Metals Exposure and Toxicity Assessment on Tribal Lands in the Southwest

Thinking Zinc —
Béésh Dootł'izh Bantsáhákees

A study to assess how taking the recommended daily amount of zinc may help repair damage from harmful metals among Navajo Nation residents

Presentation to Diné Uranium Remediation Advisory Commission
September 9, 2021

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UNM METALS Superfund Center

Funding, Disclaimer, Approvals

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Disclaimer:

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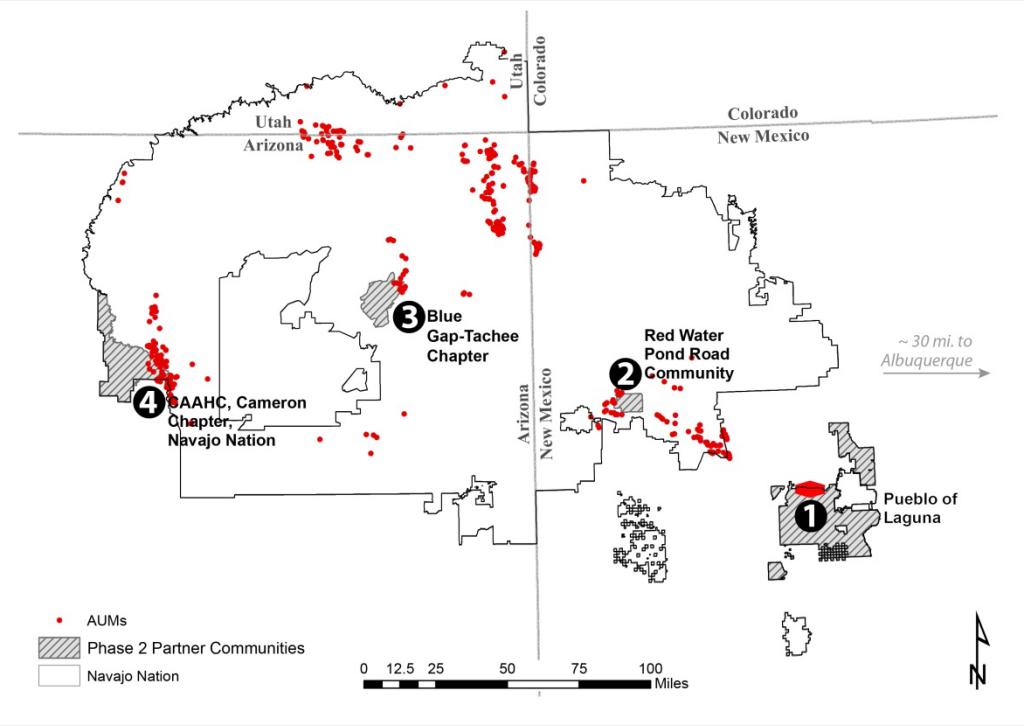
Approvals:

Human research is monitored and approved by UNM Human Research Protections Office (HRPO), the Navajo Nation Human Research Review Board (NNHRRB) and the New Mexico Cancer Care Alliance, as required by federal, state and Tribal law. ***UNM HRPO approved Thinking Zinc on December 11, 2018 (HRPO #18-381). NNHRRB approved the study on January 22, 2019 (#NNR-18.330T).***

Communities Participating in Thinking Zinc



❷ Red Water Pond Road Community

(*Tółchíí' Siką Atiin*)

or

Where the Meadows Meet

Ahidaazdigai

❸ Blue Gap-Tachee Chapter

(*Bis Dootł'izh Nídeeshgiizh*)

(dirt, blue, spread apart)

Community-engaged responses to multi-generational exposures to uranium mining wastes

Red Water Pond Road Community, Church Rock Mining District (1968-86)

4 generations… nearly 50 years

Ceremonial hogan represents goal to restore land to balance and health

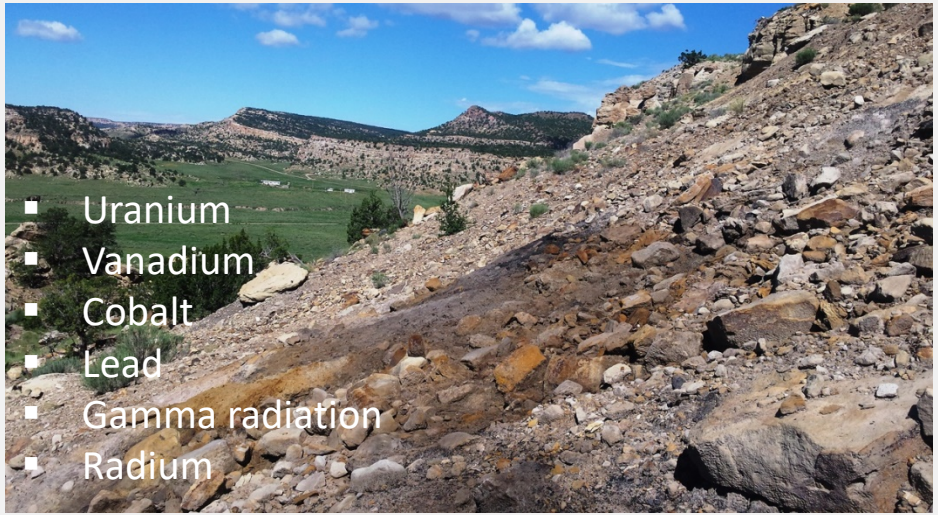
Blue Gap-Tachee Chapter, Black Mesa East Mining District (1954-68)

A family's pickup at a mine site

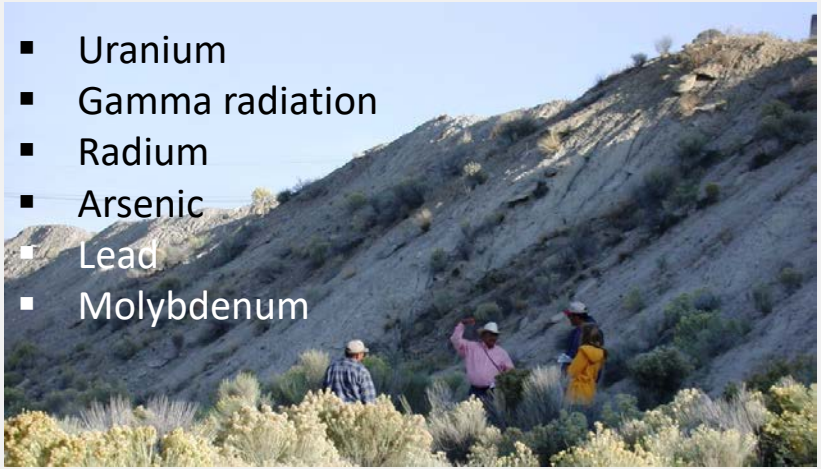
1988: First chapter resolution calling for mine cleanup

Metals, Radionuclides in Mine Wastes

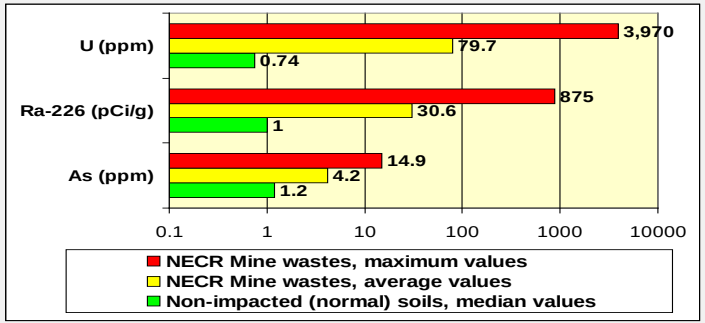
Claim 28, Blue Gap-Tachee Chapter



Northeast Church Rock Mine, Church Rock and Pinedale Chapters



	Elemental Content, ug g^{-1}							
	Si	S	Al	Fe	Mg	U	V	Ca
Native Soil	241,950	1,339	52,129	26,739	3,068	BDL*	BDL*	16,441
Mine waste1	235,563	223	69,533	15,259	181	2,248	15,814	855
Mine waste2	243,703	1,834	59,730	3,511	405	6,614	4,328	3,293



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Western Science Perspective

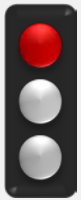
How can metals affect DNA repair?

Damaged DNA

Normal repair function: “Go”

Zn *is necessary for the repair process*

Repaired DNA



Repair function altered:
“Stopped” or “Slowed”

As or U *disrupts the repair process by replacing zinc in key proteins*

Damaged DNA

DNA repair function restored: “Go”

Zn *protects the key proteins from As or U* *and restores the repair process*

Repaired DNA

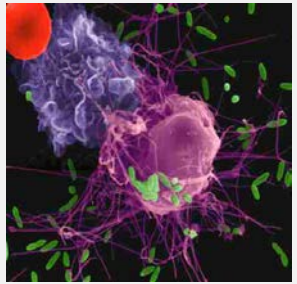
Some metals, like uranium and arsenic, can damage your health. Here are some examples, along with their Navajo interpretations:

Kidney disease

Hatsą́'áshk'azhî bąą dahaz'ą́ yileehgo
(Kidney, poor health, gets to be)

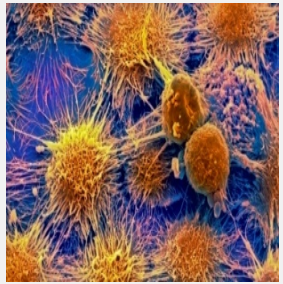
Cardiovascular Disease

Ajéé́h bąąh dahaz'ą́ yileehgo
(Heart, poor health, gets to be)



Immune Disorders

Ats'íís yich'ą́ą́h naabaah yę́ę doo hózhó naalnish da yileehgo
(Body, protect from, does not fully work, gets to be)



Cancers

Ats'íís bitł'óół dahdiníiséé́h áádóó ba'át'e' hółǫ́ yileehgo
(Body, cell growth, thereafter, bad behavior, gets to be)

Skin Problems

Hakáǵî yeenít'įįh
(Skin, affects)

Community Outreach, Support, Art, Language

Recruitment poster

Thinking Zinc — *Beesh Dootł'izh* Bantsáhákees*

[metal + blue (the one that is) + thinking about it]

- Participating Communities: Red Water Pond Road Community Association, Blue Gap-Tachee Chapter
- Both communities impacted by uranium mine wastes
- Community members took part in development of study design, Navajo language interpretation
- Native symbology used to illustrate biological functions
- Presented in Navajo to NNHRRB in January 2019
- Enrollment and sample collections began in RWPRC May 2019; four community "collection events" held prior to pandemic shutdown in March 2020
- Plan is to restart in Blue Gap-Tachee and surrounding chapters in October 2021

**From "Code Talker" by Chester Nez and Judith Schiess Avila, 2011.*

Indigenous perspective

This painting shows how metals like uranium ☢ can damage DNA and cells, through the lens of Mallery Quetawki, a Zuni artist and biologist.

Indigenous perspective

In this painting, Ms. Quetawki shows how DNA damage may be repaired, like re-stringing a broken bead strand. Zinc is necessary for this process.

Painting by Mallery Quetawki, Zuni Pueblo

Why take zinc?

- In the right amounts, zinc — a metal that comes from Mother Earth — is an *essential nutrient* that promotes good health.
- Studies have shown that many people do not get enough zinc in their diet to keep their body healthy, to achieve balance.
- Some Navajo women and men enrolled in the Navajo Birth Cohort Study were found to have insufficient levels of zinc.
- Taking a zinc pill is NOT a cure-all for all your ailments, and too much zinc may be harmful.
- Taking a zinc supplement at the recommended daily allowance of 11 milligrams zinc per day is considered safe.

Is zinc in our diets?

- Yes, but it might not be in high enough amounts
- Some Navajo foods that have higher levels of zinc include:
  - Lamb
  - *Blue corn mush from juniper ash*
  - Pinon nuts
  - Chicken
  - Beef
  - Eggs

Beesh Dootł'izh Bantsáhákees Eligibility*

Research volunteers needed

We are conducting research to understand if taking the daily recommended level of zinc protects our bodies from the effects of heavy metals in the environment.

***To be eligible, you must be**

- 21-64 years of age
- Not diabetic
- Not allergic to zinc
- Not pregnant or nursing

You will:

- Have 4 study visits over 9 months
- Take a zinc supplement tablet
- Provide blood and urine samples
- Receive a gift card each visit

INTERESTED?

For more information or to participate, send email to zinc@sric.org, call 877-545-6775, or visit www.sric.org/Zinc

COLLEGE OF PHARMACY

Your eligibility to be enrolled in the study will be determined at your first visit to a community collection event.

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Thinking Zinc Study Timeline

0
Start of study

3 months later
(3rd to 4th month)

3 months later
(6th to 7th month)

3 months later
(9th to 10th month)

Baseline

- Education
- Eligibility screening
- Consent
- Collection of blood (1 tbs) & urine (3 tbs)
- gift card

1 tablespoon (tbs)

Baseline/Zinc

- Education
- Continued eligibility
- Food frequency questionnaire
- Collection of blood (1 tbs) & urine (3 tbs)
- 3-month supply of 15 mg Zn tablets provided
- gift card

Zinc

- Education
- Continued eligibility
- Collection of blood (1 tbs) & urine (3 tbs)
- 3-month supply of 15 mg Zn tablets provided
- gift card

Last visit

- Education
- Continued eligibility
- Food frequency questionnaire
- Collection of blood (1 tbs) & urine (3 tbs)
- gift card

Our staff will contact you during the study to remind you to keep taking your zinc tablets and to attend the next visit.

Status and Progress

- Approvals
  - Navajo HRRB January 2019; UNM HRPO December 2018
  - Registration: Clinicaltrials.gov NCT03908736
- Continued Community Engagement (CEC/SRIC)
  - >50 community activities (i.e. chapter meetings, booths at events, collection days)
- Enrollment (37 of 80 goal as of February 2020)
  - 24 women, 14 men, ages 21-64, median 59
  - First enrollment, sample collection in Red Water Pond Road Community, May 2019
- COVID-19 study pause, March 2020-August 2021
- Sample analyses and data reports —in progress
- *Resuming study September 2021*

Pinedale Chapter House collection event, June 2019

Preliminary Data on Metals Levels in Urine

Table 3. *Thinking Zinc* Participant Pre-Zinc Urinary Metal Levels

Metal	PPB Median	Range	%<LOD	%>95th percentile NHANES/NBCS	NHANES 50th	NHANES 95th	NBCS 50th	NBCS 95th
Antimony	0.11	LOD – 0.398	5%	16.7%/8.3%	0.044	0.191	0.064	0.32
Arsenic	6.097	0.48 – 142.97	0%	3.3%/6.7%	5.74	49.9	3.6	16.9
Barium	1.53	LOD – 151.69	1.7%	5%/1.7%	1.17	5.39	2.375	16.25
Beryllium	LOD	LOD – 0.021	70%	30%/11.7%	LOD	LOD	0.008	0.01
Cadmium	0.20	0.029 – 1.27	0%	5%/11.7%	0.179	1.08	0.072	0.6
Cesium	3.87	0.99 – 24.84	0%	6.7%/11.7%	4.19	11.4	3.205	9.305
Cobalt	0.60	0.056 – 4.64	0%	6.7%/3.3%	0.403	1.41	0.61	2.3
Lead	0.149	LOD - 2.211	1.7%	3.3%/6.7%	0.32	1.38	0.22	0.9205
Manganese	0.126	LOD – 2.98	18.3%	21.7%/0%	0.13	0.28	0.21	3.265
Molybdenum	32.95	LOD – 160.5	1.7%	6.7%/3.3%	35.9	124	37.7	140
Platinum	LOD	LOD – 0.122	63.3%	28.3%/28.3%	.009	.017	.005	.018
Strontium	127.27	9.67 – 1075.76	0%	23.3%/8.3%	97.5	299	110	500
Tin	1.04	0.067 – 55.30	0%	15%/8.3%	0.43	3.62	1.36	11.22
Tungsten	0.0345	LOD – 0.431	15%	1.7%/0%	0.059	0.321	0.093	0.69
Uranium	0.022	LOD – 6.65	3.3%	36.7%/20%	0.005	0.031	0.011	0.07
Vanadium*	0.13	0.061 – 10.00	0%	----------	n/a	n/a	n/a	n/a

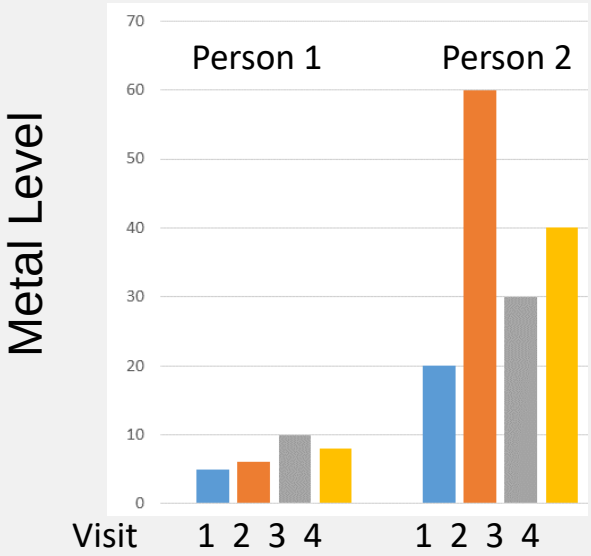
Median metal levels are shown for Visit 1 and Visit 2 samples (n=60) collected before zinc supplementation. Values are in micrograms per liter (ppb), and are uncorrected for creatinine to compare NHANES values. LOD=limit of detection. For reference, the 50th and 95th percentile levels are provided for NHANES values and participants in the NBCS including women, men and babies (N=1661-1782 for each metal). Metals results highlighted in blue represent those where more than 10% of samples had levels in excess of the NHANES 95th percentile values. *Urine levels for vanadium are not included in NHANES reporting. Nixon et al (2002) reported normal urine vanadium levels to be 0.24 ppb [Nixon DE et al. 2002]. 41% of participants had urine V levels > 0.24 ppb.

- **Data Table** – example of the detailed information comparing urine-metals levels in Thinking Zinc participants with national values and values in NBCS participants

- Some *overall results* so far:
  - **Arsenic** is *similar* to national values
  - **Lead** is *below* national values
  - **Uranium** is about *4 times higher* than national values

- *We will provide metals information <u>for each participant</u>*

Different patterns of exposure over time



Upcoming: Report-back letters to each participant who completed 4 visits will be sent in Fall 2021

Illustration on the left shows what we are seeing so far in urine-metals levels in participants:

- "Person 1" has *small changes* in metal levels between visits, and the levels don't vary much.
- "Person 2," however, has *much bigger changes* in metal levels between visits, and those levels vary considerably.
- *We will find out whether there are activities that might cause the differences so people can find ways to modify their exposure risk.*

Ongoing Research Activities and Goals

Measurements of "biomarkers" of metal effects

- Multiple markers of immune system function
- DNA damage
- Markers of inflammation, a process that contributes to many diseases

Mallery Quetawki's vision of DNA strand

Goals

- Identify which metals and metal mixtures alter the measured markers
- Determine whether zinc supplements improve the measured markers

COVID Safe Practices

- UNM and SRIC policies – abide by Public Health Orders of the Navajo Nation and rules of the chapters, UNM, State of New Mexico
- ALL UNM and SRIC personnel must have proof of COVID-19 vaccination to have any contact with study participants or community members
- ALL UNM and SRIC personnel attending community events will wear masks, maintain physical distancing
- Tables for surveys will be spaced >6 feet apart; hand sanitizer and masks will be available for participants
- Outdoor enclosures (e.g., tents) will be used to maintain good airflow
- Will make appointments for participants

Ahéhee' – Thank You!
Acknowledging Community Partners, SRIC Staff

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**Individuals no longer with the METALS program.*

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Tybur Casuse
Thomas De Pree, Ph.D.
*Tammi Duncan, Ph.D.
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*Jacquelyn Delp
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*Jennifer Ong, Ph.D
*Lucia Rodriguez-Freire, Ph.D.
Nabil Shaikh, Ph.D.
*Carmen Velasco, Ph.D.

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UNM METALS Superfund Center

Blue Gap-Tachee Community Concerns

Disruption of Life Cycles in Blue Gap-Tachee Community, Navajo Nation

Johnny Naize[1], Aaron Yazzie[1], Wallace Kee[1], Latasha James[1,2]
[1]Blue Gap-Tachee Chapter, Navajo Nation, Arizona; [2]Southwest Research and Information Center

Overview of our Community

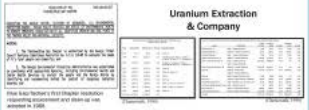
The Blue Gap/Tachee Chapter was established as a local government by Navajo Nation in 1960. In 1957, a trailer school was built in Tachee near Claim 28 (1.5 miles). A church and a Senior Center were built later at the current chapter location. The Blue Gap/Tachee Chapter is home to 20 abandoned uranium mines (AUMs), which operated from the early 1950s to the late 1960s. Many local people worked in the mines during that time. Claim 28 is the largest and is considered most dangerous because it is located within a 1-mile radius of many homes. Other existing AUMs are on the mesas near Waterfall Canyon (see map below), which is located northeast of Claim 28. The Eleshy family resides in Waterfall Canyon where they raise sheep and depend on a contaminated spring for livestock water. Since the uranium mines were abandoned, the livelihood of the community has remained unchanged.

2010 Census Demographics

Mining History

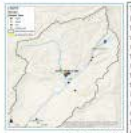
In the 1950s, the mines signified income stability for many of the Navajos living near the area, but for a short period. The workers and community knew very little about the health concerns the mines would cause later in their life.

"We were blessed, we thought. Railroad jobs were available only far off in Denver…but for mining, one can just walk to it in the canyon. We thought we were very fortunate, but were not told, later on this will affect you in this way."



Uranium Extraction & Company

Abstract



The community of Blue Gap/Tachee examines the exposure to abandoned uranium mines tracing back to the beginning in the late 1950s. Before the disruption of lifecycles, the community valued the natural state of plants, forage, land, the health and welfare of the community where everything was considered to being a beautiful state. Residents living near the area recollect painful memories of family members suffering from the effects of the uranium mines. Families resided in the area for many generations until they started having health problems leading to death of family members. Residence shared stories of their family members who worked at one of the mines near their home. They drank from hand-built dikes used to store water for livestock. The water ran off the mines into the shallow ponds. It wasn't until 1988 when the first chapter resolution was issued, because Tachee residents were experiencing health problems and deaths at an unusual rate. As of today, the effects of uranium contamination are affecting generations. Elders in the community also noted the changes in the state of the land. Members are now urging NNEPA and federal government to begin remediation. The disruption of lifecycles in plants, traditional herbs and vegetation are being witnessed by the elders. The plants native to the area no longer present in the area from the impact of uranium, and community clean-up.

Disruption of Life Cycles – Community Experiences

Helen Naz has lived her whole life in the Blue Gap Chapter on the center of the Navajo Nation near Tachee, Arizona. She had 11 children. One of her children was stillborn. She lost six additional children to Navajo neuropathy, a disability that was not recognized at the time. Three of her children died before their third birthdays. Their stomachs became bloated and their eyes became a cloudy gray color as they became sick. Through all her ordeals with each child, their help and support came from the local Catholic Church. Navajo and Hopi Medicine men, and social workers. There was no history of such sickness in either her family or her husband Leonard's until uranium mining came to Blue Gap in the 1950s. Helen said, "Leonard worked at one of the mines near their home…the family hauled it (water) for drinking, making coffee, washing dishes and clothes, and for bathing." (L. Holmes, Gallup Independent, 2009)

Claim 28 is above the Greyeyes's residence

Figure 1. View from on top of the abandoned mine.

Community members noticed the changes in the vegetation of plants on the land. The pictures depict drastic changes over 60+ years.

Ongoing Research Conducted and Selected Results

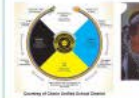
Research Conducted by

- Navajo Birth Cohort Study (NBCS) is a prospective study of pregnancy and neonatal outcomes in relationship to exposure to uranium waste.
- Navajo Nation Environmental Protection Agency (NNEPA) investigates and assesses abandoned uranium mines.
- Southwest Research and Information Center (SRIC) works with the community to document the impacts of AUMs.
- University of New Mexico (UNM) College of Pharmacy works with communities to study the connection between environmental exposures and disease
- UNM Metals Exposure and Toxicity Assessment on tribal Lands in the Southwest (METALS) is dedicated to studying the toxic effects of mined metals and uranium exposure on tribal communities in the Southwest.
- U.S. Environmental Protection Agency (USEPA) is funding and overseeing assessments and remediation of abandoned mines on the Navajo Nation.

Results: Summary of Water Quality Data in Blue Gap-Tachee Water Sources, and Use Recommendations

Traditional & Cultural Aspects of the Community

Elders in the community still uphold their cultural teachings. They still collect medicinal herbs from natural plants that grow in the area. Community members maintain that special connection to the land by prayers, songs, and traditions. Although there was a disruption in their cultural practices, community members continue to live by their traditional beliefs. A community member stated, "they still collect the different types of dirt used for traditional sandpainting." The Navajo principle Sa'ah Naagháí Bik'eh Hózhó (SNBH) in Navajo philosophy connects the Navajo people to their ancestral homeland.



Community Recommendations

1. NNEPA needs to take full control and accept the present/available reliable studies and interact with outside agencies to remediate abandoned mines. NNEPA and USEPA, in collaboration with Navajo Nation Government, must demand that Congress prioritize remediation of abandon uranium mines on the Navajo Nation. Demand an immediate action by our state's members of Congress to sponsor a legislation to amend the current Superfund Regulation to include all abandon mines whether they were considered least threat to human or nature. NNEPA should welcome and use all data, studies, analysis and investigations to accelerate remediation.
2. NN Government must direct NNEPA to isolate and fence exposed areas. Navajo Nation is definitely aware of all abandoned uranium mines throughout the Reservation and the Nation Government is very adamant on the danger of these abandoned mines. These sites have wastes and soils contaminated with harmful heavy metals. The Nation has the responsibility to protect the people and its environment.
3. Seek professional advice from scientists who have done extensive research on uranium, arsenic, and other highly toxic contaminants in the environment, to properly dispose or remediate legacy wastes based on their exposure levels. Navajo Nation needs highly accomplished Navajo scientists and modern laboratory equipment and facilities to conduct its own analytical studies to recommend clean-up methods. The Nation must be willing to accept studies from outside scientists to assist in remediation.
4. Establish cooperation/collaboration with State and Federal agencies and other Tribes in to initiate data collection and develop an agreement to share valuable data. Navajo Nation must establish communication with outside agencies to begin gathering vital data relating to all uranium issues and effects on human health and the environment. NNEPA can establish a data center to seek, receive and build a research facility.
5. Lobby for increased funding for the Navajo Birth Cohort Study and for local statistical data base regarding Navajo Neuropathy. The NBCS-ECHO will promote healthy family living and lower the risk of developmental disabilities (mental and physical). This program is very essential to the Navajo Nation.

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L-R: Johnny Naize, LaTasha James, Aaron Yazzie

UNM METALS Superfund Center

RWPR Community Concerns

Presented at 10th International Conference on Metals Toxicity and Carcinogenicity, October 2018

L-R: Teracita Keyanna, Peterson Bell, Edith Hood

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