Uranium Doesn't Grow on Trees: Impacts of the Front End of the Nuclear Cycle in Indigenous Communities

Nuclear Energy in 2023: Where We Are and What's Ahead

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- Community partners and participants in population-based health studies on the Navajo Nation and Pueblo of Laguna

Land Acknowledgement Statement: *The University of New Mexico sits on the traditional homelands of the Pueblo of Sandia. The original peoples of New Mexico have deep connections to the land and have made significant contributions to the broader community statewide. We honor the land itself and those who remain stewards of this land and acknowledge our committed relationship to Indigenous peoples.*

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- **Approvals:** Human research is approved and monitored by the UNM Human Research Protections Office and Navajo Nation Human Research Review Board: DiNEH Project, NNR-04-145; NBCS, NNR-11.323; NBCS-ECHO+, NNR-19.360; Thinking Zinc, NNR-18.330T.

Cover photo of Quivira Churchrock I Mine waste dump and homes in Red Water Pond Road Community, Coyote Canyon Chapter, Navajo Nation

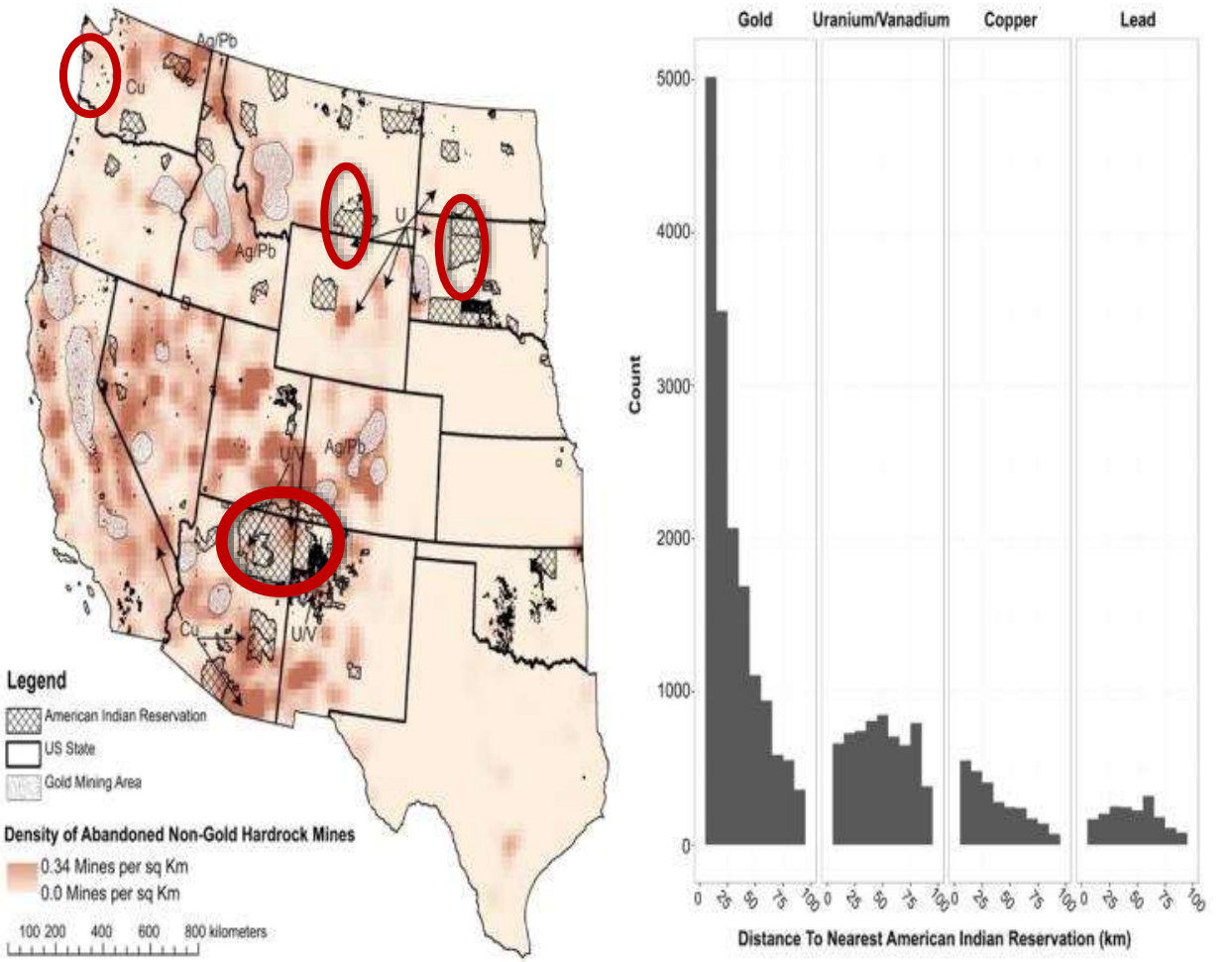
The Big Picture: Mining Impacts on Indigenous Americans

U.S. Western States

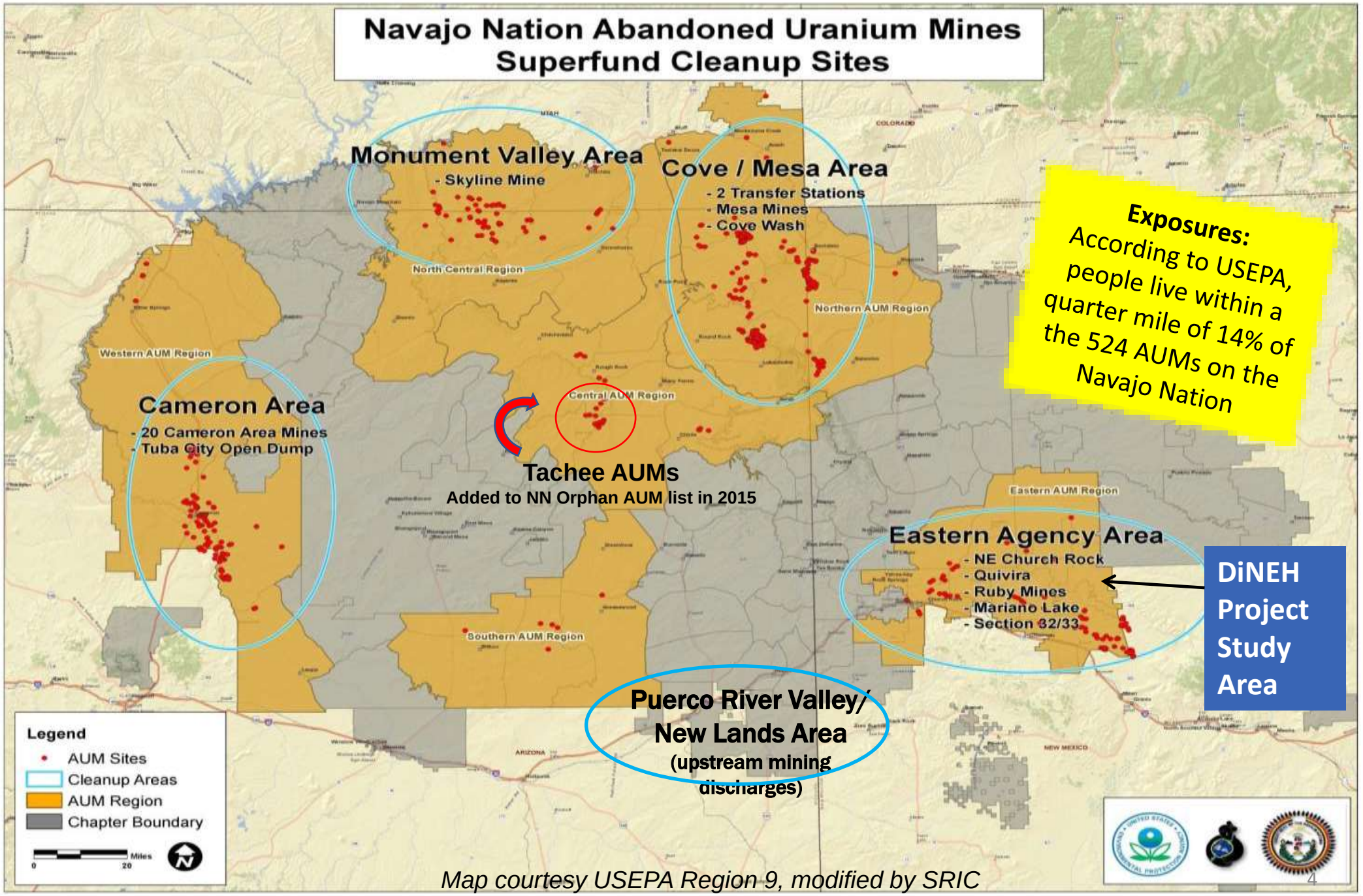
- 161,000 abandoned hard rock mines
- >500,000 sites
- 40% of watershed headwaters in West thought to be contaminated from these mines (USEPA)
- >1/2 of US Indigenous population
- >600,000 Native Americans live within 10 km of abandoned mines

Potential for higher sensitivity to toxicity among Native Americans

- reliance on local resources
- understudied genetic, epigenetic metabolic, distribution differences
- Tied to land – relocation away from mine sites not always an option to reduce exposures

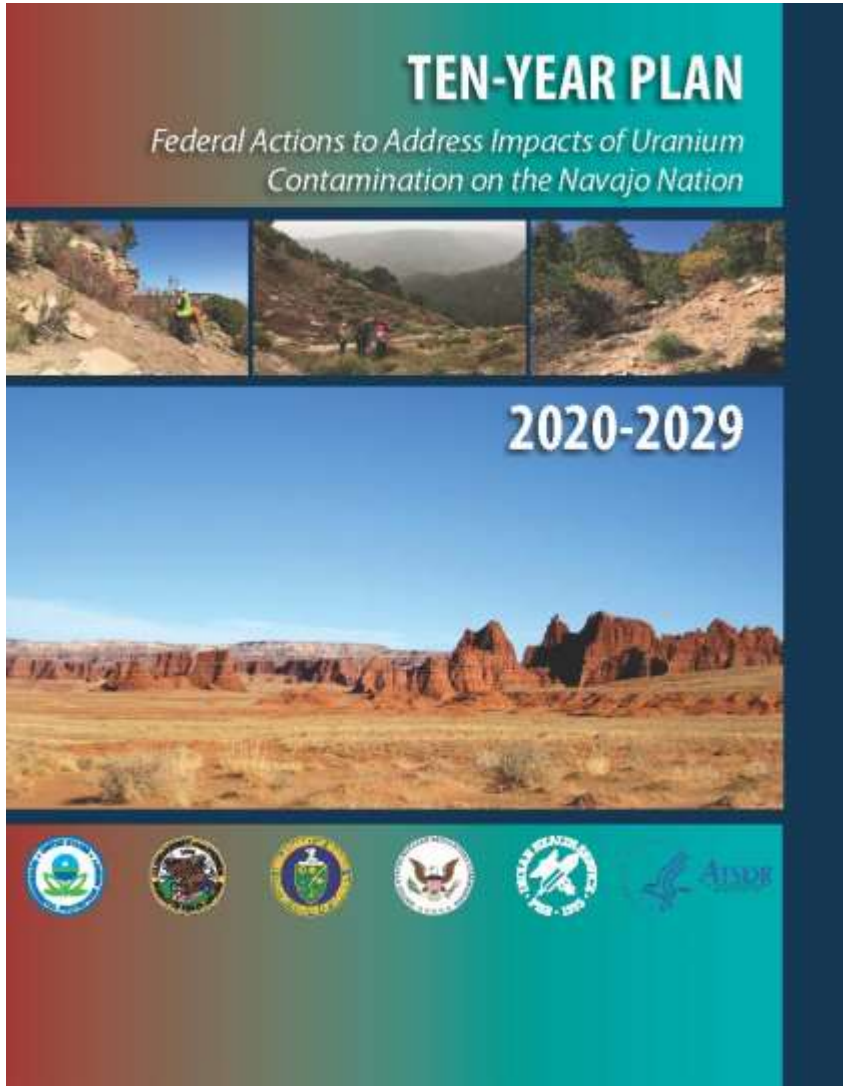


Lewis, Hoover, & MacKenzie (2017), Current Environmental Health Reports.



Map courtesy USEPA Region 9, modified by SRIC

Navajo Uranium Legacy: By the Numbers

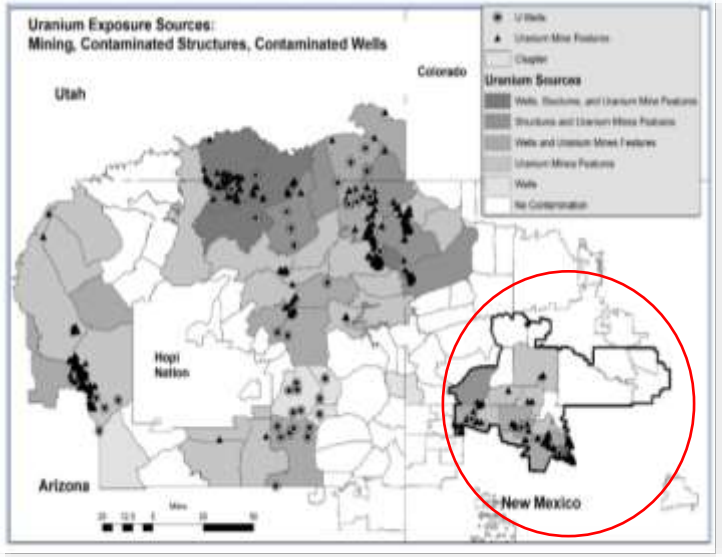


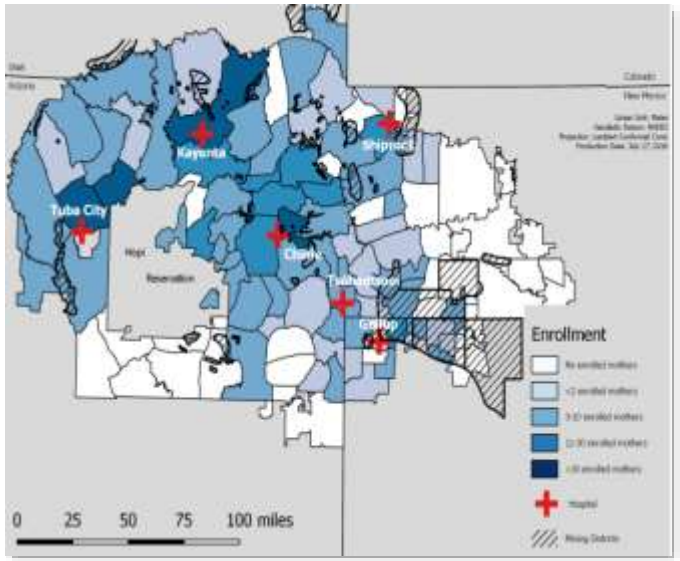
Cover of USEPA Ten-Year Plan, Jan. 2021

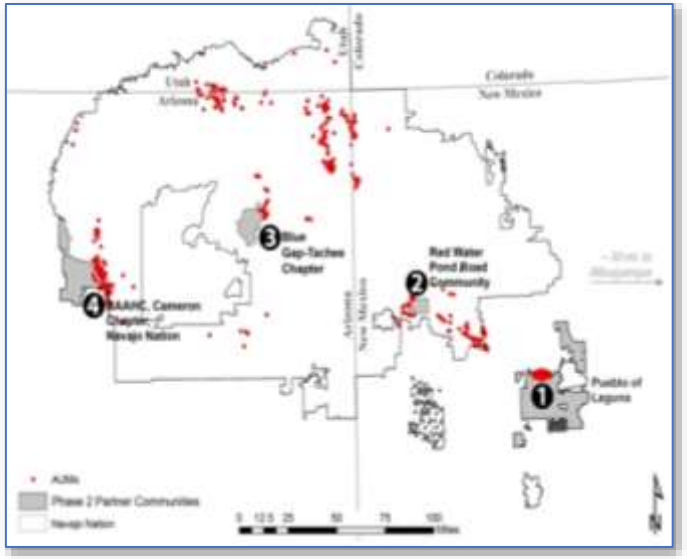
524	Abandoned uranium mines (AUMs), *plus* >1,100 mine "features"
0	***Fully remediated AUMs***
4	Interim AUM remedial actions to contain wastes
96	AUM site radiation screening reports
130	Removal Site Evaluations (RSEs) expected to be completed by end of 2022
10-15	EE/CAs* expected to be completed by end of 2022
$1.7 billion	Money USEPA says it has available for remediating **~40% AUMs** through Tronox bankruptcy, settlements with mining companies, federal contributions
3	Congressional hearings: 1979, 1993, 2007
3	Federal response plans: 2008, 2014, 2021
57 (52%)	Navajo Chapters w/ 1-3 uranium exposure sources (AUMs, water sources, contaminated structures)

*EE/CA = Engineering Evaluation/Cost Analysis

Community questions about exposures have driven UNM environmental health research







DiNEH Project, 2002-2012

- Does U in drinking water increase risk of kidney disease?
- Do multi-pathway exposures to metals in mine wastes increase risks of chronic disease?
- *Community-based trainings to develop study design, implementation methods, consents*

Navajo Birth Cohort Study, 2010-present

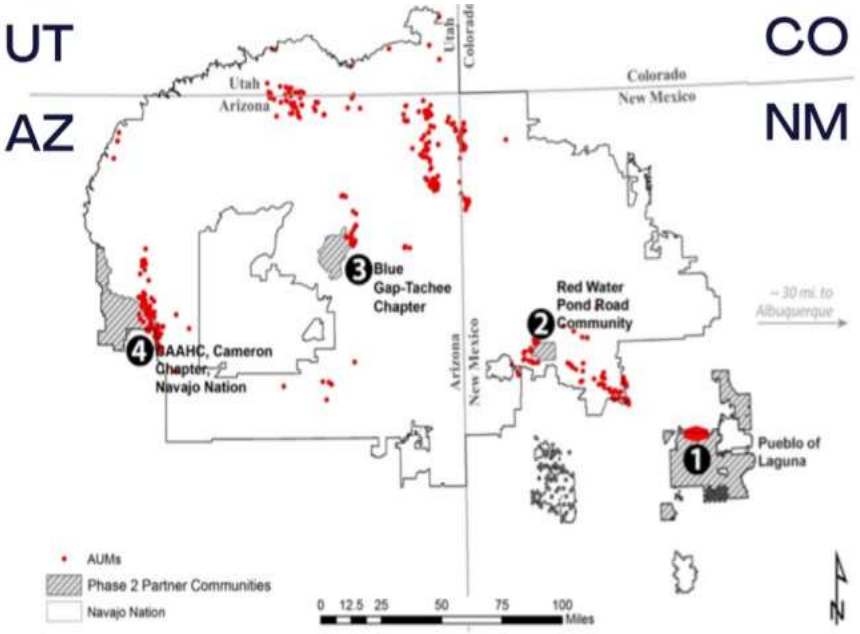
- Do exposures to U mine waste affect child health, development?
- Do exposures to metals in mine wastes increase chronic disease?
- *Extensive trainings to develop EH capacity among community members hired by UNM, SRIC and NNDOH*

METALS SRP, 2014-present

- Do mixed-metal U mine wastes contribute to air, water and farmland contamination?
- Do exposures to U wastes result in immunologic, cardiovascular, pulmonary effects?
- Status of remediation?
- *Community defines research*

Common Characteristics of AUM-impacted Native Communities

- Mine wastes replete with hazardous substances, especially metals
- Chronic exposures to contaminants in water, land, vegetation, livestock
- Communities use citizen science to address concerns



1 Pueblo of Laguna

Affected population: ~1,800 (3 of 6 villages)
Jackpile-Paguate Mine ~2,700 acres, 8,500-acre lease
CERCLA National Priorities List 2013
Production area: 1952-1982
Waste Volumes: 400 million tons
Interim Reclamation: 1989-1995
HS: As, Cr, Co, Mn, U, V, Zn

3 Red Water Pond Road Community

Affected population: ~200 within 1.5 mi of 3 sites
CERCLA Sites: A. Northeast Church Rock Mine (removal), B.Quivira Mine (removal), C. Church Rock Uranium Mill Tailings (NPL 1983)
Production era: 1968-1983
Waste Volume: 3-4 million tons across 3 sites
Removals: A. 2007-2012, B. 1991; 2006-2009
Remediation: C. 1991-present.
HS: As, Mo, No3, Ra-226, Se, U, V

Blue Gap-Tachee Chapter, Navajo Nation 2

Affected population: ~17 families (~70 people)
CERCLA Sites: Claim 28 Mine +19 other AUMs
Production area: 1954-1968
Waste Volumes: 4995 Cubic yards
@ Claim 28; 17,000 tons U Ore all mines
NNAML Reclamation to reduce safety hazards 1991-1992
HS: As, Fe, U, V

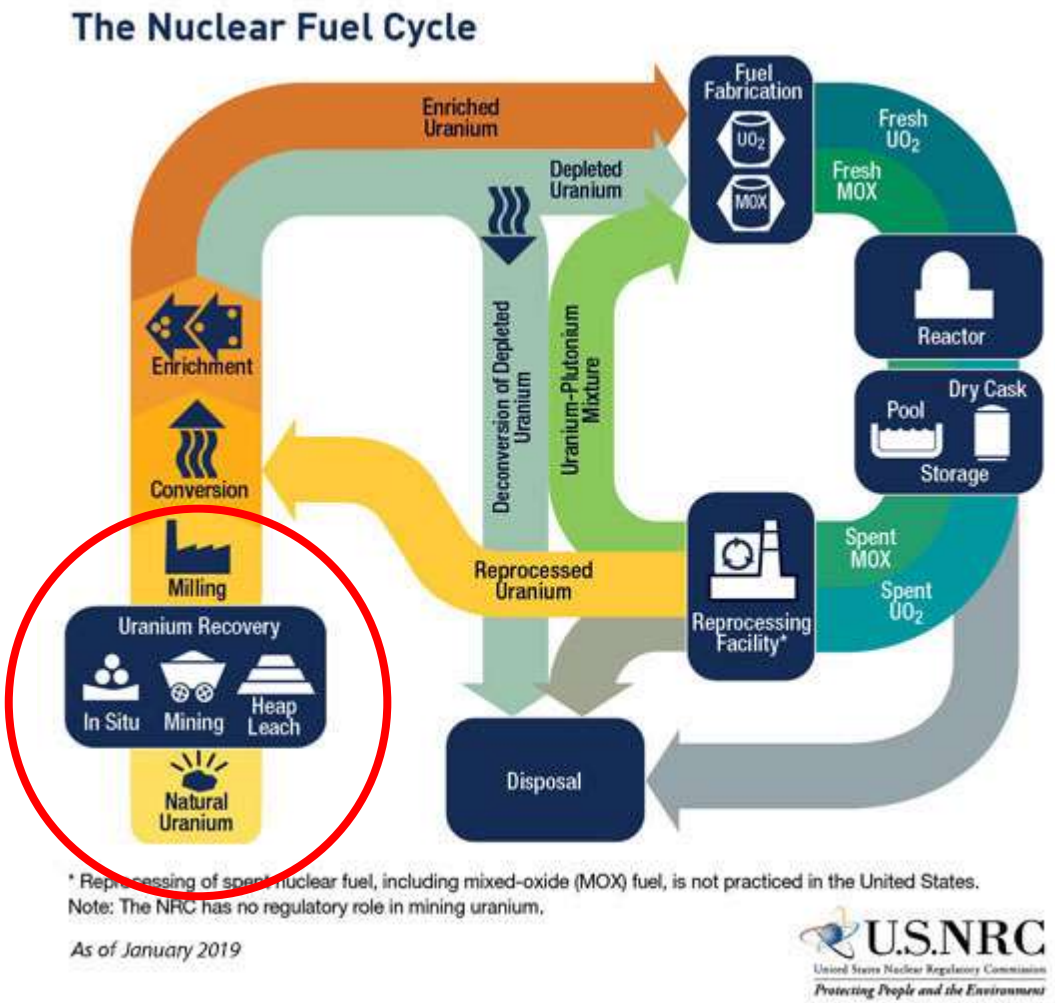
CAAHC, Cameron Chapter, Navajo Nation 4

Affected population: 885 (2010)
400 acres of farmland near 30 AUMs
CERCLA Removal Sites
Production era: 1952-1964
Waste Volumes: ~290,000 tons
NNAML Reclamation

Nuclear Fuel Cycle

Indeed, uranium does not grow on trees! It's finite…

- Naturally occurring metal and radioactive element found throughout the Earth's crust in concentrations averaging about 2.5 milligrams per kilogram (or parts per million)
- Technologically Enhanced Naturally Occurring Radioactive Materials, or TENORM – what humans have done to liberate uranium from its host rock
- Uranium first produced in the Southwest from vanadium mines in the Monument Valley area of AZ and UT in 1942
- Gov't only purchaser of U between 1949 and 1971
- AEC production incentives, 1950s to 1965
- Privatization of U market began in 1971
- Mining, milling, conversion, enrichment, fuel fabrication, and waste transportation are carbon emitters – only the reactors don't release carbon



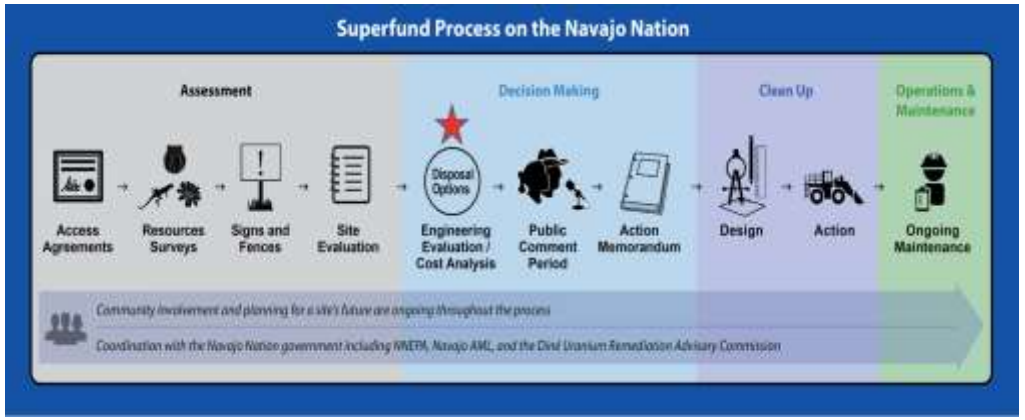
Regulatory Process for Remediation of Abandoned U Mines

History

- 1960-61 – AEC declined to regulate conventional uranium mining, i.e., the recovery of "source material" (defined as 0.05% U, or 500 ppm) from it's place in nature
- 1978 – Passage of Uranium Mill Tailings Remediation Control Act: authorized regulation of uranium processing at "active" mill sites (N=28) and remediation of tailings at "inactive" mill sites (N=24)
- States such as New Mexico adopted hardrock mining laws, regulations in the 1990s
- "Mine wastes" v. "mill tailings" – know the difference
- EPA determined CERCLA only federal statute available to regulate hazardous substances at AUM sites
- National Priority List sites (e.g., Jackpile Uranium Mine, UNC-Churchrock uranium mill tailings, Homestake-Barrick Gold Milan (NM) uranium mill, among others)
- *Most AUMs assessed under time-critical and non-time critical removal actions*

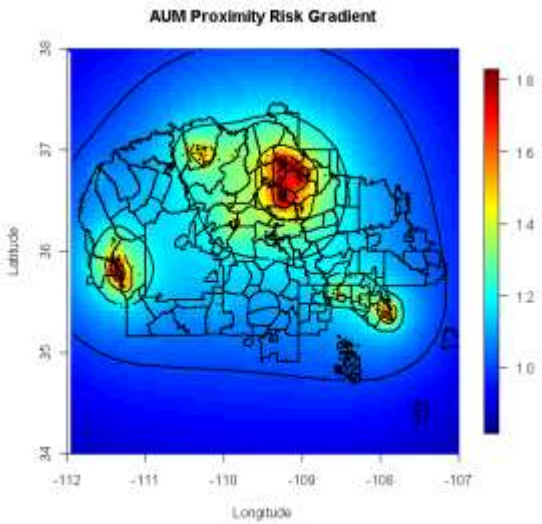
CERCLA Process for non-NPL sites

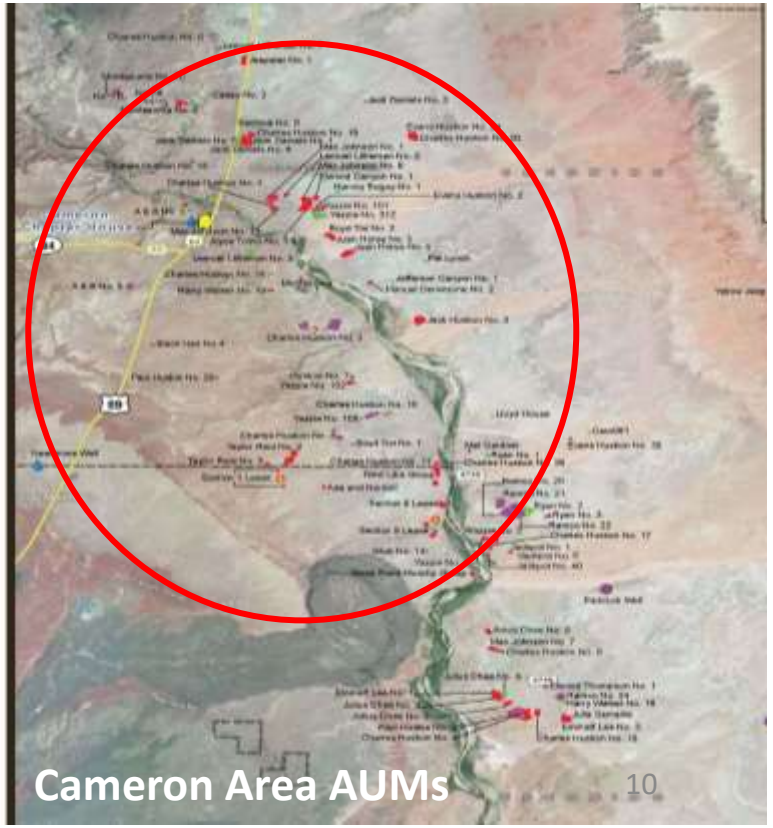
- Site Evaluation (RSE)
- Engineering Evaluation/Cost Analysis (equivalent to Remedial Investigation/ Feasibility Study for NPL sites)
- Public comment, meetings, hearings on preferred alternative
- "Action Memo" is decision document
- Disposal options – cap-in-place, consolidation of wastes from multiple sites, off-site removal – suffers from a lack of regional disposal facilities



Graphic courtesy of USEPA, June 2023

Multi-generational, chronic exposures from living close to abandoned mines





UNM Population-based EH studies to ascertain exposures and health outcomes

Study	Design	Population	Target Health Outcomes
DiNEH Project, Navajo Uranium Assessment Kidney Health	Cross-sectional; iterative, multi-pathway analysis	Phase I – 1,304 participants in 20 chapters of ENA; Phase II – 267 participants in blood and urine collections	▪ Chronic kidney disease ▪ Cardiovascular disease ▪ Autoimmunity
Navajo Birth Cohort Study	Longitudinal cohort	More than 1,800 mothers, fathers, babies in 3 phases across Navajo Nation	▪ Child development ▪ Metals and pre-term births ▪ Upper airway effects
Thinking Zinc	Clinical trial	52 volunteers from Churchrock and Blue Gap-Tachee communities	▪ Zn supplementation to repair metals-induced damage to DNA repair mechanisms
METALS Superfund Research Center	Laboratory animals	Community members exposed to dust from AUMs	▪ Cardiopulmonary effects of exposure to metals-laden “nanoparticles”