



Devon Water-Recycling Program

Prepared for the

FOURTH MEETING IN 2017 of the WATER AND NATURAL RESOURCES COMMITTEE

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New Mexico Institute of Mining and Technology

Socorro

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Agenda

- Introduction – Devon’s Water Principles
- Southeastern New Mexico
 - Operations
 - Water Resources
 - Produced Water Reuse
- Planning and Technology Piloting
- Program Execution
 - Water Storage
 - Treatment Technology
 - Water Transfer and Piping
- Results



Highlights of Devon's Water Principles

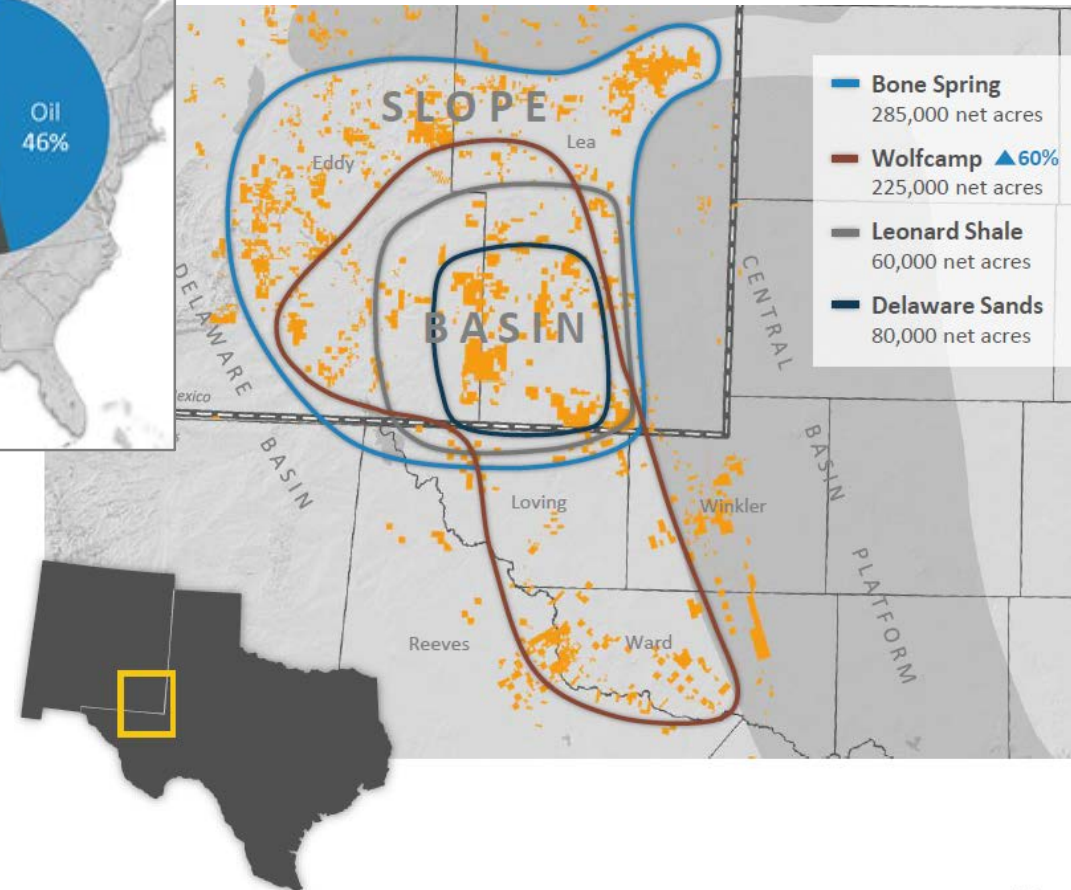
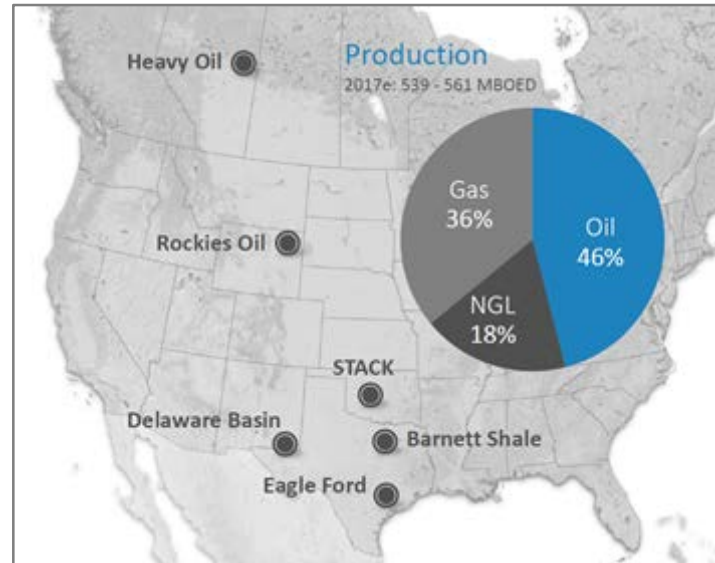
- Stakeholder Engagement
 - Educating and working closely concerning water-management needs
 - Advocating for appropriate regulations
- Water-Management Planning
 - Identifying usage needs and determining resource availability
 - Incorporating economically and operationally feasible alternatives to drinking water
- Technology Evaluation and Deployment
 - Identifying, testing and evaluating new technologies
 - Sourcing, recycling, storing and moving water
- Best Practices Development
 - Improve the economics, reliability and safety of using non-potable water supplies



Devon Operations - Southeast New Mexico



- Stacked Play
 - Delaware Sands
 - Leonard Shale
 - Bone Spring
 - Wolfcamp
- 670,000 risked net acres
- Over 5,800 risked gross locations
- Over 20,000 unrisked gross locations



Devon Energy Investor Presentation January 2017

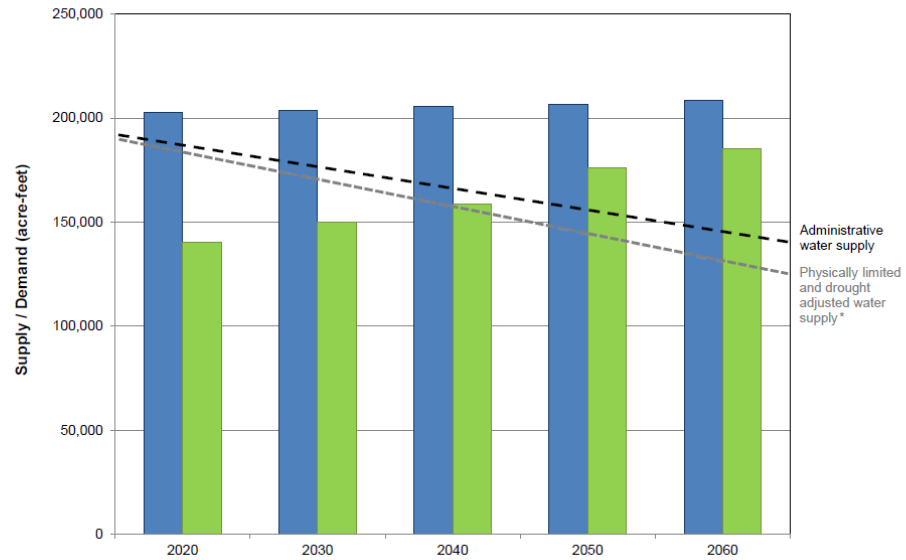
Water Resources – Southeast New Mexico



- Average precipitation: 10 in/yr and highly variable in southern New Mexico
- Evaporation: ranging from 56 to 110 inches
- Water owned by state, regulated by Office of the State Engineer (OSE)
- State divided into Water Planning Regions (WPRs)
- Devon's operations - Lea County WPR and the Lower Pecos Valley WPR
- Surface water generally not available
- Groundwater often used to meet demands associated with oil and gas
- Groundwater levels on decline, primarily due to irrigation demands (OSE, 2016a).
- Potential for supply shortfalls, especially in drought years

OSE, 2016a and 2016b

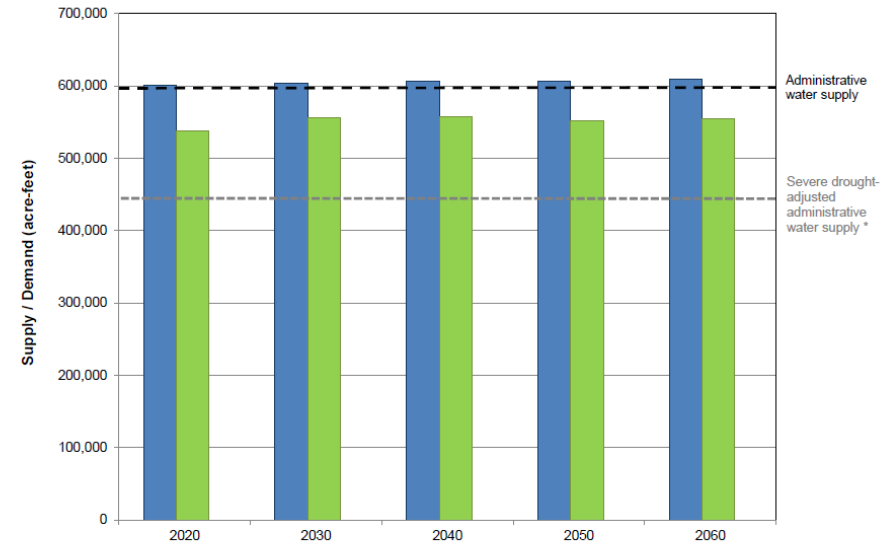
Water Supply and Demand - SE New Mexico



■ High demand projection
■ Low demand projection

* Based on modeling conducted by the New Mexico Office of the State Engineer and no surface water use.

LEA COUNTY
REGIONAL WATER PLAN 2016
Available Supply and Projected Demand



■ High demand projection
■ Low demand projection

* Based on the ratio of the minimum streamflow of record to the 2010 administrative water supply.

Note: Tribes and pueblos in New Mexico are not required to provide water use data to the State. Therefore, tribal water use data are not necessarily reflected in this figure.

LOWER PECOS VALLEY
REGIONAL WATER PLAN 2016
Available Supply and Projected Demand

OSE, 2016a and 2016b

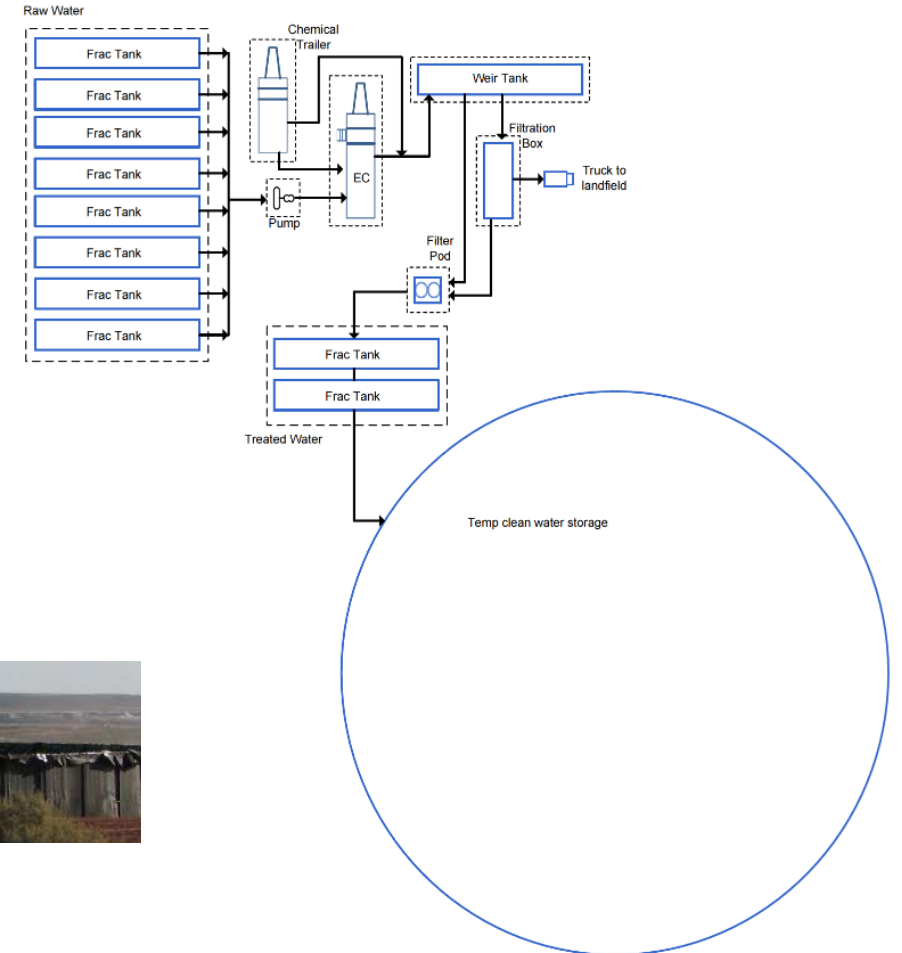
Produced Water Recycling – Key Strategy

- The regional water plans made multiple recommendations to reduce or eliminate the projected shortfall between supply and demand.
- Project categories included:
 - Municipal water conservation
 - Agricultural water conservation
 - Development of deep aquifers
 - Water importation
 - Aquifer recharge
 - Wastewater reuse
 - Weather modification
 - Produced water reuse



Piloting Technology

- 2013: First significant pilot
 - Volume: 43,000 bbls
 - Water Quality: 150,000-225,000 mg/l TDS
 - Water Treatment
 - Electrocoagulation, Weir tank, Filter
 - Storage: 41,000 bbl, above-ground storage tank (AST)
 - Transportation: Trucking
- 2014: Additional testing and successful pilots



Water Planning

- 2014: Devon implements comprehensive water planning for all operating areas
- Based on projected rig counts and shift toward slickwater and hybrid fracs, water supply identified as a risk (cost, availability)
- Disposal capacity also becoming limited
- Strategy needed to identify alternatives to traditional water supplies, reduce disposal and ultimately maximize value of the water resource
- Expanded recycling was determined to be a viable option to pursue



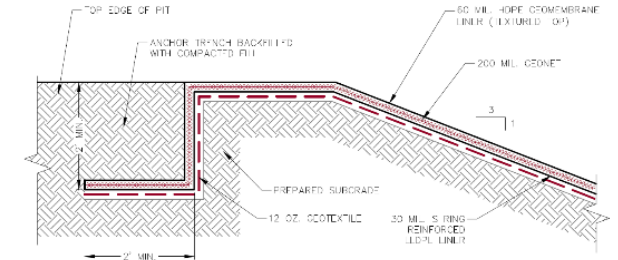
Stakeholder Engagement

- Oil and gas regulated by New Mexico Oil Conservation Division (NMOCD)
- Produced water regulated as waste
- Difficult to obtain permit for permanent, large volume ponds
- New Mexico Oil and Gas Association (NMOGA) proposed rule change
- Goals:
 - Stable, predictable regulatory framework
 - Encourage recycling and reuse
 - Improved economics, increased flexibility and simplified logistics
- 2015: NMOCD formally approves revision
 - Permit not required for use of produced water for completions



Program Execution – Water-Storage Ponds

- Primary and secondary liner, leak detection
- Automated alarms - water is in the sump
- Siting offsets from sensitive areas
- Wildlife and public access is restricted
 - Fencing and security
 - Innovative bird deterrent
- Impoundment embankments
 - Required slopes, compacted to specification, free from debris, rocks and other irregularities
- Liner seams tested by third-party inspector
- Ponds hydro-tested using dyed fresh water



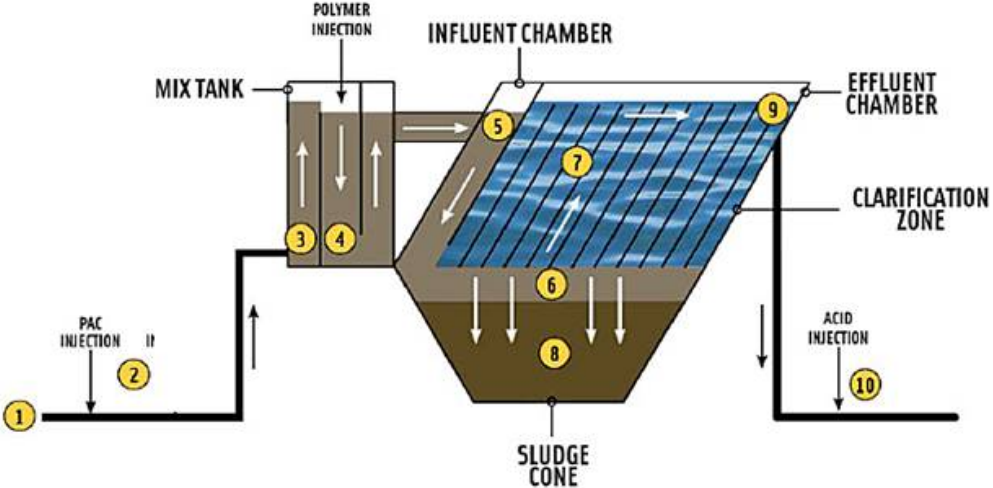
Water Treatment System #1

Process Description

- Fountain Quail's ROVER.
- Developed over a decade of pretreatment experience ahead of distillation systems
- Reduction of suspended solids - rapid mixing, flocculation and sedimentation
- Chemical used to increase pH to between 10.5 and 11.5
 - Precipitation of calcium carbonate, magnesium silicate, iron
- Polymer to aid settling
 - Flocculation - slow, controlled mixing, aggregation of floc particles
- Effluent pH adjusted to neutral
- Solids from clarifier are pumped to sludge thickener
- Sludge from sludge thickener pumped to filter press and dewatered

Water Treatment System #1

Schematic



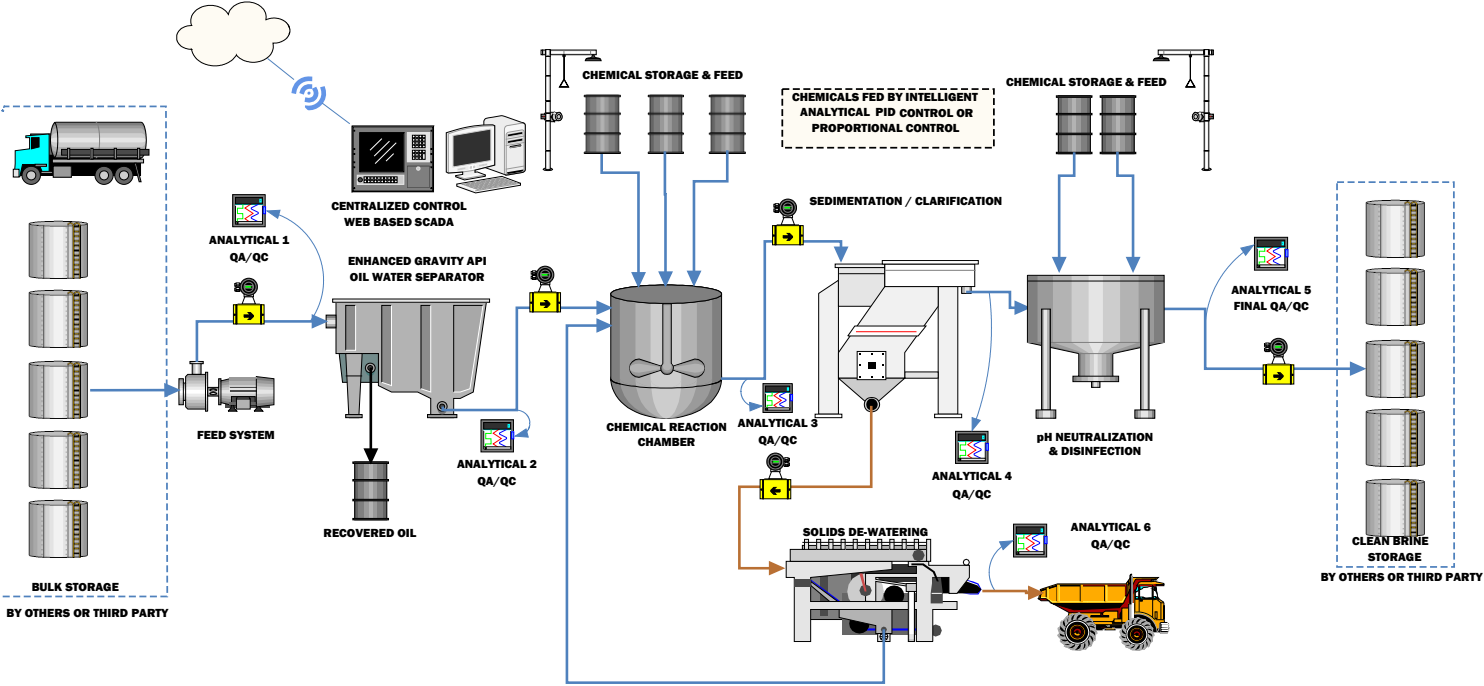
Water Treatment System #2

Process Description

- Gradient Selective Chemical Extraction (SCE™) process
- Chemically induced precipitation - removal of a wide range of contaminants
- Advanced measurement and system control methods – consistent results
 - Measure particle count, zeta potential and streaming current, turbidity
- Modified inclined plate clarifier
 - Rotating opposing pitch blade auger aided by sludge blanket level sensors
 - Bottom of the clarifier - the sludge is collected, thickened and removed

Water Treatment System #2

Schematic



Water Transfer and Piping

- Economical and safe movement of water is critical
- Hose and pipe - reduced cost and reduced number of trucks
- Collection systems were built, Devon-owned and third party
- High density poly ethylene (HDPE) and fiberglass pipe
- High rates to the frac locations through layflat hose
- High-volume capacity, portable, quickly deployed, durable
 - 200 psi, up to 80 bpm depending on job conditions
- Best practices
 - Preplanning, hydraulic evaluation, pressure testing and monitoring of piping systems critical to job success



Results

- Delaware Basin Water Management Program has reused
 - 1.6 million barrels (bbls) in 2014
 - 3.5 million bbls in 2015
 - 2.1 million bbls in 2016
 - 3.0 million bbls in 2017 (to date)
 - 2018 - significant expansion planned
- Reduced fresh-water demand
- Reduced disposal volumes
- Savings to capital and lease operating expenses for Devon and its partners.



Questions & Answers

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Thank you.