Produced Water Reuse and Recycling: Role in Long-term Water Sustainability

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The southern U.S. and the mid-latitudes are in the 100th year of a 300 year arid cycle - not a drought.

Univ. of Arizona – Tree Ring Research Lab – 50 year averages
Climate Changes will Impact Temperatures, Precipitation, Evapotranspiration, and Runoff

Mid-latitude population and grain belts will be strongly affected.
The region is delicately balanced in terms of water supplies and demands

Impacts of climate change and energy production are acute

Important water-energy challenges:
- Climate impacts
- Disruptive events: fire, floods, infrastructure failure
- Fully allocated water rights
- Growing/shifting population
- Rapid and extensive energy development
- Uncertainties in water for power production

Established regional energy water partnership
“Results are not predictions, but rather a starting point for dialogue and increased awareness of potential impacts of climate change.”

Roach et al.
Elephant Butte Reservoir
NASA Earth Observatory
Landsat 8 images

Acquired June 2, 1994
89% of maximum
(2.2 Maf)

Acquired July 8, 2013
3% of maximum

http://earthobservatory.nasa.gov/IOTD/view.php?id=81714
Recent NM Policy Changes and Adaptations for Future Water Sustainability

- State Energy Policy - Includes Energy-Water Nexus
- Hybrid, alternative cooling and water implementation
- New regulations - recycling of Produced Water
- Brackish Water and Waste Water resource evaluation
- EWN collaborations - public and private entities

PNM Afton Gas-fired, Hybrid-cooled Generation
New Mexico Produced Water Regulatory Framework for Reuse—*a fuzzy dividing line*.....

- **Recycle and Reuse**
  - Oil and Gas Production and Operations
  - No Permit Needed
  - New PW ReuseRegs 19.15.34.8 NMAC

- **Treatment**
  - Waste Disposal
  - Other Uses Case-by-Case

- **Meter**
  - No permit/right needed
  - Metered Basins
  - Permit/right needed

- **Public Waters**
  - Spills NMED
  - NM Oil Conservation Division Jurisdiction
  - Unmetered Basins
  - NM State Engineer Jurisdiction

- **Spills NMED**
Alternative Uses for Produced Water to Support Water Resource Sustainability In SW and SRM

• Reuse in oil and gas production
  – Hydraulic fracturing
  – Steamflooding (California)
• Irrigation (after treatment or dilution)
  – Rangeland rehabilitation
  – Non-food (cotton) crops
• Algal biofuel production
• Potash solution mining (proposed)
Rangeland Improvement

- Watered with ~4000, ~5000 and ~12,000 TDS produced water
  - Limited irrigation, focus to establish (jump start) grasses
  - The Sodium Absorption Ratio (SAR) and Electrical Conductivity (EC) of the soil rose only slightly.
  - Soil conductivity and Sodium Absorption Ratio values remain under critical limits for forage production for most grasses planted
- Chief Intermediate Wheatgrass, Hy-Crest Crested Wheatgrass, and San Louis Slender Wheatgrass had best overall rating for stand establishment
- Land Management Guidance, ~1500 TDS water
Produced Water Treatment for use in Rangeland Rehabilitation, Bloomfield NM

- Coal bed methane produced water was treated with multiple steps for organic, coal fine, and salt removal.
- Water was discharged to comparative rangeland plots to evaluate most appropriate quality for vegetation rehabilitation.
- Collaborative effort between Conoco Phillips, small businesses, LANL, SNL, Bureau of Land Management, and State of NM.

Coal fines accumulating in the modified zeolite filtration medium.
Produced Water Resource Study in SE New Mexico-Lea and Eddy Counties

- New project with NMSU/WRRI, NMT/PRRC, LANL, NMED, EMNRD
- Focus is reuse of PW as replacement for FW
- Stakeholder engagement and public meetings
- Visits to treatment facilities, regulatory analysis, cost analysis, mapping and quality analysis for future uses, treatment options
- Results available to public via map and database products, final reports

Photo: EJS Graham January 2016
Produced Water Treatment Process, Jal, NM

- Sampling event on October 4, 2011 at the Jal, NM Facility.
- Sampling points include raw inflow water from an oil well, post oil/water separation, post sand/carbon filtration, post flocculation and post ozone treatment.
Growing algae in Produced Water

**Lab Scale-LANL**
*N. Salina* 1776; *Scenedesmus+Tetracystis*
Salinity 10,000-30,000 mg/L
Testing various salinity ranges (10,000-30,000 mg/L); Cu:Zn ratios; HCO$_3^-$ concentrations (200-1,000 mg/L)
Modeling used to optimize media recipes

**Pilot Scale-Texas Agrilife Pecos**
*N. Salina* 1776;
salinity 19,000-28,000 mg/L
OD=0.6-0.8; AFDW=0.35 g/L;
BI=8-50 g/L
Exhibited low tolerance to higher salinity range

**Field Scale-Eldorado Biofuels**
*Scenedesmus+Tetracystis (Jalgae™)*;
Salinity 11,000-13,000 mg/L
Growing consistently in treated PW
Low concentration commercial fertilizer sources of N, P, K
HCO$_3^-$ concentrations ~700-900 mg/L
Diluent fresh water from local stock well
Quality is similar to FW samples
Recent Energy Water Program Plans Include Produced Water Treatment and Management

- **Technology RDD&D**
  - Thermoelectric Cooling Improvements
  - Waste Heat Recovery in Energy Systems
  - Process Water Use Efficiency and Quality
  - Traditional and Non-traditional Hydropower Improvements
  - Alternatives to Fresh Water Use in Energy Production Using Advanced Materials and Processes
  - Desalination Improvements
  - Net-Zero Municipal Wastewater Treatment
  - Sensors
  - Deployment

- **Analysis and Modeling**
  - Integrated Analytical Platforms
  - Decision Support Tools

- **Policy Framework**

- **Stakeholder Engagement**

- **International Diplomacy**