Produced Water for Cooling – A Case Study
San Juan Generating Station

Advanced Cooling Technologies
EPRI Workshop

Presented by
Michael N DiFilippo, Consultant

July 08, 2008
Produced Water for Cooling – A Case Study
San Juan Generating Station
San Juan generating Station’s Water Issues…..

- **San Juan Generating Station (SJGS)** consumes 22,000 acre-feet of water per year (467,600 BPD or 13,640 gpm) from the San Juan River.
- SJGS is a base-loaded plant and needs a reliable source(s) of water to operate.
- **Researchers at the University of Arizona predict an extended drought for the region – possibly lasting 40 to 50 years.**
- SJGS is a long-term energy production site and will be there 25 years or more.
- PNM has negotiated short-term and long-term water contracts to ensure supply, however if a severe drought develops water contracts are irrelevant.
- If SJGS uses less water through conservation and obtains alternative supplies (e.g. produced water), more water will be available for other beneficial uses.
One drought scenario.....

- **SJGS has to reduce power by 10% for an entire year.**
- SJGS has a long-term take-or-pay fuel contract, i.e. PNM must pay for fuel whether it uses it or not.
- SJGS will have to purchase power from other generators (most likely gas-fired combined cycle plants).
- **The financial impact for this scenario could be in excess of $45 million per year.**
- PNM has looked at scenarios where water reductions approach 30%.

The basis for this project was to provide supplemental water to avoid or minimize the financial impact of such a scenario.....
For every barrel of oil, 8 to 10 barrels of water are brought to the surface.....
Onshore Produced Water Generation

- 0 mgd
- 0 gpm
- 0 AF/yr
- 0-700 gpm
- 0-1,120 AF/yr
- 700-7,000 gpm
- 1,120-11,200 AF/yr
- 7,000-70,000 gpm
- 11,200-112,000 AF/yr
- 70,000-420,000 gpm
- 112,000-672,000 AF/yr
- 100-600 mgd
- 70,000-420,000 gpm
- 112,000-672,000 AF/yr
Project Setting
Base Map of Study Area (~2,200 sq miles)
Total Produced Water = 61,775 BPD

Each circle represents a production well or well cluster

In the Four Corners area almost all of the produced water is trucked to disposal.....
McGrath is a large SWD near Farmington, New Mexico. Produced water generated at the wellhead is transported by tanker trucks to SWDs. At the SWD, oil is separated from the produced water. The water is then filtered and injected into a non-producing formation at depths that sometimes reach 5,000 feet. In some locations, injection pressures exceed 1,500 psi. There are 53 SWDs in the San Juan Basin.
Produced Water Generation – High-Volume Areas

New Mexico Oil Conservation Division, 2003

High-Volume Production Areas
- Fairway: 20,680 BPD
- Close-in: 12,520 BPD
- Tri-City: 2,760 BPD
- Total: 39,560 BPD

Produced Water Generation – High-Volume Areas

39,560 BPD = 1,154 gpm
Life-of-project recoverable water.....
Project Implementation

Cost sharing with the oil & gas producers reduced overall costs.....
The project would be implemented in two phases.....

Phase 1
- An 11-mile pipeline would be build to collect water from Close-in producers (exclusively CBM production).
- Producers would inject filtered water into the line.
- Producer disposal costs would be reduced by $0.25/bbl.

Phase 2
- PNM would extend the pipeline an additional 17.5 miles to Bloomfield.
- Burlington resources would refurbish two existing pipelines and install satellite collection stations to gather theirs and other producer’s water in areas of heavy tanker-truck traffic.
- PNM would build a collection Center in Bloomfield to accept and pretreat water gathered by Burlington Resources.
- Producer disposal costs would be reduced by up to $1.00/bbl.
- Some SWDs could be put on stand-by and the life of costly injection wells ($1.5 to $2.5 million per well) would be extended.
Produced Water Treatment
Produced Water Salinity
Burlington Resources, McGrath SWD

Sample Date
4/4/03 4/9/03 4/14/03 4/19/03 4/24/03 4/29/03 5/4/03 5/9/03

TDS, mg/l
5,000 10,000 15,000 20,000 25,000
Brine Concentrator – Process Schematic
Treated Produced Water Reuse Points
San Juan Generating Station

Cooling Towers (4 units)

Ash System (4 units)

Process Wastewater Ponds

Evaporation Ponds (75 acres)

Limestone Prep

Slurry Dewatering

FGDs (4 units)

Recycle to Limestone Prep

Boiler Make-up

Distillate

Brine Concentrators (2)

Steam Losses

Boiler Blowdown

Plant Drains

San Juan River

Wastewater to Evap Ponds

Produced Water Treatment

Water Lost to Disposal

Overflow (occasional)

Spent Regen

Water Loss to Flue Gas

Boiler Cleaning (occasional)

Evaporation & Drift

Boiler Blowdown

Plant Drains

Coal Pile Runoff (occasional)

Evaporation Ponds (75 acres)

Evaporation & Drift

Boiler Blowdown

Plant Drains

Coal Pile Runoff (occasional)

Treated Produced Water Reuse Points
San Juan Generating Station
Economic Analysis
2004 Basis
## Capital Costs Incurred by PNM

<table>
<thead>
<tr>
<th></th>
<th>Collection Center</th>
<th>14-inch Pipeline</th>
<th>HERO + BC 3</th>
<th>Total Project</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capacity, BPD</td>
<td>34,000</td>
<td>60,000</td>
<td>53,000</td>
<td></td>
</tr>
<tr>
<td>Peak Conditions, BPD</td>
<td>30,670</td>
<td>44,710</td>
<td>48,130</td>
<td></td>
</tr>
<tr>
<td>Equipment &amp; Installation</td>
<td>$5,200,000</td>
<td>$12,900,000</td>
<td>$11,800,000</td>
<td>$29,900,000</td>
</tr>
<tr>
<td>Contingency 15%</td>
<td>$780,000</td>
<td>$1,940,000</td>
<td>$1,770,000</td>
<td>$4,490,000</td>
</tr>
<tr>
<td>NMGRT (1) 6.125%</td>
<td>$320,000</td>
<td>$790,000</td>
<td>$720,000</td>
<td>$1,830,000</td>
</tr>
<tr>
<td>PNM G&amp;A (2) 5.5%</td>
<td>$290,000</td>
<td>$710,000</td>
<td>$650,000</td>
<td>$1,650,000</td>
</tr>
<tr>
<td>Total Project</td>
<td>$6,590,000</td>
<td>$16,340,000</td>
<td>$14,940,000</td>
<td>$37,870,000</td>
</tr>
</tbody>
</table>

**Notes.....**

1. NMGRT is the New Mexico Gross Receipts Tax.
2. G&A is a "general and administrative" charge applied to all PNM projects.
Infrastructure Costs Incurred by PNM & Oil Producers

<table>
<thead>
<tr>
<th></th>
<th>Description</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>BR</td>
<td>Gathering system to Collection Center</td>
<td>$5,000,000</td>
</tr>
<tr>
<td>Dugan</td>
<td>Inject into pipeline</td>
<td>$100,000</td>
</tr>
<tr>
<td>Richardson</td>
<td>Inject into pipeline</td>
<td>$100,000</td>
</tr>
<tr>
<td>PNM</td>
<td>Collection Center, pipeline &amp; treatment</td>
<td>$37,900,000</td>
</tr>
<tr>
<td><strong>Total Project</strong></td>
<td></td>
<td><strong>$43,100,000</strong></td>
</tr>
</tbody>
</table>

*Notes.....*
1. Installation costs for Dugan and Richardson are most likely high.
PNM Operating Costs

PNM - Produced Water Project - SJGS

Water Recovery Cases
- 90% – Case 5
- 80% – Case 4
- 70% – Case 3

Scenario 3
6% Declination

Likely Recovery Range

Project Year

Escalated Annual Op Cost

Millions

$5.0
$5.5
$6.0
$6.5
$7.0

2005 2010 2015 2020 2025 2030
PNM was planning to qualify for a State of New Mexico for a tax credit of $1,000/AF for water-savings infrastructure. The tax credit would have an annual limit and life-time cap.....
Revenue to PNM would be generated by reducing producer disposal costs.....
Producer participation significantly influenced the cost of this water resource.....
Produced water project economics are based on capital and operating costs as well as a revenue stream.

PNM’s operating costs include treatment chemicals, power, labor, materials, maintenance and capital recovery costs.

Revenue streams offset PNM operating costs.

The first revenue stream would be a tax credit of $1,000/AF provided by the State of New Mexico (the tax credit would have an annual limit and life-time cap).

The second revenue stream would be a share of the oil-producer savings derived from reduced disposal of produced water and deferred costs of injection wells.

Depending on the revenue scenario, the 20-year, life-of-project costs would vary as follows:

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Cost Range</th>
<th>Annual Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>50-50 Share of producers savings with the New Mexico tax credit</td>
<td>$720 to $970/AF ($125 to $150/AF)*</td>
<td>$1.3 to $1.7 million/year</td>
</tr>
<tr>
<td>50-50 Share of producers savings without the tax credit</td>
<td>$1,200 to $1,500/AF ($160 to $200/AF)</td>
<td>$2.0 to $2.6 million/year</td>
</tr>
<tr>
<td>No revenue streams</td>
<td>$2,500 to $3,000/AF ($260 to $330/AF)</td>
<td>$4.3 to $5.1 million/year</td>
</tr>
</tbody>
</table>

*Blended water costs – San Juan River @ $75/AF plus treated produced water.*
PNM Project Benefits.....

- Conserve river water for other beneficial uses in New Mexico.
- Enable the San Juan Generating Station to be more drought resistant.
- Avoid costly fuel-delivery penalties and power purchase costs.

Oil & Gas Producer Benefits.....

- Reduce the volume of produced water that must be handled and injected.
- Establish an infrastructure to minimize produced water injection in the San Juan Basin.
- Establish area-wide opportunities to reduce produced water handling and injection costs.