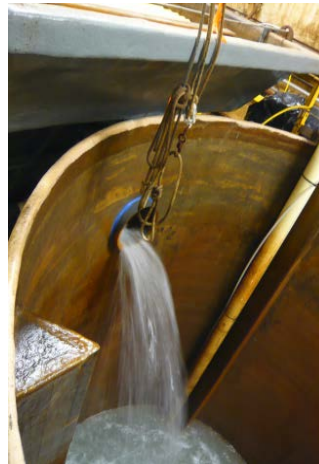


Overview of Hydraulic Fracturing Wastewater Research

**Technical Workshop Series:
Wastewater Treatment and Related Modeling**



Cynthia Sonich-Mullin & Christopher A. Impellitteri
EPA-Research Triangle Park • April 18, 2013

EPA Study of the Potential Impacts of Hydraulic Fracturing on Drinking Water Resources

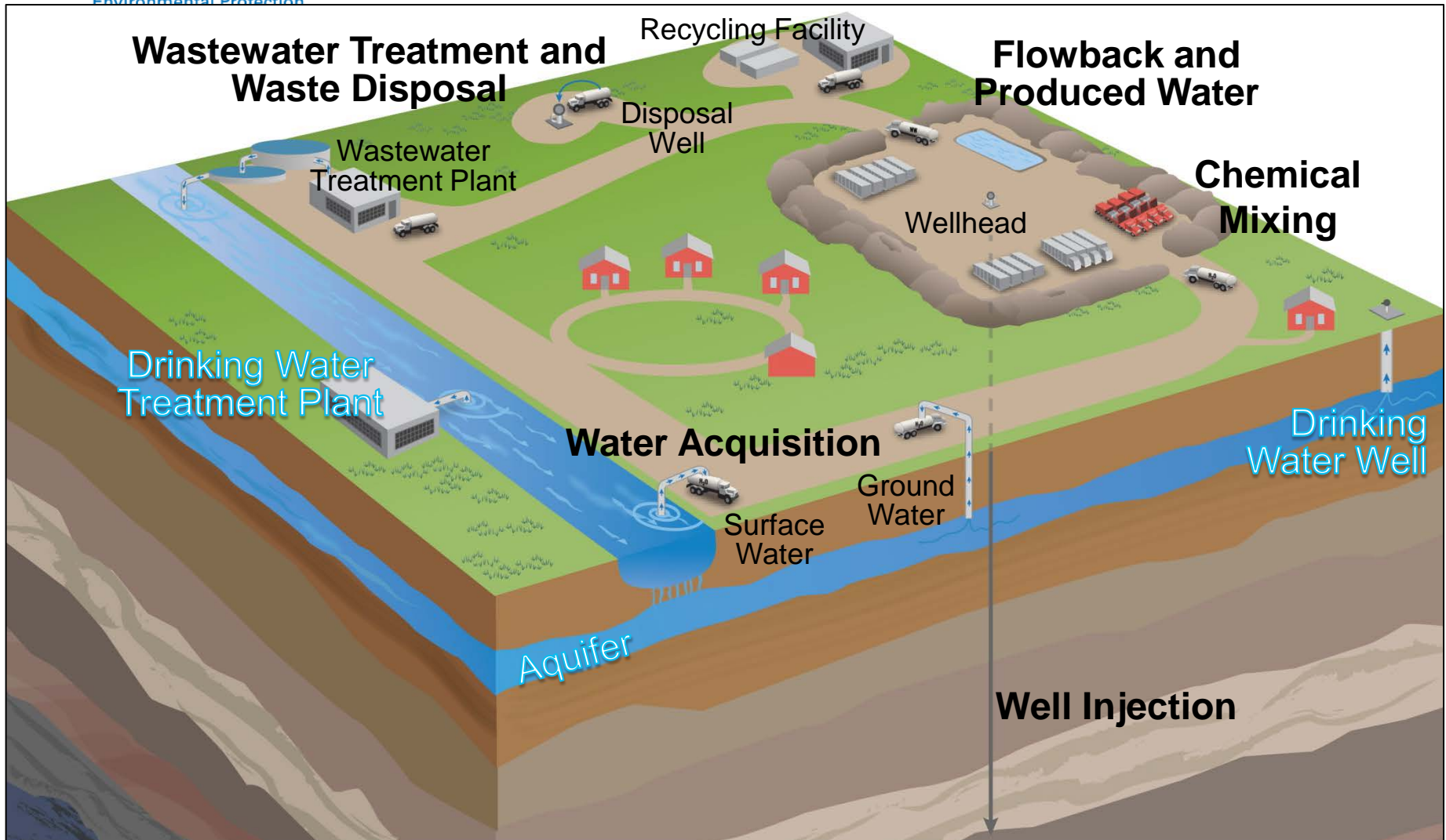
EPA Study Goals:

- Assess the potential impacts of hydraulic fracturing on drinking water resources
- Identify the driving factors that affect the severity and frequency of any impacts



For more information: <http://www.epa.gov/hfstudy>

Hydraulic Fracturing Water Cycle



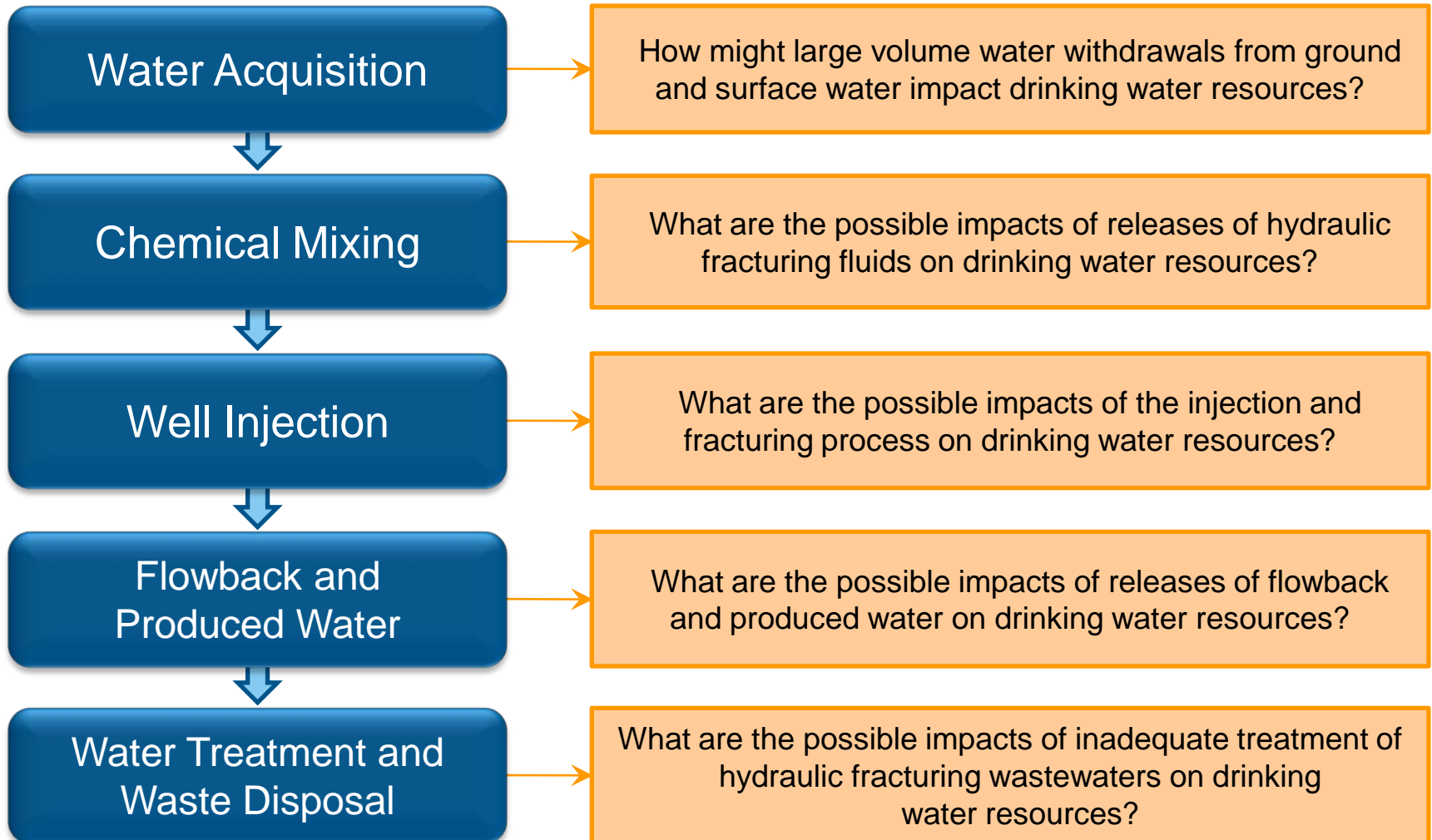
WATER CYCLE STAGES

2

Water Acquisition → Chemical Mixing → Well Injection →
Flowback and Produced Water → Wastewater Treatment and Waste Disposal

Primary Research Questions

Research Questions



Secondary Research Questions

Secondary Research Questions

What are the common treatment and disposal methods for hydraulic fracturing wastewater and where are these methods practiced?

How effective are conventional POTWs and commercial treatment systems in removing organic and inorganic contaminants of concern in hydraulic fracturing wastewater?

What are the potential impacts from surface water disposal of treated hydraulic fracturing wastewater on drinking water treatment facilities?

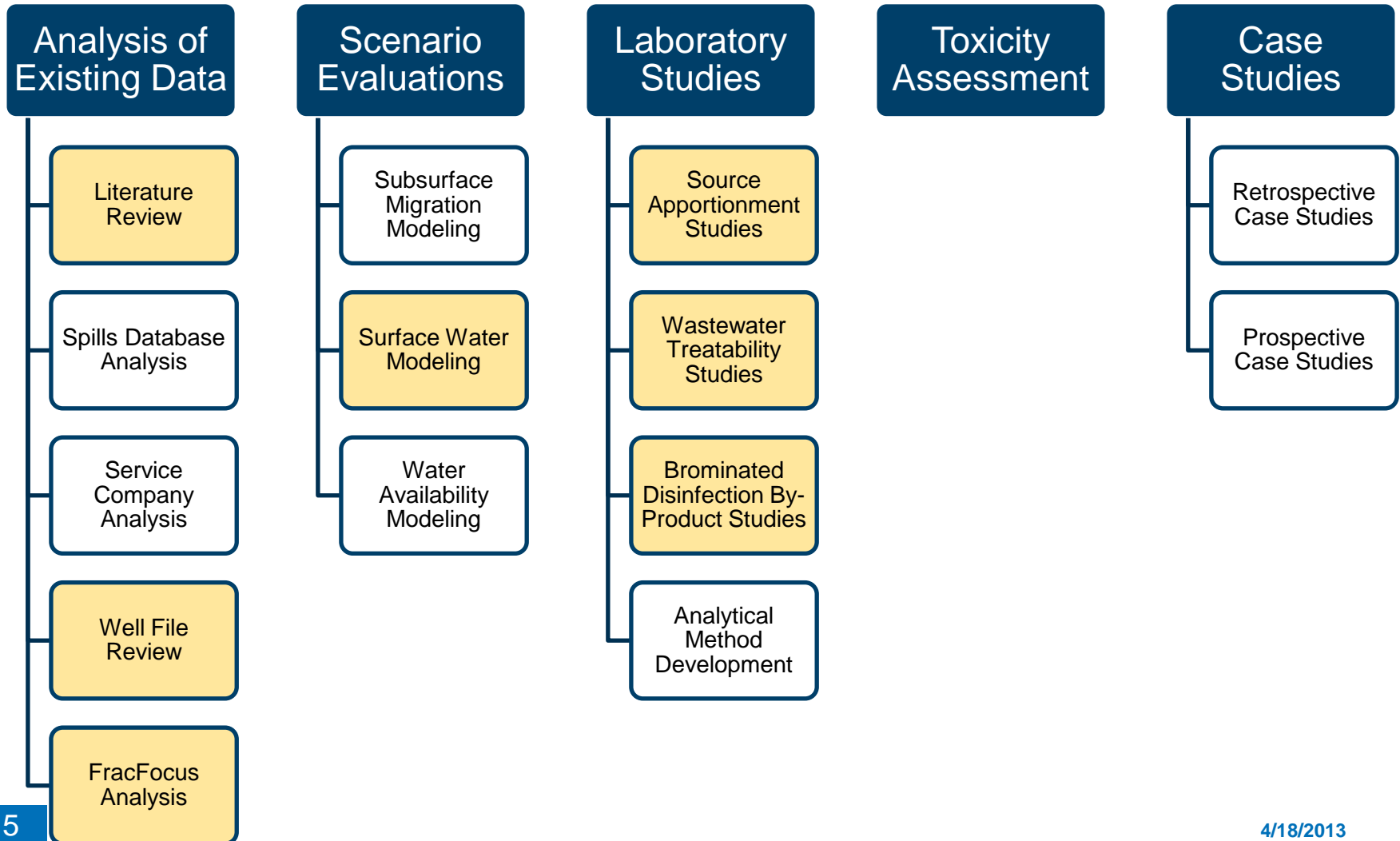
Research Projects

Literature Review
Well File Review
FracFocus Analysis

Literature Review
Wastewater Treatability Studies

Literature Review
Surface Water Modeling
Source Apportionment Studies
Brominated Disinfection By-Product Precursor Studies

Types of Research Projects



Literature Review

Analysis of Existing Data

Objective: Collect information on wastewater treatment and disposal from hydraulic fracturing operations to inform project plans and interpretations of results

Research Progress

- Evaluate information on wastewater treatment and disposal from hydraulic fracturing operations from existing papers and reports, focusing on peer-reviewed literature
- Follow procedures identified in study plan

Next Step

- Continue to review and assess literature related to wastewater treatment and disposal according to research questions in the study plan

Well File Review

Analysis of Existing Data

Objective: Assess well construction and hydraulic fracturing operations as reported by nine oil and gas operators

Research Progress

- Well-specific records:
 - Provided by nine oil and gas operators (includes confidential business information)
 - Includes hydraulic fracturing wastewater treatment and disposal practices for 332 wells hydraulically fractured in 2009 and 2010
- Extraction of available data from the well files is underway

Next Steps

- Work with oil and gas operators to clarify information provided
- Analyze data to address research questions

FracFocus Analysis

Analysis of Existing Data

Objective: Collect information on water volumes and sources as reported by oil and gas companies

Research Progress

- Extracted data, checked for quality issues, and organized in a database for analysis
- Developed draft queries to address research questions

Next Steps

- Analyze water usage
- Summarize data by water source or type

Wastewater Treatability

Laboratory Studies

Objective: Assess effectiveness of wastewater treatment processes on selected chemicals found in hydraulic fracturing wastewater

Commercial Treatment Systems

- Field studies
- Collect influent, effluent, and residuals samples
- Analyze concentrations of VOCs, SVOCs, anions, metals/inorganics, TDS, radionuclides

Wastewater Treatment Facility/Biological Processes

- Bench studies with chemostat reactors
- Blend hydraulic fracturing wastewater with synthetic municipal wastewater
- Collect influent and effluent samples
- Monitor effects on biological processes within wastewater

Surface Water Modeling

Scenario Evaluations

Objective: Identify possible concentrations of selected chemicals at public water system intakes downstream from wastewater treatment facilities

- Collect model inputs from the National Pollutant Discharge Elimination System monitoring reports and USGS stream water quality and flow rate data
 - Use three modeling approaches to determine potential bromide and radium levels downstream
 - 1) Steady-state mass balance model
 - 2) Transient empirical model
 - 3) Hybrid empirical-numerical model
 - Run models with different discharge scenarios and stream flow scenarios based on data collected
- Monte Carlo simulation used to estimate uncertainty in output
- Confirm results with USGS tracer data and EPA Water Quality Simulation Package

Source Apportionment

Laboratory Studies

Objective: Identify proportion of hydraulic fracturing wastewater that may impact public water system intakes downstream from wastewater treatment facilities

Sample Analyses

- Field studies on two rivers
- Collect samples upstream and various distances downstream from discharge
- Analyze samples for suite of elements and ions including strontium 87/86 ratios

Modeling

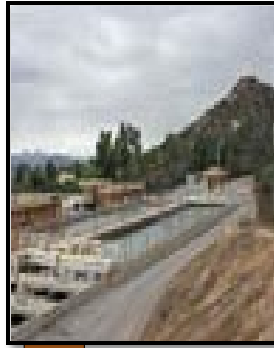
- Compare two rivers using peer-reviewed models
- Identify and quantify contaminant source types using receptor models
- Receptor models include Unmix, Positive Matrix Factorization, Chemical Mass Balance

Source Apportionment

Laboratory Studies

Discharge Point

Discharge includes hydraulic fracturing wastewater, coal-fired power plant effluents, mining effluent, and road salt



ISCO Sampler

Sample Upstream

Sample Discharge

Sample Downstream

Sample Drinking Water Intake



Brominated Disinfection By- Product Precursor Studies

Laboratory Studies

Objective: Assess the contribution of hydraulic fracturing wastewater to formation of brominated disinfection by-products at public water systems

Total Trihalomethanes

- Focus on the formation of brominated trihalomethanes
- Bench studies
- Compare equimolar concentrations of bromide in spiked laboratory water and blended effluents
- Maintain chloride:bromide ratio found in effluents in spiked waters
 - Eliminate chloride:bromide ratio as a variable

Discussion

Are there other sources of data and/or samples which could be obtained for further study?

What are the most important future research topics regarding wastewater management and water reuse?