



# Pilot Demonstrations of Arsenic Removal Technologies

**New Mexico Rural Water Association Meeting  
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# Team Members

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# The New Standard for Arsenic

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- **Recent reduction of drinking water Maximum Concentration Level (MCL) for arsenic from 50 ppb to 10 ppb was intended to reduce incidence of bladder cancer and other cancers in US.**
- **Southwestern United States is characterized by high and variable background levels for arsenic**
- **Estimated national annual costs of implementing 10 ppb MCL range from \$165M to \$605M to save 7 – 33 lives.**
  - **\$5M – \$23.9M /life saved**
  - **\$1.3M – \$6.6M/ year of life saved**
    - **About 1 life/500,000 exposed persons per year**
- **New MCL is controversial due to high costs and uncertain health benefits.**

**Can advances in water treatment technology significantly reduce costs?**



# Arsenic Water Technology Partnership

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- **Congressional Appropriation - \$10M**
- **DOE- funded peer-reviewed, cost-shared research program to develop and demonstrate innovative technologies for removal and disposal of arsenic from drinking water**
- **Partners**
  - **Bench-Scale Studies (AwwaRF)**
  - **Demonstration Studies (Sandia)**
  - **Economic Analysis/Outreach (WERC)**
- **Focus on small systems**
  - **40% of resources directed to rural and Native American utility needs**
  - **Minimize costs - capital, operating, maintenance**
  - **Minimize residual quantities & disposal costs**

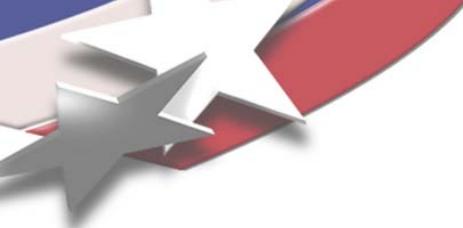




## Activities (FY2003 – 2005)

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- Initial technology deployment at Kirtland AFB
- Sponsored activities at New Mexico Environ. Health Conference (October 2003)
  - Theme session to introduce program
  - Vendors Forum to evaluate commercial technologies
  - Website: <http://www.sandia.gov/water/arsenic.htm>
- 2<sup>nd</sup> Vendors Forum at 9<sup>th</sup> New Mexico Environmental Health Conference (Oct. 19 - 20)
- Start pilot test deployment at Socorro, NM, Jemez Pueblo, and Desert Sands, NM



# Outline

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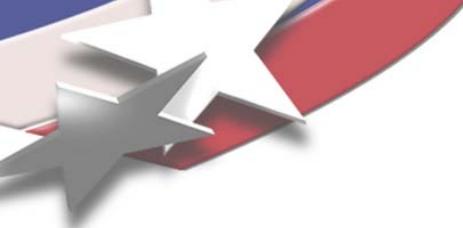
- **Concepts for Pilot Demonstration Tests**
- **Site selection**
- **Technology selection process**
- **Examples of Innovative Technologies**
- **Initial Tests in New Mexico**



# Sandia Pilot Test Concepts

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- **Side-by-side demonstrations of technologies tested by AwwaRF bench-scale program, WERC design contest or commercial technologies vetted through Vendor Forums**
  - Test duration: 3 – 9 months
  - Test size: 0.3 – 10 gpm
  - Different technology classes: adsorptive media, Coagulation/Filtration, membranes, electrochemical
- **Cooperative effort between Sandia, Technology Owner and Site Owner**
- **Test Protocols developed with help from NSF International , academia, industry during 2004**



# Pilot Test Configurations

- Pump house
- Skid Mount or container
- Mobile unit

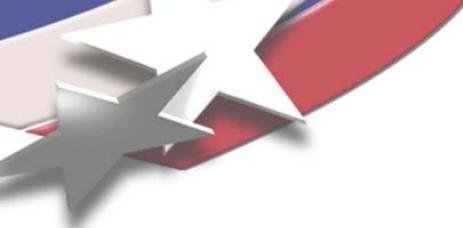




# Roles and Responsibilities

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- **Technology Owner**
  - Provides material or technology
- **Sandia National Laboratories**
  - Funds and oversees test
- **Site Owner**
  - Assists with test
- **WERC**
  - Economic analysis and tech transfer

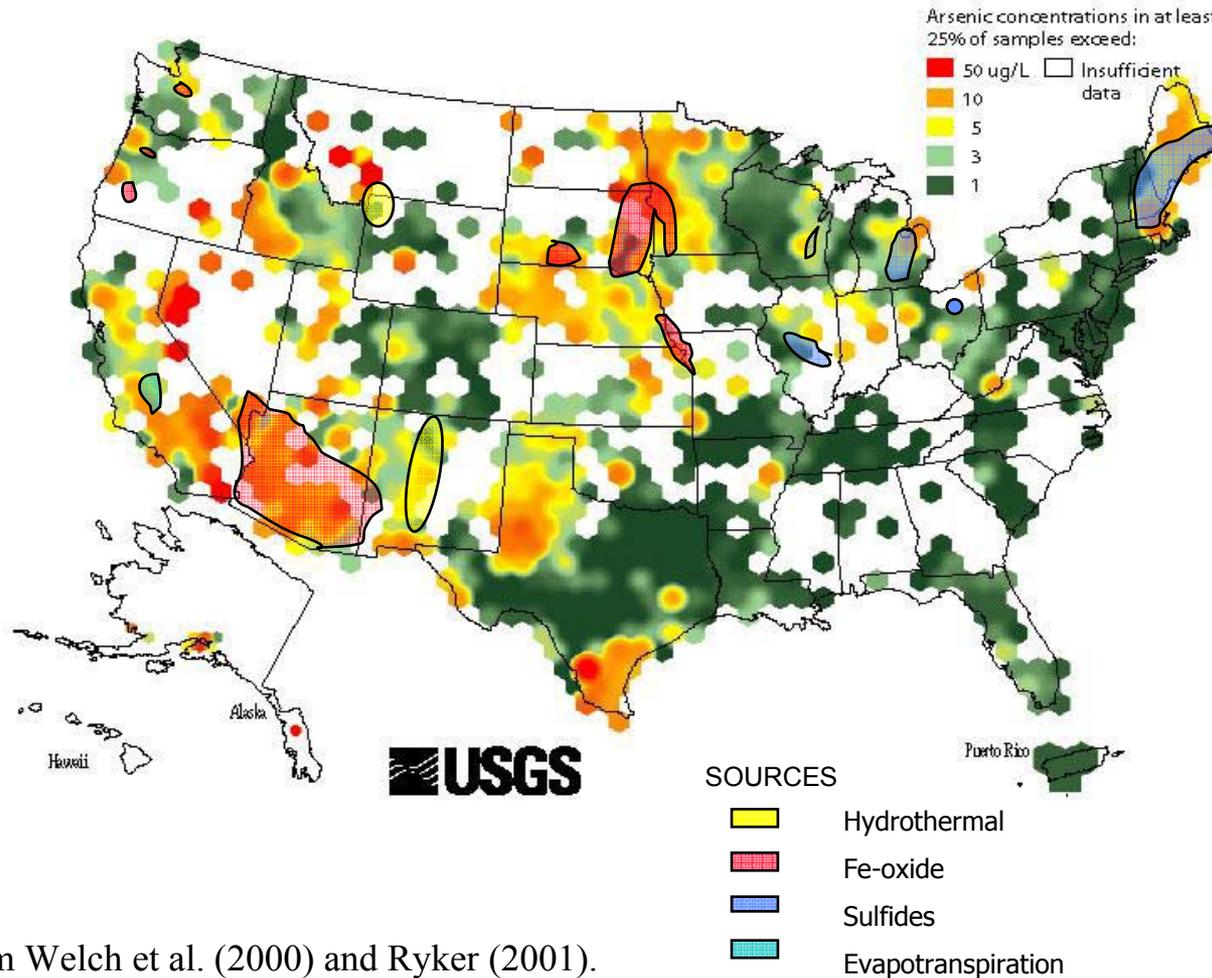


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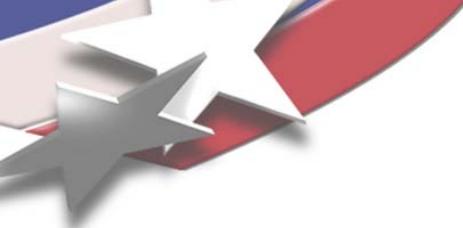
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- **Concepts for Pilot Demonstration Tests**
- **Site Selection**
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# National Scope of Program: Consider all Arsenic source types



Adapted from Welch et al. (2000) and Ryker (2001).

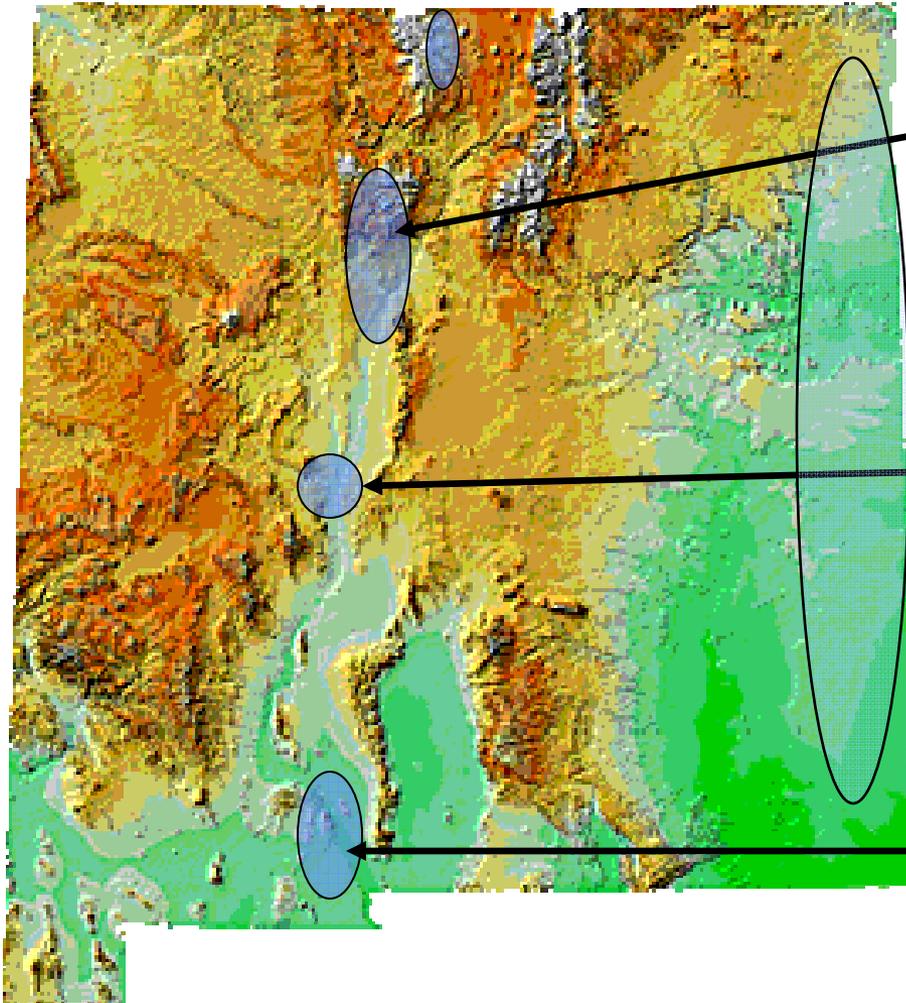


# Things we look for in a pilot site

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- **As concentration (>10 ppb)**
- **Example ground water composition that will help other communities**
  - pH, TDS, foulants such as Fe, Mn, silica, and organics
  - As(III)/As(V)
  - Competing ions (V, SO<sub>4</sub>, etc. )
  - Other contaminants of concern/benefit (e.g, Ra, U, ClO<sub>4</sub>, F)
- **Small size of system to be treated (< 10,000 users)**
- **Community support facilitates rapid deployment**
  - Water utility
  - Municipal government
- **Ability to deal with residuals/treated effluent**
- **Rural and Native American communities that would benefit from assistance**

# High Arsenic in New Mexico's Waters



• **Abundant in silicic volcanics**  
– derived volcaniclastic sediments and associated hydrothermal systems

• **Arsenic enrichment by Potassium Metasomatism**  
– low temperature alteration common in closed hydrographic basins in arid climates

**Mixing of deep geothermal waters and shallower surface influenced waters**



# Hydrothermal Waters in Jemez Silicic Volcanic Field

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- Thermal springs plume extends along Jemez fault zone (San Diego Canyon).
- Composition similar to deep thermal waters.
- Soda Dam
  - Na-HCO<sub>3</sub>-Cl water
  - pH = 6.7
  - Na = 960 ppm
  - HCO<sub>3</sub> = 1500 ppm
  - Cl = 1500 ppm
  - As = 1500 ppb
- Jemez Springs
  - As = 700 ppb
- Jemez River
  - As = 28 - 66 ppb
- Jemez Pueblo
  - 20 ppb As(III)
  - New standard = 10 ppb

# Jemez Pueblo, NM

- **As levels : 20-30 ppb ; optimal F level**
- **Treatment plant under construction (May 2005 completion?)**
- **Opportunities for training and outreach will be important aspects of pilot test program**





# Arsenic Enrichment near Socorro

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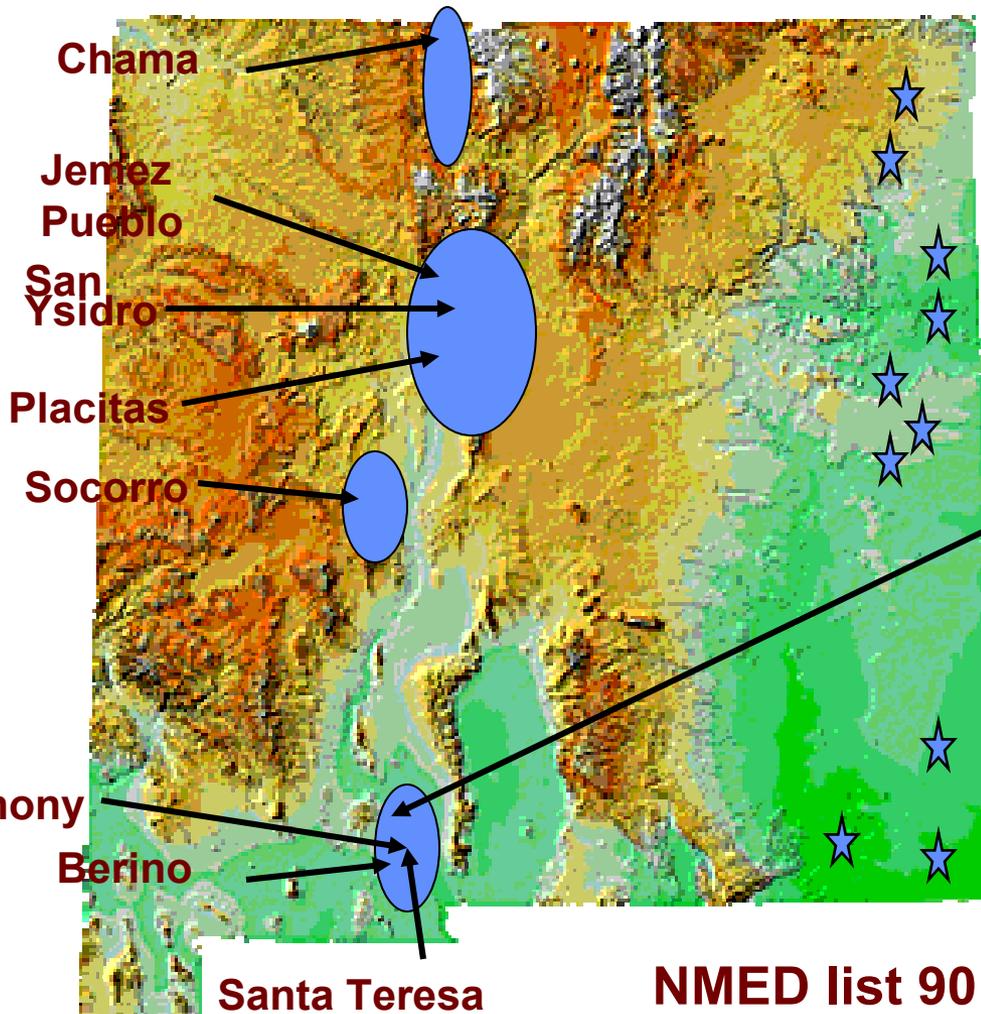
- K-metasomatism near Ladron Mtn region
  - 700 sq mi x 5000 ft thick
  - As range: 3 - 10 ppm, mean 5 ppm in altered rock
  - As mean = 1 ppm in fresh rocks
- Local hydrothermal alteration
  - As contents range: 2- - 200 ppm
- Local groundwaters
  - <2 ppb - 40 ppb As
- Sources: Chapin & Dunbar, 1994; *Brandvold 2001*

# First Community Pilot: Socorro, NM

- 100% groundwater source for drinking water
- Warm springs (90°F) provide 500 gpm, 20 – 40 ppb As by gravity flow.
- Formerly site of tap for bottled water company; optimal F
- Installation complete: 12/15/2004
- Training audit by NSF
- Full operation started Feb 2005
- 2 Phases
- Completion 10/2005



# Additional Sites in New Mexico



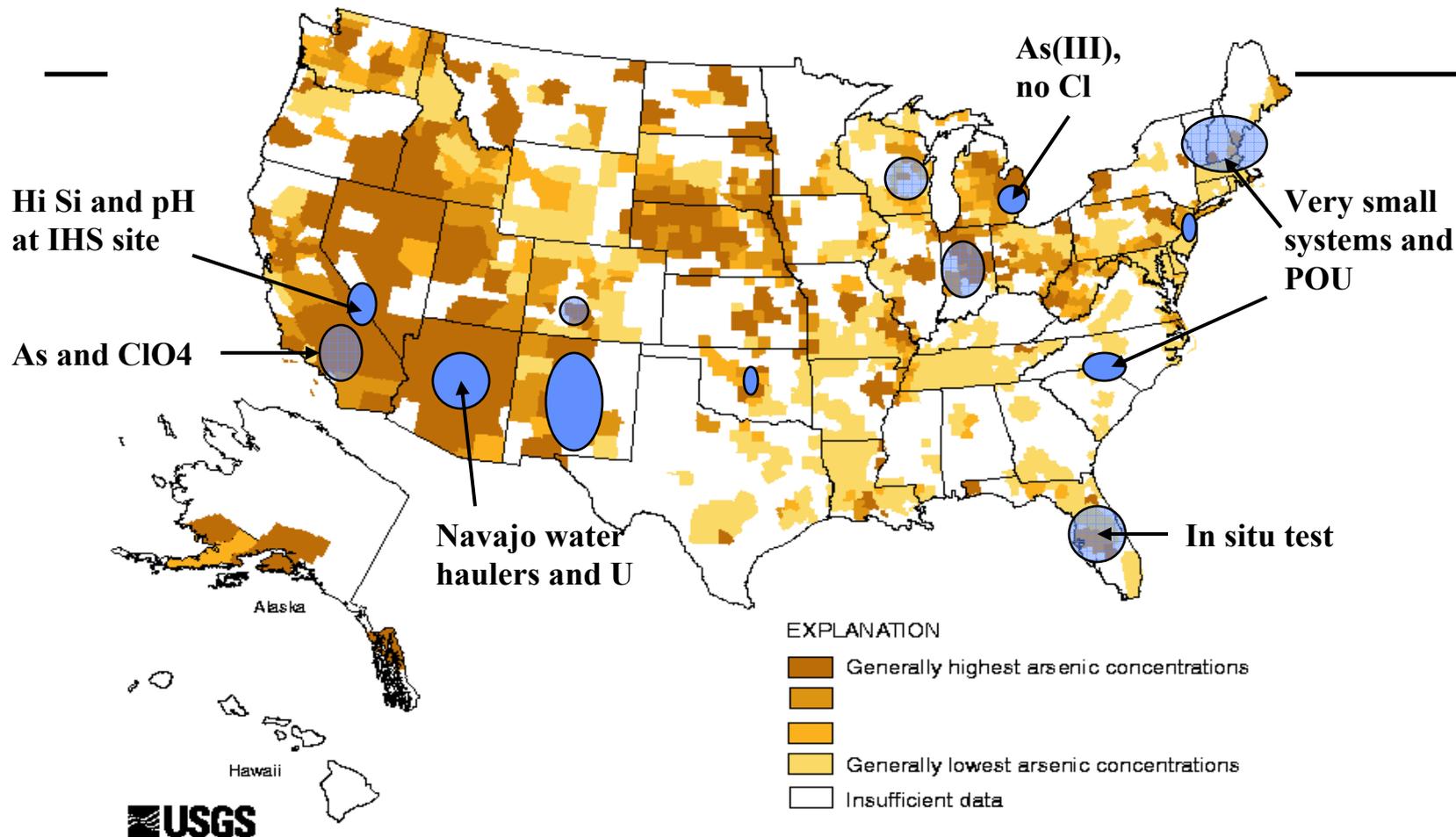
## Desert Sands

- EPA test site
- 10 adsorptive media
- Rapid small scale tests
- As(III) vs As(V) removal
- Full scale cost data
- Late Spring start



NMED list 90 sites >10 ppb in state

# Future Pilot Studies Under Consideration



10-15 pilot sites during program lifetime

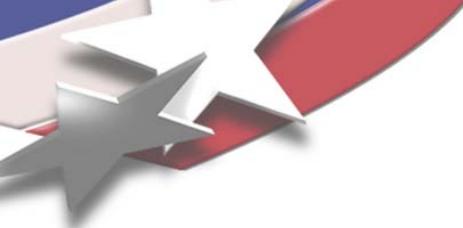
New technologies from industry, academia and DOE labs



# Arsenic Occurrence in Drinking Water Sources on the Navajo Nation

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- Public Water Systems Supervision Program under Navajo Nation EPA regulates approx. 200 public water systems (PWSs)
- Water sources of 26 PWSs (13%) exceed Arsenic MCL of 10 ppb; 15 are Community Water Systems (CWSs) and 11 are Non-Transient Non-Community Water Systems (NTNCWSs)
- Over 30% of Navajo residents are not connected to PWSs. Most of them haul water from unregulated water sources which contain contaminants such as arsenic, uranium, coliform and pesticides

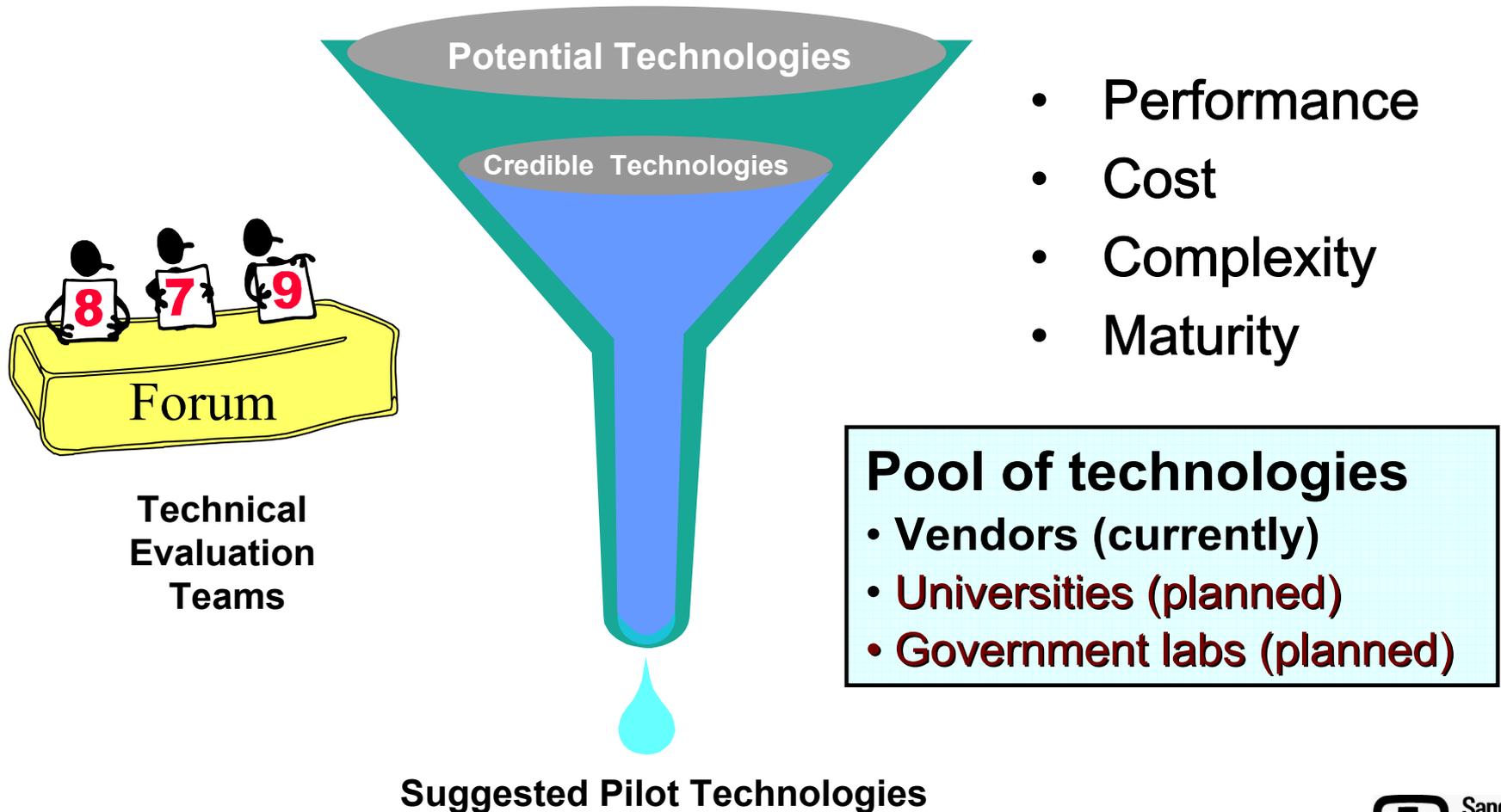


# Outline

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# Pilot Technology Selection Process

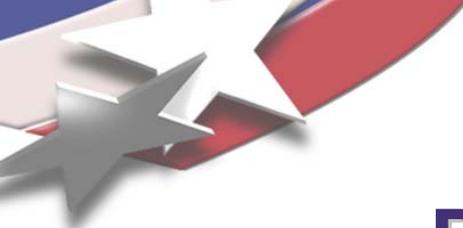




# Current Treatment Alternatives

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- **Sorption treatment processes**
  - Ion exchange
  - Activated alumina
  - Iron-based sorbents
- **Membrane treatment processes**
  - Reverse-osmosis
  - Precipitation/filtration processes
    - Conventional gravity coagulation/filtration
    - Coagulation-assisted microfiltration
    - Enhanced lime softening
    - Oxidation/filtration

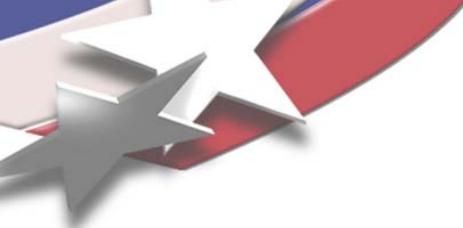


# Proposed Treatment Innovations

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- **Sorption treatment processes**
  - Regenerable, higher capacity and selectivity
    - Modified Fe-based sorbents
    - Ti, Zr-based sorbents
    - Resin-metal oxide hybrids
  - More stable residuals
  - ‘Tougher’ sorbents
  - Coatings on inexpensive materials (industrial waste, natural materials)
- **Precipitation/filtration processes**
  - Enhanced coagulation with Fe compounds or polyelectrolytes
  - Improved filtration with nanocomposite materials

**Vendor Forums led to recommendation of 10 innovative technologies for initial pilots and 6 for bench-scale studies**



# Promising Technologies Identified at the Arsenic Treatment Vendor Forums

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- **Pilot technologies from 2003 Forum**
  - Magnesium Elektron Inc. ( Isolux - Zr-oxide)
  - Hydroglobe (MetSorb - nanocrystalline Ti-oxide)
  - AdEdge (Granular Fe-oxide)
  - Filtronics (Coagulation/Electromedia filtration)
  - Kinetico (Macrolite media)
- **Pilot Technologies from 2004 Forum**
  - Purolite (ArsenX<sup>np</sup> – Fe-IX resin)
  - Engelhard (ARM-200 – GFO)
  - DOW – (Absorbsia – GTO)
  - Watts Premier and Zenon RFO membranes
  - Several others need bench scale studies before pilot



# Summary

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- **Pilot Test Demonstration Objectives**
  - Generate cost/performance data for innovative technologies for small communities
- **Site Selection**
  - Initial sites in New Mexico
  - Subsequent sites chosen through State and Tribal contacts and Web site applications
- **Technology Selection**
  - Initial technologies chosen from participants in Vendors Forum
  - Later stages include technologies vetted by university and government labs with State and Federal funding
- **Initial Pilot Studies**
  - Socorro, NM – February 2005 start
  - Desert Sands, NM – Spring 2005 start
  - Jemez Pueblo – Spring 2005 start