

# RECLAMATION

*Managing Water in the West*

## Navajo Generating Station Update

Northern Arizona University

March 16, 2017



U.S. Department of the Interior  
Bureau of Reclamation

# Agenda

- Introductions
- Opening statements
- NGS Update
- NGO Presentation/Comments
- Discussion
- Next Steps

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# Colorado River Basin Project Act of 1968

- P.L. 90-537, § 303 (a) “...nothing in this section or in this Act contained shall be construed to authorize the study or construction of any dams on the main stream of the Colorado River between Hoover Dam and Glen Canyon Dam.
- P.L. 90-537, § 303 (b) “... the Secretary may enter into agreements with non-Federal interests proposing to construct thermal generating powerplants whereby the United States shall acquire the right to such portions of their capacity, including delivery of power and energy over appurtenant transmission facilities to mutually agreed upon delivery points, as he determines is required in connection with the operation of the Central Arizona Project. When not required for the Central Arizona Project, the power and energy acquired by such agreements may be disposed of...so as to produce the greatest practicable amount of power and energy that can be sold at firm power and energy rates.”

RECLAMATION

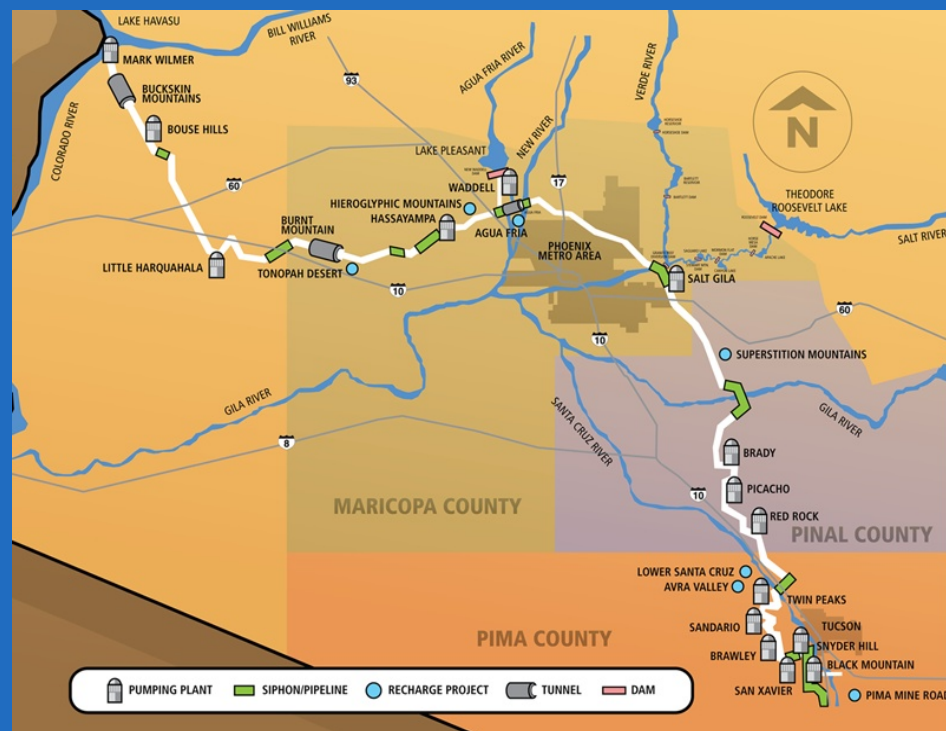
## Bureau of Reclamation & CAP

- Approximately two-thirds of the U.S. share of NGS power (reserve power) provides approximately 90% of the power used to deliver CAP water in Arizona.
- The U.S. share of NGS power not used to operate the CAP pumps, approximately one-third, is sold at market rates as “surplus” power.



# Reclamation & Central Arizona Project (CAP)

- CAP
  - 336-mile distribution system
  - Delivers ~1.5 million acre-feet of Colorado River water in AZ annually
- U.S. participation in Navajo Generating Station (NGS)
  - provide primary CAP power supply





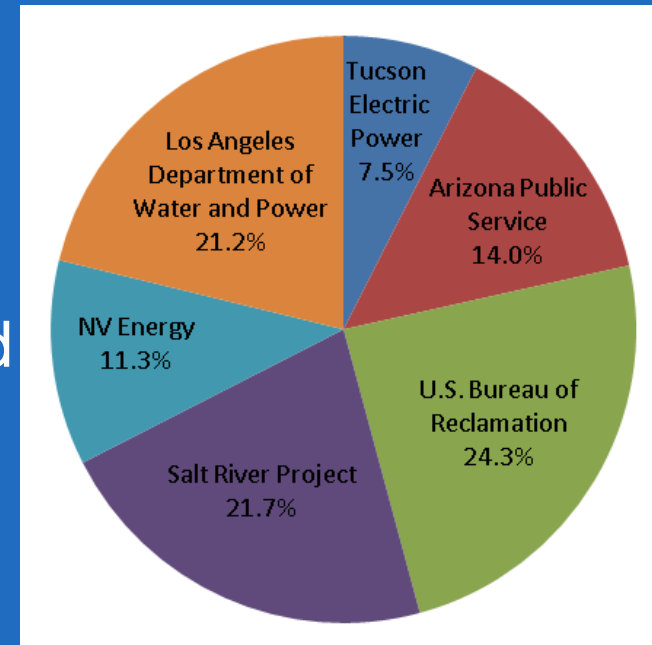
# Navajo Generating Station

- **NGS is a 3-unit, 2,250 MW coal fired power plant**
  - **Located on Navajo tribal trust lands near Page, Arizona**
- **Coal supplied exclusively by the Kayenta Mine**
  - **Located on Navajo and Hopi tribal trust lands, ~80 miles SE of NGS**
- **Significant economic benefit to NGS-affected Tribes**

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# NGS Owners

- Salt River Project for the Use and Benefit of the United States\* (24.3%)
- Salt River Project\*\* (21.7%)
- Los Angeles Department of Water and Power (21.2%)
- Arizona Public Service (14.0%)
- Nevada Energy\*\*\* (11.3%)
- Tucson Electric (7.5%)



\*The United States is referred to as a “Participant.”

\*\*SRP is the NGS Operating Agent. In 2015, SRP purchased the Los Angeles Department of Water & Power’s 21.2% entitlement share to operation until the end of 2019

\*\*\* Nevada Energy is actively seeking to divest its entitlement share

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# Joint Federal Agency Workgroup

- EPA, DOI, and DOE have committed to work together to support stakeholder interests in NGS
  - Create a long-term EPA-DOI-DOE Working Group
  - Work with stakeholders, including the owners of NGS, tribes and other CAP water users, and environmental and community groups, to develop a roadmap to achieve long-term goals related to clean energy, sustainable water supplies, and sustainable economic development
  - Complete the Phase 2 report on clean energy options for NGS
  - Support shorter term investments that align with long term clean energy goals

# Technical Work Group (TWG)

- Established by Salt River Project, as the NGS Operating Agent, to develop a potential additional “Better than BART” alternative.
- TWG Agreement signed in 2013
- Largely adopted by EPA final rule in 2015



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# TWG Key Assumptions

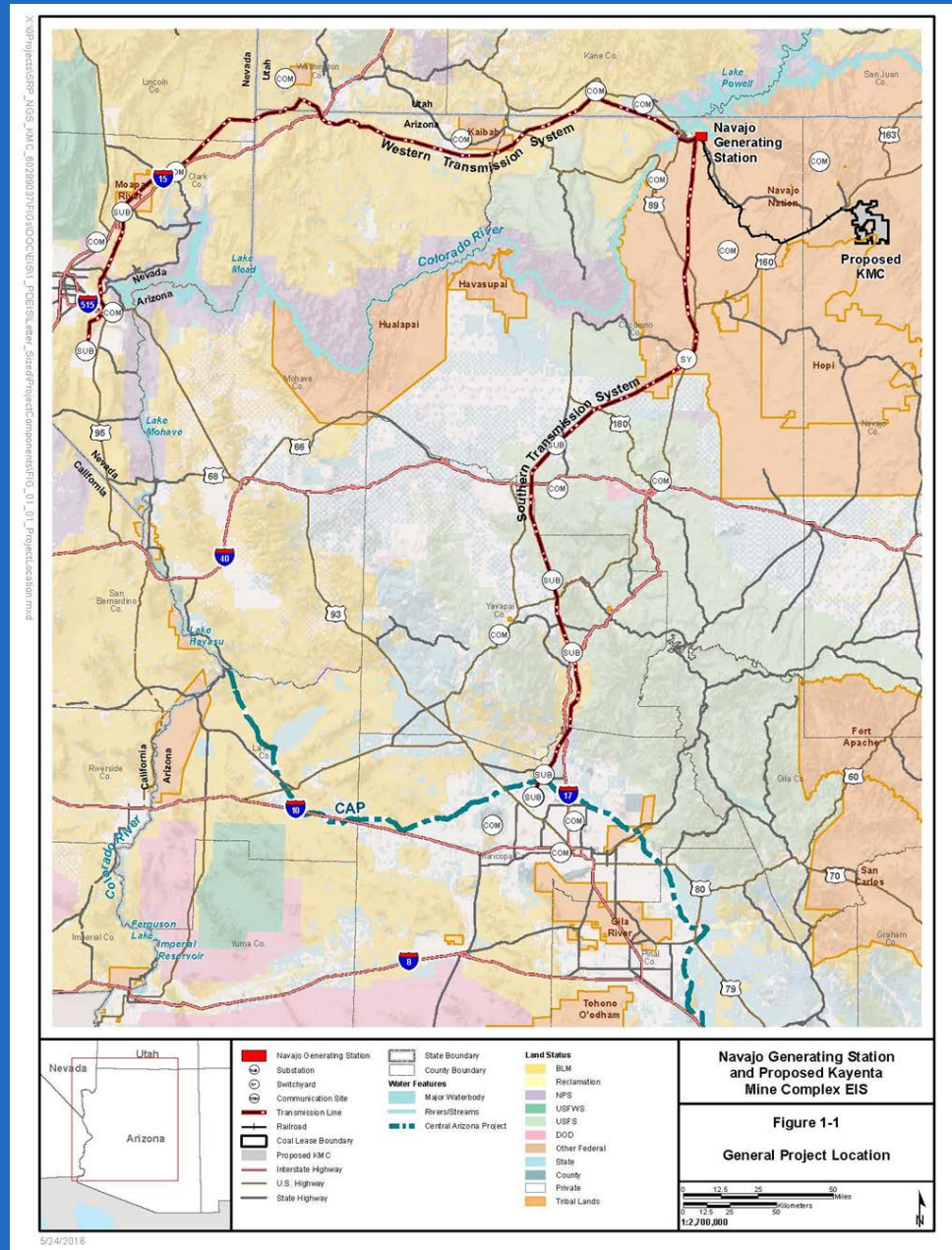
- Assumed plant operations from 2019 – 2044 with pollution controls installed by 2030
- Assumed a “glidepath” development of NGS alternatives over the post 2019 operations period
- Appendix “B” included “Better than BART” alternative adopted by EPA in final rule
- Appendix “C” (DOI Commitments)
  - Accounting Implementation Guide – COMPLETE
- Appendix “E” NREL Phase II Study
  - Volume One – Baseline COMPLETE
  - Technical Assistance to Tribes (Navajo, Hopi, GRIC)
    - Funding agreements executed and technical assistance ongoing

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# Environmental Compliance

- EIS started in 2014
- General Project Area:
  - Arizona, Nevada, Utah
- Major Components
  - NGS and associated facilities
  - Kayenta Mine
  - Transmission systems and communication sites



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# Key Dates

- Sept 2016: Draft EIS published;  
Start of public comment period
- Oct/Nov 2016: 11 public meetings across Arizona
- Dec 2016: 90-day public comment period ended
- February 2017: Non-US owners press release

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# NGS Coordinating Committee

- Comprised of representatives from each participant
- Each representative holds equal voting rights
- February 13, 2017 Meeting

# SRP Press Release – 2/13/17

“The current utility owners of Navajo Generating Station today voted not to continue operations at the plant beyond the end of the current lease term. The vote means SRP efforts will now focus on reaching an agreement with the Navajo Nation that lets the plant run through December 2019 by allowing access after that date for removal and restoration work.”

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# Potential Operations Alternatives

- 2019
  - Coal generation through end of 2019 with 2 year decommissioning
  - Requires extension of current lease (for retirement purposes)
- 2017
  - Coal generation through end of 2017 with 2 year decommissioning
  - Does not require extension of current lease
- 2019 +
  - Would require costs to appeal to current or new Co-Tenants

# What Changed?

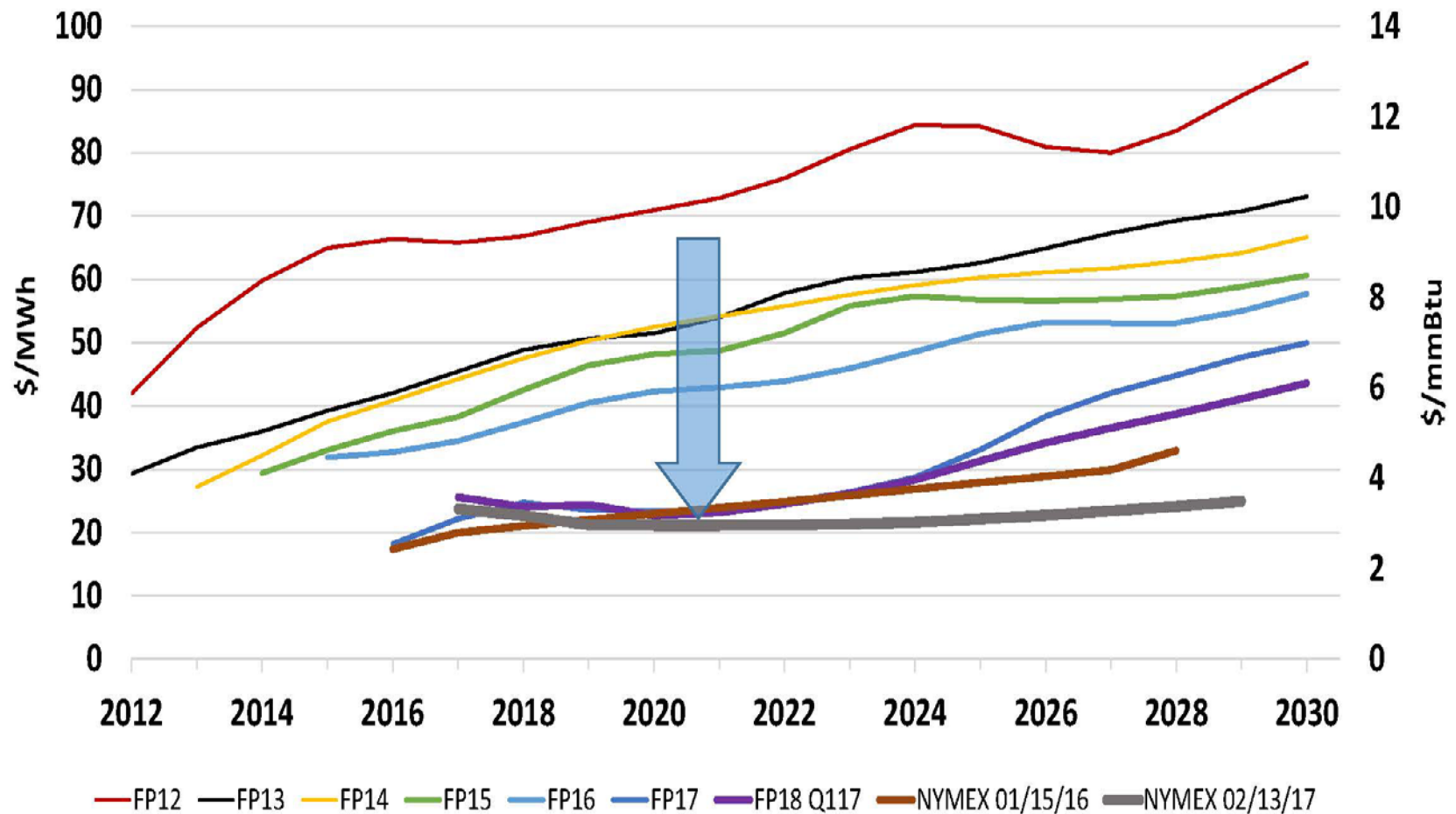
- Energy Market Economics
- Natural Gas – sets wholesale market energy price
- Available generation in the mass electric system
- Utility obligations to provide best price power to customers
- Salt River Project projects NGS costs 2017-2019: ~\$40/MWh and 2020-2030 between \$50/MWh and \$60/MWh
- Mead Hub wholesale energy rate < \$30/MWh
- Natural gas prices projected to remain competitive alternative to NGS

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# Gas Price Forecasts Dropping over Time

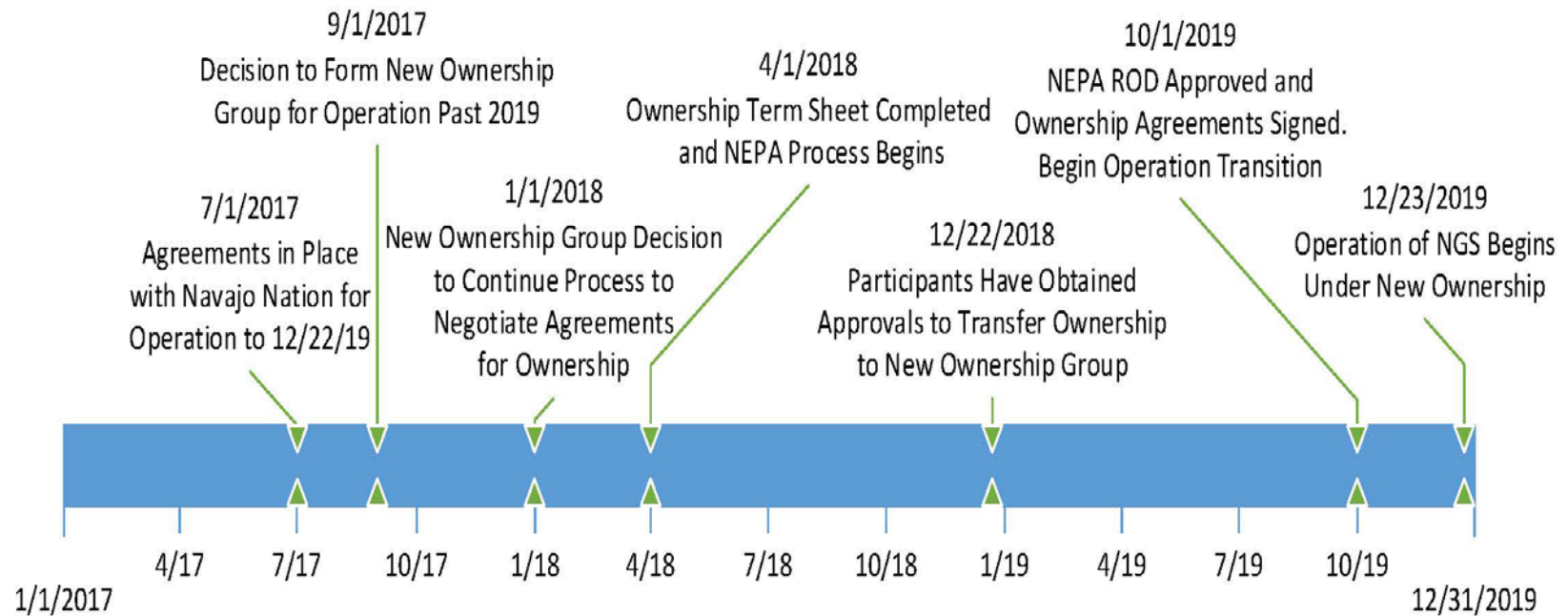
Combined Cycle Plant with 7,400 heat rate



# March 1, 2017 Meeting

- The Department of the Interior hosted a meeting with multiple stakeholders to discuss their views about the future of the NGS.
- Discussion
- Outcome
  - Individual groups will be discussing follow-up topics
  - Two topics relate to tribes/tribal interests
    - Exploring ways to minimize impacts to affected tribes
    - CAP Tribal matters
- Next Meeting April 12, 2017, in Washington DC

# NGS Ownership Transition Timeline

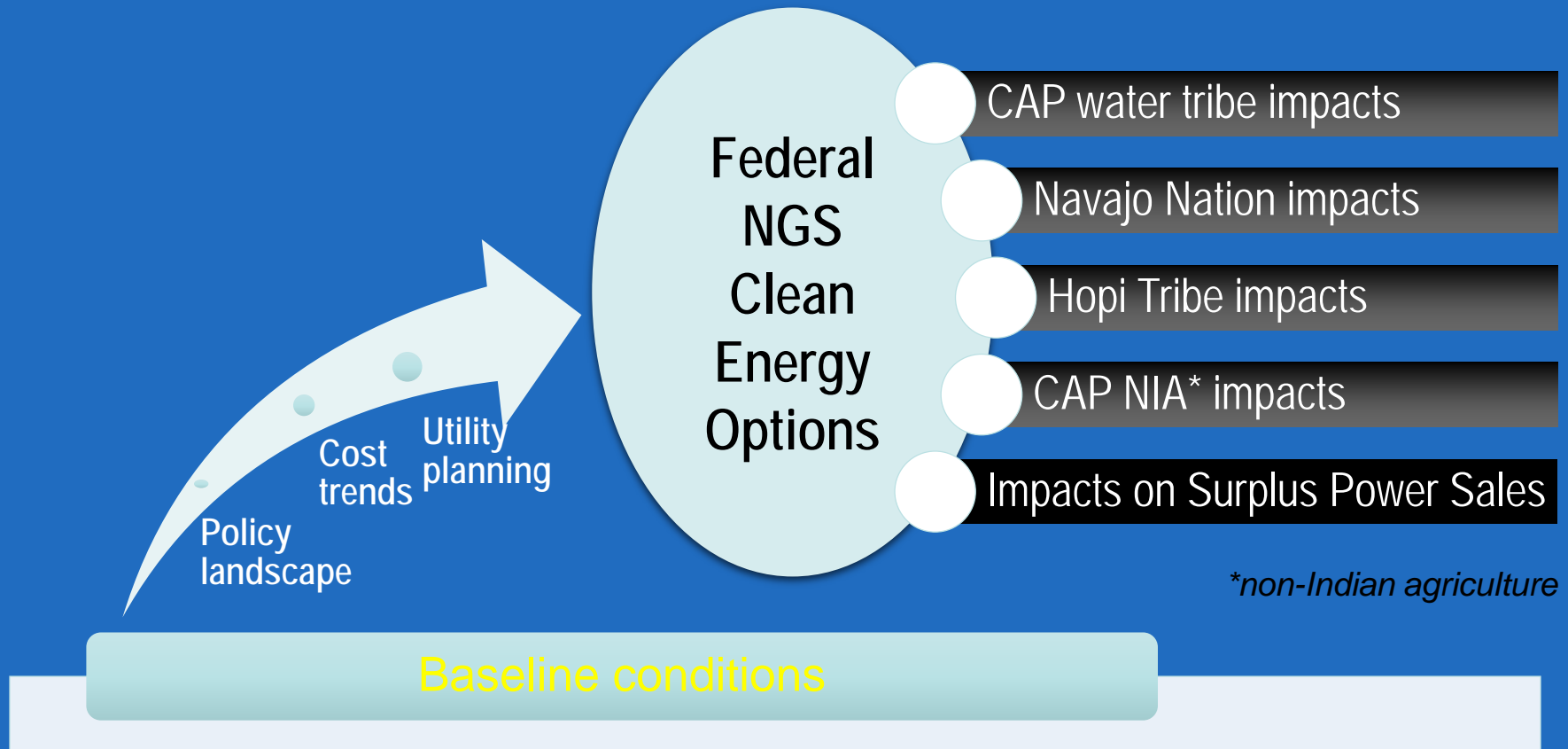


# NE Arizona Tribal Clean Energy and Water Development Planning

- **National Renewable Energy Laboratory**
  - Utility Resource Planning
  - Market Economics
  - NGS Operations Scenarios
- **Technical Assistance**
  - Navajo
  - Hopi
  - GRIC

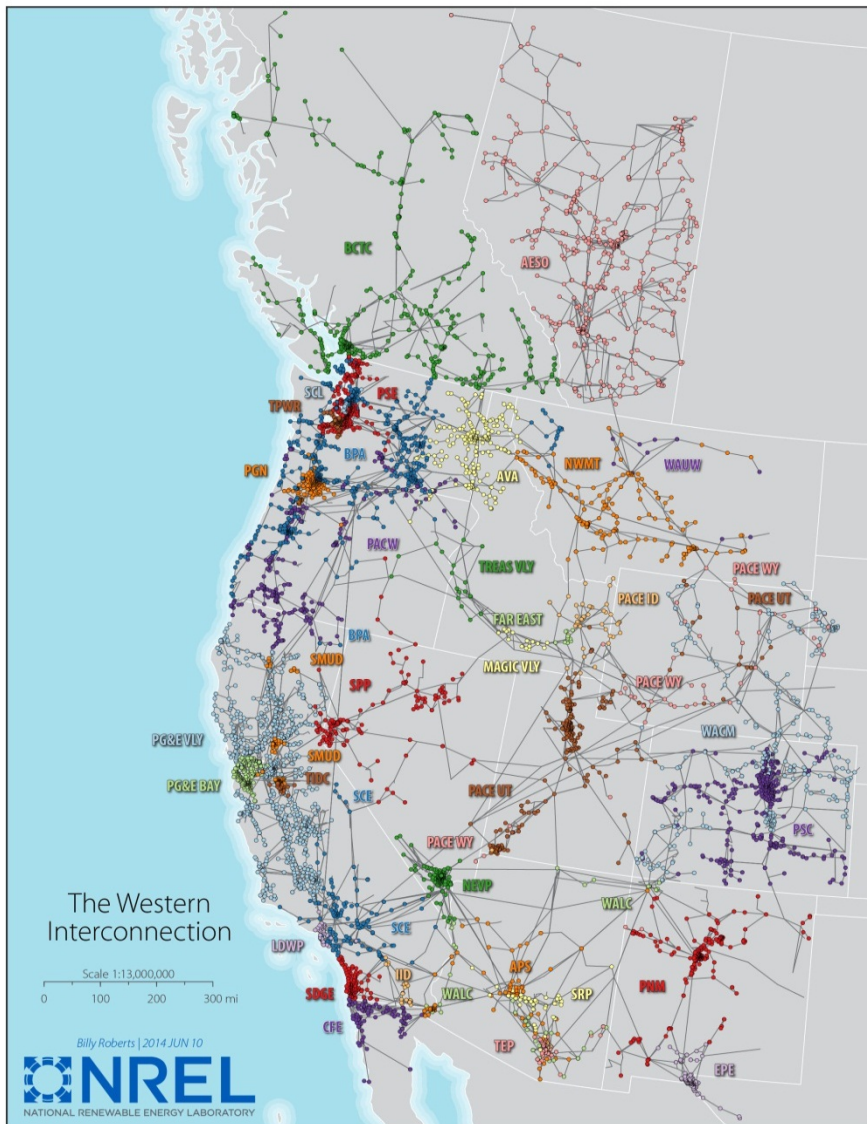
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# Elements of NREL Phase 2 Study



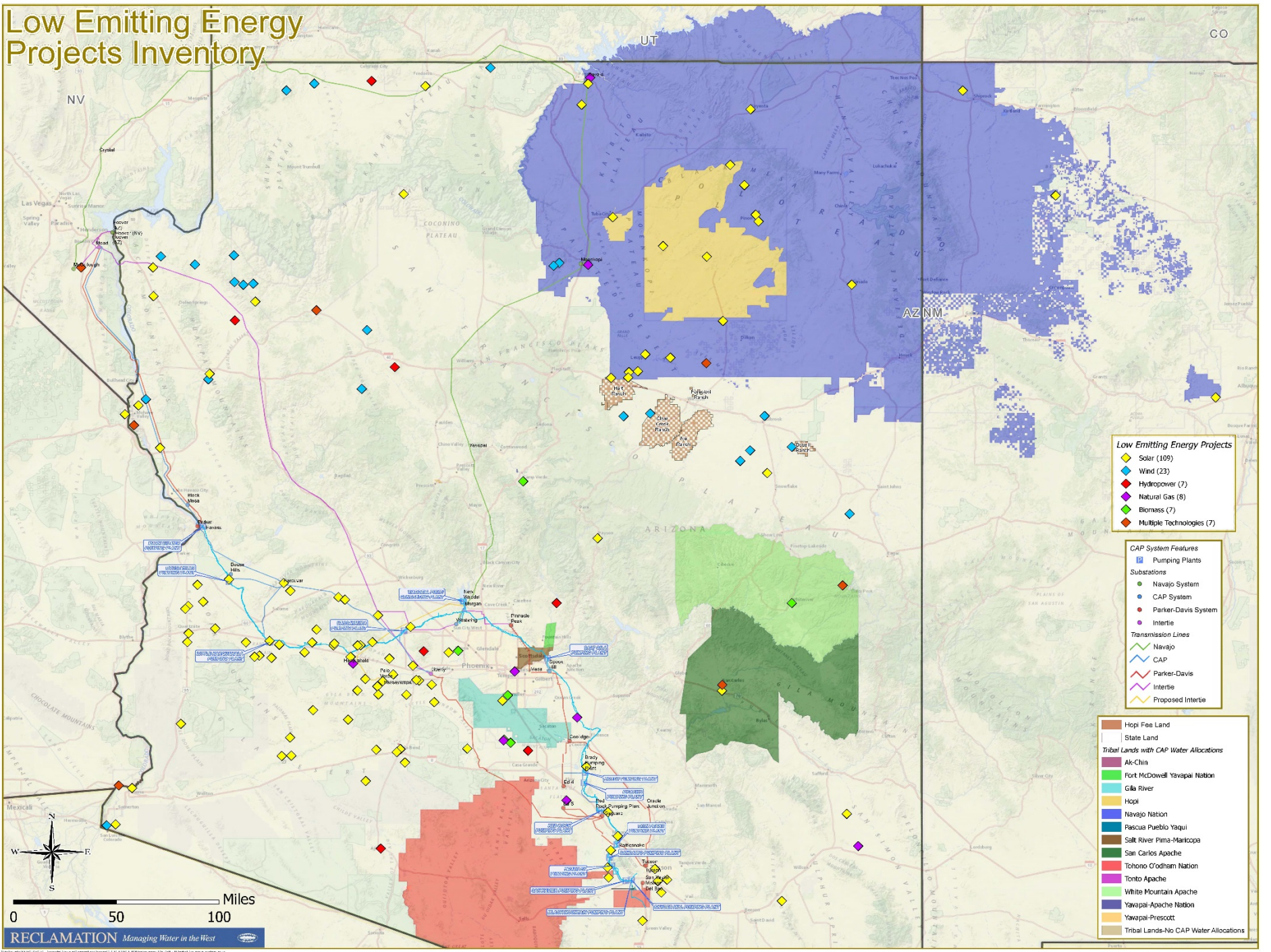
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# Resource Planning Model Retirements and Expansions





# Low Emitting Energy Projects Inventory

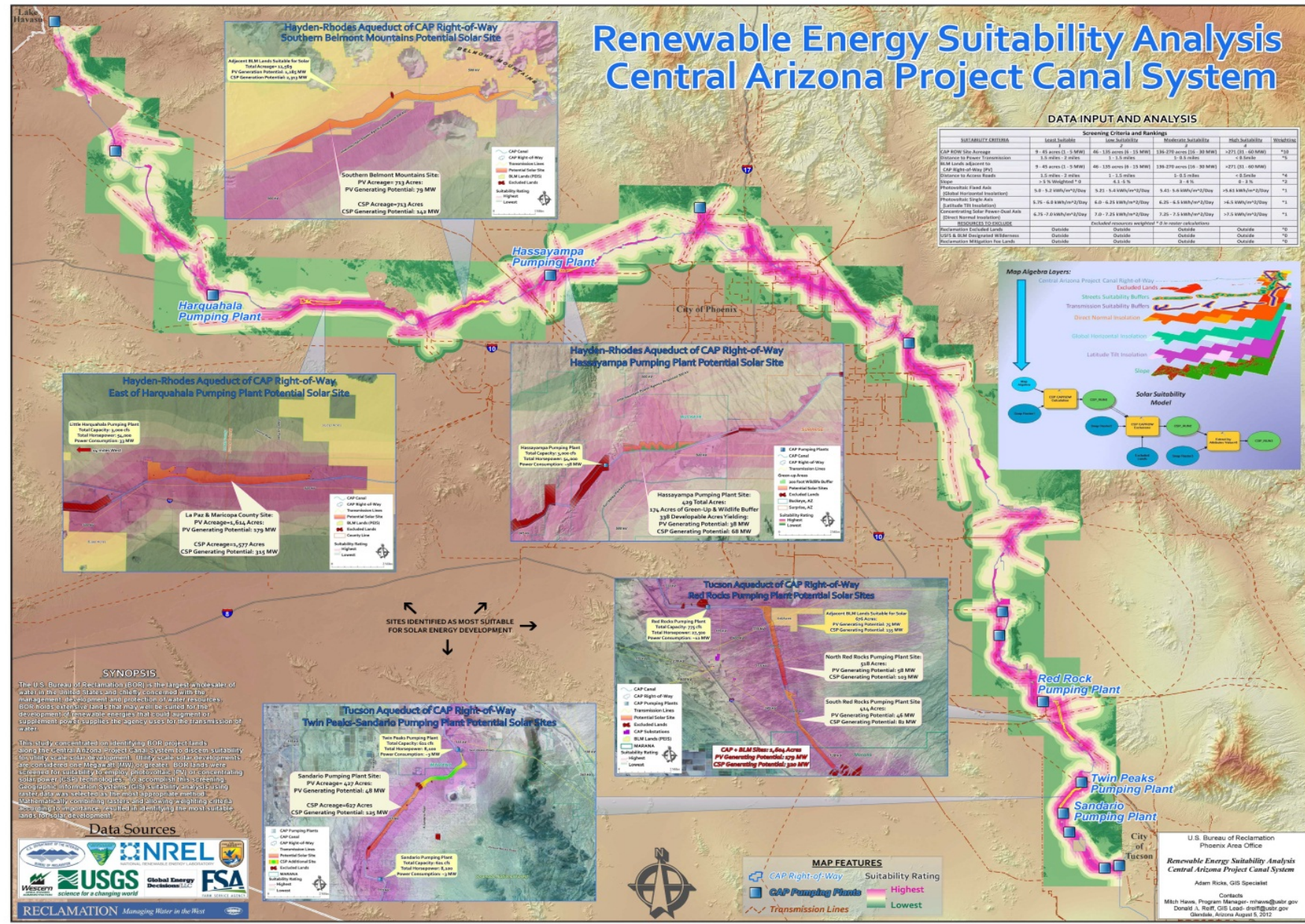
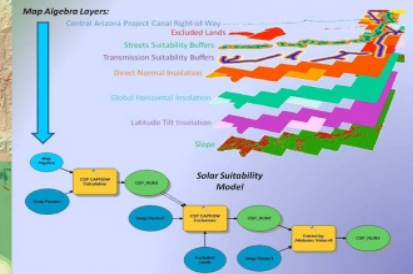




# Renewable Energy Suitability Analysis Central Arizona Project Canal System

## DATA INPUT AND ANALYSIS

SUITABILITY CRITERIA	Low Suitability	Medium Suitability	High Suitability	Excluded
CAP Right-of-Way	0 - 65 acres (1 - 15 MW)	66 - 135 acres (16 - 35 MW)	136 - 270 acres (36 - 60 MW)	>271 acres (60 MW)
Distance to Power Transmission	1.5 miles - 2 miles	1 - 1.5 miles	0 - 1 miles	< 0.5 miles
CAP Right-of-Way (PV)	0 - 40 acres (1 - 5 MW)	40 - 135 acres (10 - 30 MW)	136 - 270 acres (30 - 60 MW)	>271 acres (60 MW)
Distance to Access Roads	1.5 miles - 2 miles	1 - 1.5 miles	0 - 1 miles	< 0.5 miles
Topography	0 - 1.5 miles	1.5 - 3 miles	3 - 4.5 miles	> 4.5 miles
Phonetic First Axis	0 - 1.5 miles	1.5 - 3 miles	3 - 4.5 miles	> 4.5 miles
Global Horizontal Insolation	5.0 - 6.0 kWh/m <sup>2</sup> /day	6.0 - 7.0 kWh/m <sup>2</sup> /day	7.0 - 8.0 kWh/m <sup>2</sup> /day	> 8.0 kWh/m <sup>2</sup> /day
Latitude Tilt Insolation	5.0 - 6.0 kWh/m <sup>2</sup> /day	6.0 - 7.0 kWh/m <sup>2</sup> /day	7.0 - 8.0 kWh/m <sup>2</sup> /day	> 8.0 kWh/m <sup>2</sup> /day
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SITES IDENTIFIED AS MOST SUITABLE FOR SOLAR ENERGY DEVELOPMENT

## SYNOPSIS

The U.S. Bureau of Reclamation (BOR) is the largest wholesaler of water in the United States and is currently concerned with the long-term sustainability of its water resources. BOR holds extensive lands that may be suited for the development of renewable energy and is looking for opportunities to supply the agencies for the transmission of water.

This study concentrated on identifying BOR project lands along the Central Arizona Project Canal System to assess a sustainable solar energy development. The study area was selected based on the availability of solar resources. BOR lands were identified for suitability for solar energy development. BOR is considering solar power (CSP) technologies to accomplish this screening. Geographic Information Systems (GIS) suitability analysis using raster data was selected for this study. Mathematical modeling (costs) and showing weighting criteria (benefits) were used to identify the most suitable areas for solar development.

## Data Sources



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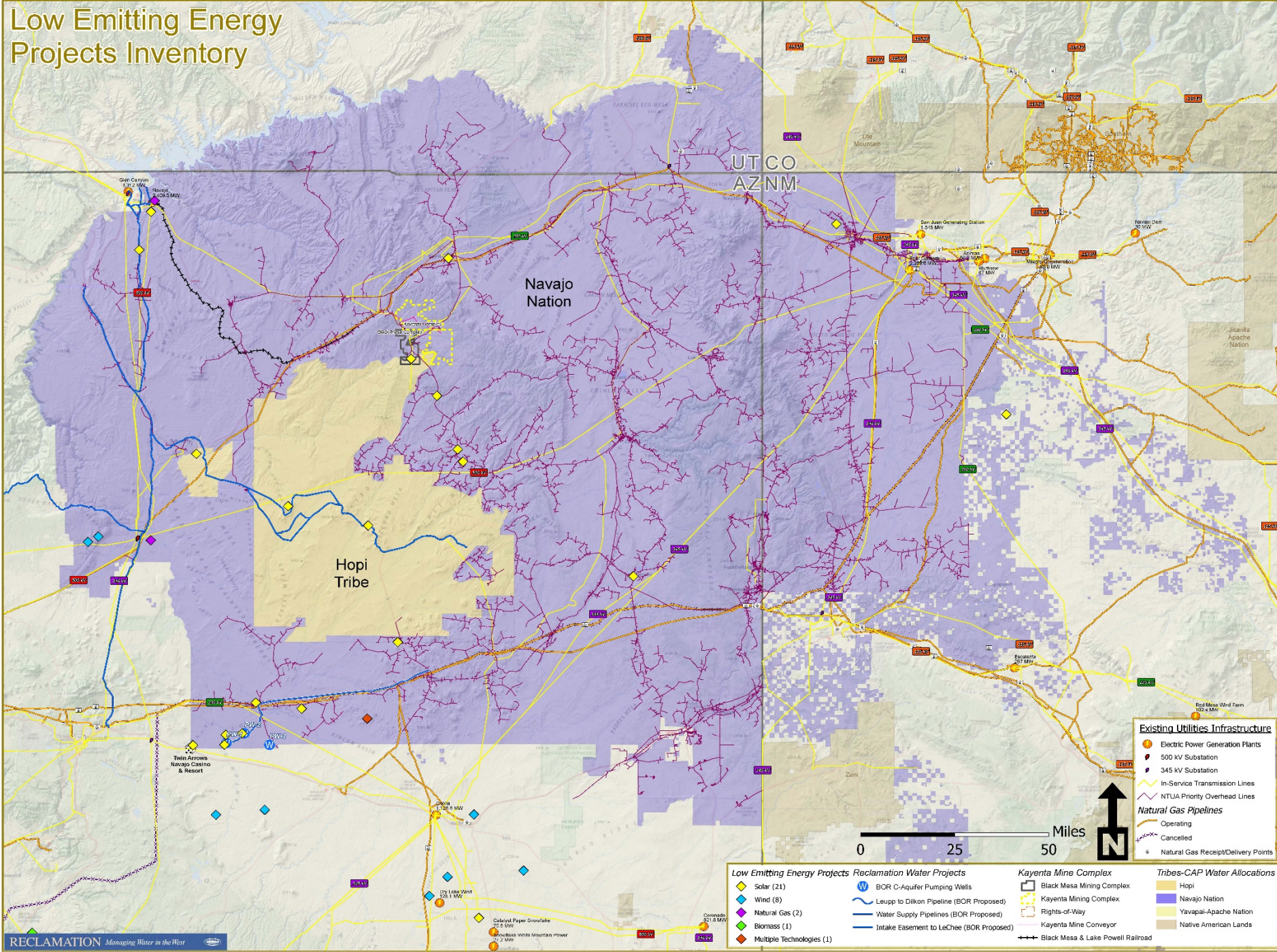
**MAP FEATURES**  
 CAP Right-of-Way  
 CAP Pumping Plants  
 Transmission Lines  
 Suitability Rating  
 Highest  
 Lowest

U.S. Bureau of Reclamation  
 Phoenix Area Office  
 Renewable Energy Suitability Analysis  
 Central Arizona Project Canal System  
 Adam Ricks, GIS Specialist  
 Contacts:  
 Mitch Hawn, Program Manager: mhawn@usbr.gov  
 Donald J. Reiff, GIS Lead: dreeff@usbr.gov  
 Glendale, Arizona August 8, 2012

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# Low Emitting Energy Projects Inventory



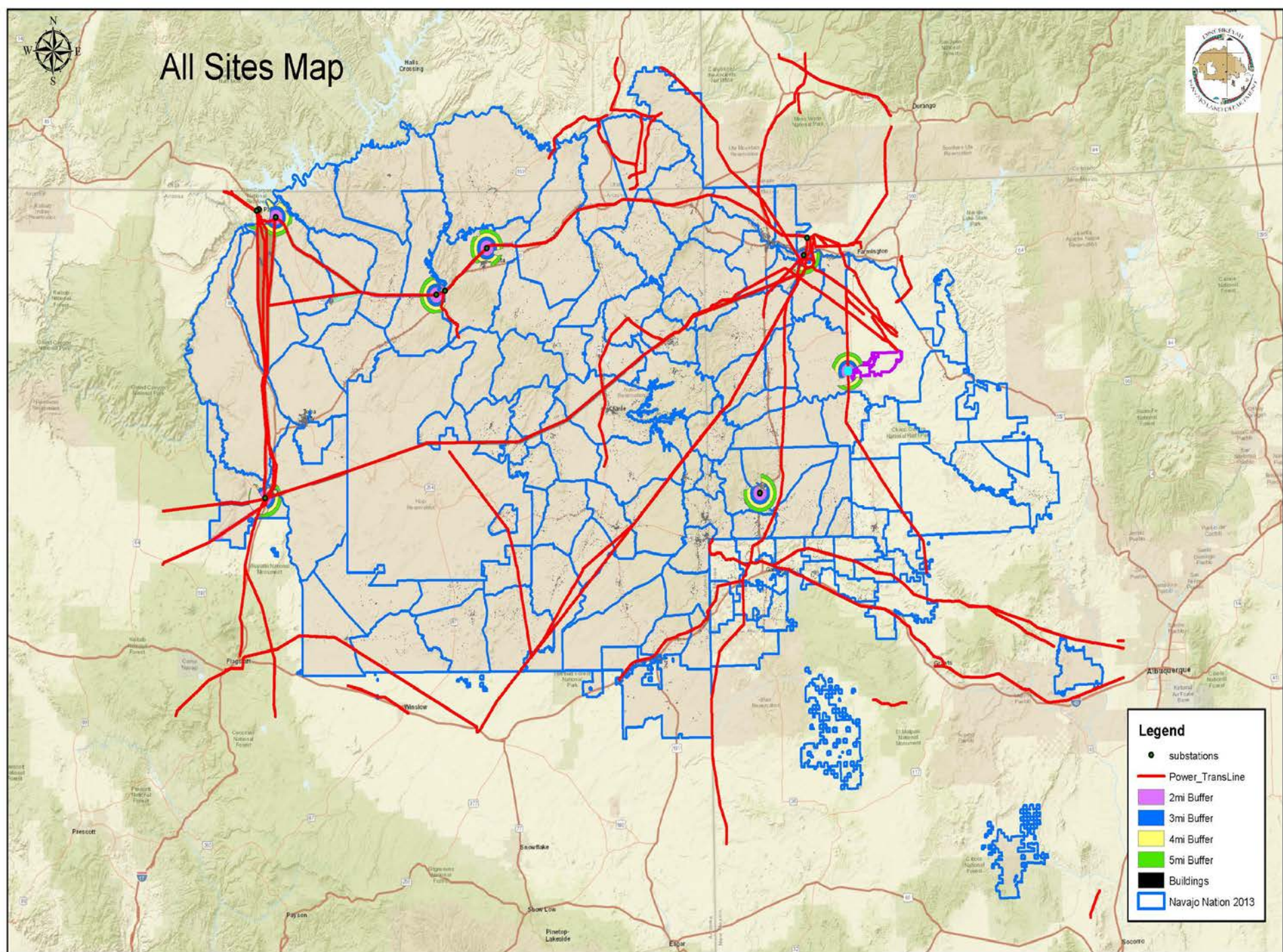


# All Sites Map



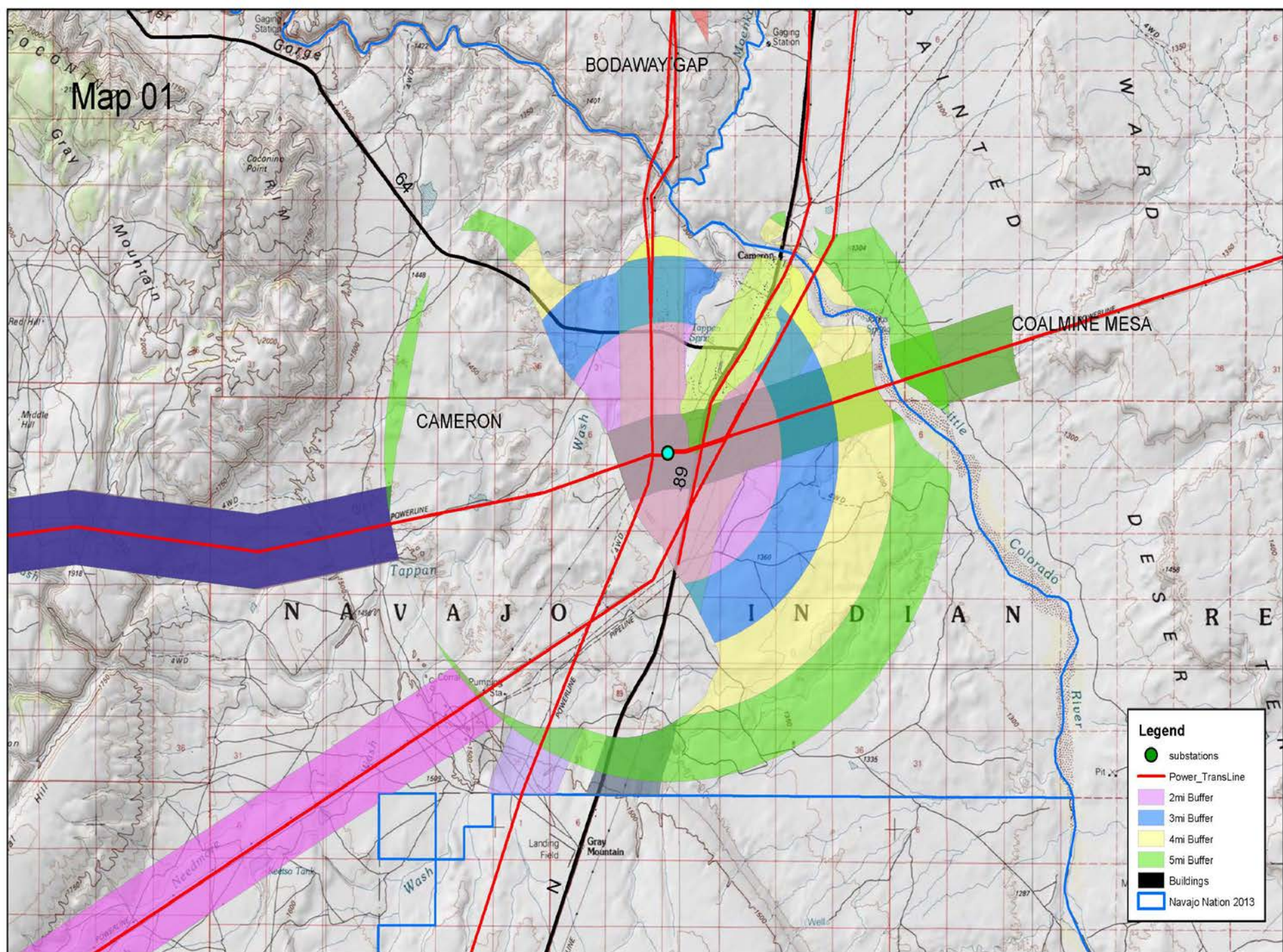
## Legend

- substations
- Power\_TransLine
- 2mi Buffer
- 3mi Buffer
- 4mi Buffer
- 5mi Buffer
- Buildings
- Navajo Nation 2013





# Map 01







# Map 02

NAVAJO MOUNTAIN

INSCRIPTION HOUSE

LECHEE

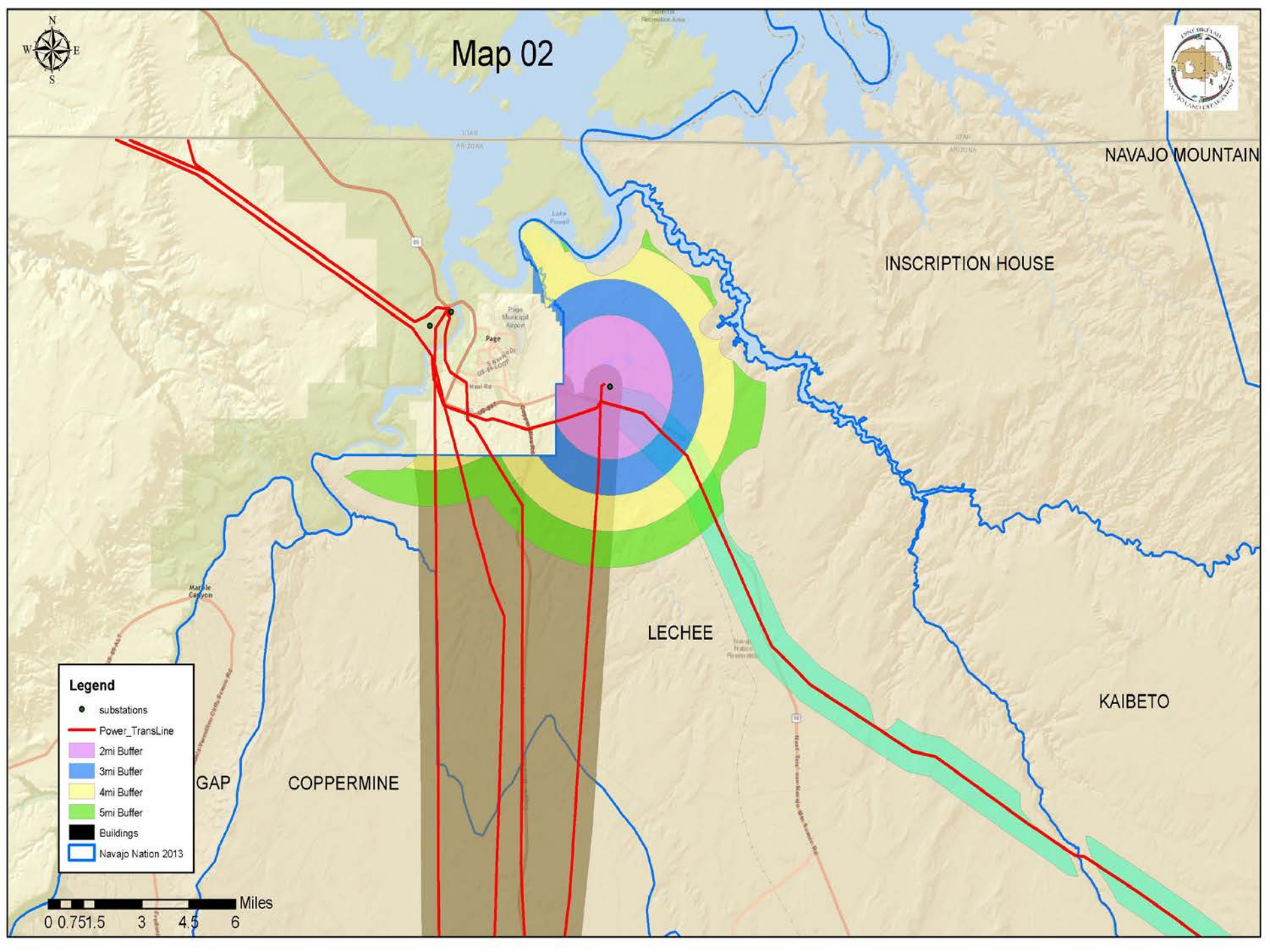
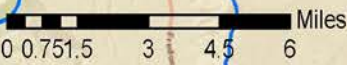
KAIBETO

COPPERMINE

GAP

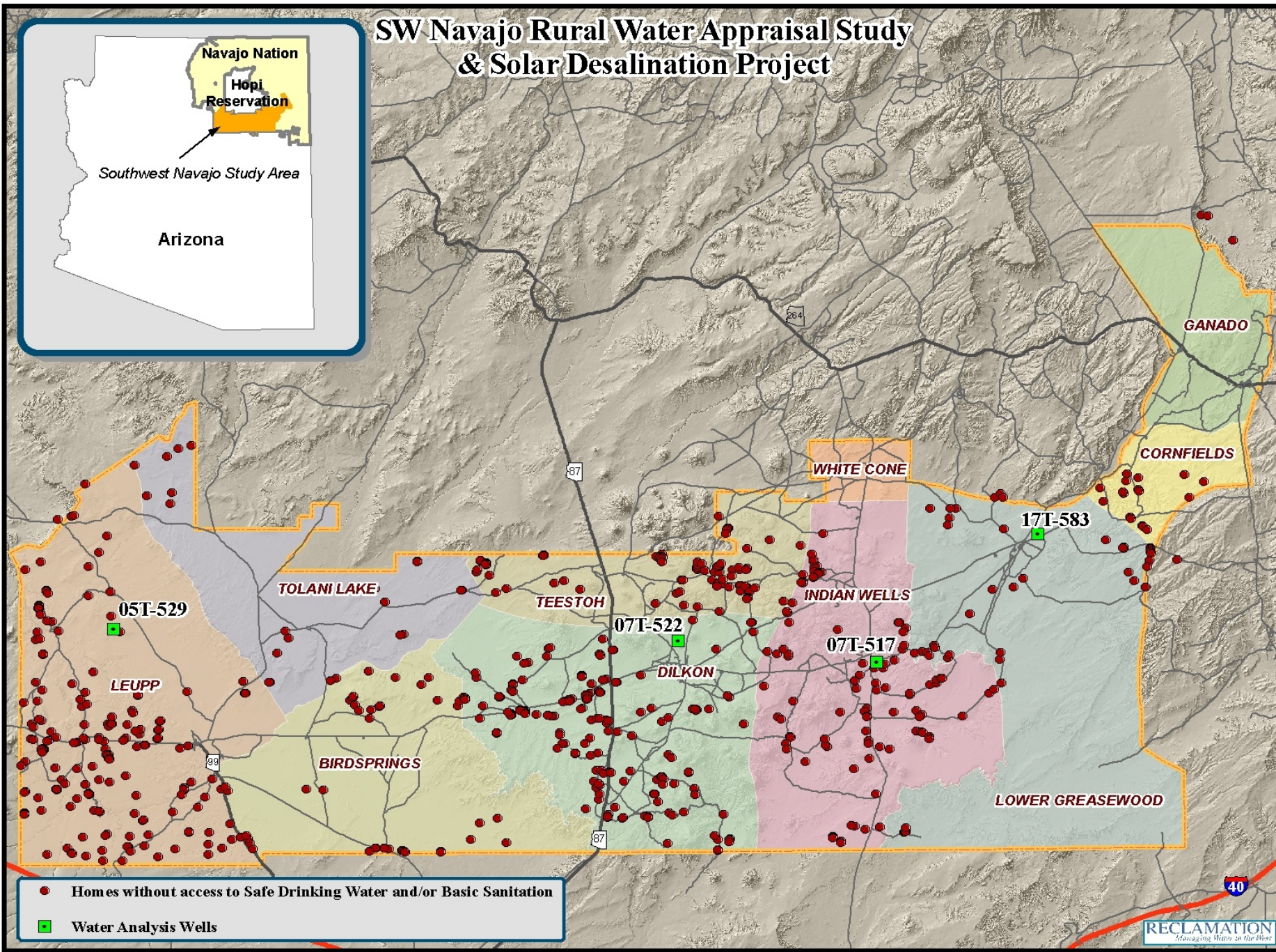
**Legend**

- substations
- Power\_TransLine
- 2mi Buffer
- 3mi Buffer
- 4mi Buffer
- 5mi Buffer
- Buildings
- Navajo Nation 2013





# SW Navajo Rural Water Appraisal Study & Solar Desalination Project



- Homes without access to Safe Drinking Water and/or Basic Sanitation
- Water Analysis Wells



Navajo Nation  
IHS Chapters

Bird Springs  
Cornfields  
Dilcon  
Ganado  
Indian Wells  
Leupp  
Lower Greasewood  
Teestoh  
White Cone

Total population 12,757

Location Index Map

Legend

- Wells
- Storage Tanks
- TDS 1000 ppm contour
- Distribution Main
- Reservation Boundaries

Navajo Reservation (Arizona)  
Hopi Reservation  
Southwest Navajo Study Area  
Arizona

TDS greater than 1000 ppm

TDS less than 1000 ppm

TDS less than 1000 ppm

Southwest Navajo Rural Water Project



## SOLAR DESALINATION USING DISTILLATION on the NAVAJO NATION

### INTRODUCTION

The Navajo Nation's low population density coupled with water scarcity and water impairment makes access to adequate water supply a daunting challenge. A large portion of the population relies primarily on groundwater which is often in deep aquifers and of brackish quality. Consequently, a large fraction of the population lacks water from remote wells at high costs. In addition, lack of grid delivered electricity in many areas further complicates delivery of basic water and power services. This project will utilize solar power and heat coupled with a membrane distillation technology to supply both freshwater and sustainably potable water for small remote installations.

### OBJECTIVE

The Bureau of Reclamation in collaboration with the University of Arizona and the Navajo Nation have been researching and deploying an autonomous (off-grid) system to pump and treat brackish ground water using solar energy and advanced water treatment. A bench scale proof of concept was produced at the University of Arizona and is now being deployed to the Navajo Nation as an applied research project.

### BACKGROUND INFORMATION

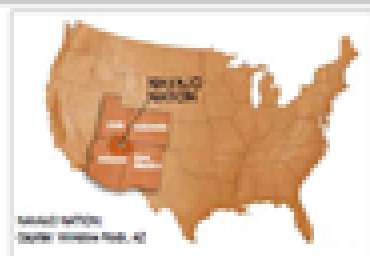


Figure 1. The Navajo Nation covers 27,000 square miles, mostly in southwestern AZ, but also in New Mex and UT ([www.navajonation.net](http://www.navajonation.net))



Figure 2. View of the well located near Joplin. (Courtesy of Aron Bernhart)



Figure 3. Sampling Bishachi Well. (Courtesy of Aron Bernhart)

Parameter/Depth	Arizonia	Utah	Utah	Utah	Utah
SPH-1	6.00	5.00	6.00	5.00	6.00
SPH-2	6.00	5.00	6.00	5.00	6.00
SPH-3	6.00	5.00	6.00	5.00	6.00
SPH-4	6.00	5.00	6.00	5.00	6.00
SPH-5	6.00	5.00	6.00	5.00	6.00
SPH-6	6.00	5.00	6.00	5.00	6.00
SPH-7	6.00	5.00	6.00	5.00	6.00
SPH-8	6.00	5.00	6.00	5.00	6.00
SPH-9	6.00	5.00	6.00	5.00	6.00
SPH-10	6.00	5.00	6.00	5.00	6.00
SPH-11	6.00	5.00	6.00	5.00	6.00
SPH-12	6.00	5.00	6.00	5.00	6.00
SPH-13	6.00	5.00	6.00	5.00	6.00
SPH-14	6.00	5.00	6.00	5.00	6.00
SPH-15	6.00	5.00	6.00	5.00	6.00
SPH-16	6.00	5.00	6.00	5.00	6.00
SPH-17	6.00	5.00	6.00	5.00	6.00
SPH-18	6.00	5.00	6.00	5.00	6.00
SPH-19	6.00	5.00	6.00	5.00	6.00
SPH-20	6.00	5.00	6.00	5.00	6.00
SPH-21	6.00	5.00	6.00	5.00	6.00
SPH-22	6.00	5.00	6.00	5.00	6.00
SPH-23	6.00	5.00	6.00	5.00	6.00
SPH-24	6.00	5.00	6.00	5.00	6.00
SPH-25	6.00	5.00	6.00	5.00	6.00
SPH-26	6.00	5.00	6.00	5.00	6.00
SPH-27	6.00	5.00	6.00	5.00	6.00
SPH-28	6.00	5.00	6.00	5.00	6.00
SPH-29	6.00	5.00	6.00	5.00	6.00
SPH-30	6.00	5.00	6.00	5.00	6.00
SPH-31	6.00	5.00	6.00	5.00	6.00
SPH-32	6.00	5.00	6.00	5.00	6.00
SPH-33	6.00	5.00	6.00	5.00	6.00
SPH-34	6.00	5.00	6.00	5.00	6.00
SPH-35	6.00	5.00	6.00	5.00	6.00
SPH-36	6.00	5.00	6.00	5.00	6.00
SPH-37	6.00	5.00	6.00	5.00	6.00
SPH-38	6.00	5.00	6.00	5.00	6.00
SPH-39	6.00	5.00	6.00	5.00	6.00
SPH-40	6.00	5.00	6.00	5.00	6.00
SPH-41	6.00	5.00	6.00	5.00	6.00
SPH-42	6.00	5.00	6.00	5.00	6.00
SPH-43	6.00	5.00	6.00	5.00	6.00
SPH-44	6.00	5.00	6.00	5.00	6.00
SPH-45	6.00	5.00	6.00	5.00	6.00
SPH-46	6.00	5.00	6.00	5.00	6.00
SPH-47	6.00	5.00	6.00	5.00	6.00
SPH-48	6.00	5.00	6.00	5.00	6.00
SPH-49	6.00	5.00	6.00	5.00	6.00
SPH-50	6.00	5.00	6.00	5.00	6.00

Table 1. Groundwater Quality Survey. Much of the groundwater in the Navajo Nation is brackish water with TDS levels above the secondary drinking standards of 500 mg/L. Other constituents found above primary and secondary drinking water standards in some wells include nitrate, arsenic, uranium and iron.

Andrew F. Carroll<sup>1</sup>, Aron Bernhart<sup>2</sup>, Andrew Shroeder<sup>1</sup>, Bryan Martinez<sup>1</sup>, George Filwood<sup>2</sup>, Mitch Housh<sup>1</sup>, Kevin Black<sup>2</sup> & Wendell Esh<sup>1</sup>

<sup>1</sup>Department of Chemical and Environmental Engineering, Institute of Environment, Agriculture & Resource Economics, UA/The University of Arizona, <sup>2</sup>Bureau of Reclamation Phoenix Area Office

### PROGRESS

Navajo well 27-228 near Joplin, Arizona was determined to be the best location for the solar distillation system and well was rehabilitated and a design was developed for a test facility. The test facility was constructed and the solar powered pumping system was installed into the well. The test solar ground surface. The Concentrating Photovoltaic Thermal Hybrid System (CPVTHS) was installed, tested, and is now operational at the site. The Membrane Distillation (MD) system has been installed is being tested and data collection is now beginning (Spring 2022).

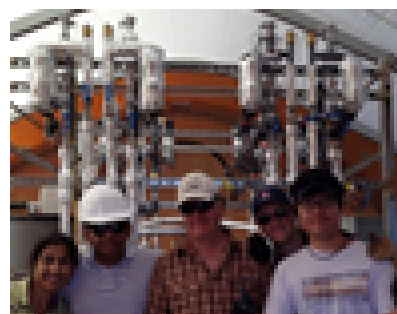


Figure 4. Members Distillation system team. (Courtesy of Mitch Housh)

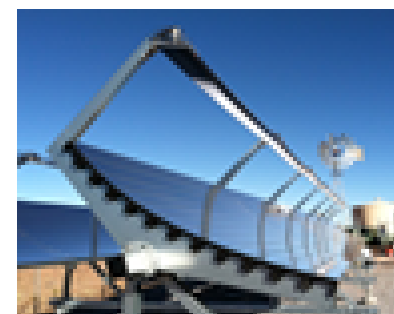


Figure 5. Concentrating Photovoltaic Thermal Hybrid System (CPVTHS). (Courtesy of Mitch Housh)



Figure 6. Solar Desalination test facility. (Courtesy of Mitch Housh)

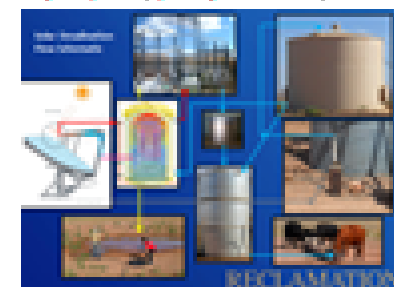
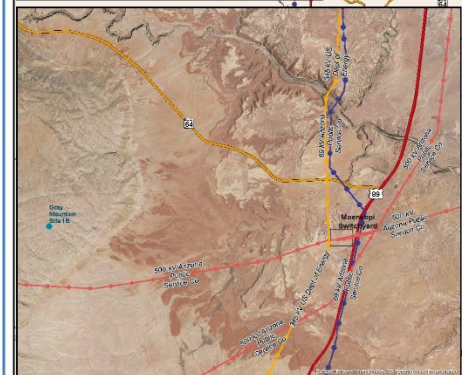
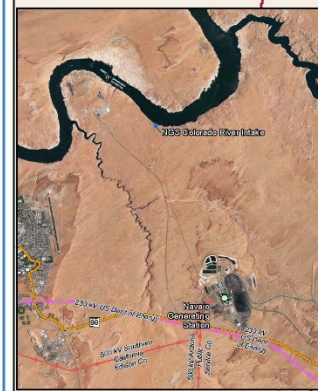
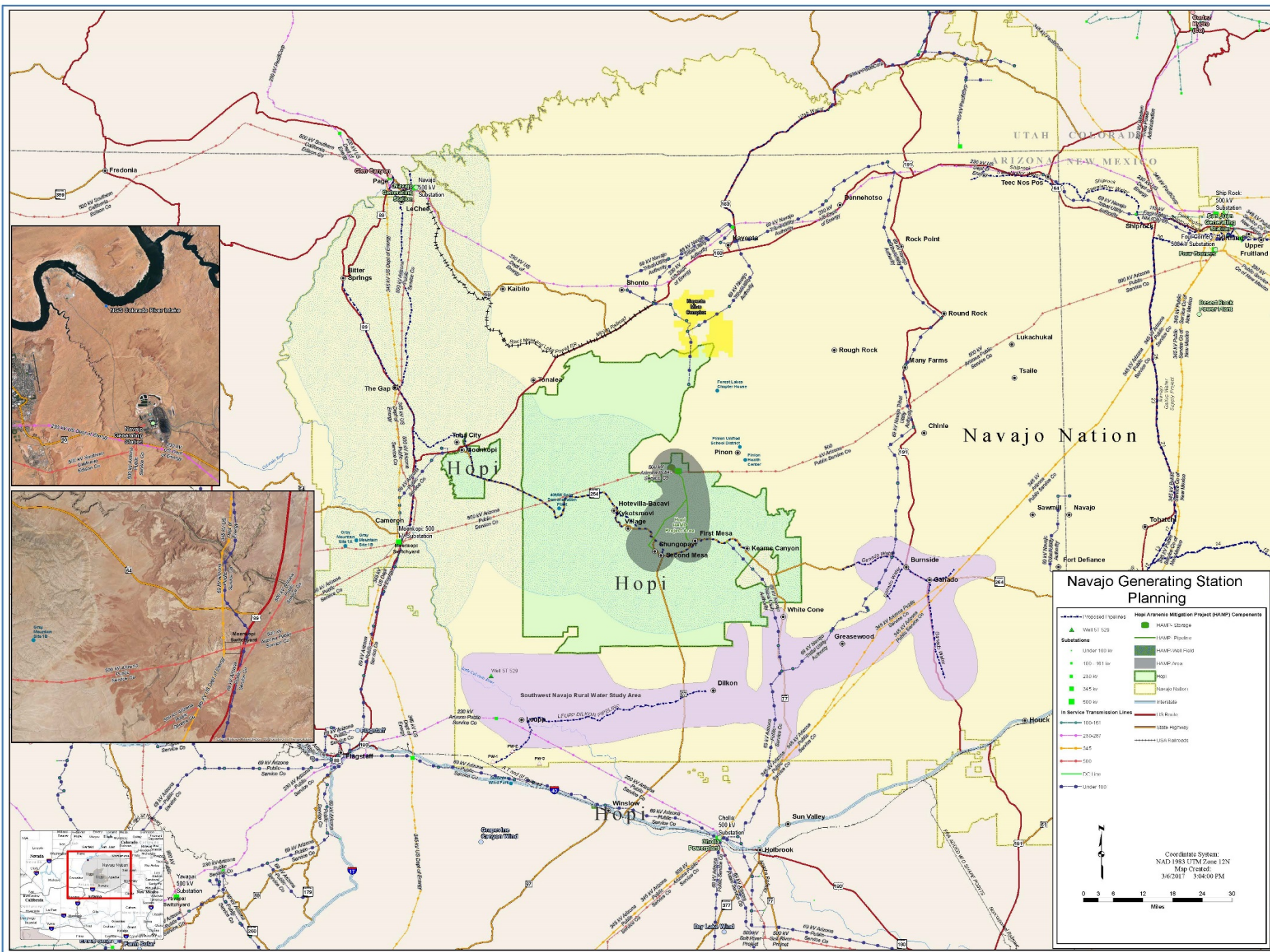


Figure 7. Well Site CPVTHS system operation schematic. (Courtesy of Mitch Housh)

### PROJECT PARTNERS





### Navajo Generating Station Planning

**Proposed Pipelines**

- Wail ST 529
- Wail ST 529

**Substations**

- Under 100 kv
- 100 - 181 kv
- 230 kv
- 345 kv
- 500 kv

**In Service Transmission Lines**

- 100-181
- 230-287
- 345
- 500
- DC Line
- Under 100

**Hopi Arsenic Mitigation Project (HAMP) Components**

- HAMP Storage
- HAMP Pipeline
- HAMP Well Field
- HAMP Area
- Hopi
- Navajo Nation

**Legend**

- Interstate
- US Road
- State Highway
- USA Railroads

**Coordinate System**

NAD 1983 UTM Zone 12N  
Map Created: 3/6/2017 3:04:00 PM

**Scale**

0 3 6 12 18 24 30 Miles