Energy &
Homeland Security

ENSURING A SAFE AND SECURE NATIONAL WATER SUPPLY AT THE ENERGY-WATER NEXUS

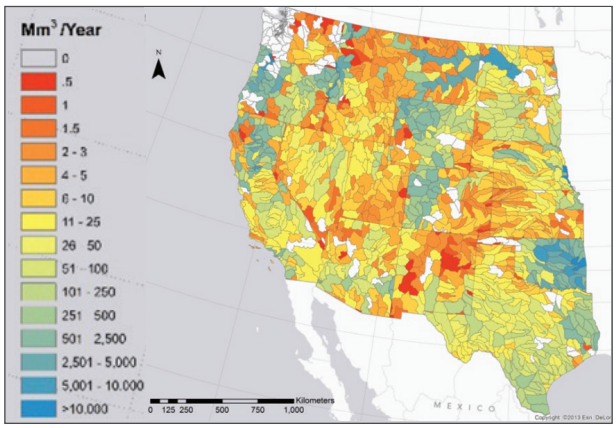
For over two decades, Sandia has applied interdisciplinary expertise to assess and create new water supplies from alternative water sources, monitor existing supplies and operations, evaluate risks to distribution infrastructure, and develop new methods to remove harmful by-products—ensuring the safety and security of the nation's energy-related water system.

THE NEED

The United States faces increasing water supply challenges in the form of aging water infrastructure, overdrawn aquifers, increasing demands, growing environmental regulation, and more frequent and intense extreme weather events driven by climate change. Solutions to these unique water-related challenges require a broad range of science and technological research. To address these national security challenges, Sandia applies its expertise in five priority areas to advance water technologies and address water supply challenges: resource assessment, risk and resilience analysis, critical minerals and rare earth element recovery, subsurface monitoring and characterization, and water treatment.

RESOURCE ASSESSMENTS

Sandia has assembled water inventories and conducted long-term monitoring in areas such as the Permian and San Juan Basins to assess water resources and how they would change with fossil energy operations. We have also designed system dynamics simulations that improve both our understanding of possible trade-offs across disciplines and evolving carbon management priorities.



The Water Atlas displays water budgets obtained by aggregating available water sources and subtracting the projected change in consumptive use.

Some examples of Sandia's resource assessment activities:

Water Atlas: A map of water budgets for various hydrologic units across the United States, across different source waters *(see above).*

Produced Water - Economic, Socio, Environmental Simulation Model (PW-ESESim): Assesses economic, social, and environmental tradeoffs for alternative water management strategies.

Water, Energy, and Carbon Sequestration Model (WECS-SIM): Calculates potential performance, location, and cost characteristics with a national CO_2 storage program utilizing geologic saline formations.

Water Balance Model: An analysis that explores the dynamics between a water source, its primary uses, and its potential use for oil and gas extraction activities.

Groundwater Monitoring: Field measurements, laboratory analysis, and monitoring of water supplies in the San Juan Basin and New Mexico portion of the Permian Basin.

U.S. DEPARTMENT OF ENERGY | NNSA National Nuclear Security Administration

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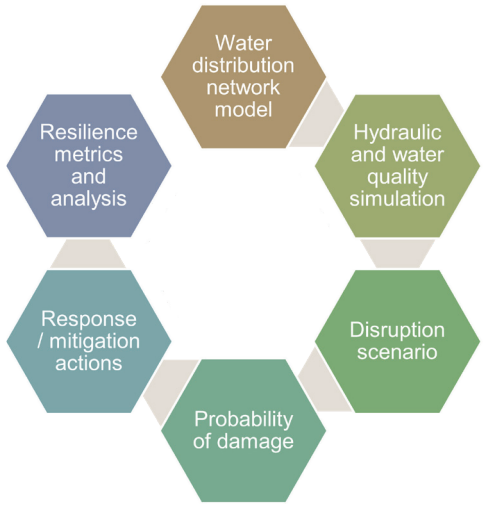
RISK AND RESILIENCE ANALYSES

Sandia applies its engineering expertise using various simulation tools to evaluate risk from natural hazards (e.g., a flood or fire) and determine the resilience of power and water distribution systems.



The Water Network Tool for Resilience (WNTR) is an open-source Python package developed at Sandia which can be used to simulate and analyze the resilience of water distribution networks. Sandia develops and maintains tools like WNTR to analyze risks and enhance resilience across energy and water infrastructure.

CRITICAL MINERALS AND RARE EARTH ELEMENT RECOVERY

Sandia researchers are developing innovative methods for the economic extraction of critical materials from unconventional domestic sources including coal, coal ash, produced water, oil and gas shales, and mine tailings. These advances will aid in the domestic production of the critical materials needed to advance a carbon-free energy future.

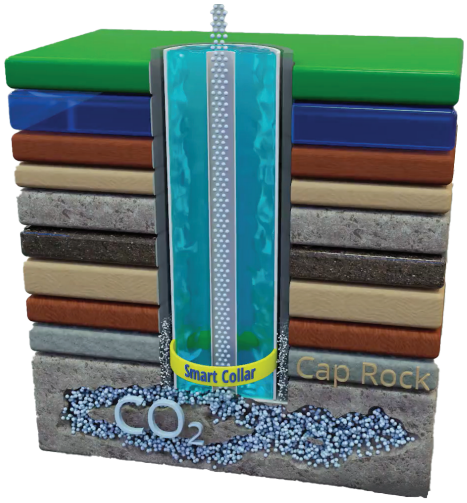
Methods and technologies under development at Sandia in this area include:

- **Resource assessments** of unconventional domestic sources for the economical recovery of critical materials
- **Environmentally benign extraction** of critical materials from unconventional domestic sources using Sandia's supercritical CO_2-water-citric acid fluid technology

SUBSURFACE MONITORING AND CHARACTERIZATION

Building on decades of subsurface characterization experience, Sandia has developed several new methods that enable improved monitoring of high temperature, high pressure settings, including underground transport and leak detection:

- **High temperature, high pressure sensors:** measures pH, chloride, and iodide
- **Subsurface CO_2 monitoring:** identifies leaks and takes measurements from within the casing annulus of an injection well



The smart collar technology, illustrated here, will detect leaks from CO_2 storage locations to ensure captured CO_2 stays deep underground.

WATER TREATMENT

Sandia's water treatment program officially began in 2003 and since that time has expanded to include many aspects of desalination and additional water treatment technologies. Highlights include:

Contaminant Selective Technologies:

- Materials that can selectively remove radionuclide contaminants, including cesium, strontium, uranium, plutonium, technetium, and iodine
- Materials for toxic metal removal, including arsenic, selenium, mercury, barium, and lead

Perfluoroalkyl Substances (PFAS) Treatment:

- Novel removal technologies to address PFAS contamination

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