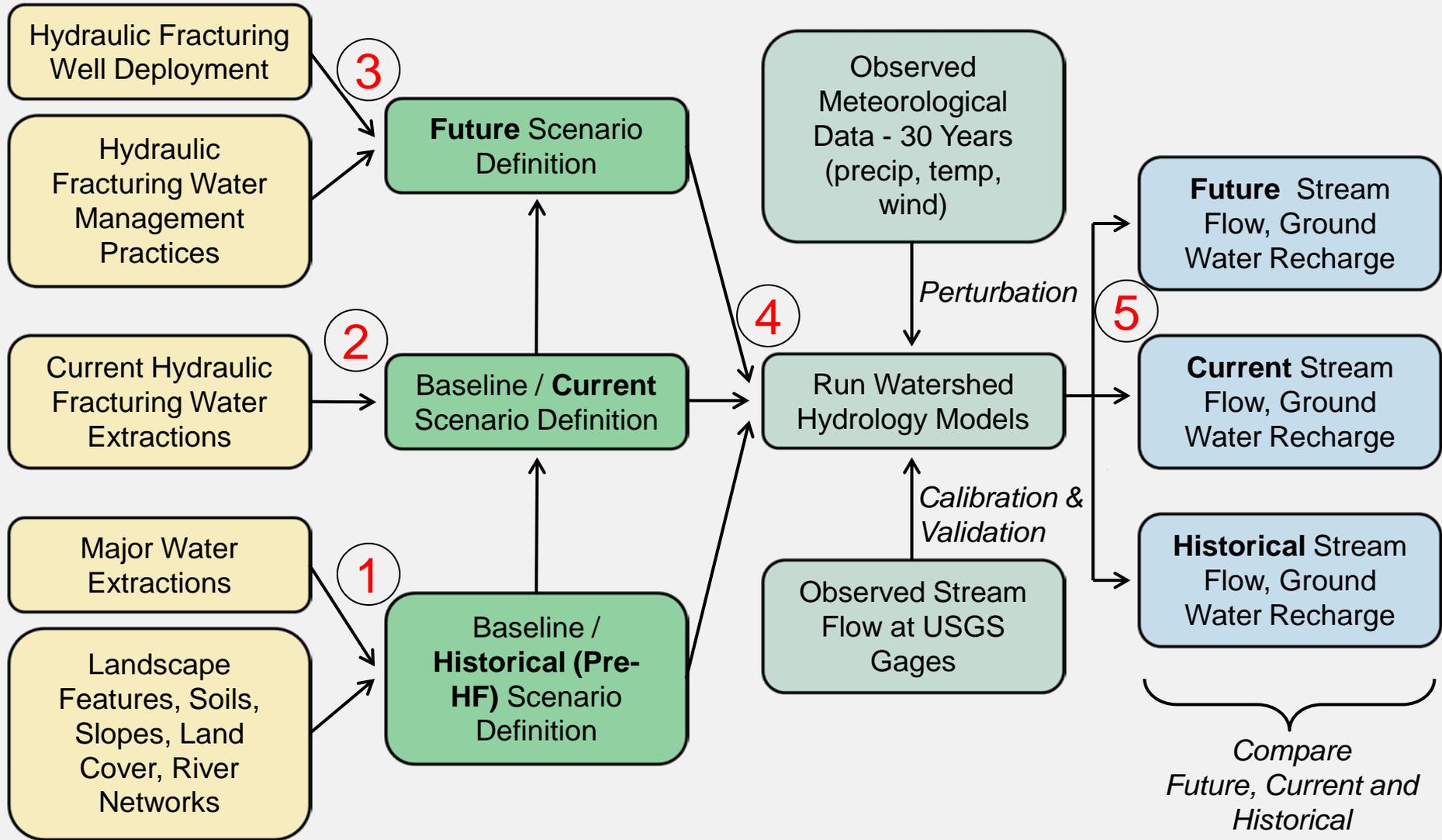
OBJECTIVE:

To evaluate possible impacts of large-volume consumptive water withdrawals supporting hydraulic fracturing in comparison to water availability in representative basins under hypothetical yet possible future scenarios.

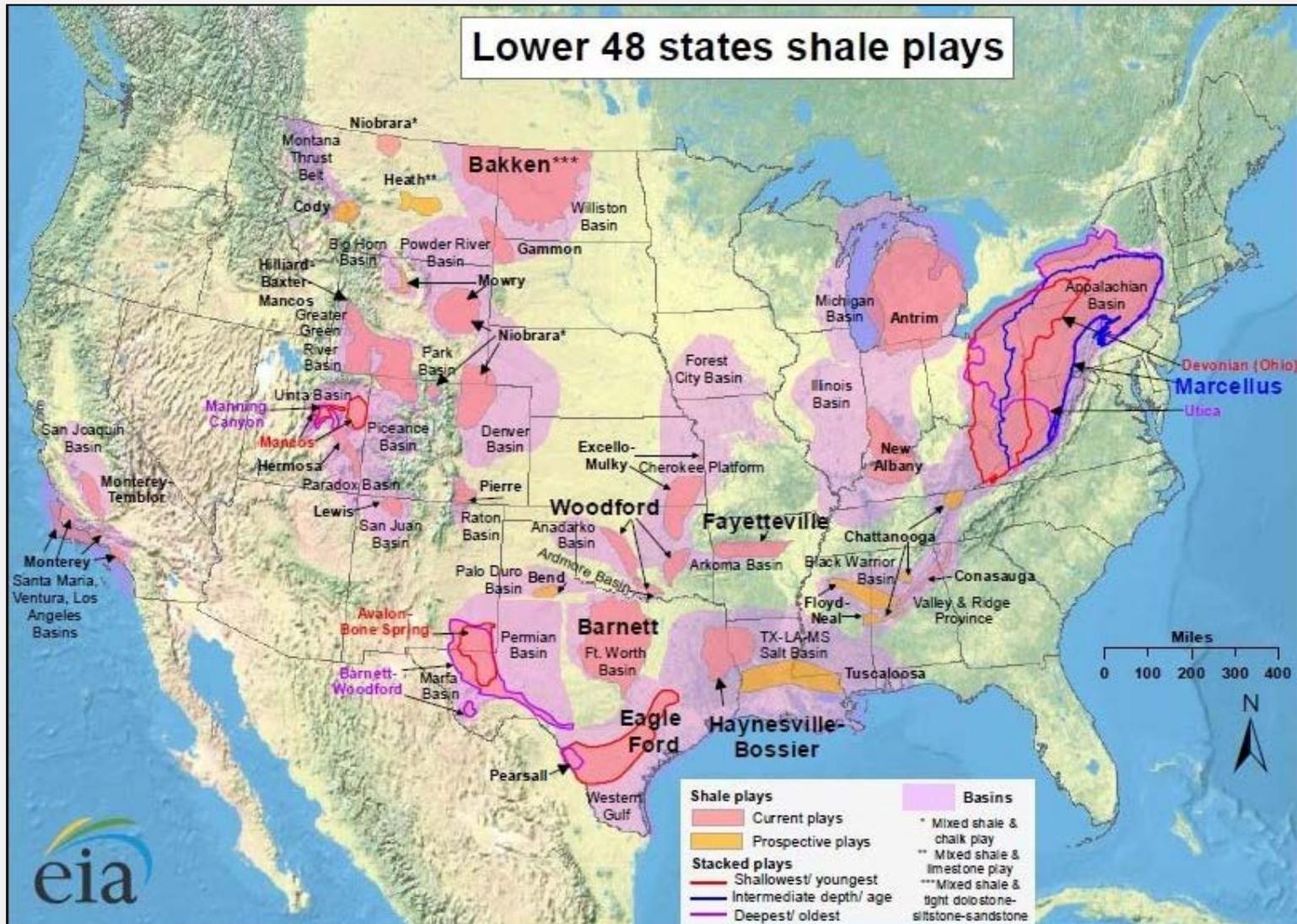
APPROACH:

1. Select representative watersheds from western semi-arid and eastern humid climates for scenario evaluations.
2. Establish baseline representation of watershed hydrological conditions using historical observed water fluxes (precipitation, streamflow) and observed major USGS water use designations, such as agriculture or energy.
3. Modify baselines to include recent water withdrawals supporting hydraulic fracturing operations.
4. Design future scenarios for (1) “business as usual;” (2) “energy plus;” and (3) “green technology.”
5. Conduct analyses of potential changes in stream flows and ground water recharge among historical, current, and future scenarios.
6. Investigate hydraulic fracturing water use in comparison to water availability at various scales (basin, county, subwatershed, headwater).

Critical Path for Modeling Approach

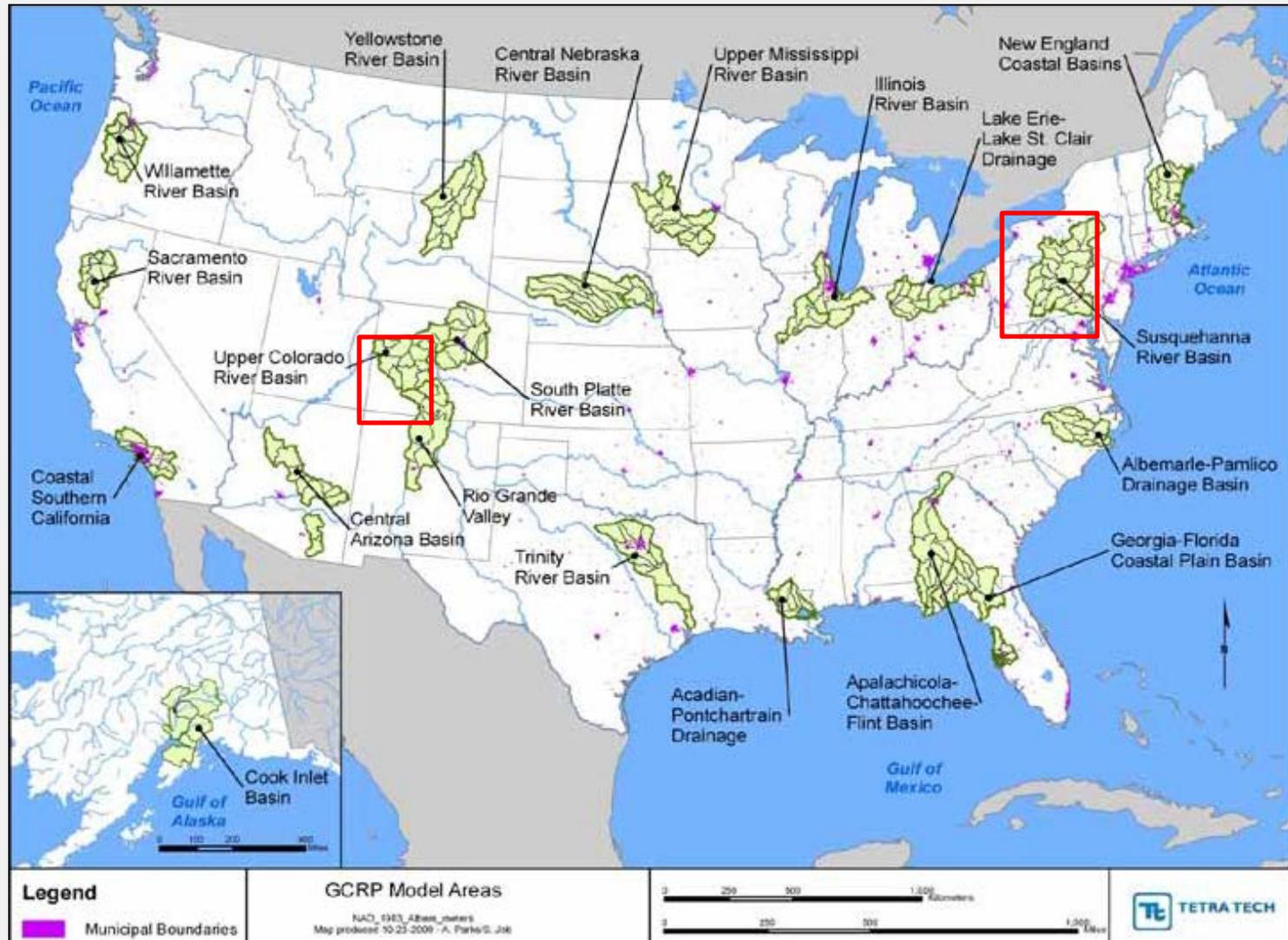


Watershed Selection (1)



Source: US Energy Information Administration based on data from various published studies
 Updated: May 9, 2011

Watershed Selection (2)



Future Scenarios: Model Assumptions

Hydrology Models

SWAT: USDA Soil-Water Assessment Tool – Upper Colorado

HSPF: EPA Hydrologic Simulation Program-Fortran – Susquehanna

MODEL ASSUMPTIONS	FUTURE SCENARIOS		
	Business as Usual	Energy Plus	Recycling Plus
Projected number of wells (peak yr)	Average projected*	High-end projected*	Average projected*
Projected water use per well	Average observed	Average observed	Lower observed**

* Based on US Energy Information Administration and US Geological Survey projections

Technical Stakeholder Input*

- Recycling decreases need for fresh water
- Withdrawals may be from small drainage areas that may result in more impacts than withdrawals from larger drainage areas
- Seasonal impacts to ground water can be greater than hydraulic fracturing impacts
- Suggested modeling ground water-dependent system

Challenges

Impacts of large volume water withdrawals may be more localized

Other potential scales of analysis:

- Local (e.g., small streams, headwaters)
- Shorter time windows (e.g., seasonal, monthly, daily impacts)
- Long-term cumulative impacts

Additional Information

Summary of Available Information

PROJECT	ANTICIPATED AVAILABLE INFORMATION
Literature Review	<ul style="list-style-type: none">• Studies on volumes and sources of water used for hydraulic fracturing fluids in various plays<ul style="list-style-type: none">– Peer-reviewed studies on: Barnett, Eagle Ford and Haynesville Shales– Limited peer-reviewed data from Bakken Shale
Service Company Analysis	<ul style="list-style-type: none">• Water volumes needed for hydraulic fracturing by shale play<ul style="list-style-type: none">– Information was not provided for other geologic formations• Water acquisition procedures and considerations from nine hydraulic fracturing service companies<ul style="list-style-type: none">– Standard operating procedures, water quality requirements, water source preferences decision processes
Well File Review	<ul style="list-style-type: none">• Volumes and sources of water used in hydraulic fracturing fluids for 333 wells fractured between 2009 and 2010

Summary of Available Information

PROJECT	ANTICIPATED AVAILABLE INFORMATION
FracFocus Analysis	<ul style="list-style-type: none">• Water volumes used for hydraulic fracturing fluids in >30,000 wells fractured between Jan. 1, 2011, and Feb. 28, 2013• Limited data on water volumes by type<ul style="list-style-type: none">– Fresh water, produced water, brine, recycled water
Water Availability Modeling	<ul style="list-style-type: none">• Volumes and sources of water used for hydraulic fracturing fluids in the Susquehanna River Basin and the Upper Colorado River Basin<ul style="list-style-type: none">– Water records from the Susquehanna River Basin Commission and the Pennsylvania Department of Environmental Protection– Water records from the Colorado Oil and Gas Conservation Commission