



April 2021 Working Group Updates

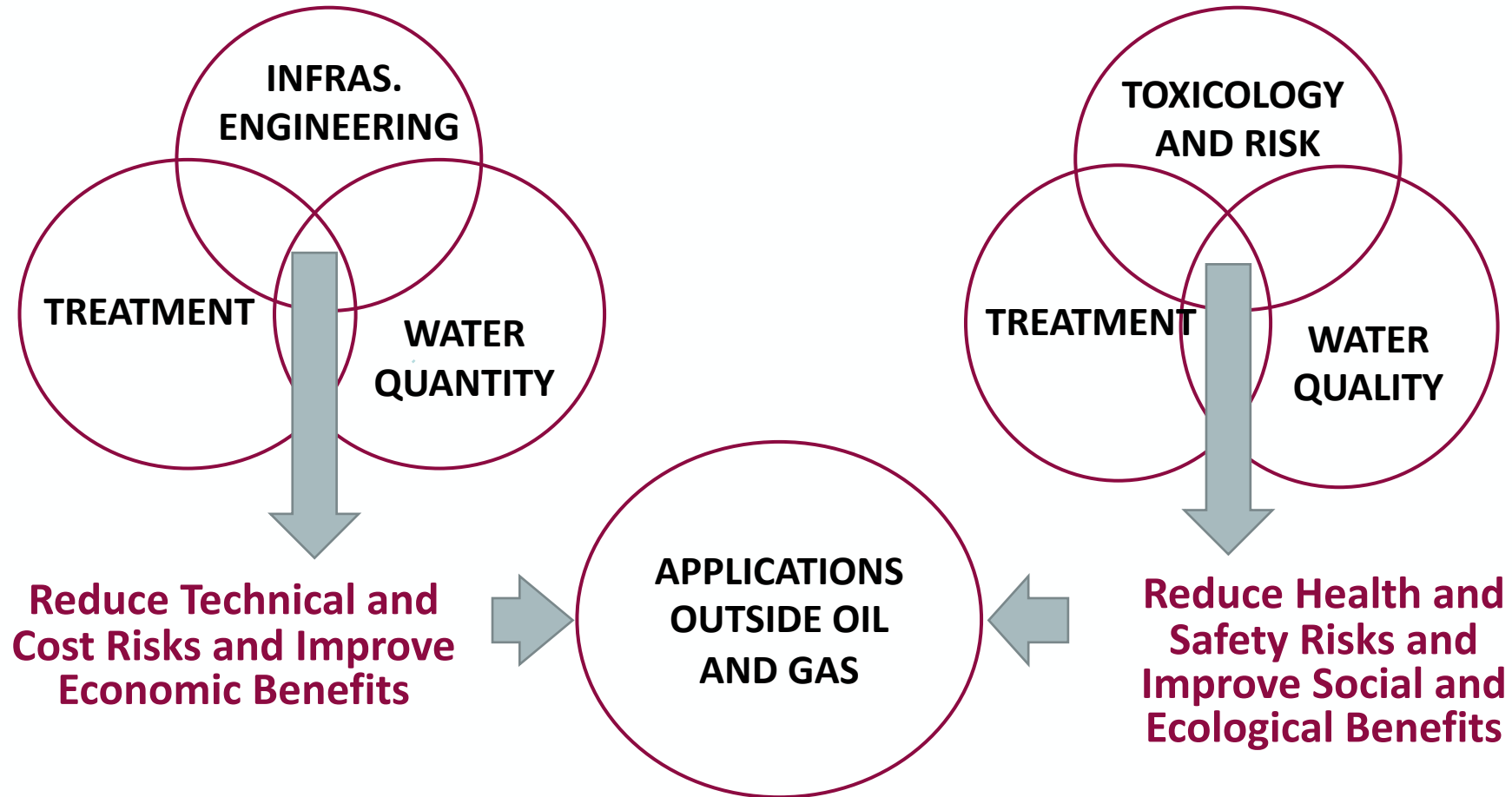
NM PW Research Consortium Management Team
Mike Hightower, Pei Xu, Deborah Dixon, Jeri Sullivan Graham
April 27, 28, 29, 2021



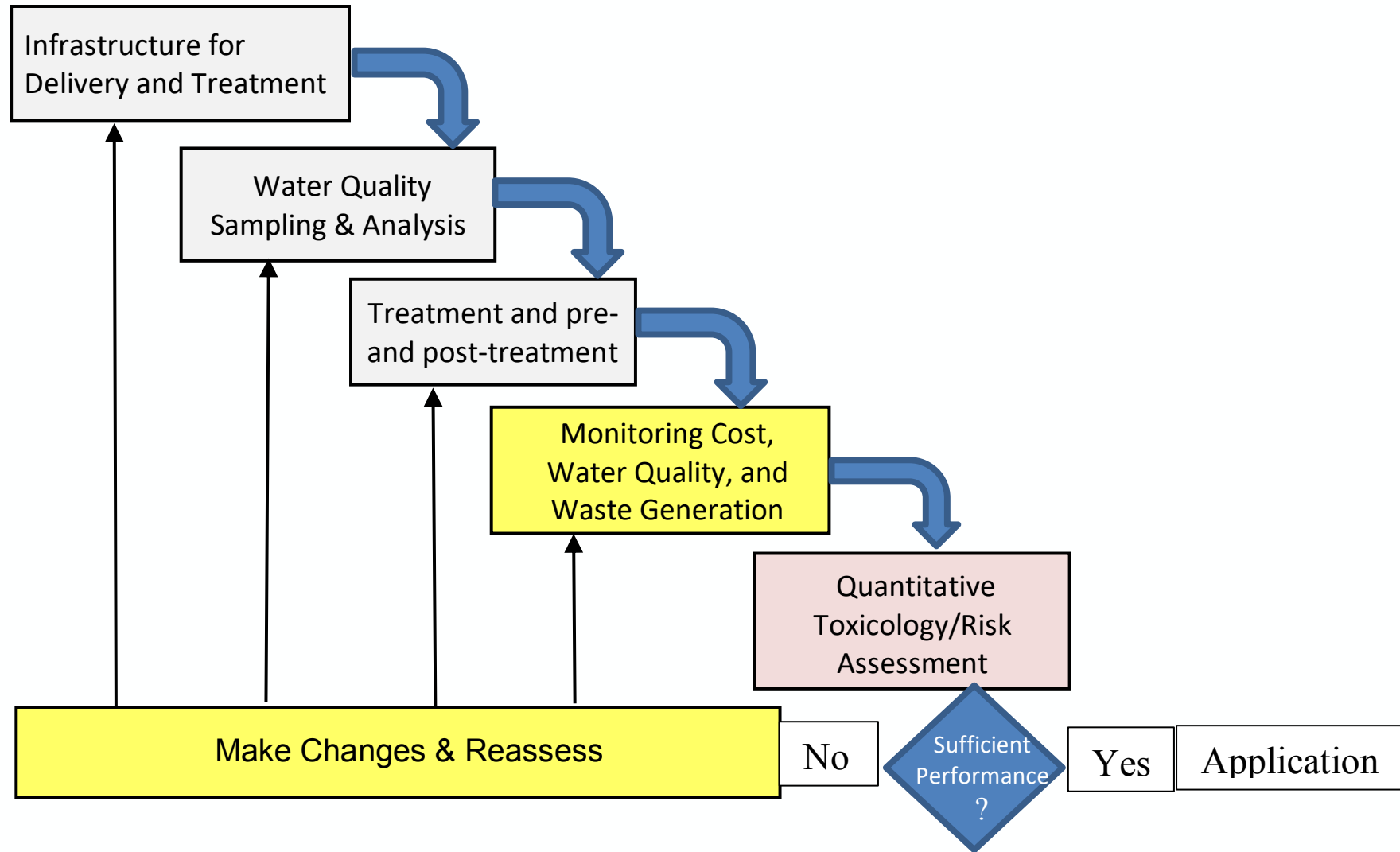
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NEW MEXICO PRODUCED WATER RESEARCH CONSORTIUM

Technical Organizational and Operational Structure



Consortium Risk Assessment Process



NM Produced Water Research Consortium

2021 Program Tasks (November 2020 thru December 2021)

April 2021 Update

1. Produced Water RFP Review Committee

- Supported by all 6 Working Groups members
- Phase 1 - Publish RFP based on Research Plan,
- Establish review committees, review, discuss, and select initial projects
- Phase 2 - Work with review committee to approve test plan and
- Identify Independent 3rd Party Review teams from Treatment, Infrastructure, Applications, and GAB groups, expect up to 12 projects in 2021
- Phase 3 – Use report template in Testing and Evaluation Document to prepare draft evaluation reports
- Provide data and samples to Treatment, Risk and Toxicology and Socio-Economic CBA Committees

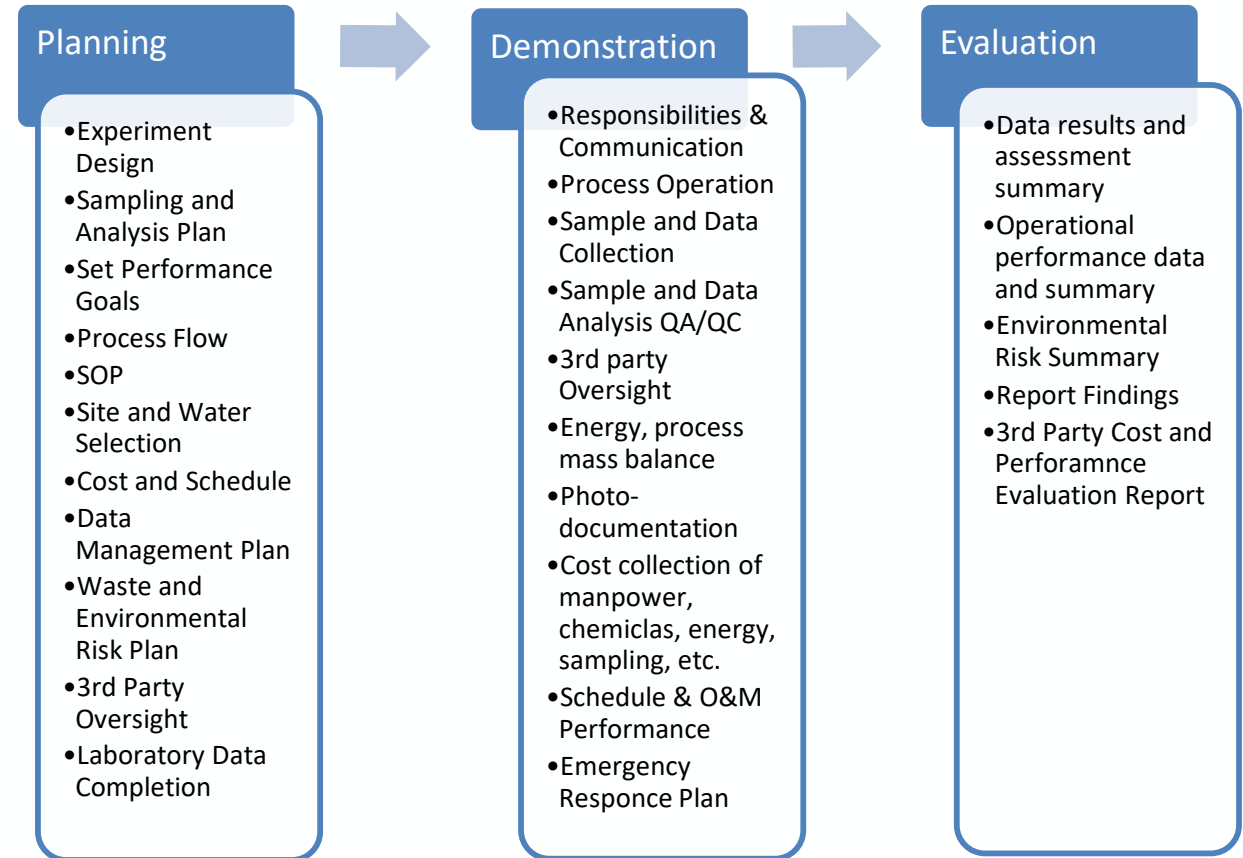
2021 Consortium Projects

| Proposal Team | Technology Description | Location Identified | Project Type |
|------------------------------|---|--|-------------------------------|
| Eureka Resources | PW <u>thermal treatment</u> and mineral recovery | Ship PW to PA for full-scale treatment | Core Research - RFP Selection |
| zNano Membranes | Polymeric-based ceramic membrane for <u>pretreatment</u> of PW | Brackish GW National Desalination Research Facility (BGNDRF) | Core Research - RFP Selection |
| Crystal Clearwater Resources | PW low-temperature distillation <u>treatment</u> | Permian Basin midstream or BGNDRF | Core Research - RFP Selection |
| Katz Water Technologies | PW thermal <u>treatment</u> | BGNDRF | Core Research - RFP selection |
| Marah Water Services | PW Electro-coagulation/cavitation <u>pretreatment</u> | Permian Basin Midstream or BGNDRF | Core Research - RFP selection |
| Hydrozonix | Ozone PW <u>pre-treatment</u> | Permian Basin operator | Core Research - RFP Selection |
| Geosyntec | ESG Stakeholder Analysis Tool | Permian Basin stakeholders | Core Research- RFP Funded |
| NMSU and TTU ENGR. | Risk, Toxicology, Chemical Testing and Analysis | NMSU and TTU | Core Research - RFP Funded |
| NMSU WRRI | System Dynamics modeling of produced water impact on State/regional Water Plans | NMSU/WRRI | Core Research - RFP Funded |

| Proposal Team | Technology Description | Location Identified | Project Type |
|------------------------------------|---|---|--------------------------------------|
| NMTech and Hilcorp | Membrane distillation <u>treatment</u> | San Juan Basin | Complementary Research - Self funded |
| HPOC | <u>RO Treatment</u> of Cuba Basin -7000 ppm TDS Entrada Sandstone | BGNDRF and NMSU, collaboration with BOR | Complementary Research - Self Funded |
| Bechtel | Phase 1 and Phase 2 <u>treatment</u> | Ship PW to TX for system treatment | Complementary Research - Self Funded |
| Mycelx | <u>Pretreatment</u> | Permian Basin | Complementary Research - Self Funded |
| 1 or 2 additional companies likely | <u>Pretreatment</u> | Bench -scale at BGNDRF | Complementary Research - Self Funded |
| DOE Office of FE | System Dynamics Socio-economic Environmental Ecological CBA | DOE/Sandia/ NMPWRC | Complementary Research - DOE funded |
| EPRI | PW treatment for cooling water augmentation | EPRI/NMPWRC | Complementary Research - EPRI funded |

Quantitative Treatment Data at Scale

- Produced Water Treatment Testing and Evaluation
 - Providing a step-by-step for bench and pilot-scale testing
 - Is based on several federal agency – EPA, DOE, and DoD innovative treatment programs
 - Accurately collect operational cost and performance data for independent 3rd party review
- Will be testing 6-8 treatment and pretreatment technologies in 2021 – some pilot and some bench scale
- Open for additional testing opportunities



2. Produced Water Treatment Quality Monitoring Goals Committee

- Supported by Water Quality, Risk and Toxicology, and Treatment Working Groups members
- Identify NPDES+ elements for testing projects in 2021 and beyond
- Improve NPDES constituents applicable to produced water constituents
- +Plus could include - NORM, SOC, TPH, BTEX, etc., pre-treatment etc.
- Base on nominal various state approaches, relative to Pecos/San Juan River quality parameters
- Provide selected values to Data Portal Task Tier 1 and 2 and for 2021 Treatment Projects

3. Produced Water Data Portal Committee

- Supported by Water Quality and Quantity Working Groups
- Phase 1 - Coordinate MOU with PRRC and GWPC to establish Water Star data portal
- Use info from NPDES+ Committee to set up Tier 1 and 2 data information
- Integrate NMSU PW data GIS approach into PW Data Portal
- Collect produced water data from producers and integrate into Data Portal – use NDA and NTK process approach in Information Protection Plan
- Phase 2 - Have knowledgeable users assess operations for Tiers 1 and 2 data
- Work with private companies to establish Tier 3 options for 2022

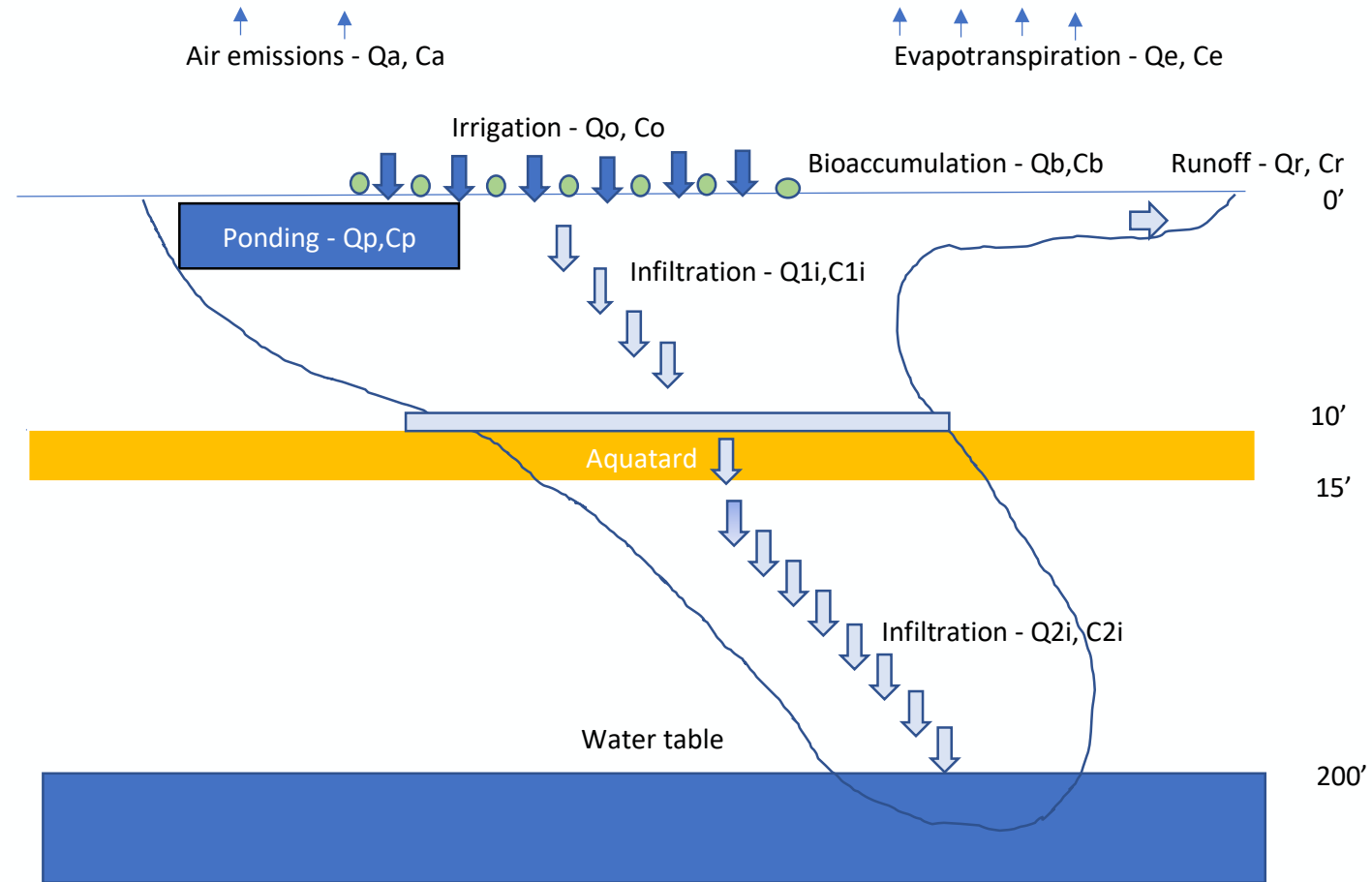
4. Produced Water Collection Committee

- Supported by Water Quality, Quantity, Treatment and Toxicology Working Group members
- Improve data in Data Portal
- Collect proprietary data on fracking chemicals
- Work with producers to collect and coordinate water for 2021 treatment testing
- Coordinate information with NPDES, Data Portal, Toxicology, and Treatment Committees
- Start in April 2021 with producers and midstream companies

5. Risk and Toxicology Studies Committee

- Supported by Risk and Toxicology, Water Quality, and Treatment Working Group members
- Phase 1 – Using NPDES+ data developed above,
- Review and select quantitative toxicology testing approach for NM
- Review and select quantitative risk assessment approach for NM
- Review and select constituent fate & transport modeling approaches for NM
- Phase 2 – Provide information to Socio-economic CBA Committee
- Take treated produced water and put in green house and do crop and soil bioaccumulation studies to begin toxicity, risk, and transport modeling and testing.

Example Ag Application Conceptual Impact Model Drives Fate and Transport Modeling and Risk and Toxicology Testing



Q_x - treated produced water or emissions volume or flow rate
 C_x - constituent concentration

Application Treatment Options

| Produced Water Quality (ppm) TDS | Application | Treated Water Salinity Goal (ppm) TDS | Priority Constituent Quality Analysis Approach* |
|---|---|---|---|
| Conventional 10K to 50K 50% < 35K | Wholesale Water - industrial, commercial, and municipal | 1500-2500 | pHOTOS, NPDES+ |
| | Brackish Aquifer Storage | 2000-2500 | pHOTOS, NPDES+ |
| Unconv. 60K to 250K 75% > 100K | Agriculture and livestock | Class 1 < 700 Class 2 700 - 2000 Class 3 > 2000 | pHOTOS, NPDES+, WET, and < 60% Na, B < 0.5 60-75% Na, B < 2.0 up to 75% Na, B ~ 2 |
| | Rangeland | 2,000 – 8,000 | pHOTOS, NPDES+, WET, and B ~ 2 |
| | Surface Flow Augmentation | 700-2500 (varies by watershed) | pHOTOS, NPDES+, and WET |
| | Mineral Recovery | 200,000-300,000 | pHOTOS, iNPDES |
| | Solution mining | < 250,000 | pHOTOS, iNPDES |
| | Road Constr. | 30,000 - 100,000 | pHOTOS, NPDES+, WET |
| | Drinking | 500-600 | pHOTOS, NPDES+, SDWS |

- PWS pHOTOS - Produced Water Society pretreatment std. - pH, ORP, turbidity, and oil sheen
- NPDES+ - NMPWRC treatment standard
- WET - whole effluent toxicity for aquatic, terrestrial, plant, or microbial species
- iNPDES - industrial NPDES treatment standard, as applicable
- SDWS - safe drinking water standard

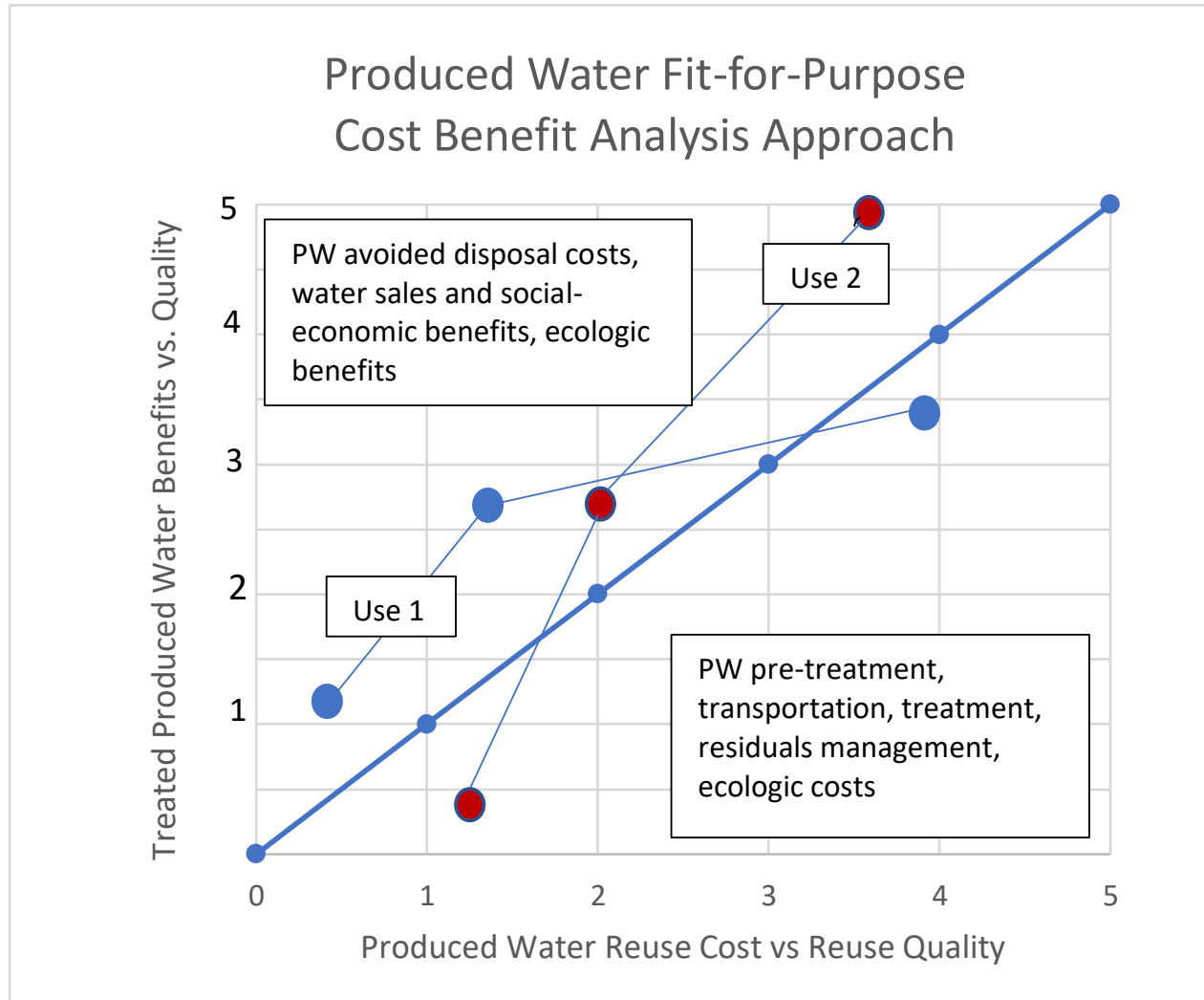
6. Socio-economic Ecologic Cost/Benefit Analysis Modeling Committee

- Supported by Water Quality, Water Quantity, Infrastructure Engineering, Treatment, Risk and Toxicology, and Applications Working Group Members
- Phase 1 - RFP for Benefit Cost Analysis – Review approaches
- Consider producer and public needs/tools with DOE and Consortium funding
- Identify approaches and establish working teams of stakeholders
- Phase 2 - Incorporate data from testing into working models
- Utilize stakeholders to evaluate ease of use and information available from models
- With Stakeholders, conduct a Scenario Analysis with federal, state, county, and community agencies to assess likely available produced water for reuse and industrial development opportunities and benefits/costs.

7. Produced Water Public Outreach

- Supported by Treatment, Risk and Toxicology, Infrastructure Engineering, and Applications Working Groups plus GAB support
- Phase 1 – Develop and establish a Public Education and Outreach Program
- Select two sites to update public on PW safety, issues, challenges, etc. upcoming efforts - web site, data portal, treatment testing, tours, etc.
- Late Spring - April - June with NMED and other state agencies
- Phase 2 – Focus outreach to include testing and applications results
- Late summer early fall - August, September, November with NMED and other state agencies
- Would include tours of first tests, impacts, demonstration of data portal use, summary risk and toxicology approach and data, etc.

Socio-Economic Ecological Benefit Cost Analysis Needs



| Cost/Benefit | Range of Values |
|--|------------------|
| Price of Oil (WTI) | \$55.00 |
| Price of Recycled Water per barrel | \$0.50 - \$7.00 |
| Marginal Cost of Production & Taxes | \$20 - \$25 |
| Marginal Cost of Water Disposal per barrel | \$0.50 - \$2.25 |
| Marginal Cost of Transportation | \$0.00 - \$9.00 |
| Marginal Cost of Recycling | \$1.00 - \$16.00 |
| Marginal Private Value of Recycled water | \$0.25 - \$1.75 |
| Marginal Social Value of Recycled Water | \$0.48 - \$51.24 |

(Chermak & Patrick, 2018)