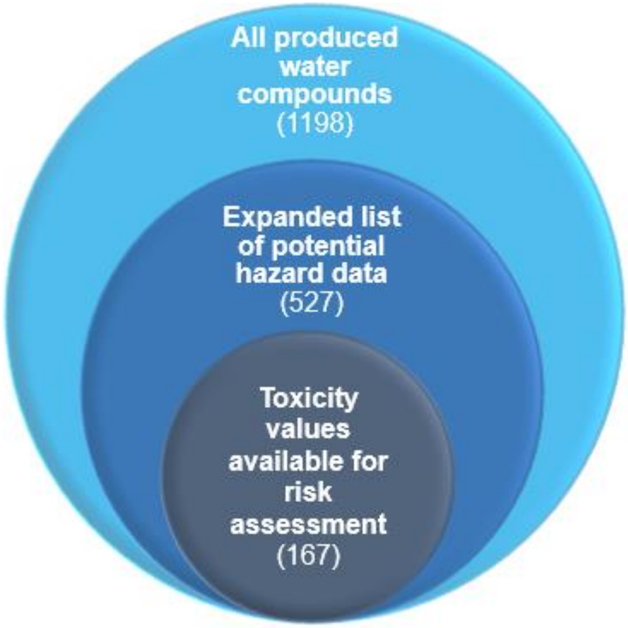
Produced Water – Research, Reuse, and Regulation

ECOS Update, Shale Gas Caucus – September 2019

Environmental Defense Fund (EDF) has worked to better understand the character, treatability, and toxicity of produced water over the past five years. Together with academic partners across the country, multi-stakeholder groups like the Groundwater Protection Council (GWPC) and others, we have worked to elucidate the challenges of understanding, managing, and regulating produced water – particularly in the emerging context of reuse or discharge outside of oil and gas operations.

As an update for the Environmental Council of States (ECOS) Shale Gas Caucus (SGC), EDF has prepared a brief overview of recent learnings and implications for policy and regulatory decision-making on produced water reuse. Toward that end, we've compiled the following "Top 5" list for discussion.



(Danforth et al., *An Integrative Method for Identification and Prioritization of Constituents of Concern in Produced Water from Onshore Oil and Gas Extraction*, submitted, under review).

1. Known and predicted toxicity values for produced water constituents, while limited, can begin to help to prioritize chemicals of concern for near-term assessment and action.

A collaborative study conducted by EDF, TEDx, and Texas A&M summarizes a comprehensive literature review and presents a method to identify and prioritize produced water chemicals of concern using multiple tiers of hazard data – both known and modeled/predicted. Combining results of that assessment with knowledge regarding existing regulatory programs (e.g., NPDES) can help highlight opportunities for near-term action – for example, chemicals for which we (1) have actionable toxicity data, (2) have an approved method, (3) but don't currently consider in produced water permits. Should we?

- Of the 1198 identified produced water compounds, 167 have the types of toxicity values that EPA guidelines and directives typically require for risk assessment (see figure to left; EPA OSWER, 2003). Of those, 95% have standard analytical methods, but less than half are considered in existing NDPES permits.
- Chemicals with *some* hazard data and chemicals without adequate data should still be prioritized for review for further research. Monitoring of chemicals with limited data can also help to understand a chemical's presence, quantity, and potential exposure.
- Chemicals can be prioritized on a case-by-case or regional geographical basis based on how often they are detected, if they have concentration data, and whether they have multiple types of hazard data – resulting in chemicals of note based on relative hazard.
    - E.g.: 1,4-Dioxane – common additive in hydraulic fracturing, likely human carcinogen, difficult to treat with conventional methods

When published, this paper will include the most comprehensive databased of identified produced water chemicals, to-date.

2. Salt isn't the only enemy. Organic compounds can present serious challenges and risks.

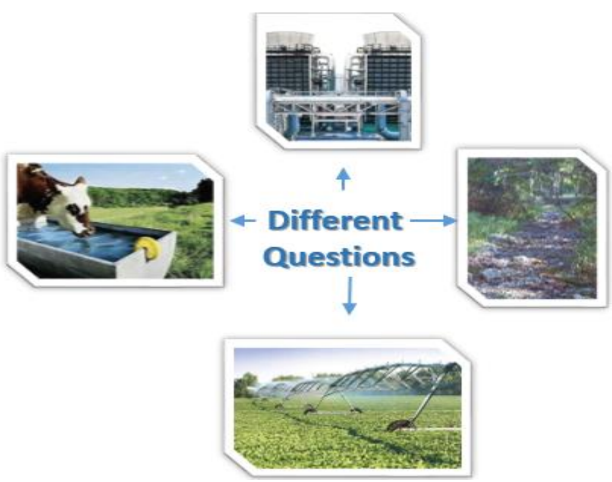
Total dissolved solid (TDS) levels can provide informative boundaries on economic and efficient treatment technologies and can negatively impact how analytical methods function. However, salts are not the only concerning component of produced waters. For example,

- Organic additives used in operations can be of toxicological concern, long lasting, and found in produced water (e.g., biocides; nonylphenol ethoxylate)
- Preliminary toxicity testing reveals that while salts contribute to acute toxicity, organic compounds contribute to chronic toxicity and may play a role in phytotoxicity and soil health
- While biological treatment can help to degrade problematic organics, even in high salinity environments, some organics can be resistant to this type of treatment or pass through other treatments due to their size or character.

This means that focus cannot be on reducing TDS alone. Care must be given to ensure that organics, which can pose serious risks even at trace levels, are identified and addressed.

3. There is no "silver bullet" research or regulatory program – and research in support of regulatory development should be "fit-for-purpose."

The practice of designing programs to fit defined outcomes, or "fit-for-purpose" does not only apply in the treatment technology context. As the Groundwater Protection Council emphasizes in its recent produced water report, both research and regulatory programs will differ based on the potential end use.



GWPC's Module 3 also presents a research and decision-making framework that ties assessment of risk and risk management tools to not only what is known about the produced water, but also the particular end-use.

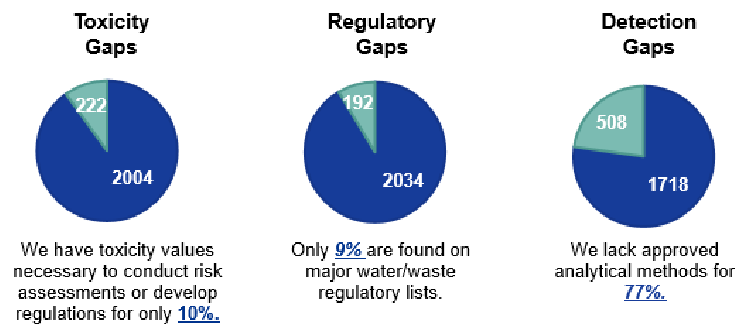
"Potential risks must be well understood and appropriately managed in order to prevent unintended consequences."

–Ground Water Protection Council, Produced Water Report, Module 3

Additionally, monitoring and regulatory tools and requirements will inevitably vary based on the reuse scenario. A recent EDF publication emphasizes one challenge of this variability in that available standards and toxicity tools (e.g., Whole Effluent Toxicity test) are developed and suited for the aquatic environment, leaving similar standards and tools in the terrestrial environment lacking.

4. Data, method, and science gaps and emerging research have both positive and negative implications for update and/or development of regulatory programs.

Emerging research regarding produced water character, toxicity, and treatability can help to narrow focus of regulators to identify important gaps that need to be filled to gain specific knowledge necessary to inform the development of regulatory programs.



Knowledge Gaps: Chemicals Potentially Present in PW (including FracFocus disclosures) [EDF ongoing analysis]

Importantly, even the limited knowledge and tools we have today can inform and support the review and update of standards likely to be involved, including water quality standards, irrigation standards, and drinking water standards. We can also use existing and growing knowledge to inform and prioritize advancements in monitoring tools, like analytical methods or whole effluent bioassays.

5. Collaboration and transparency among and between industry, academia, state and federal agencies, and stakeholders is key to forward progress.

Addressing these challenges will be complex, and fostering an environment of transparency and collaboration is vital. For example, research and regulator access to produced water samples can expedite outcomes. EPA and states can work together to prioritize standard and method development.