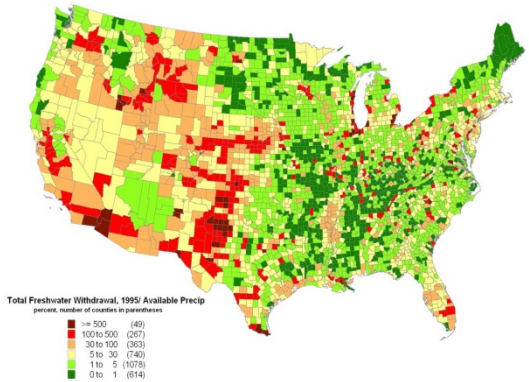
SAND2017-3535PE

Exceptional service in the national interest

Sandia National Laboratories



Sandia Water Treatment & Desalination Research, Development & Demonstration

Susan J. Altman, Ph. D.
Manager, Geochemistry Department

April 4, 2017

U.S. DEPARTMENT OF ENERGY

National Nuclear Security Administration

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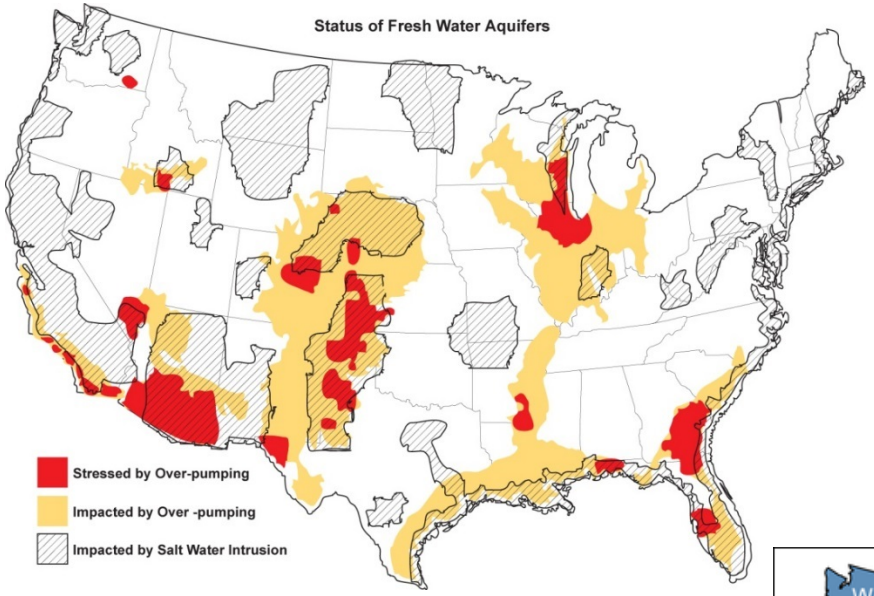
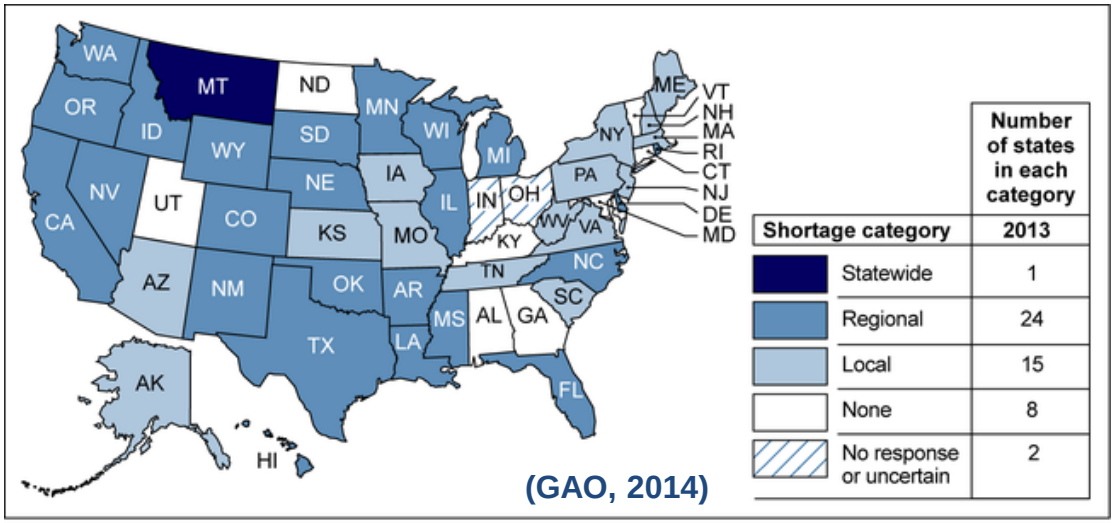
U.S. Water Stress is Growing



(Shannon 2007)

- Many major groundwater aquifers seeing reductions in water quality and yield
- Little increase in surface water storage capacity since 1980
- Concerns over climate impacts on surface water supplies



Sources: GAO analysis of state water managers' responses to GAO survey; Map Resources (map).

Water Withdrawal Trends

Sandia National Laboratories

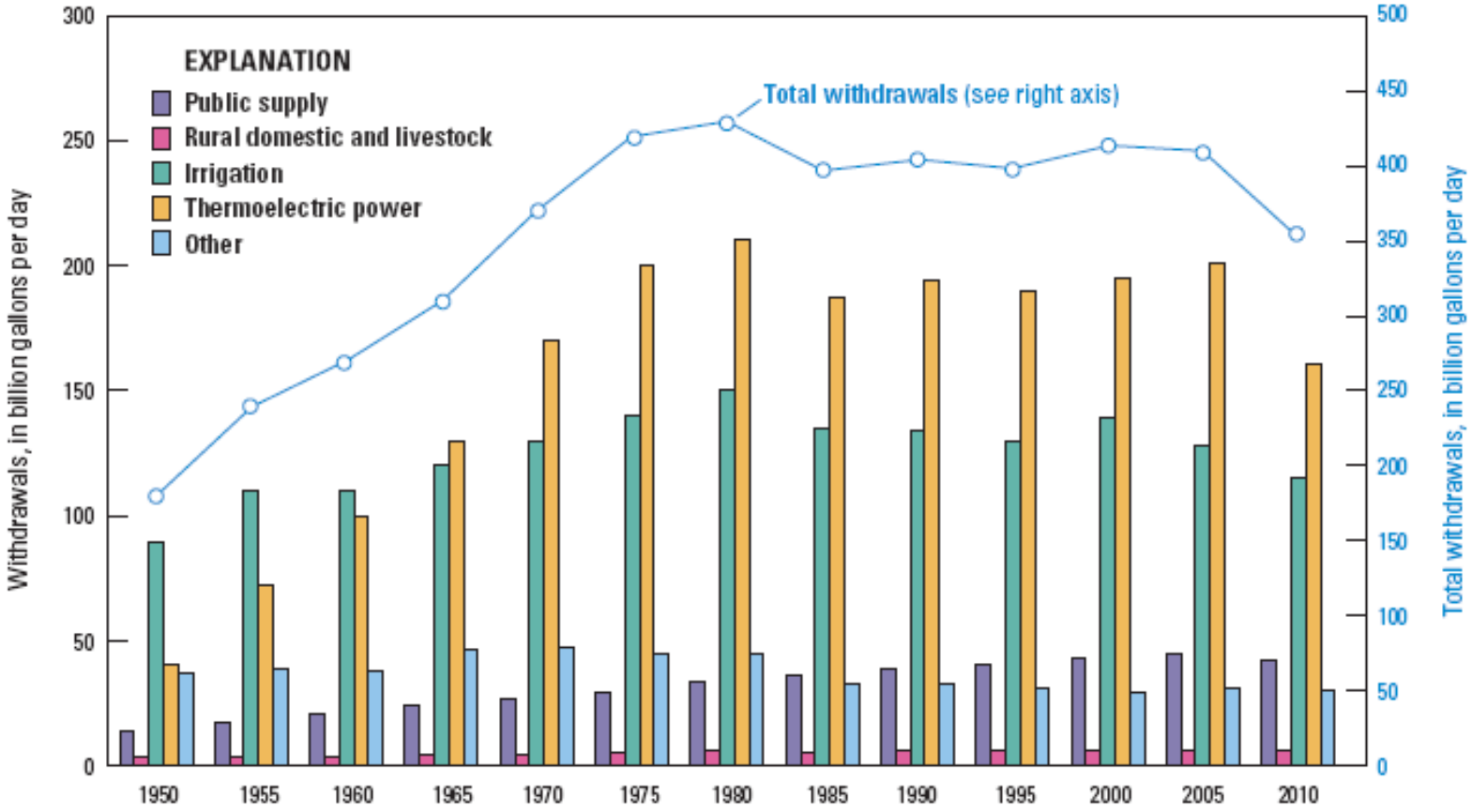
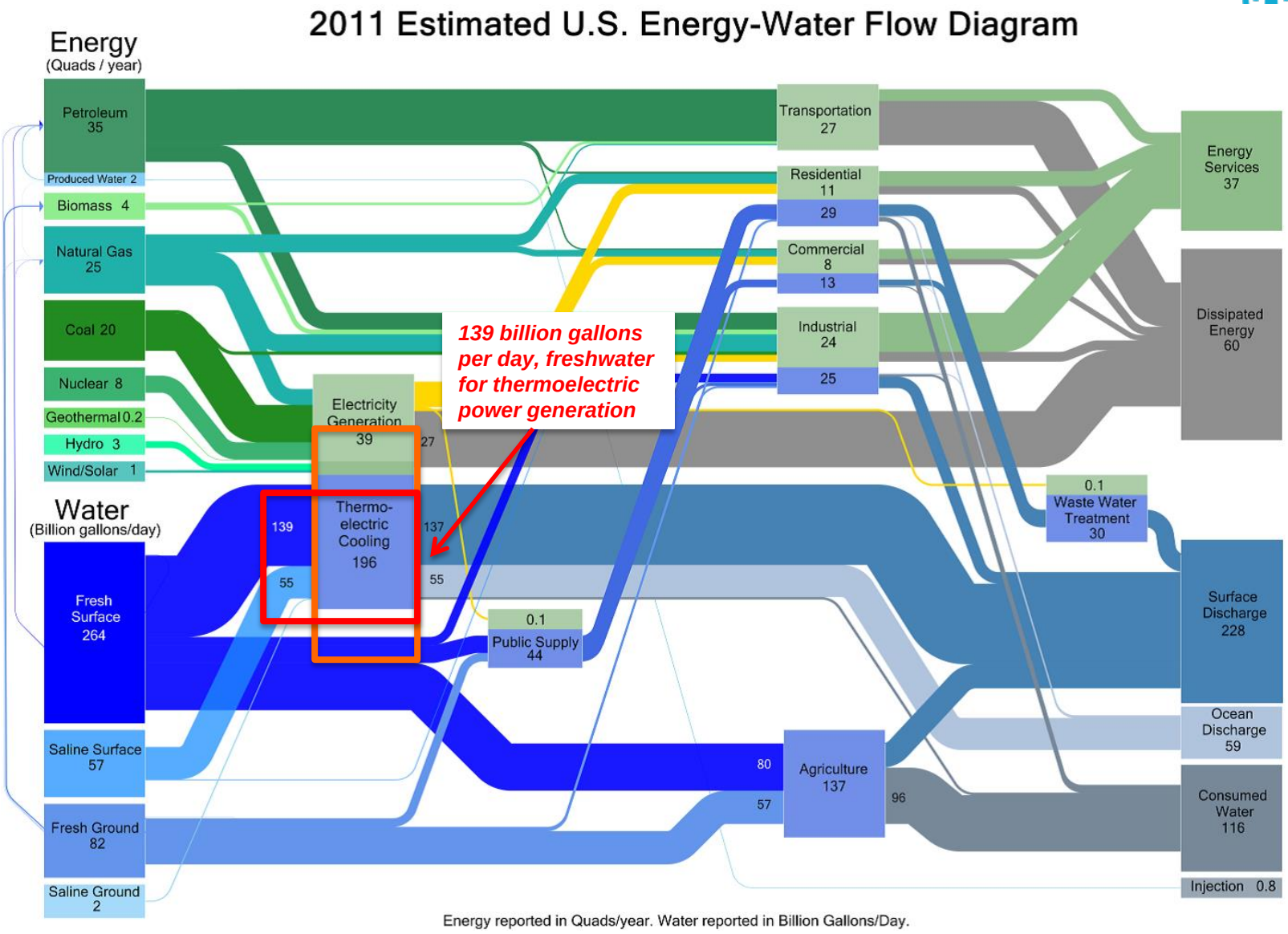


Figure 14. Trends in total water withdrawals by water-use category, 1950–2010.

[USGS]

Energy-Water Nexus



Source: Energy, U. S. Department of Energy (2014), The Water-Energy Nexus: Challenges and Opportunities.

water.sandia.gov

Sandia National Laboratories

Energy & Climate — Secure & Sustainable Energy Future

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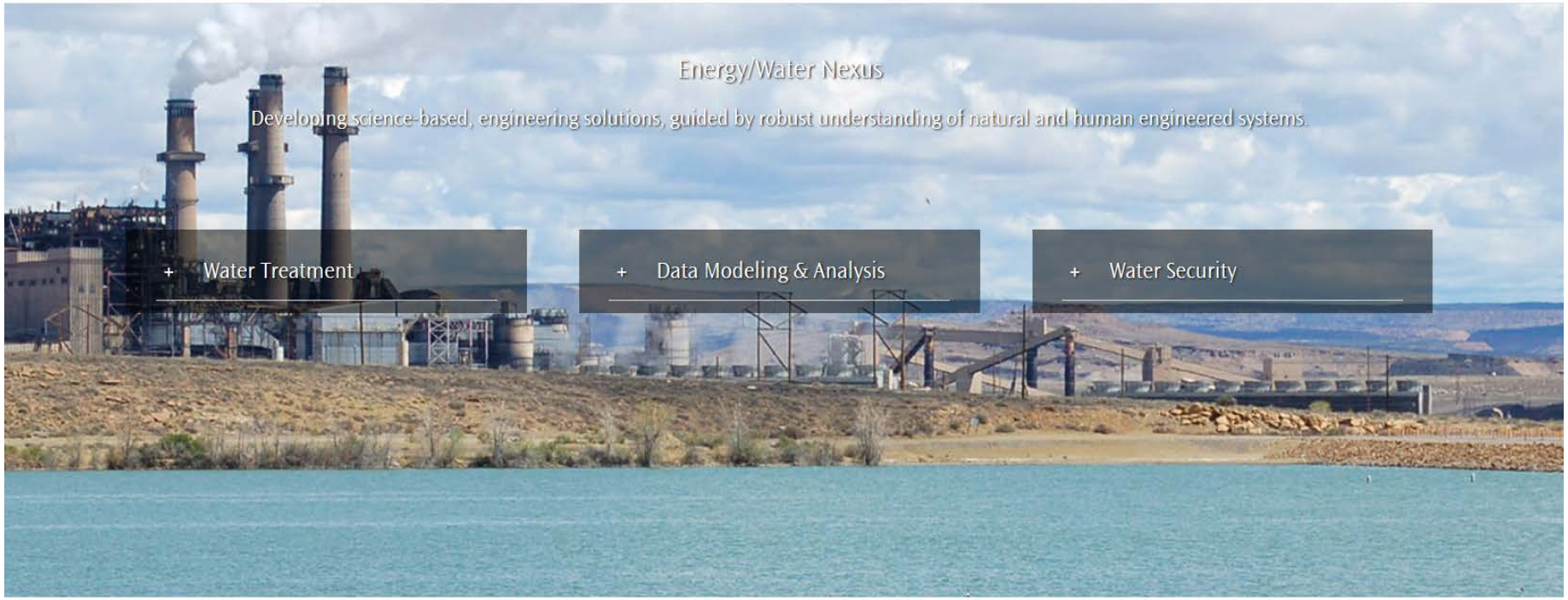
Stationary Power | Climate & Earth Systems | Transportation Energy | Energy Research | About EC



The continued security and economic health of the United States depends on a sustainable supply of both energy and water. The availability of adequate water supplies has a profound impact on the availability of energy, while energy production and power generation activities affect the availability and quality of water. While our supply of water today is largely safe and adequate, we as a nation face increasing water supply challenges in the form of extended droughts, demand growth due to population increase, more stringent health-based regulations, and competing demands from a variety of users.

Sandia's Energy-Water program strives to:

- Increase the safety, security, and sustainability of water infrastructure through the development of advanced technologies that create new water supplies,
- Decrease demand through efficient water use, and
- Provide decision-making tools to the institutions responsible for balancing supply and demand.

Decision Modeling and Analysis | Energy and Water program

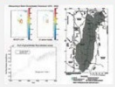
Sandia National Laboratories

Contact: Stephanie Kuzio
Energy & Water Program Manager
spkuzio@sandia.gov

2001-2003 — Middle Rio Grande Regional Water Planning Model

2002 — Middle Rio Grande EIS Support

2004-2006 — Water Management Toolbox



2005 — Borders as Membranes

2005-2007 — Modeling the Gila-San Francisco Basin

2006-present — Upper Rio Grande Simulation Model

2005-2006 — Water Quality Monitoring in the Jordan River Valley

2007 — Libyan Workshop

2007 — Water Resources Decision Making

2007 — Algae Testbed Project

2007 — New Mexico Dairy Project

2009 — Study of the Willamette Basin, Oregon

2010 — State-wide Climate Study through 2050

2011-2014 — Hydropower Optimization

20011-2014 — Model for Geothermal Energy Development

2013 — Spatially Variant Process Models

2014-present — Energy Water in the Eastern Interconnect

2015 — Climate Change Impacts in the Southeast US

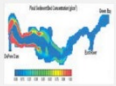
2015-2016 — Water Atlas

2000 — 2005 — 2010 — 2015 — Present

2001-2010 — NMSBA Projects Providing Technical Support to New Mexico Small Businesses

2001-2008 — Water Quality Monitoring in Central Asia

2002 — Evaluation of Contaminants in Rivers



2003-2005 — Tool to Evaluate Sediment Transport in Western Streams and Rivers

2005-2006 — Water Resource Management for the Rio Grande

2005 — Global Water Futures

2006 — Rainey River Basin Project

2007 — Water Leasing Market Design for Mimbres River

2007 — Nambe Pueblo Project

2007-2008 — Model for Iraqi Water Planners

2008 — Algae Biofuels Project

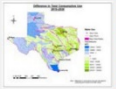
2008 — Sandia-GM Biofuel Deployment Model

2010-2014 — Energy-Water Planning in the Western and Texas Interconnections

2010 — Algae Biofuels Technology Roadmap

2011-2013 — WECSim Model

2012-2013 — ERCOT Climate Study



2012 — Upper Rio Hondo Water Availability Model

2014-2016 — High Plains Aquifer Analysis

2014-present — SWaRMS Regional Partnership

2014 — National Climate Assessment Energy-Water-Land Chapter

2015 — Water Consumption for Energy Production Around the Pacific Rim

2016-2017 — Water Sustainability in the Permian Basin Region of New Mexico

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Sandia Water Security Software

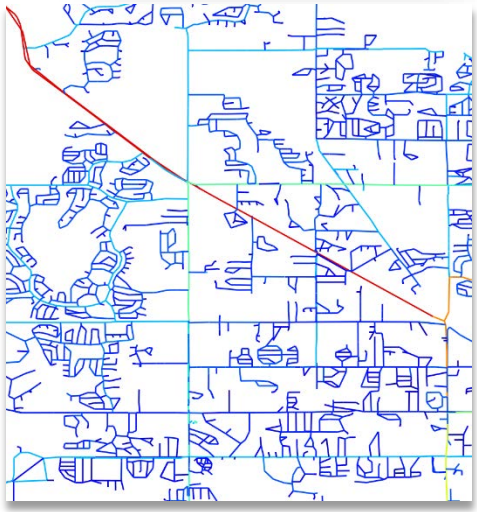
Sandia has developed a wide range of simulation and optimization software tools to improve security and resilience of water distribution networks. These tools include:

SPOT – Sensor placement optimization tool

Optimize sensor placement locations in the network to minimize impact. (2008 Edelman Prize, 2008 COIN-OR Cup, used to place sensor in 4 US cities)

CANARY – Real time event detection

Event detection algorithms for online sensors, alerts water utilities if water quality becomes anomalous. (2010 R&D100 Award, running at Metropolitan Water District of Southern California, and on the Singapore national system)



WNTR – Water Network Tool for Resilience

Simulate and analyze water distribution networks under disaster scenarios. (Release October 2016 on the USEPA GitHub site)

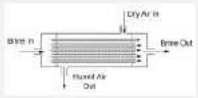
Sandia National Laboratories

Sandia has been actively working in a broad range of water treatment technical challenges for over a decade

2000 — ADVANCED CONCEPTS WATER-TREATMENT PROGRAM BEGINS

2001 — DESALINATION TECHNOLOGY ROADMAPS

2002 — DEVELOPMENT OF SWEEPING GAS MEMBRANE DESALINATION USING COMMERCIAL HYDROPHOBIC HOLLOW FIBER MEMBRANES

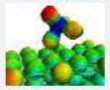


For more information contact:

Susan J. Altman, Ph.D.
Geochemistry Department
sjaltma@sandia.gov

2003 — ARSENIC WATER TECHNOLOGY PARTNERSHIPS FORMS

2004 — DEVELOPMENT OF NOVEL ARSENIC TREATMENT APPROACHES



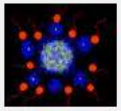
2005 — FRONTIERS OF INTERFACIAL WATER RESEARCH WORKSHOP

ARSENIC PILOT DEMONSTRATION PROJECTS

UV ULTRAVIOLET WATER PURIFICATION SYSTEMS FOR RURAL ENVIRONMENTS AND MOBILE APPLICATIONS

2006 — PRODUCED WATER PILOT SAN JUAN BASIN

CAPACITIVE IONIZATION FOR COAL-BED NATURAL GAS PRODUCED WATER



PATENT FOR NEXT-GEN COAGULENT FOR THE REMOVAL OF BACTERIA AND VIRUSES

2007 — JOINT WATER REUSE & DESALINATION TASK FORCE

WATEREUSE

METHOD FOR SYNTHESIZING LAYERED DOUBLE HYDROXIDE CAPABLE OF SORBING ANIONIC AND IONIC CONTAMINANTS FROM FLUID

2008 — COMMERCIALIZATION OF ZERO LIQUID DISCHARGE PROCESS FOR BRACKISH WATER DESALINATION

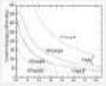
BRACKISH GROUNDWATER NATIONAL DESALINATION RESEARCH FACILITY

2009 — IMPLEMENTATION OF THE NATIONAL DESALINATION AND WATER PURIFICATION TECHNOLOGY ROADMAP

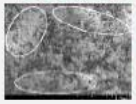
EXPLOITING INTERFACIAL WATER PROPERTIES FOR DESALINATION & WATER PURIFICATION APPLICATIONS

2010 — MEMBRANES & SURFACES NANO-ENGINEERED FOR PATHOGEN CAPTURE & DESTRUCTION

LOW COST ARSENIC TREATMENT SYSTEM FOR SMALL COMMUNITIES



SELF-SEALING EVAPORATIVE POND LINER



BIOMIMETIC MEMBRANE R&D 100 AWARD

MEMBRANE DISTILLATION WATER TREATMENT USING POWER PLANT WASTE HEAT

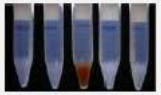
2011 — MICRO-MIXERS FOR MITIGATING MEMBRANE FOULING

NOVEL SILICA REMOVAL STRATEGIES BY WARM LIME SOFTENING

BIO-FOULING RESISTANT CERAGENIN-MODIFIED WATER TREATMENT MEMBRANES

MEMBRANE TREATMENT OF SIDE-STREAM COOLING TOWER FOR REDUCTION OF WATER REUSAGE

2012 — CRYSTALLINE SILICOTITANATES FOR RADIOACTIVE CESIUM REMEDIATION



COAGULATION CHEMISTRIES FOR SILICA REMOVAL FROM COOLING TOWER WATER

2013 — PATENT ON METHOD FOR RECOVERING ALKALI METALS

APATITE PERMEABLE REACTIVE BARRIERS FOR IN SITU REMEDIATION OF URANIUM IN SUBSURFACE OF UMTRA SITE

2014 — USE OF FLUE GAS TO CONTROL SILICA AND CALCITE SCALE IN COOLING TOWERS

NMSBA

MEMBRANE DISTILLATION PROJECT FOR SMALL NEW MEXICO BUSINESS

2015 — WASTE WATER FOR POWER GENERATION VIA ENERGY EFFICIENT SELECTIVE SILICA SEPARATIONS

GRAPHENE OXIDE/POLYMER MEMBRANES

2016

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Sandia National Laboratories

Sandia has been active … water treatment technical challenges for over a decade

DESALINATION AND WATER PURIFICATION TECHNOLOGY ROADMAP

A REPORT OF THE EXECUTIVE COMMITTEE

Discussion Facilitated by Sandia National Laboratories and the U.S. Department of Interior, Bureau of Reclamation

Desalination & Water Purification Research & Development Program Report #95

Sandia National Laboratories

ADVANCED CONCEPTS WATER-TREATMENT PROGRAM BEGINS

DESALINATION TECHNOLOGY ROADMAPS

…OMMERCIALIZATION …F ZERO LIQUID …SCHARGE PROCESS …OR BRACKISH …ATER …ESALINATION

…RACKISH …ROUNDWATER …ATIONAL …ESALINATION …ESEARCH FACILITY

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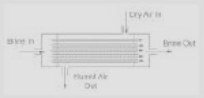
2000 2001 2002 2003 … 2008 2009 2010 2011 2012 2013 2014 2015 2016



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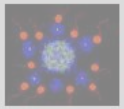

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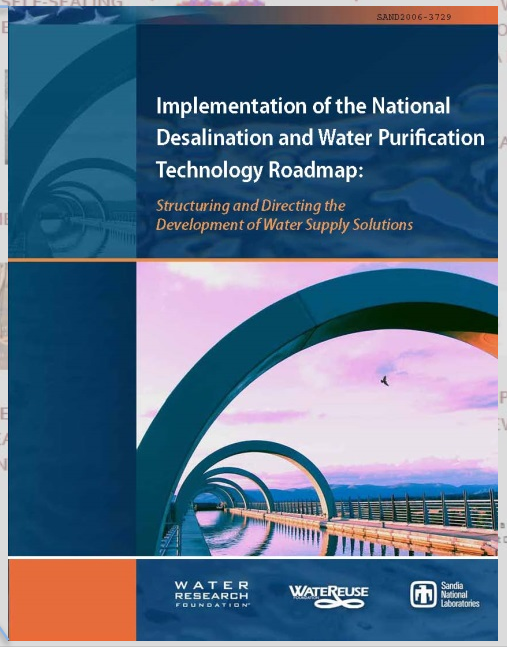

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Roadmapping

Efforts to Accelerate Brackish Water Desalination Technology Development

Sandia National Laboratories

Brackish Groundwater National Desalination Research Facility (BGNDRF) Alamogordo, NM

- Led effort with Bureau of Reclamation on a Report to Congress for the conceptual design of a national brackish water desalination research facility - 2003
- Supported BOR on final design, construction, and operation - 2004 - 2009

Clients:

UTEP, Texas Tech University, NM State University, Voltea, LG, AtlantisTechnologies Cost-effective Wastewater Desalination, GE, OASYS WATER, University of Nevada, Reno, VEOLIA, LG WATER STANDARD A global water solution in partnership with nature

Fundamental Research

Sandia National Laboratories

road range of water treatment technical challenges for over a decade

JOINT WATER REUSE & DESALINATION TASK FORCE

WATEREUSE

COMMERCIALIZATION OF ZERO LIQUID DISCHARGE PROCESS FOR BRACKISH WATER DESALINATION

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CAPACITIVE IONIZATION FOR COAL-BED

IMPLEMENTATION

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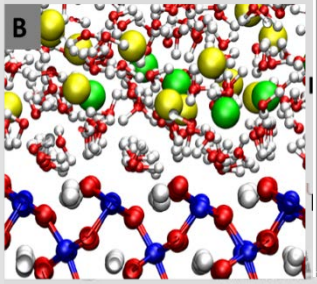
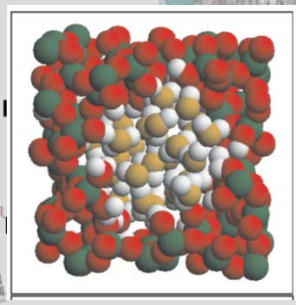
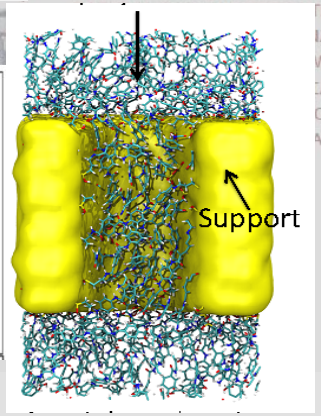
SELF-SE EVAPOR POND

BIOM MEMBRAN 100 A

MEMBRANE DISTILL WATER TREATMENT POWER PLANT WAST







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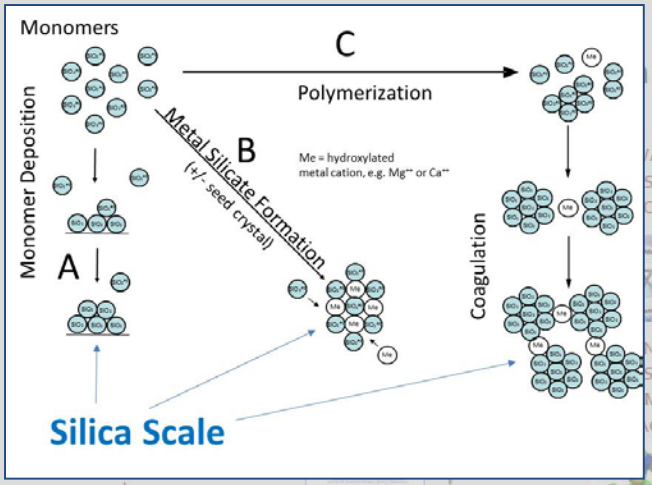
Silica Removal



Sandia National Laboratories

...a broad ...chnical challenges for over a decade

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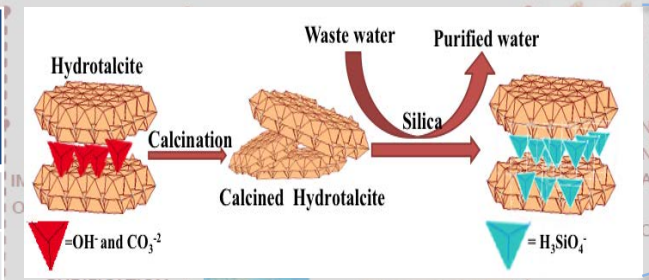
Silica: Chloride Ratio	% Silica Removed		Silica: Sulfate Ratio	% Silica Removed
1:1	99.0		1:1	99.0
1:5	98.8		1:5	97.0
1:10	98.5		1:10	95.8
1:15	97.9		1:15	95.2
1:20	97.6		1:20	94.8

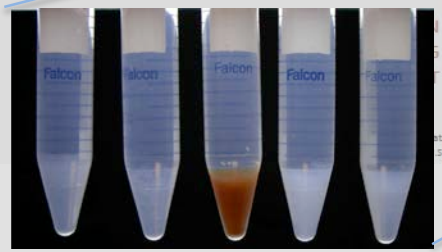
ENVIRONMENTS AND MOBILE APPLICATIONS

THE REMOVAL OF BACTERIA AND VIRUSES



PURIFICATION TECHNOLOGY ROADMAP

COAGULATION CHEMISTRIES FOR SILICA REMOVAL FROM COOLING TOWER WATER



WASTE WATER FOR POWER GENERATION VIA ENERGY EFFICIENT SELECTIVE SILICA SEPARATIONS

USE OF FLU... GAS TO CONTROL SILICA AND CALCITE SCALE IN COOLING TOWERS

GRAPHENE OXIDE/POLYMER MEMBRANES

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MEMBRANE DISTILLATION PROJECT FOR SMALL NEW MEXICO BUSINESS

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Mitigation of Biofouling

Sandia National Laboratories

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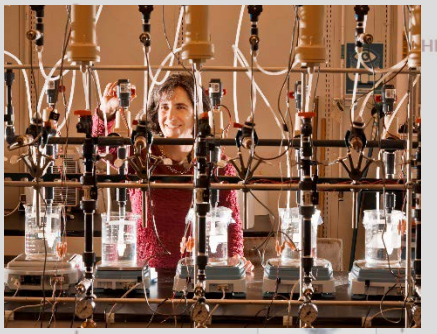

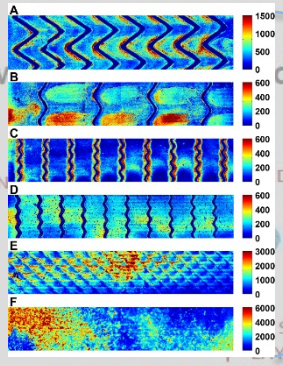

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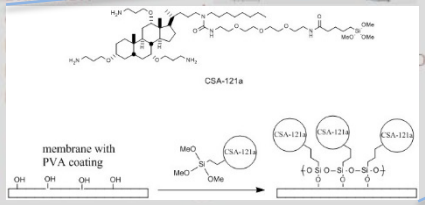
BRACKISH

MEMBRANES & SURFACES NANO-ENGINEERED FOR PATHOGEN CAPTURE & DESTRUCTION



MICRO-MIXERS FOR MITIGATING MEMBRANE FOULING

NOVEL SILICA REMOVAL STRATEGIES BY WARM LIME SOFTENING

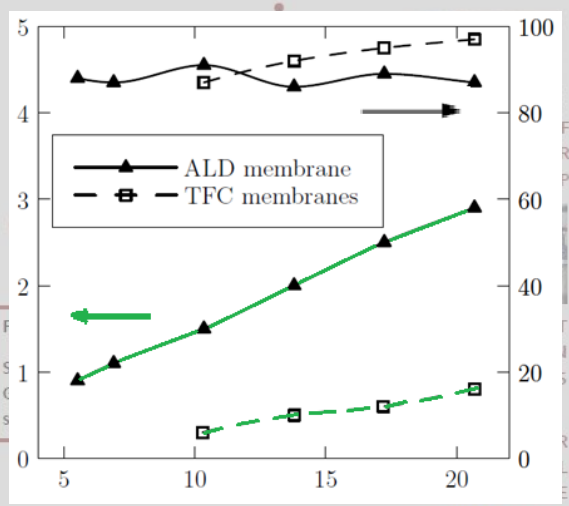
BIOFOULING RESISTANT CERAGENIN-MODIFIED WATER TREATMENT MEMBRANES

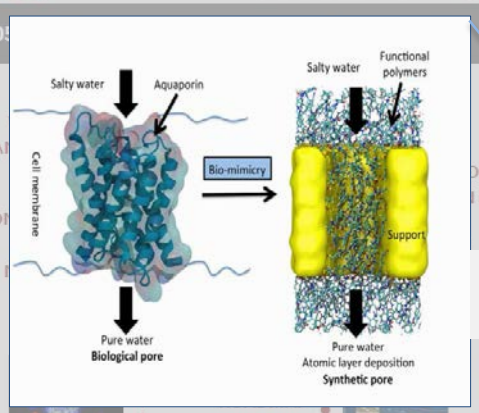
MEMBRANE TREATMENT OF SIDE-STREAM COOLING TOWER FOR REDUCTION OF WATER REUSAGE

PATENT ON METHOD FOR RECOVERING ALKALI METALS

APATITE PERMEABLE REACTIVE BARRIERS FOR IN SITU REMEDIATION OF URANIUM IN SUBSURFACE OF UMTRA SITE

2000 2001 2002 2003 2004 2005 2010 2011 2012 2013 2014 2015 2016





SELF-SEALING EVAPORATIVE POND LINER

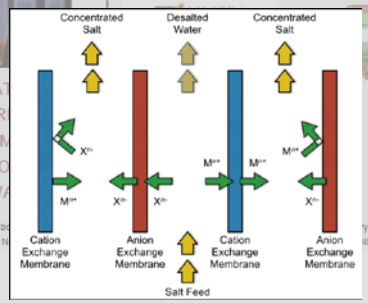
BIOMIMETIC MEMBRANE R&D 100 AWARD

CRYSTALLINE SILICOTITANATES FOR RADIOACTIVE CESIUM REMEDIAT…

WASTE WATER FOR POWER GENERATION VIA ENERGY EFFICIENT SELECTIVE SILICA SEPARATIONS

USE OF FLUE GAS TO CONTROL SILICA AND CALCITE

Bio-inspired Ion-Selective ED Membranes



PATENT FOR

R&D 100

MEMBRANE DISTILLATION WATER TREATMENT USING POWER PLANT WASTE HEAT

COAGULAT… CHEMISTR… SILICA REM… FROM COO… TOWER WA…

APPLICATIONS

Sandia National Laboratories is a multi-mission labo… Corporation, for the U.S. Department of Energy's N… y of Lockheed Martin … ID2016-12525 M

Bio-Inspired Membranes

Pilot Testing

Sandia has been actively working in a broad range of wa

Sandia National Laboratories

lenges for over a decade

LOW COST ARSENTIC TRATMENT FOR SMALL COMMUNITIES

MEMBRANE TREATMENT OF SIDE-STREAM COOLING TOWER WATER FOR REDUCTION OF WATER USAGE

ADVANCED CONCEPTS WATER-TREATMENT PROGRAM BEGINS

ARSENIC WATER TECHNOLOGY PARTNERSHIPS FORMS

JOINT WATER REUSE & DESALINATION TASK FORCE

WATEREUSE

METHOD FOR SYNTHESIZING AYERED DOUBLE HYDROXIDE CAPABLE OF ORBING ANIONIC AND IONIC CONTAMINANTS FROM FLUID

BRACKISH GROUNDWATER NATIONAL DESALINATION RESEARCH FACILITY

O-MIXERS FOR GATING BRANE FOULING

EL SILICA REMOVAL TEGIES BY WARM SOFTENING

FOULING RESISTANT CERAGENIN-MODIFIED WATER TREATMENT MEMBRANES

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2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016

DEVELOPMENT OF SWEEPING GAS MEMBRANE DESALINATION USING COMMERCIAL HYDROPHOBIC HOLLOW FIBER MEMBRANES

FRONTIERS OF INTERFACIAL WATER RESEARCH WORKSHOP

ARSENIC PILOT DEMONSTRATION PROJECTS

V ULTRAVIOLET WATER N SYSTEMS FOR RURAL ONMENTS AND MOBILE APPLICATIONS

PRODUCED WATER PILOT SAN JUAN BASIN

CAPACITIVE IONIZATION FOR COAL-BED NATURAL GAS PRODUCED WATER

PAT N COAGUL THE REM BACTE

EXPLOITING

ROADMAP

SELF-SEALING EVAPORATIVE LINER

IMETIC NE R&D AWARD

CRYSTALLINE SILICOTITANATES FOR RADIOACTIVE CESIUM REMEDIATION

USE OF FLU GAS TO CONTROL SILICA AND CALCITE SCALE IN COOLING TOWERS

MEMBRANE

COAGULATION

WASTE WATER FOR POWER GENERATION VIA ENERGY EFFICIENT SELECTIVE SILICA SEPARATIONS

GRAPHENE OXIDE/POLYMER MEMBRANES

For more information contact:

Sandia Water Treatment Partnerships: Past and Present

TROJAN technologies
el paso WATER
Imperial Oil
uop A Honeywell Company
conoco
CalgonCarbon
carollo
ABQ Bernalillo County Water Utility Authority
Jemez Pueblo
WateReuse Foundation
Water Research Foundation
Electric Power Research Institute EPRI
Brackish Groundwater National Desalination Research Facility
HDR Engineering
B&W Global Tech LLC
MIOX Corporation
Sandia National Laboratories
U.S. DEPARTMENT OF ENERGY
NNSA National Nuclear Security Administration
Bureau of Reclamation
Environmental Protection Agency
Los Alamos National Laboratory
NETL National Energy Technology Laboratory
National Renewable Energy Laboratory
UT El Paso
New Mexico State
University of New Mexico
New Mexico Tech
University of Illinois Affordable Desalination Coalition
Colorado School of Mines
Water Education Foundation
International Energy Agency

Contact
Name: Susan Altman
Phone: (505) 844-2397
E-mail: sjaltma@sandia.gov

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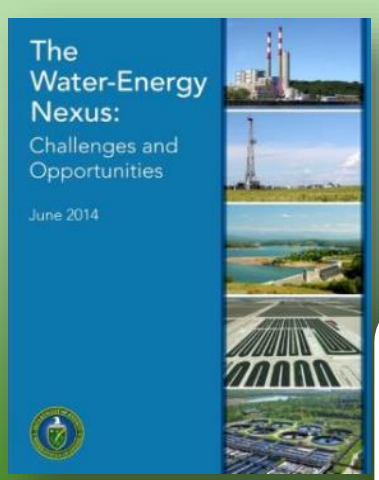
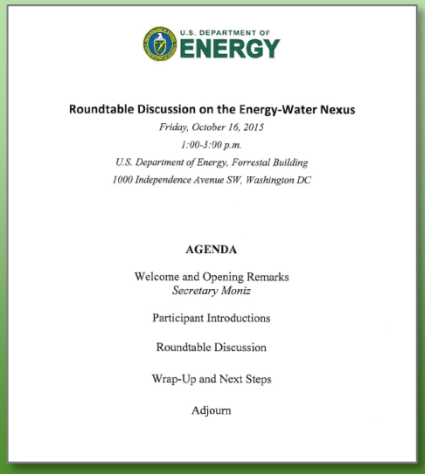
Energy-Water Nexus Policy/Budget Developments



June 2014
DOE Water-Energy
Technology Team
Publishes
Water-Energy Report


U.S. DEPARTMENT OF ENERGY

Roundtable Discussion on the Energy-Water Nexus

Friday, October 16, 2015
1:00-3:00 p.m.
U.S. Department of Energy, Forrestal Building
1000 Independence Avenue SW, Washington DC

AGENDA

Welcome and Opening Remarks
Secretary Moniz

Participant Introductions

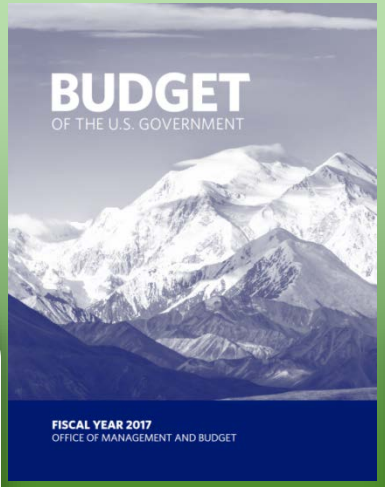
Roundtable Discussion

Wrap-Up and Next Steps

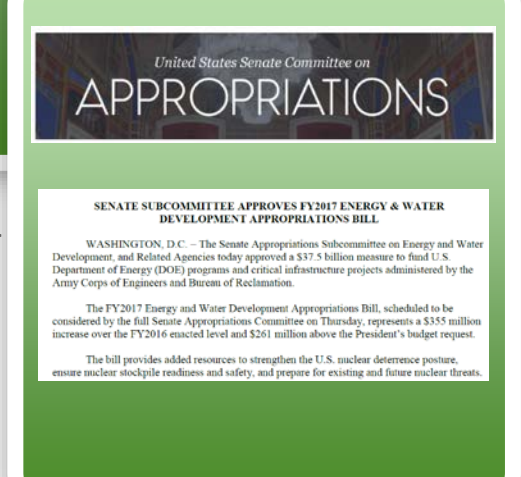
Adjourn

October 2015 Secretary Moniz Hosted
Capstone Energy-Water Roundtable

December 2015 White House Hosted
Energy-Water Event



Energy-Water in FY17
President's Budget Request -
$96M


United States Senate Committee on
APPROPRIATIONS

SENATE SUBCOMMITTEE APPROVES FY2017 ENERGY & WATER DEVELOPMENT APPROPRIATIONS BILL

WASHINGTON, D.C. – The Senate Appropriations Subcommittee on Energy and Water Development, and Related Agencies today approved a $37.5 billion measure to fund U.S. Department of Energy (DOE) programs and critical infrastructure projects administered by the Army Corps of Engineers and Bureau of Reclamation.

The FY2017 Energy and Water Development Appropriations Bill, scheduled to be considered by the full Senate Appropriations Committee on Thursday, represents a $355 million increase over the FY2016 enacted level and $261 million above the President's budget request.

The bill provides added resources to strengthen the U.S. nuclear deterrence posture, ensure nuclear stockpile readiness and safety, and prepare for existing and future nuclear threats.

FY17 Energy & Water Appropriations
(Senate Passed 5/12/16)