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# 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

Jody Waugh, S.M. Stoller Corporation  
Garry Jay, Intern, U.S. Department of Energy  
Perry Charley and Marnie Carroll, Diné Environmental Institute, Diné College



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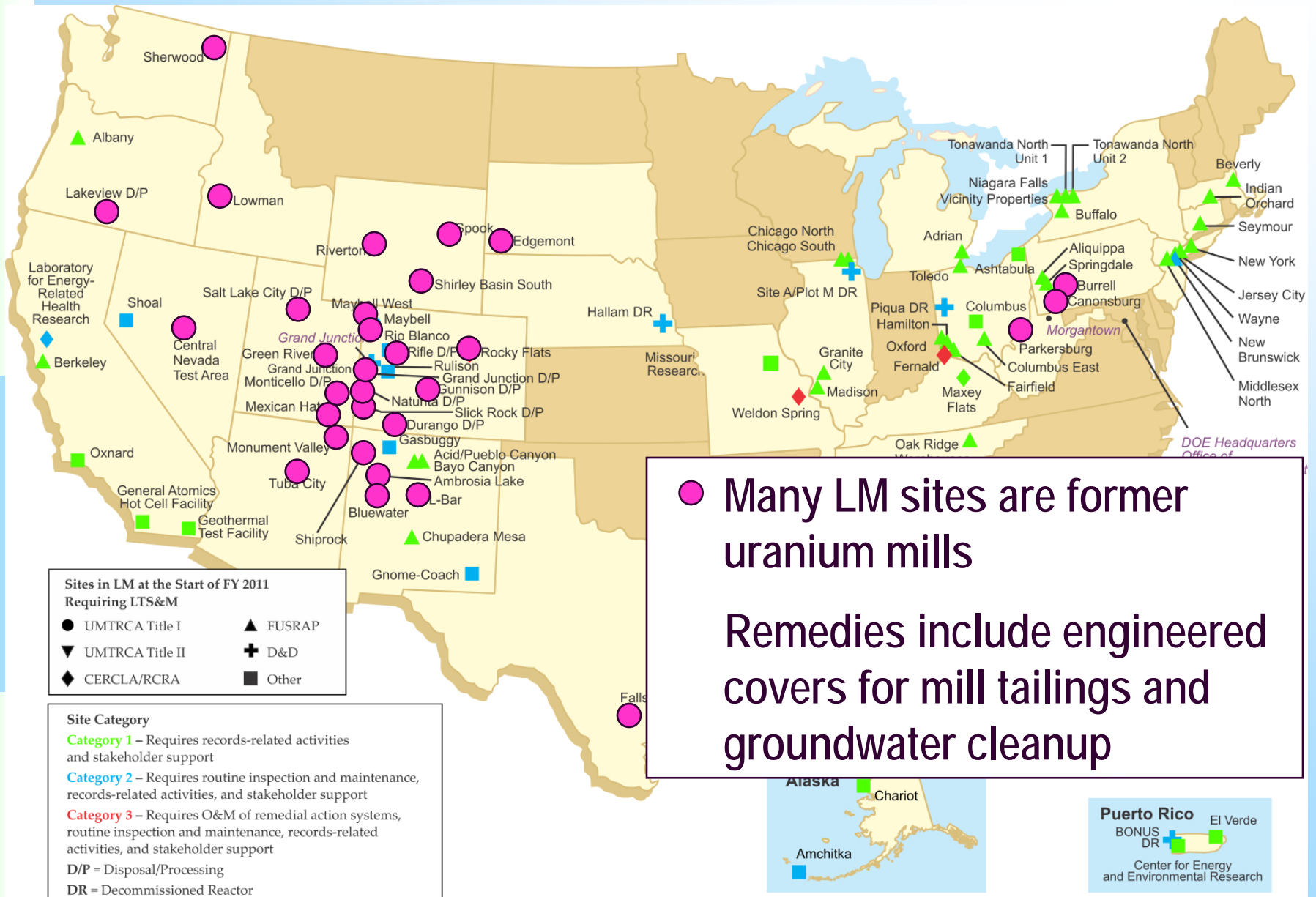
# U.S. Department of Energy (DOE) Office of Legacy Management (LM) Sites

## LM Mission:

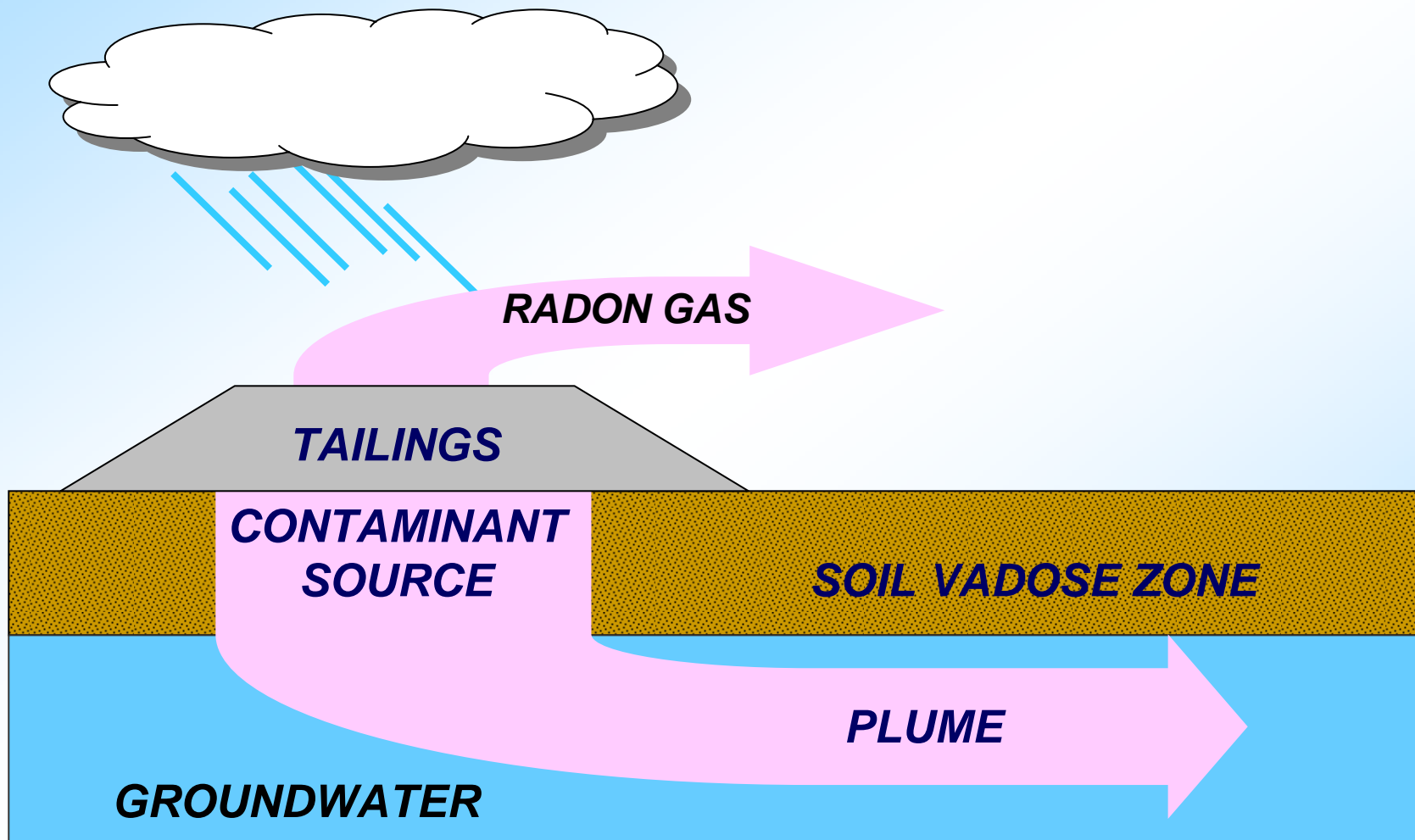
“... ensure the future protection of human health and the environment.”



# Remedies at LM Sites



# Uranium Mill Tailings: *Contaminant Release Pathways*

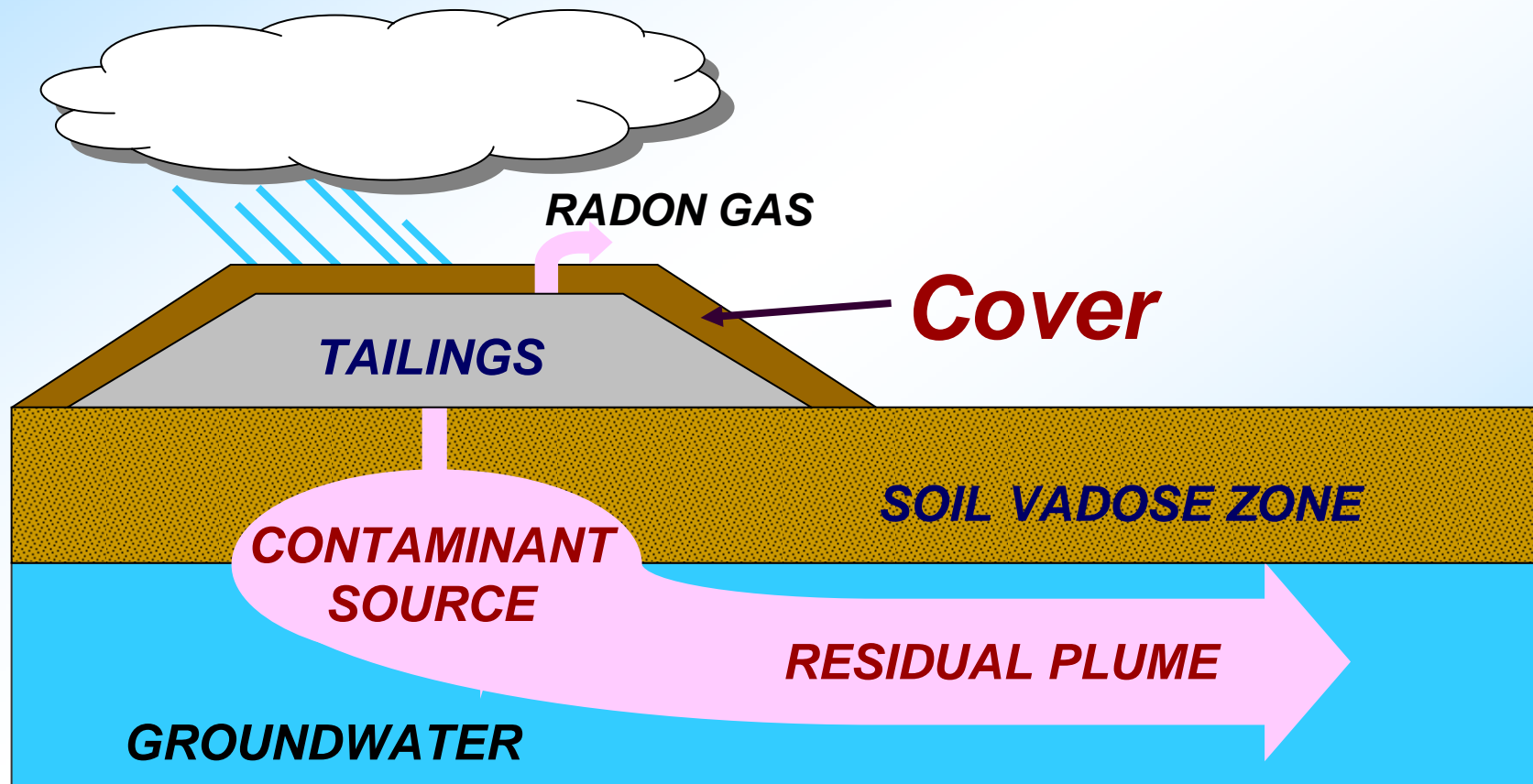


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# Remedy: Engineered Cover

*Residual groundwater contamination may remain*



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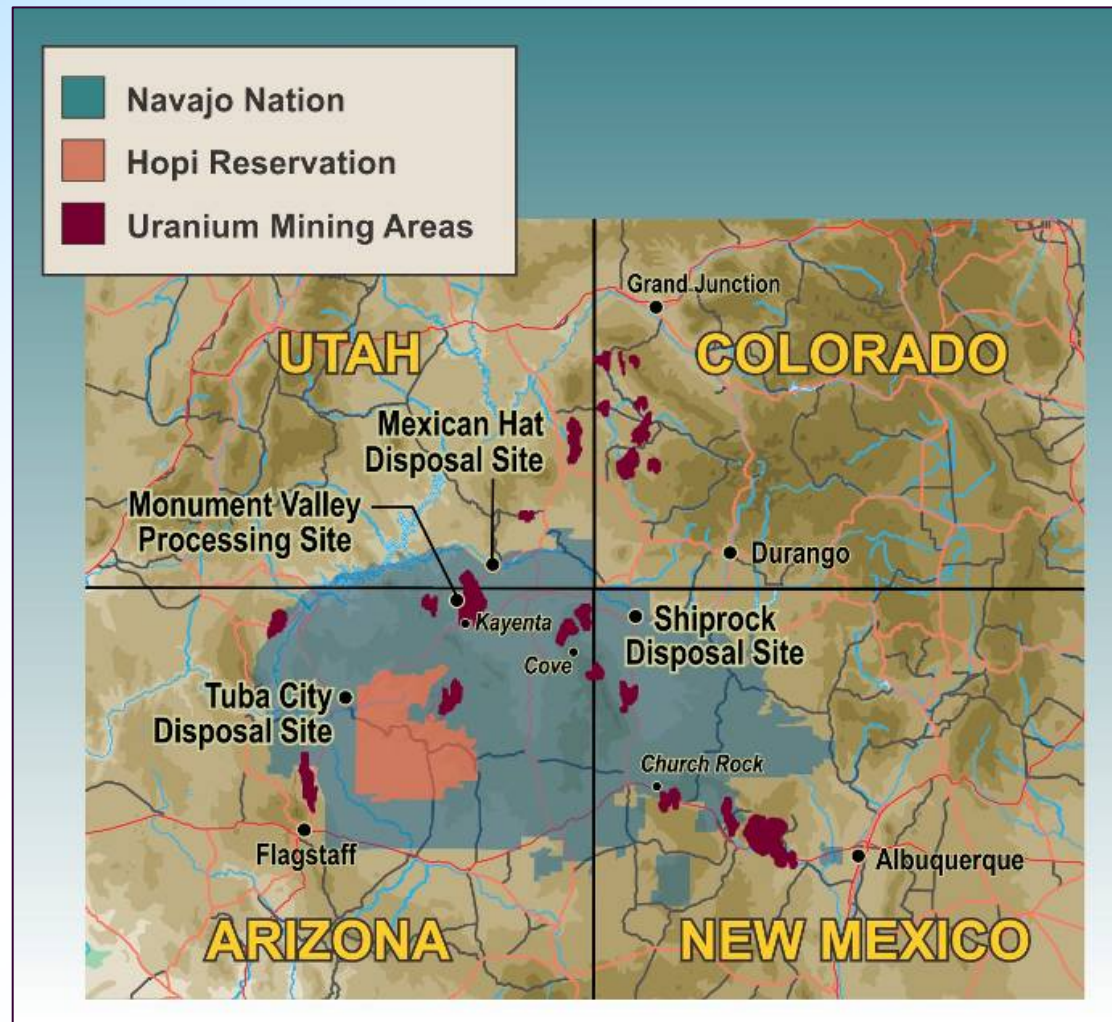
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# DOE Uranium Processing Sites on Navajo Land





# Uranium Mining Regions and Mill Sites on Navajo Land



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# DINÉ COLLEGE MULTI-SITE SYSTEM



**"The Navajo Nation  
is Our Campus"**  
**Established in 1968**



## Diné College Locations:

Tsaile, AZ (Main Campus)  
Tuba City, AZ  
Chinle, AZ  
Crownpoint, NM

Window Rock, AZ  
Ganado, AZ  
Kayenta, AZ  
Shiprock, NM



# Diné College, Tsaile, Arizona



Image USDA Farm Service Agency

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7/2007

36°17'39.83" N 109°12'58.15" W elev 7078 ft

Eye alt 11851 ft



# **Diné College Educational Philosophy**

## **Sá'ah Naaghái 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



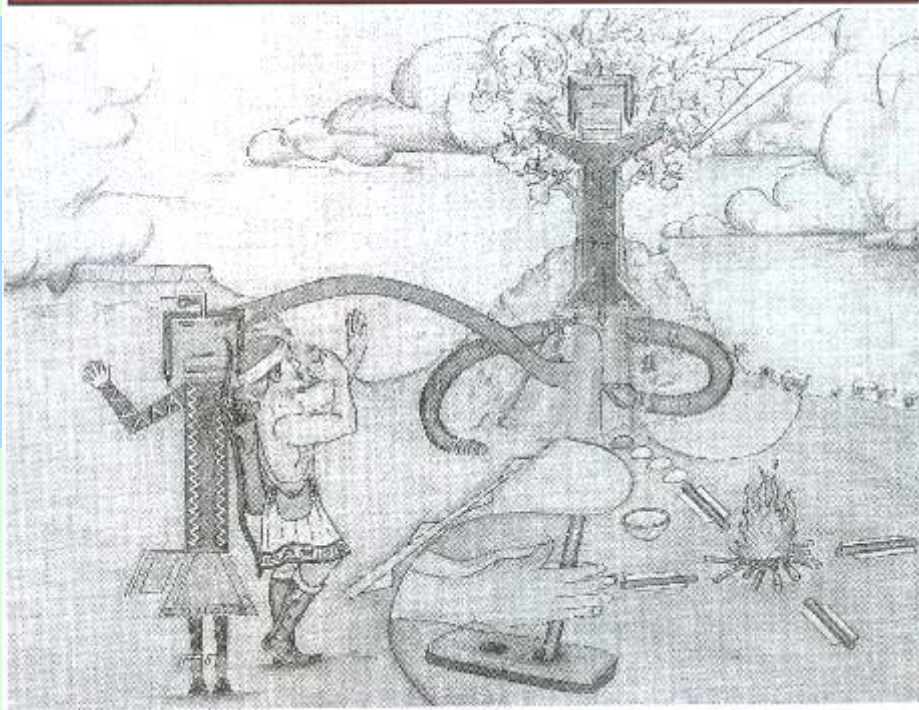
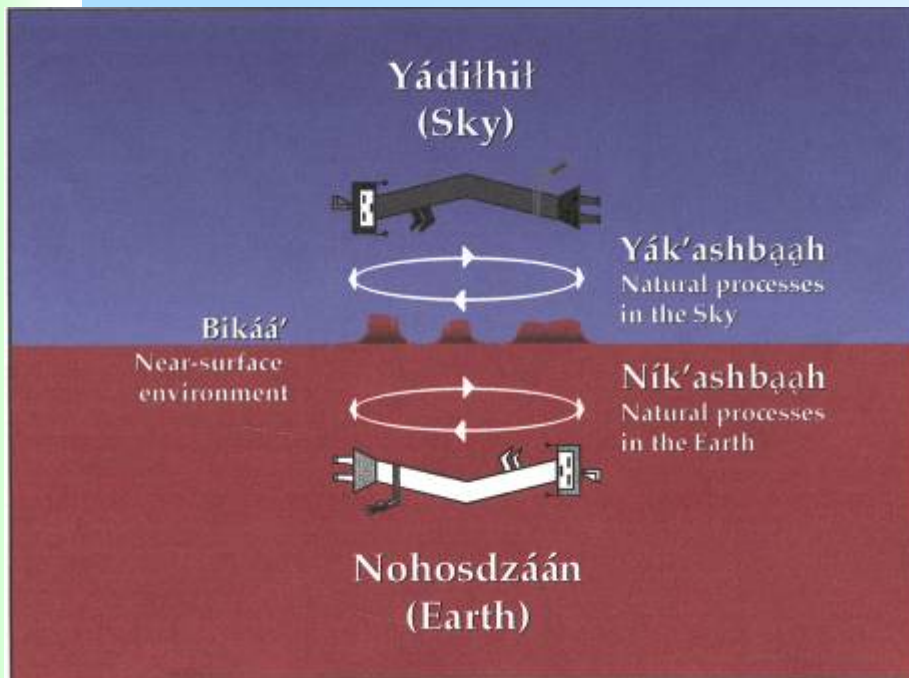
# Diné Environmental Institute (DEI)

**DEI unites the traditional Sá'ah Naagháí 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 Mill Circa 1960





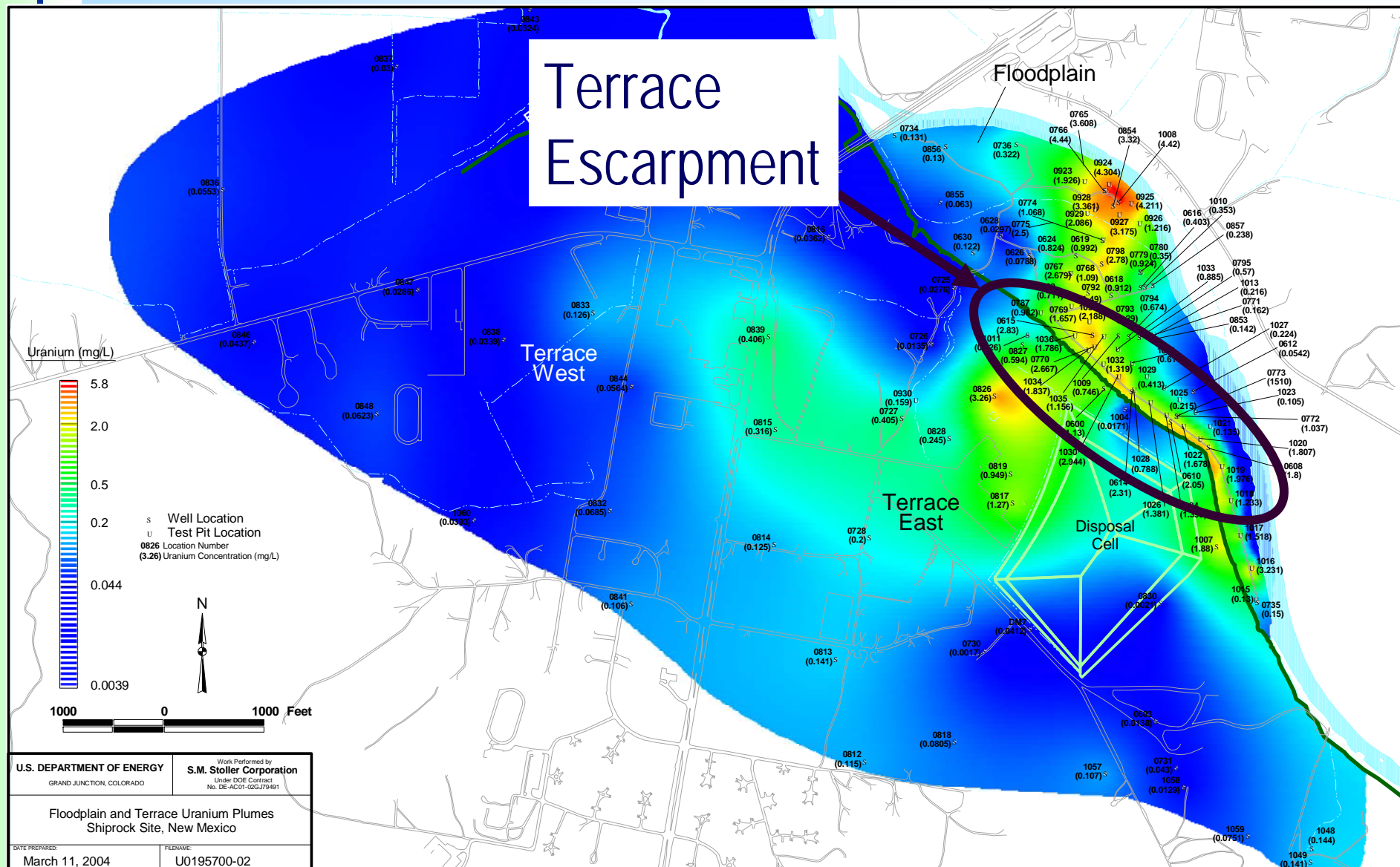
# Shiprock, New Mexico, Disposal Cell

Disposal Cell





# Shiprock Groundwater Uranium Plume: Phytoremediation Study Area



# Terrace Escarpment, North of Shiprock Uranium Tailings Disposal Cell



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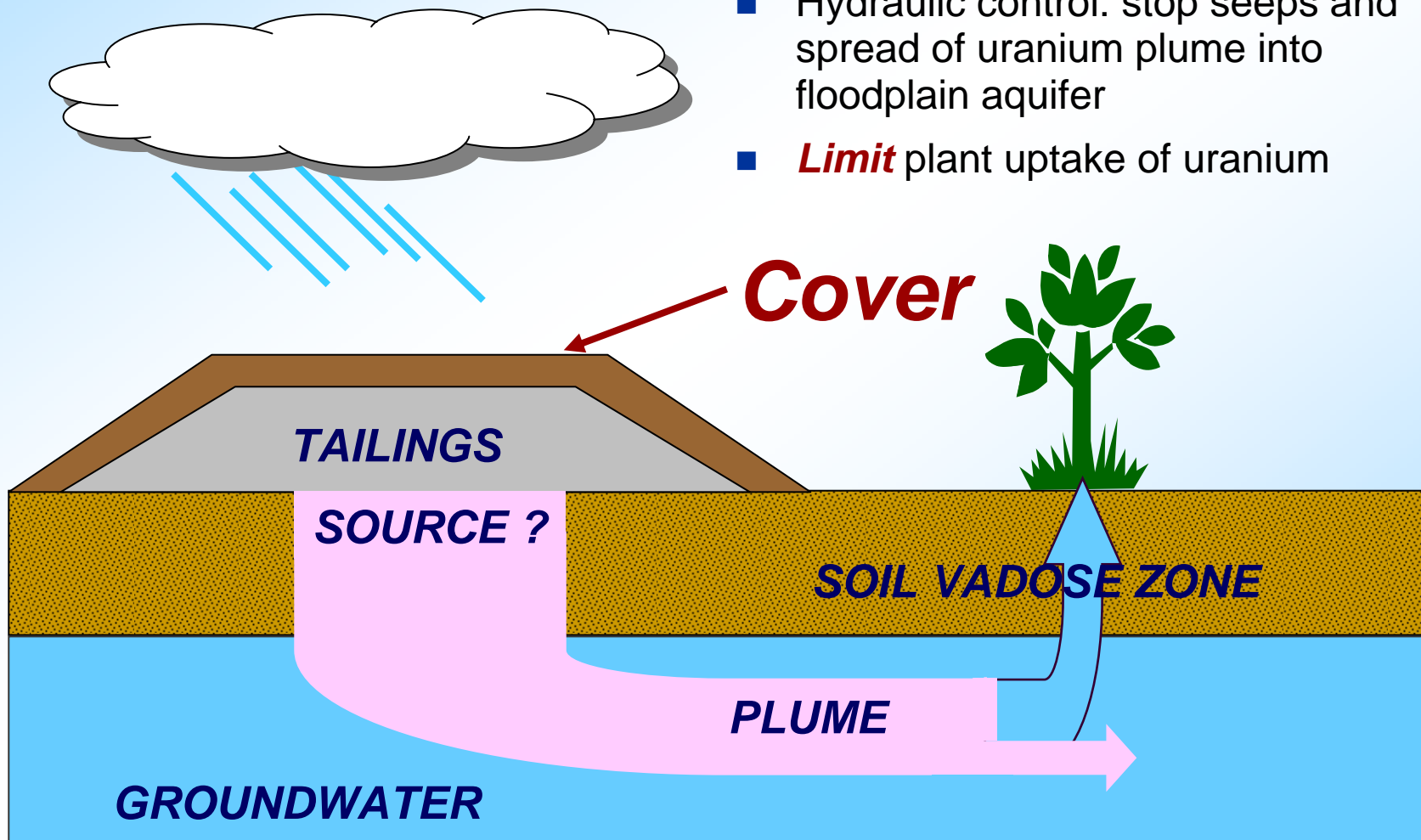
# Terrace Escarpment

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





# Phytoremediation of Soil and Groundwater: Desert Phreatophytes Tested

## Black greasewood

Díwózhiishzhiin  
(*Sarcobatus vermiculatus*)

- Goosefoot family (Chenopodiaceae)
- Monoecious or dioecious native shrub
- Obligate phreatophyte:  
roots almost always grow  
into groundwater



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# Phytoremediation of Soil and Groundwater: Desert Phreatophytes Tested

## Fourwing saltbush

Díwózhii\_beii  
(Atriplex canescens)

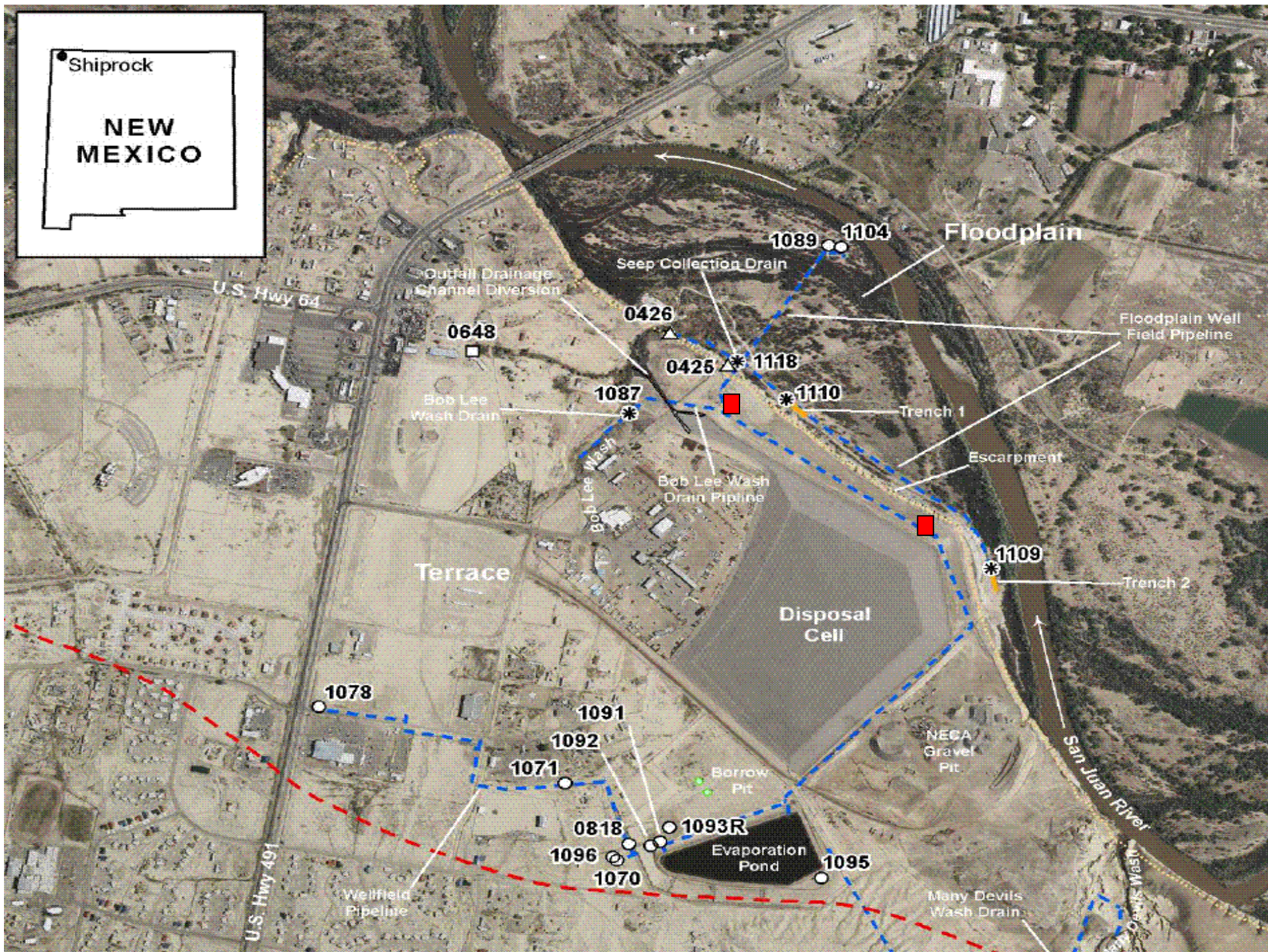
- Goosefoot family  
(Chenopodiaceae)
- Dioecious native shrub
- Facultative phreatophyte:  
roots sometimes grow  
into groundwater



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# Diné College Student Participation

- Soil testing
- Field sampling of soils and vegetation





# Diné College Student Participation (continued)

- Planting and irrigating test plots

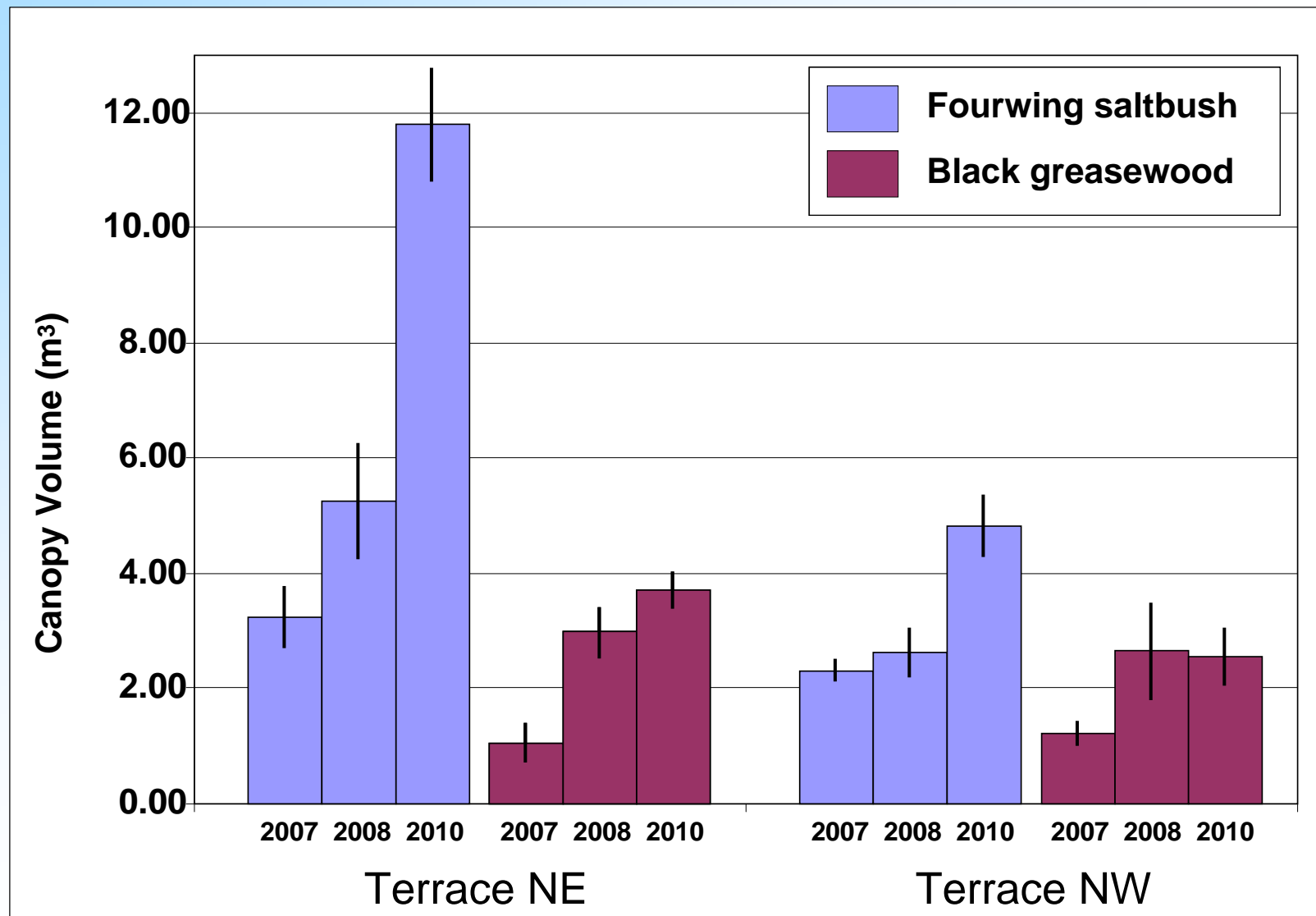




# Diné College Student Participation (continued)

- Plant measurements and tissue sampling



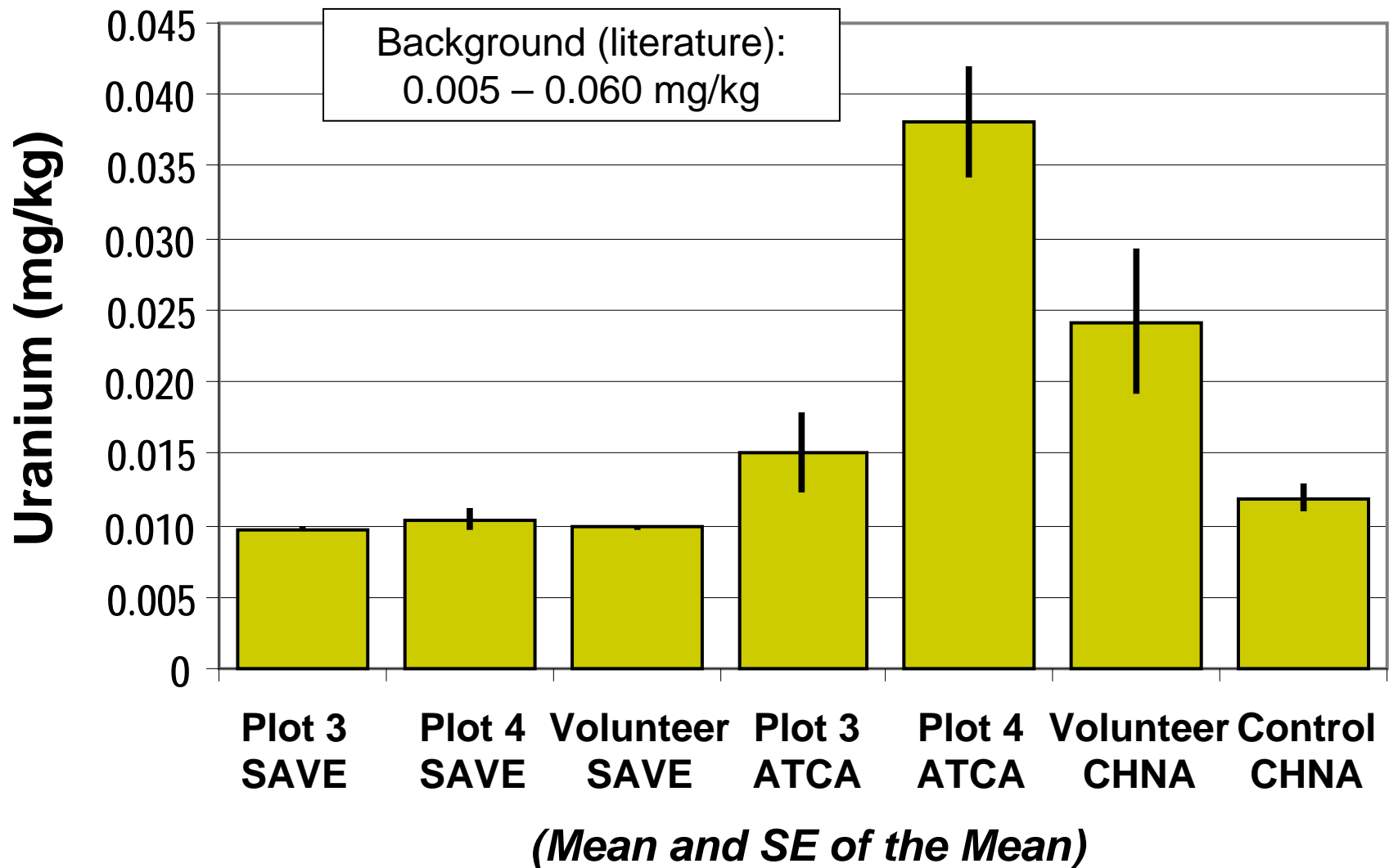


Changes in fourwing saltbush and black greasewood plant canopy volume





# Uranium in Terrace Phyto Plots (mg/kg Plant Stems and Leaves – DW)

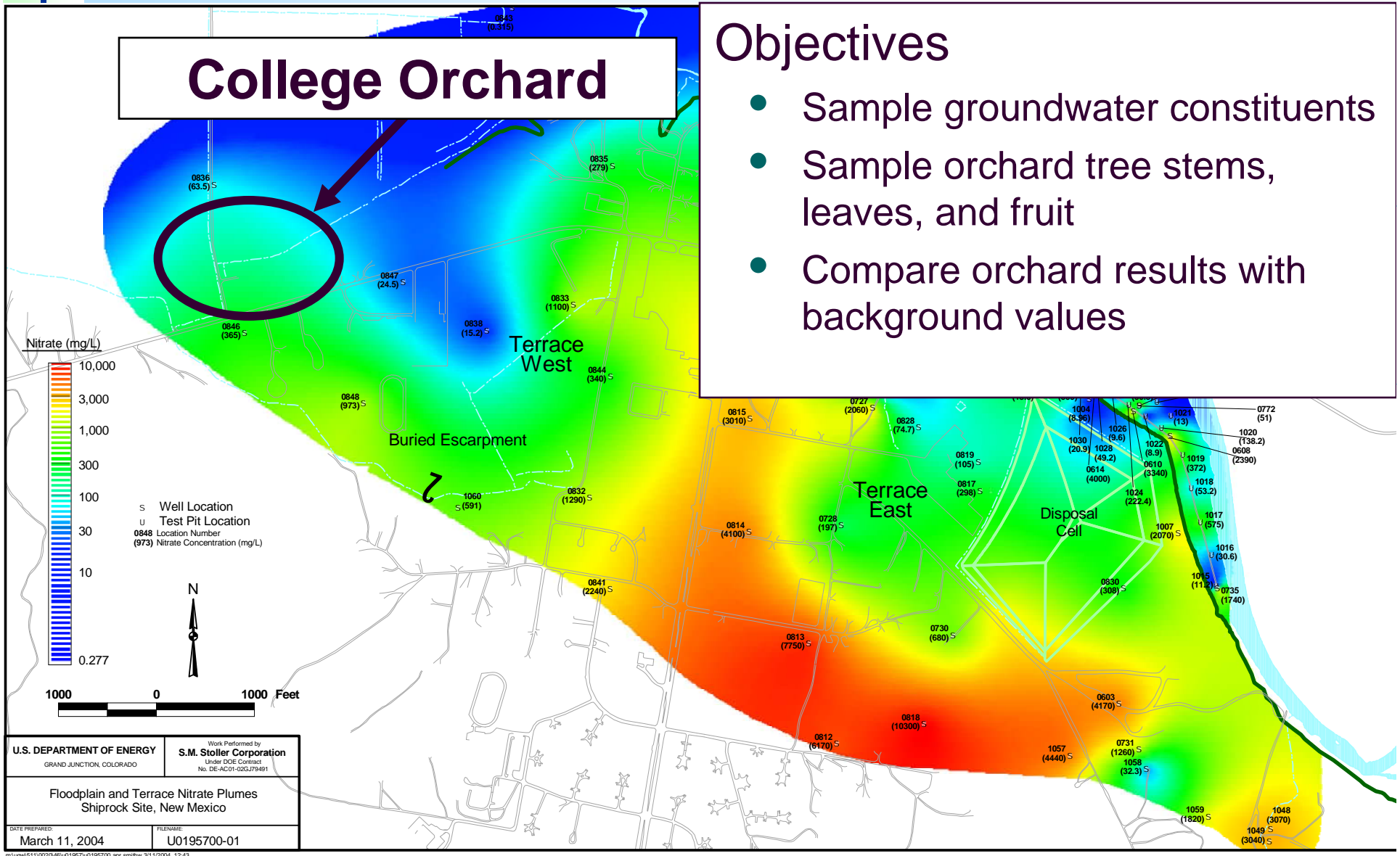


# Diné College Orchard Risk Screening Study

## College Orchard

## Objectives

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



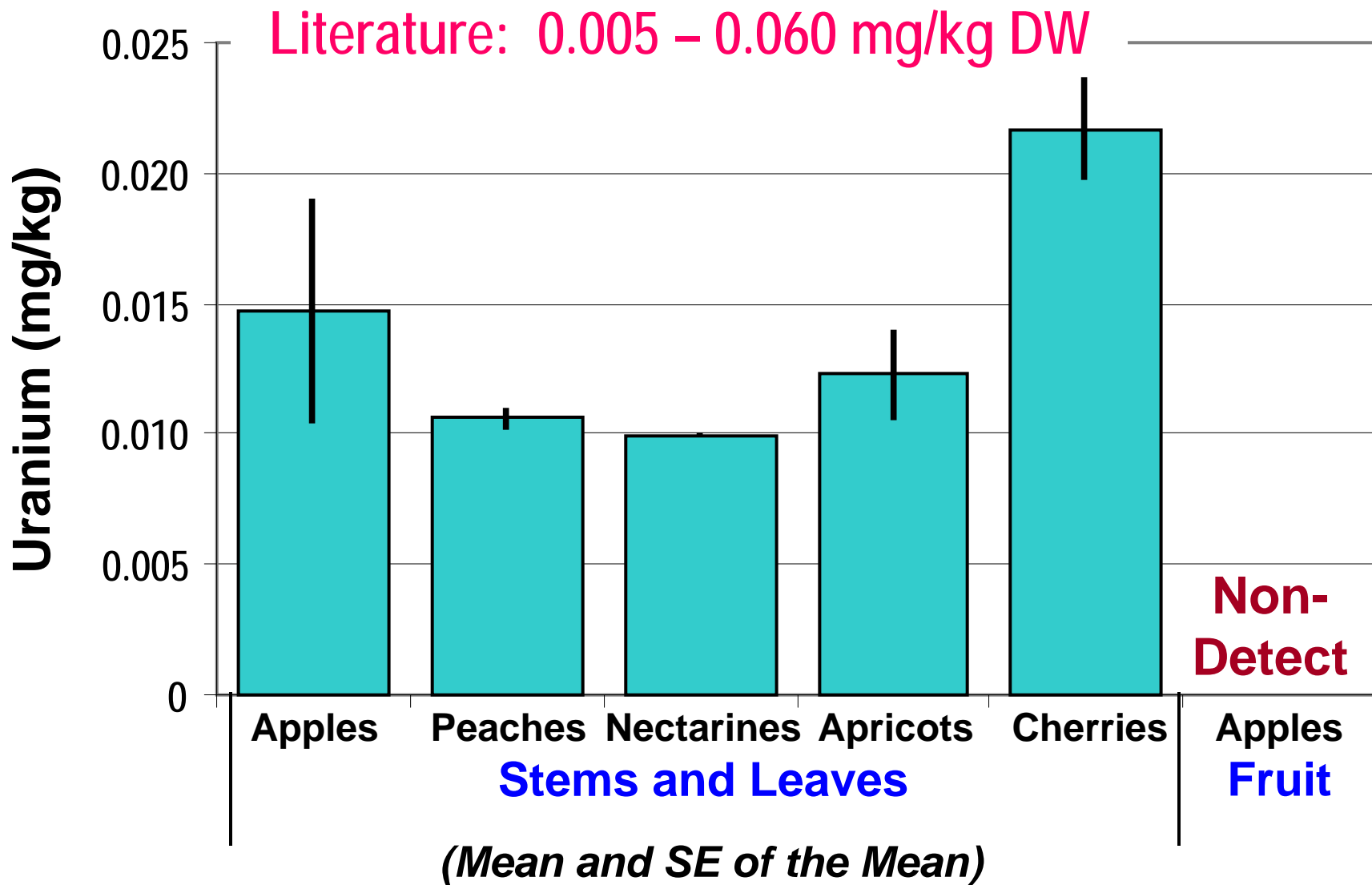


# Diné College Student Participation

- Bio-uptake study at the Diné College orchard



## Uranium: Diné College Orchard (mg/kg Plant Stems, Leaves, and Fruit – DW)





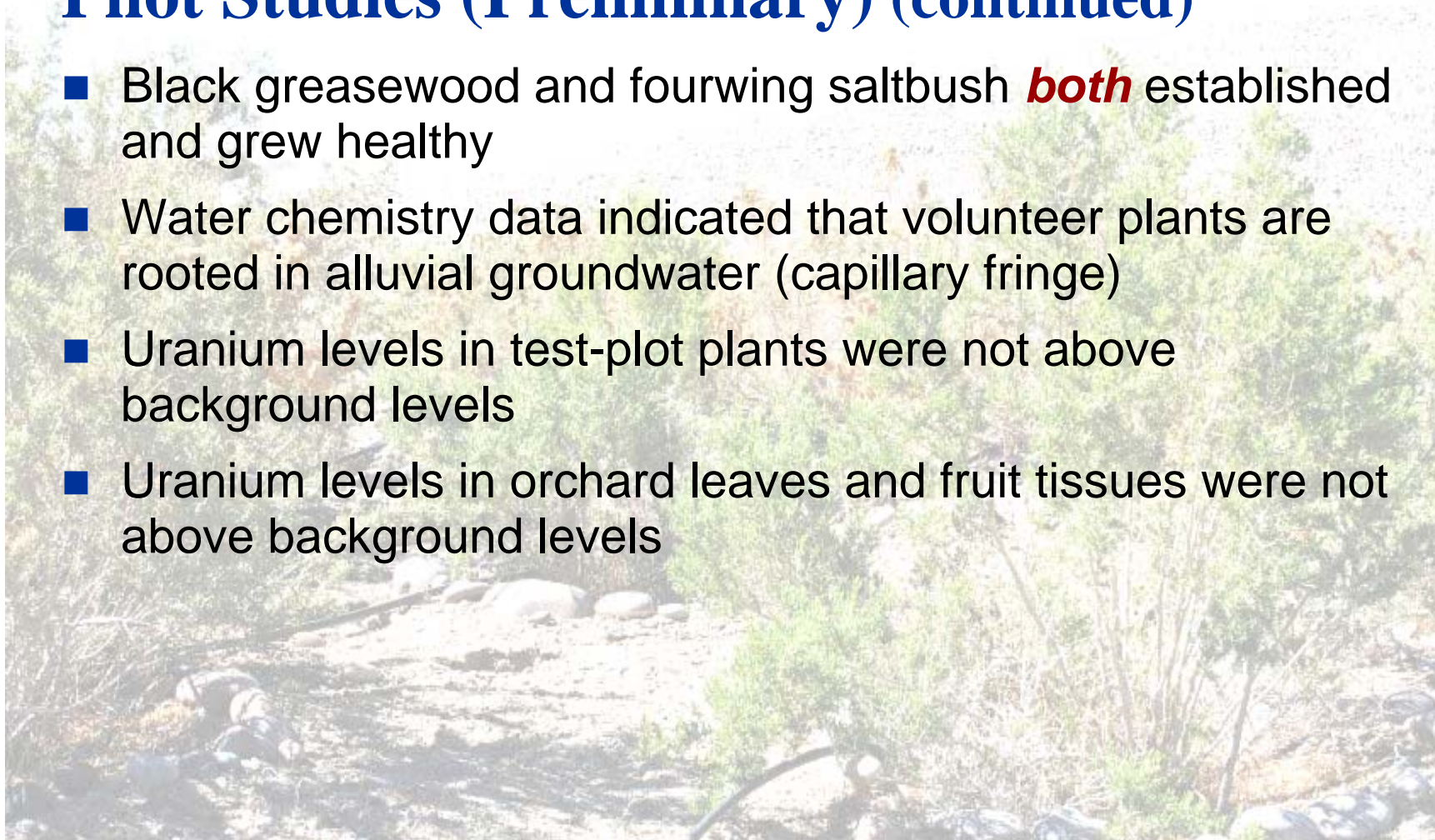
# Summary of Shiprock Phytoremediation Pilot Studies (Preliminary)





# 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



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**National Science Foundation Documentary**  
**Weaving STEM Education and Culture**

