Helping Mother Earth Heal
Diné College and Natural Remedies for U.S. Department of Energy Uranium Processing Sites on Navajo Land

Shiprock Public Meeting
Shiprock Chapter
August 17, 2011

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LM Mission:
“... ensure the future protection of human health and the environment.”
Many LM sites are former uranium mills.

Remedies include engineered covers for mill tailings and groundwater cleanup.
Remedy: Engineered Cover

Residual groundwater contamination may remain
DOE Uranium Processing Sites on Navajo Land

Shiprock, New Mexico

Monument Valley, Arizona

Mexican Hat, Utah

Tuba City, Arizona

Sites in LM at the Start of FY 2011 Requiring LTS&M
- UMTRCA Title I
- UMTRCA Title II
- CERCLA/RCRA
- FUSRAP
- D&D
- Other

Site Category
- Category 1 – Requires records-related activities and stakeholder support
- Category 2 – Requires routine inspection and maintenance, records-related activities, and stakeholder support
- Category 3 – Requires O&M of remedial action systems, routine inspection and maintenance, records-related activities, and stakeholder support

D/P = Disposal/Processing
DR = Decommissioned Reactor

Puerto Rico
BONUS DR
Center for Energy and Environmental Research
Uranium Mining Regions and Mill Sites on Navajo Land
"The Navajo Nation is Our Campus"  
Established in 1968
Diné College, Tsaile, Arizona
Diné College Educational Philosophy
Sá’ah Naagháí Bik’eh Hózhóón

Roughly translated: “walking or being in the pattern of beauty that surrounds you,” or, in other words, placing human life in harmony with the natural world

- Nitsáhákees – consciousness or creative thought
- Nahatá – planning, actions, and implementation of our thoughts and ideas
- Liná – living by achieving quality outcomes of thoughts and actions as a community
- Siih Hasin – having the assurance of personal stability and satisfaction with life’s achievements
Shiprock, New Mexico
Diné Environmental Institute (DEI)

DEI unites the traditional Sá’ah Naaghái Bik’eh Hózhóón philosophy with Western environmental science methods.

Curriculum and research programs are linked with the four Navajo sacred elements of natural systems:

- **Fire/Light** – Increase applications of renewable energy technology including solar and wind resources for families not connected to the grid.
- **Air** – Improve outdoor and indoor air quality affecting the health of Navajo people (radon and proper fuel use).
- **Water** – Improve water quality including groundwater quality, watershed management, erosion control, drought mitigation, and waterborne diseases.
- **Earth** – Improve remediation and reclamation of abandoned coal mines, and abandoned uranium mines and mills.
Ultimate goal: Balance and harmony between humans and nature – everything has a place.

Uranium is approached with understanding of its placement in natural order and its properties.

Regarded as the antithesis of the sacred corn pollen used to bless Navajo lives.

Diné traditional belief is that illness is related to an imbalance in life.

Mining disrupts the balance of Earth and Sky and therefore is disrespectful to Mother Earth.

Wholistic healing – interconnectiveness between physical, emotional, psychological, and spiritual existence.
Enhanced Attenuation Research: Linking Navajo Tradition and Science

- **Navajo tradition** teaches us to fulfill our duty as caretakers of Mother Earth by helping her restore and maintain the natural balance of the land.

- **Navajo science** is asking two questions:
  1. What is Mother Earth already doing to cleanse desert soil and groundwater?
  2. How can we help her?

- The answers may involve native plants (**phytoremediation**) and existing microbes (**bioremediation**) in soil and groundwater.

Father Sky, Mother Earth (Weaving)
Shiprock, New Mexico, Disposal Cell

Disposal Cell
Shiprock Groundwater Uranium Plume: Phytoremediation Study Area

Uranium (mg/L)

Well Location
Test Pit Location

Shiprock Site, New Mexico

DATE PREPARED: March 11, 2004
FILENAME: U0196700-02

U.S. DEPARTMENT OF ENERGY
GRAND JUNCTION, COLORADO

S.M. Stoller Corporation
Under DOE Contract No. DE-AC01-02GJ79491

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Terrace Escarpment, North of Shiprock Uranium Tailings Disposal Cell
Terrace Escarpment

Volunteer black greasewood
(*Sarcobatus vermiculatus*)
Shiprock Pilot Study Objectives

- Plant, irrigate, and accelerate spread of native desert phreatophytes
- Hydraulic control: stop seeps and spread of uranium plume into floodplain aquifer
- Limit plant uptake of uranium

Cover

**Diagram**

- TAILINGS
- SOURCE ?
- SOIL VADOSE ZONE
- GROUNDWATER
- PLUME
- GROUNDWATER
Phytoremediation of Soil and Groundwater: Desert Phreatophytes Tested

**Black greasewood**

Díwóžhiishzhiin (Sarcobatus vermiculatus)

- Goosefoot family (Chenopodiaceae)
- Monoecious or dioecious native shrub
- Obligate phreatophyte: roots almost always grow into groundwater
Phytoremediation of Soil and Groundwater: Desert Phreatophytes Tested

Fourwing saltbush
Díwózhii_beii (Atriplex canescens)
- Goosefoot family (Chenopodiaceae)
- Dioecious native shrub
- Facultative phreatophyte: roots sometimes grow into groundwater
Diné College Student Participation

- Soil testing
- Field sampling of soils and vegetation
Diné College Student Participation (continued)

- Planting and irrigating test plots
Diné College Student Participation (continued)

- Plant measurements and tissue sampling
Changes in fourwing saltbush and black greasewood plant canopy volume
Uranium in Terrace Phyto Plots (mg/kg Plant Stems and Leaves – DW)

Background (literature): 0.005 – 0.060 mg/kg

(Mean and SE of the Mean)
Objectives

- Sample groundwater constituents
- Sample orchard tree stems, leaves, and fruit
- Compare orchard results with background values
Diné College Student Participation

- Bio-uptake study at the Diné College orchard
Uranium: Diné College Orchard (mg/kg Plant Stems, Leaves, and Fruit – DW)

Literature: 0.005 – 0.060 mg/kg DW

(Mean and SE of the Mean)
Summary of Shiprock Phytoremediation Pilot Studies (Preliminary)
Summary of Shiprock Phytoremediation Pilot Studies (Preliminary) (continued)

- Black greasewood and fourwing saltbush *both* established and grew healthy
- Water chemistry data indicated that volunteer plants are rooted in alluvial groundwater (capillary fringe)
- Uranium levels in test-plot plants were not above background levels
- Uranium levels in orchard leaves and fruit tissues were not above background levels
Epilogue

- Weaving STEM education and culture
- National Science Foundation documentary
- Film clip about Diné College and DOE collaboration
National Science Foundation Documentary

Weaving STEM Education and Culture