Health Concerns of Chronic Ingestion of Uranium in Drinking Water

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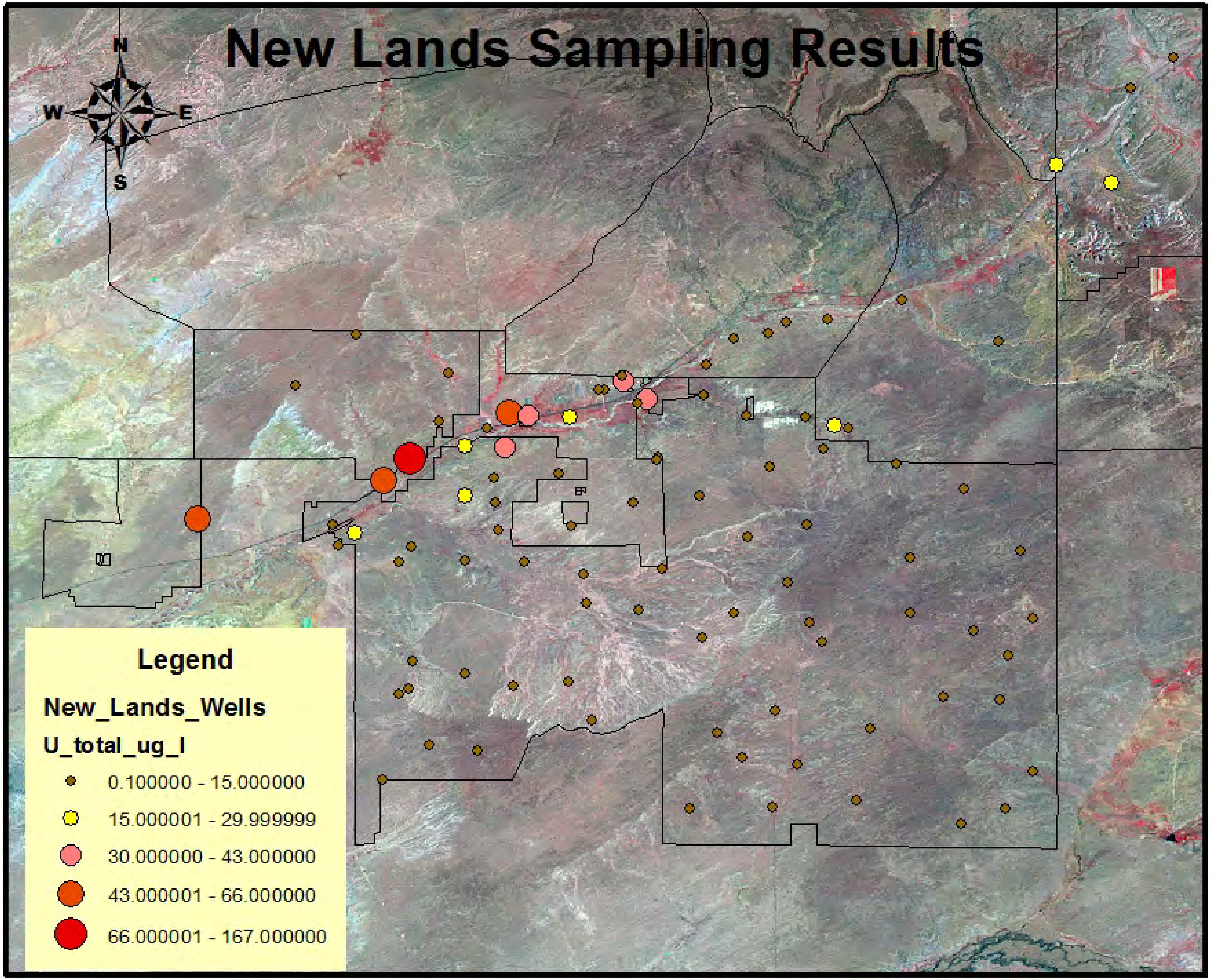
For Tó Łani Enterprises Puerco-LCR Water Quality Project

July 24, 2015
Nahata Dziil Commission Governance

Park Estates Subdivision, Sanders, AZ


New Lands Sampling Results
N
W
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U_total_ug_l
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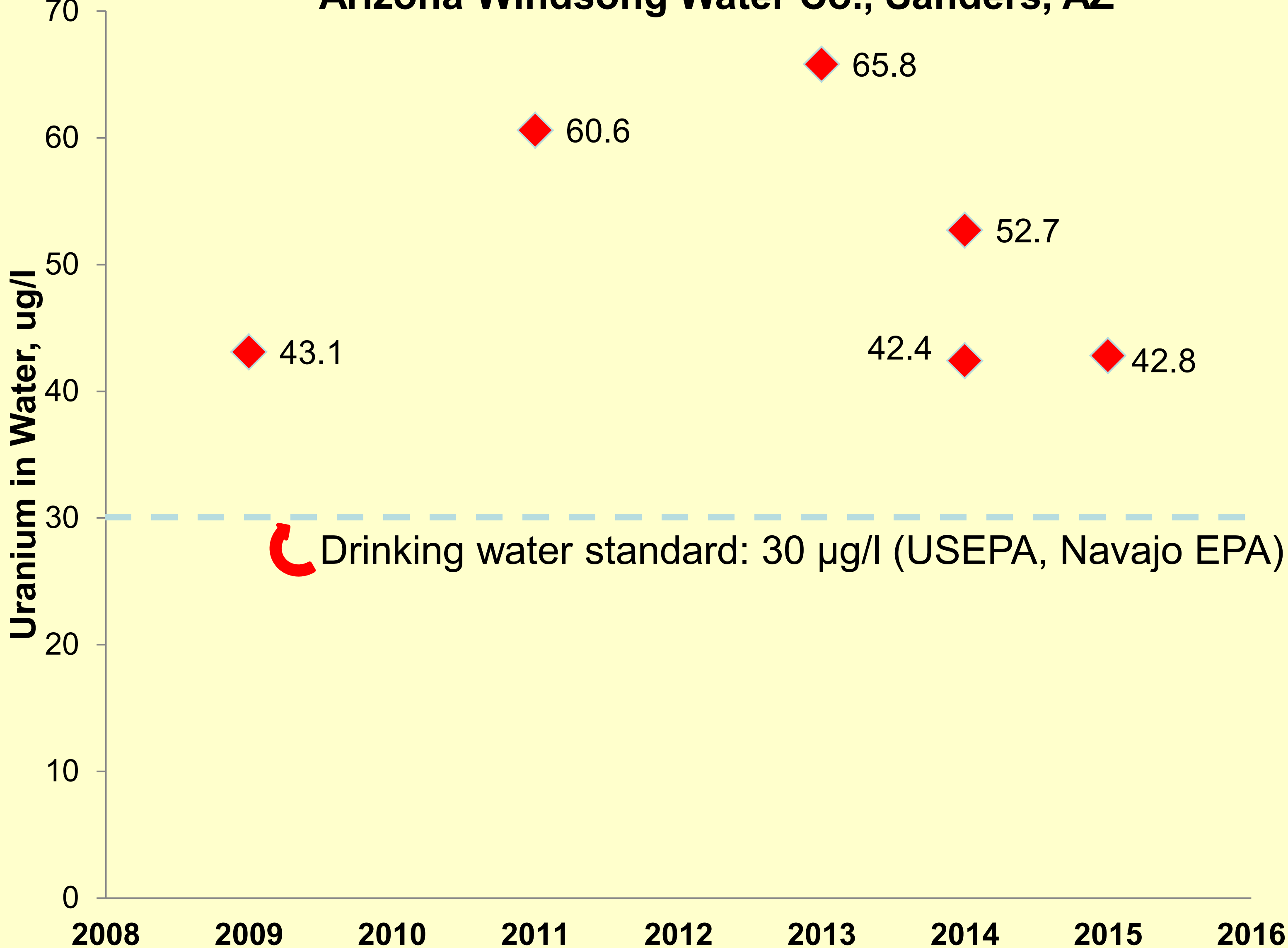
15.000001 - 29.999999
30.000000 - 43.000000
43.000001 - 66.000000
66.000001 - 167.000000

Uranium in Drinking Water (µg/l)

Arizona Windsong Water Co., Sanders, AZ



Sources: ADEQ 2008-2015 (http://azsdwis.azdeq.gov/DWW_EXT/JSP/WaterSystemDetail.jsp?tinwsys_is_number=9&tinwsys_st_code=AZ); Tolani Lake Enterprises, 2015.

DiNEH water quality statistics compared with USEPA data

(Concentrations in mg/l; Radium and Gross Alpha in pCi/l)

DiNEH* (2003-2010)

	MCL	N	Range	Mean ± SE	Med.
As	0.01	158	0-0.482	0.007±0.0399	0.00094
U	0.03	135	0-0.26	0.009±0.0286	0.00027
Se	0.05	157	0-1.0	0.014±0.082	0.0011
F	4.0	192	0-8.3	1.15±1.177	0.705
Ra	5.0	84	0-10.9	1.87±2.10	1.28
NO_2	1.0	118	0-7.5	0.131±0.694	0
NO_3	10.0	199	0-29.0	1.583±3.54	0.3
GA	15	26	0.3-21.7	5.15±5.012	3.99
Pb	.015	154	0-0.021	.0012±0.0028	0

*All water sources in 20 chapters of Eastern Agency
GA = Gross alpha radioactivity

USACE-USEPA* (1994-2000)

	MCL	N	Range	Mean ± SE	Med.
As	0.01	222	0-0.282	0.009±0.028	0.0028
U	0.03	222	0-0.286	0.0198±0.039	0.0076
Se	0.05	222	0-0.957	0.0094±0.07	0
Ra	5.0	222	0-8.2	0.56±1.7	0.6
GA	15.0	222	0-155	11.5±21.98	4.4
Pb	0.015	222	0.0.1	0.0029±0.012	0
Al**	0.05-2.0	222	0.61.9	0.84±4.8	0.08

*All water sources located in the western half of the Navajo Nation in Arizona and Utah
**Aluminum has no MCL; the reference range given is the secondary drinking water standard
GA = Gross alpha radioactivity

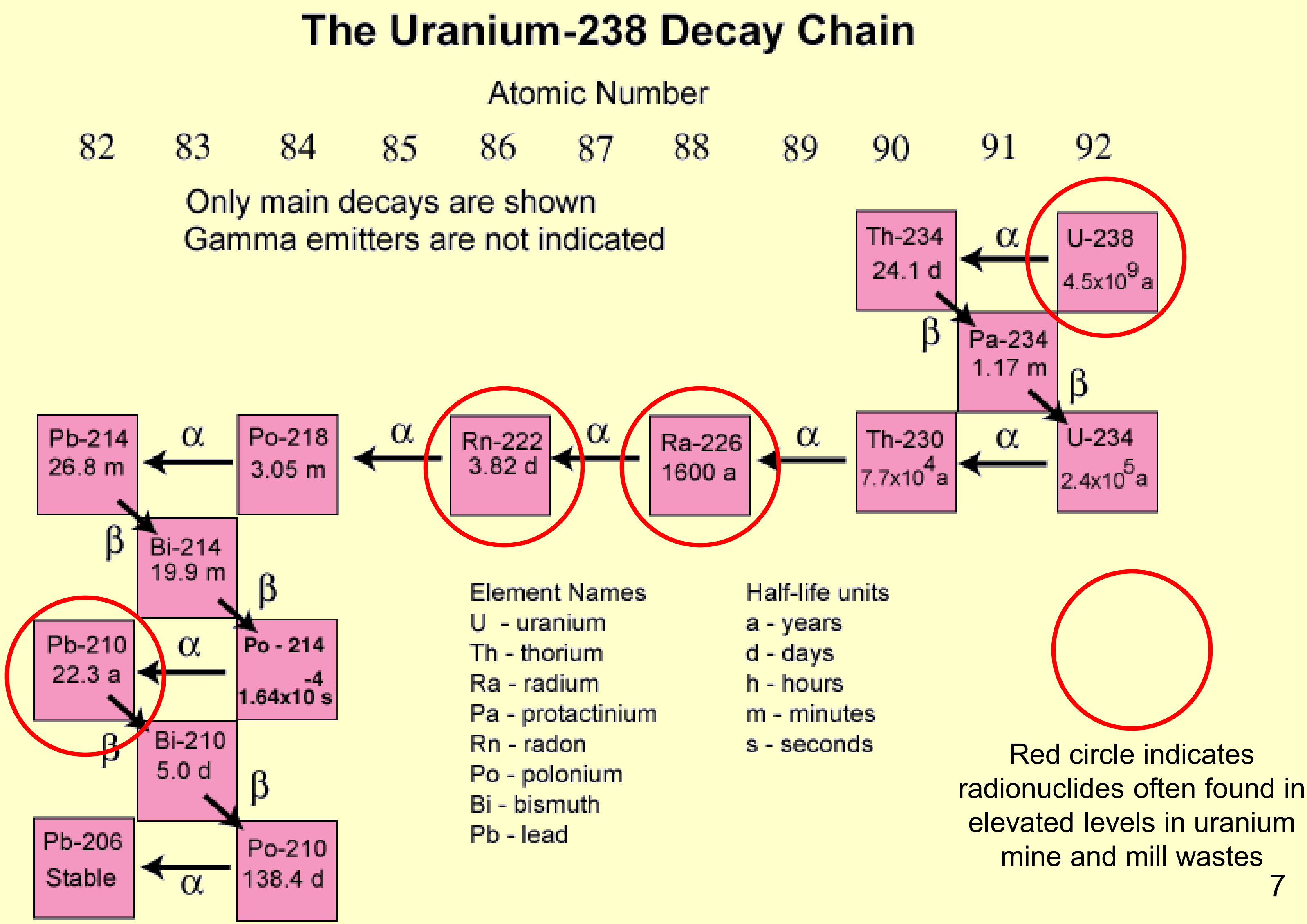
The Basics of Uranium

(*Łeetso,* or "yellow dirt", may <u>not</u> be accurate)

- Discovered in Russia in 1789
- A heavy metal — the heaviest natural element (No. 92)
- Abundance about 0.5-5 ppm (0.00005%-0.0005%) in the continental crust (1000x more abundant than gold)
  - Carnotite, most common uranium mineral
  - Yellow flecks or streaks in gray-black matrix

- A mixture of three different weights of atoms, called isotopes:
  - U-238 (99.3%), U-235 (0.7%), U-234 (<0.05%)
- U is radioactive (its atoms spontaneously decay, releasing energy as a new element is formed)
- Primary uses:
  - 1940s-1960s: fissile material for nuclear weapons
  - 1960s – present: fuel for nuclear power
  - 1980s – present: metal casings for field ordnance

What are the elements that result from the decay of uranium, and what types of radiation do they emit?

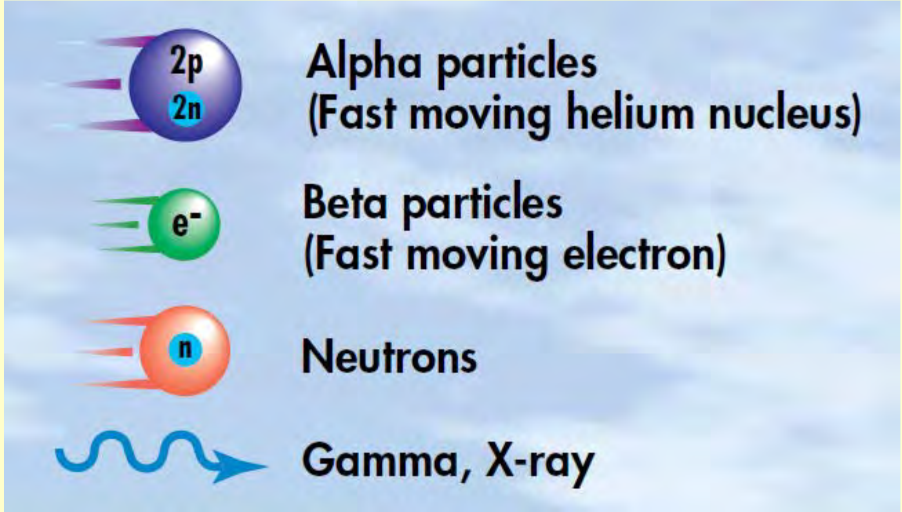


Father Sky-Mother Earth Interaction:

Types of Radiation

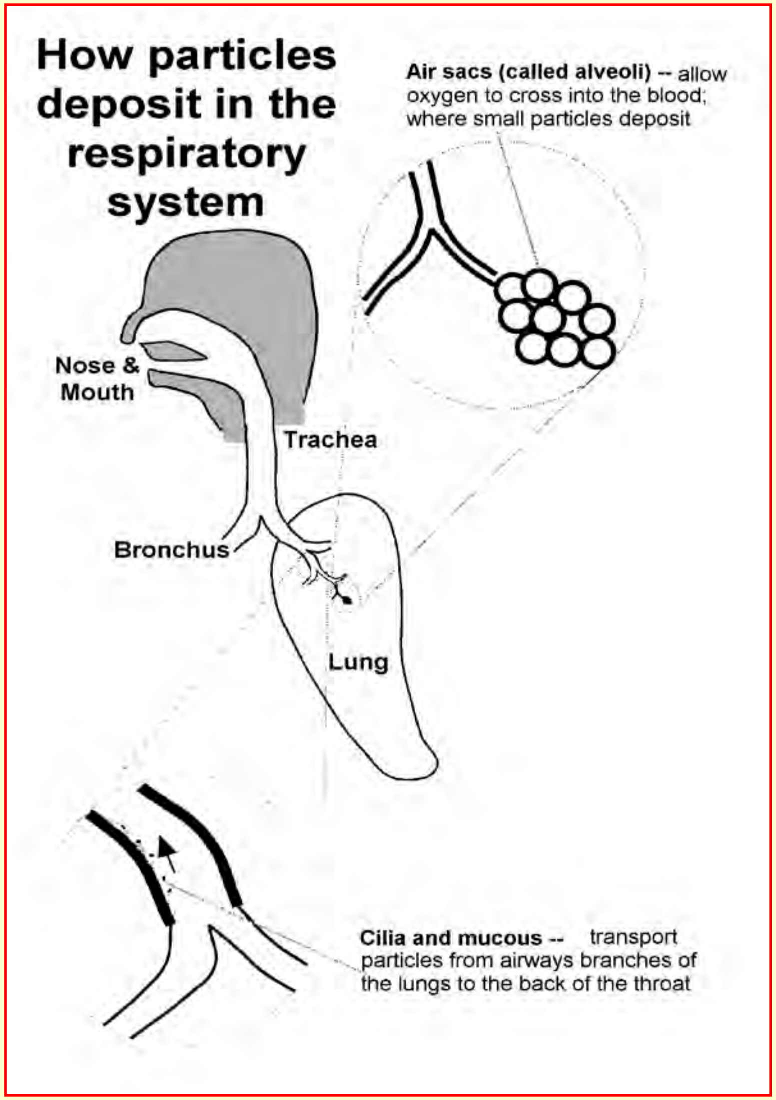
- Radiation: Energy that travels through space in the form of particles or waves
- *Non-ionizing radiation*
  - Light, heat, microwaves and radio waves

- *Ionizing radiation* (Greek symbol): energy sufficient to remove an electron from an atom or molecule
  - alpha (α) particles
  - beta (β) particles
  - neutrons
  - gamma (γ) rays (photons)



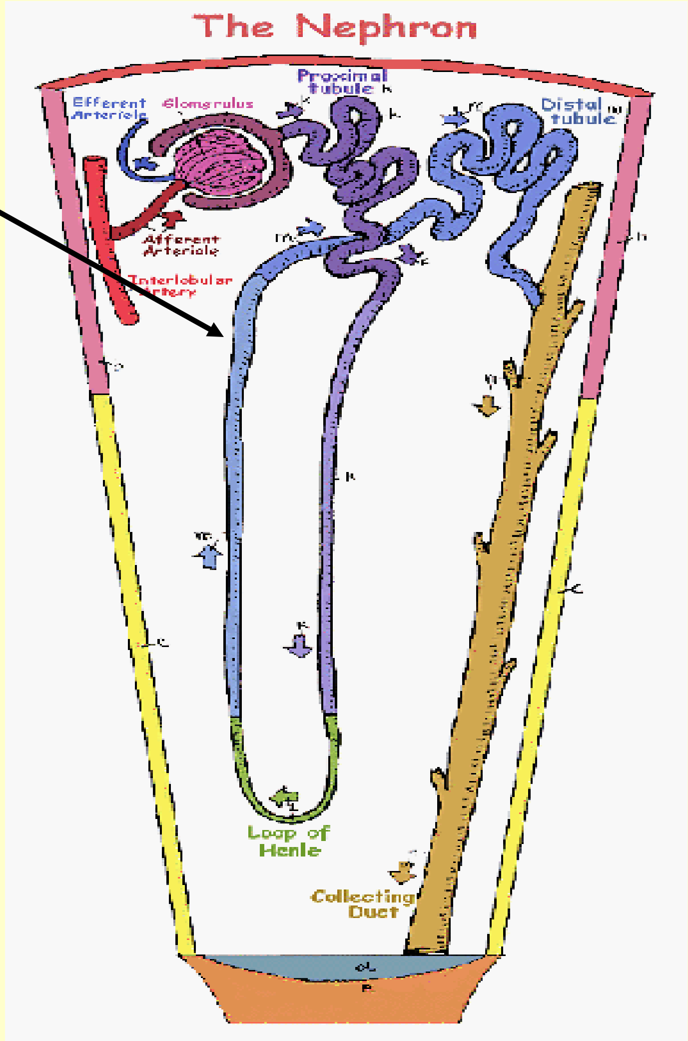
How Does Uranium Get In You?

- *Inhalation* — breathing uranium in air
  - in mines and mills, hauling ore (workers)
  - living around mine waste dumps
  - dust and erosion from rocks
- *Ingestion* — eating and drinking substances that contain uranium
  - drinking water: most important pathway (about 80%)
  - eating animals, plants

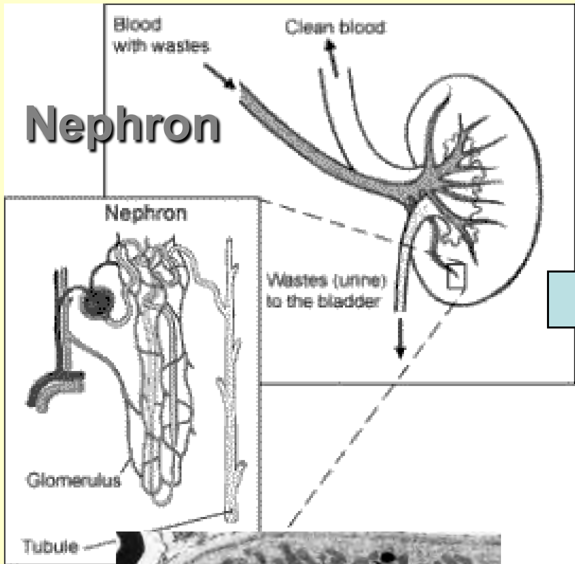


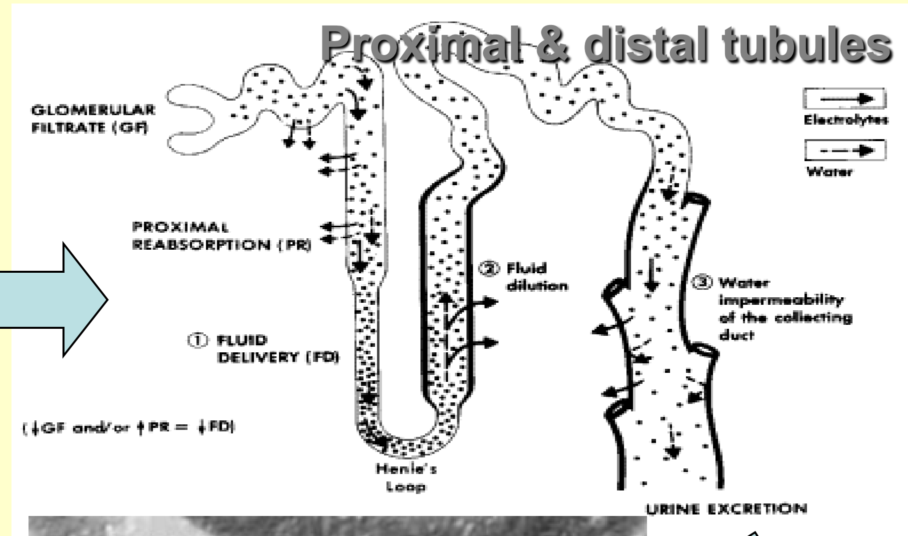
Why is Uranium Harmful?

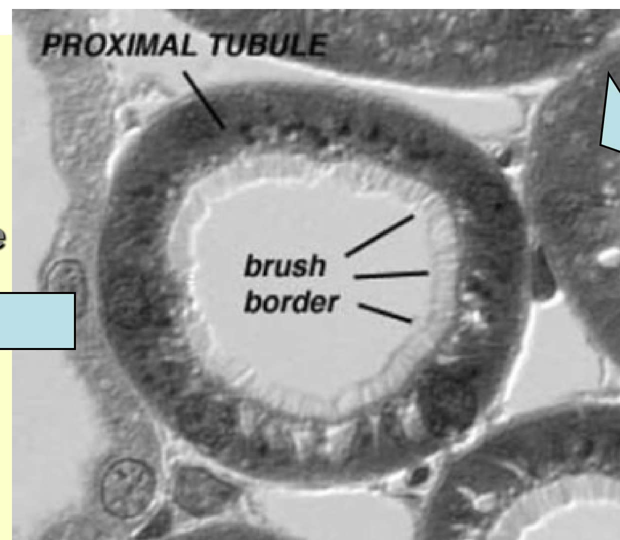
- **Chemical toxicant:** causes kidney damage, disease (proximal tubules)
- **Radiotoxicity:** causes lung and bone cancers from radioactive decay products
- Dozens of scientific, medical studies over last 125 years
- Studies of human populations exposed to *low levels* of uranium in drinking water

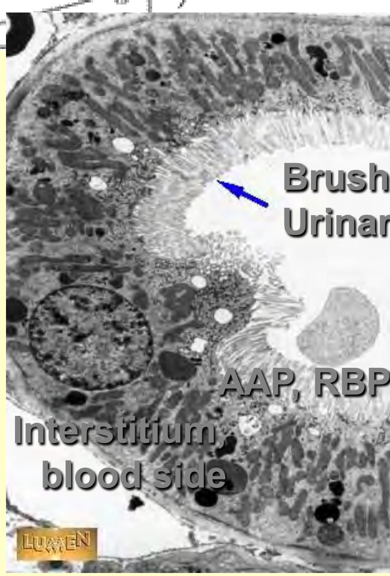


Sites of Uranium Toxicity to the Kidney*: Proximal Tubules







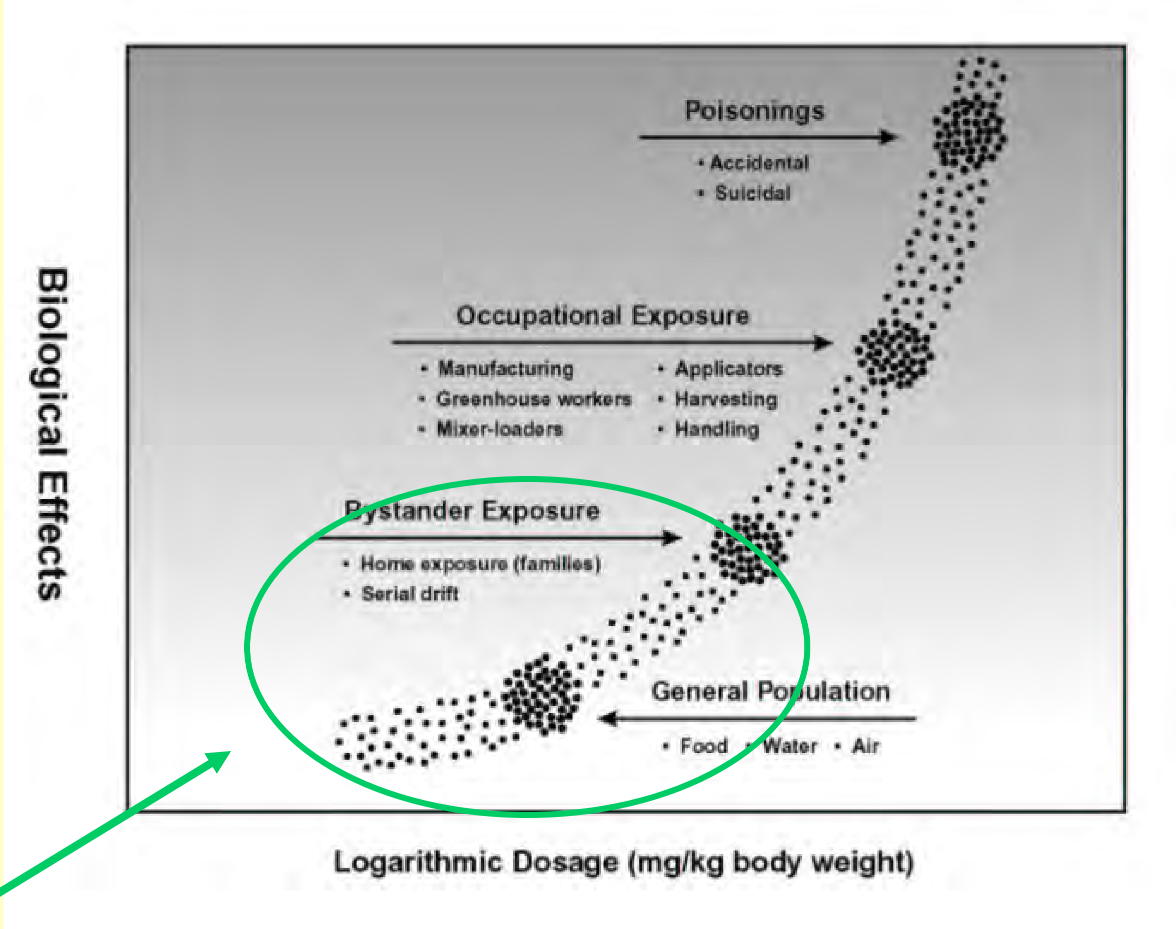


***Kidney toxicity based on animal, human studies of uranium ingestion through water; LOAEL = ~14.5 ug/l-water.**

Exposure continuum

←Chronic ------------------------------ Acute →

(long-term, over time) (immediate effects)



- Generally, lower dose → less risk

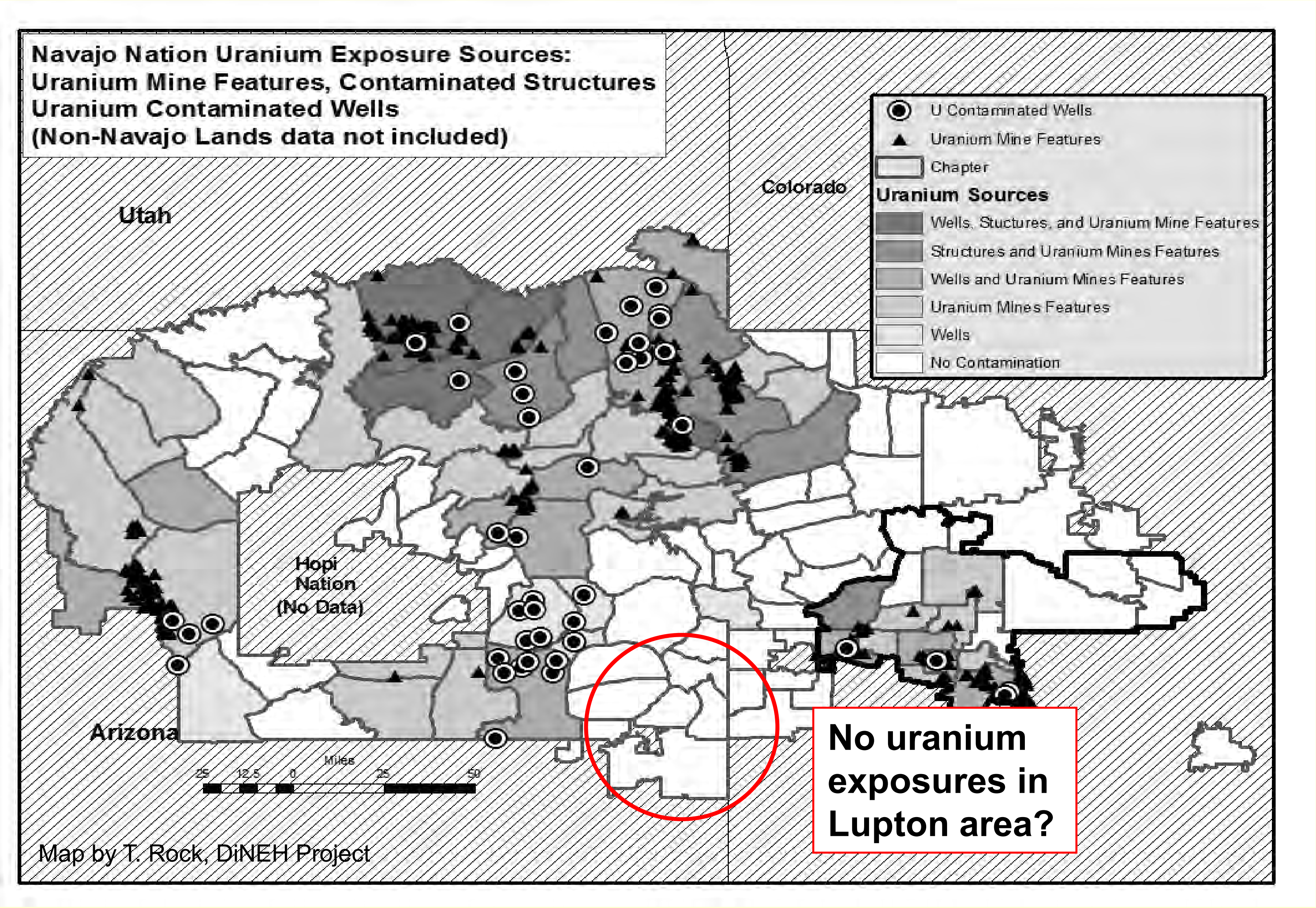
However,

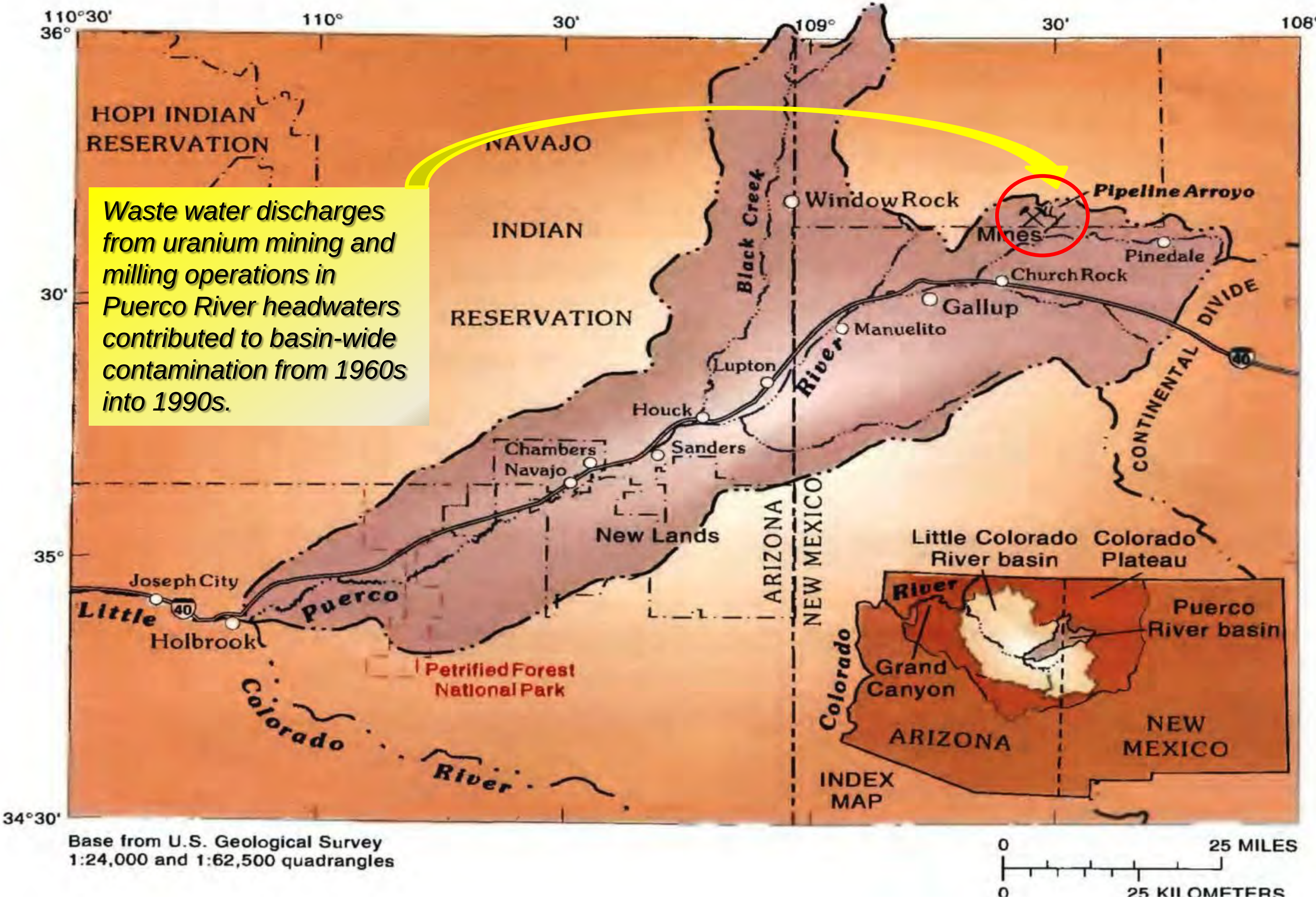
- *Low concentration over longer exposure time → higher cumulative dose, greater risk*

Most of the environmental exposures we see in human uranium studies are in the chronic, low-dose region

Community Exposures to Uranium

About half of all Navajo Chapters have 1 or more uranium exposure sources





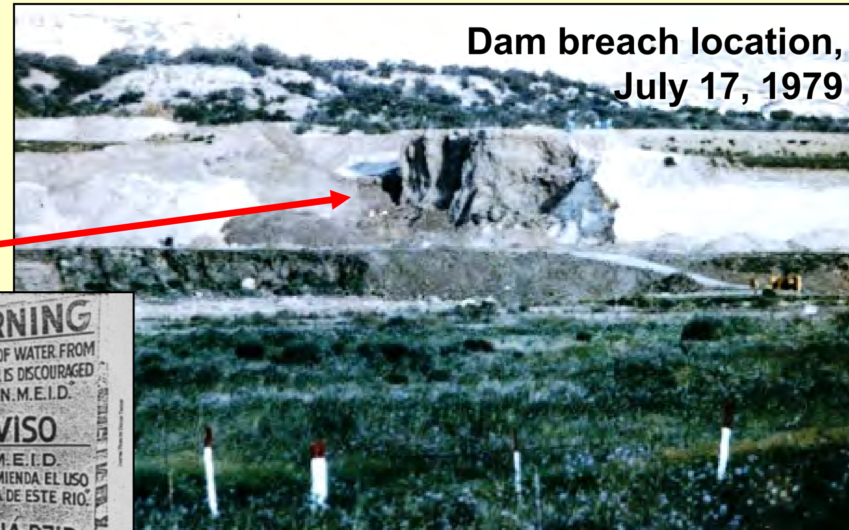
Puerco River Basin, New Mexico and Arizona. USGS WRI 94-4192, p. 4.

Puerco River Contaminant Source:

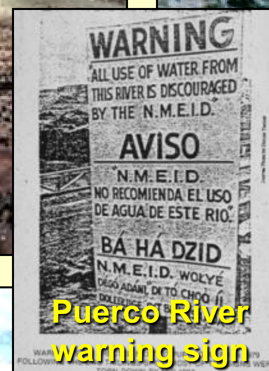
Church Rock Uranium Mill Tailings Spill,* July 16, 1979

***Largest release of radioactive wastes, by volume, in US history**

United Nuclear Corp. Uranium Mill Tailings Dam, July 16, 1979



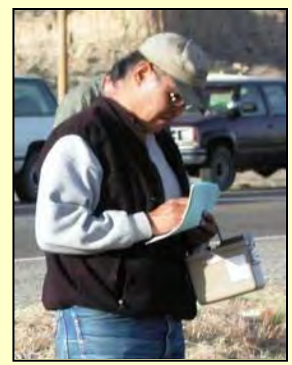
Dam breach location, July 17, 1979



Puerco River warning sign

NMEID Sampling in Puerco R. after spill

Livestock tracks in Puerco River downstream of spill, July 17, 1979



Community leaders Larry J. King (L) and Robinson Kelly addressed long-term impacts of spill in 2009.

Photos courtesy of Southwest Research and Information Center, New Mexico Environmental Improvement Division, Albuquerque Journal.

Northeast Church Rock Mine and Red Water Pond Road Community, 1972-2009

Mine water discharges to Pipeline Arroyo, 1969-1983: More radioactivity released to Puerco River system by mine dewatering than 1979 tailings spill.

Father Sky-Mother Earth Interaction:

When removed from *Nik'ashbááh*, uranium is oxidized and moves rapidly in water

U^{+4} — in most undisturbed rocks and groundwater, insoluble

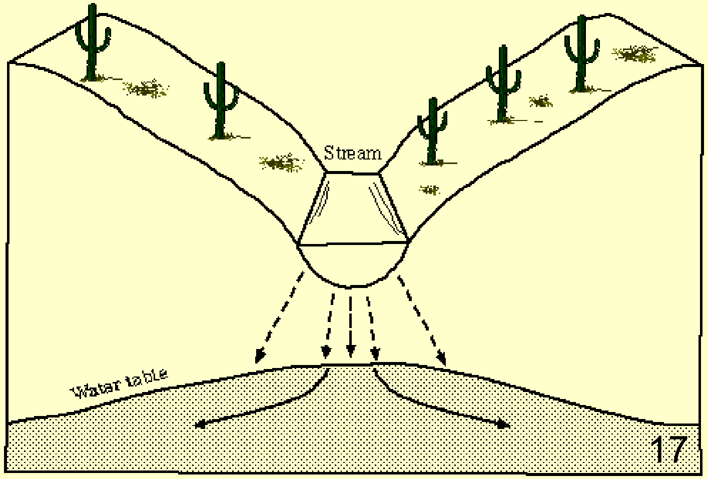
U^{+6} — when brought to the surface and exposed to oxygen in the air, highly soluble

Solubility

Does it dissolve slowly or quickly?

Transport:

Where does it go?



Modified from slide by J. deLemos, 2007

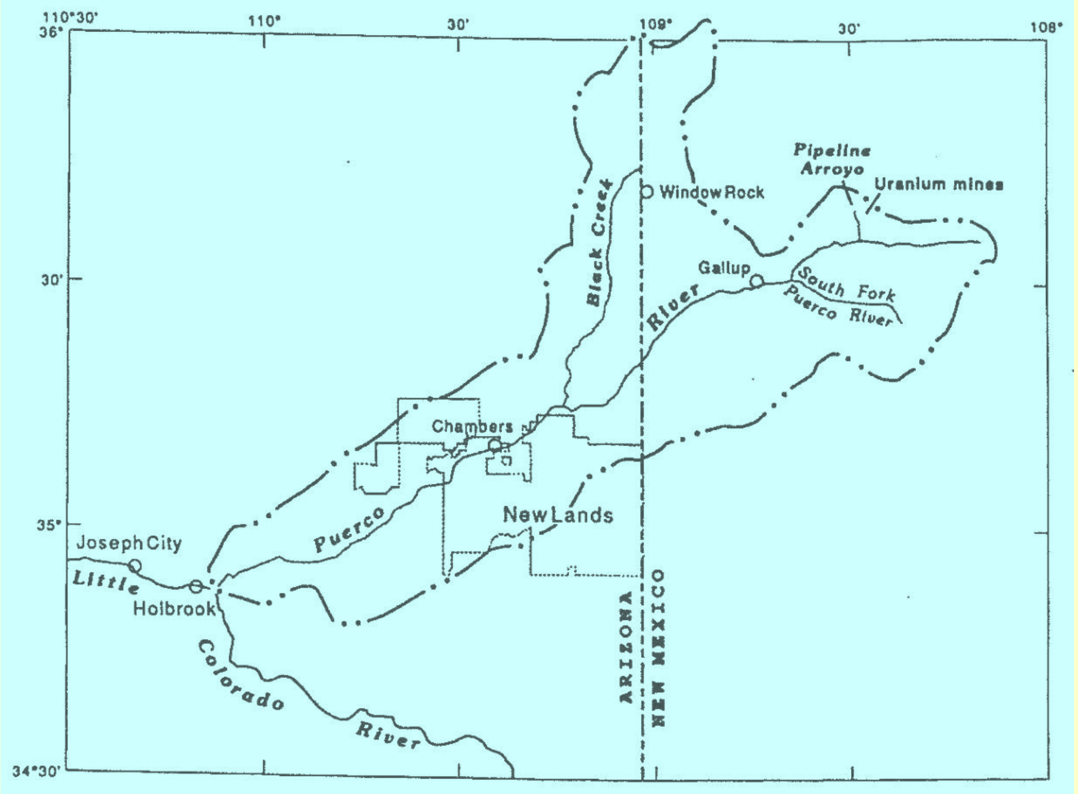
Historic Contaminant Discharges to Puerco River

(from Shuey, 1992)

- **20+ years of discharge of uranium mine water**
  - 450 gpm in 1963 to 5,200 gpm in 1982
  - Wirt (USGS, 1994): "effects of uranium mining can no longer be identified in water and sediment samples from the Puerco or Little Colorado rivers"
- **1979 Church Rock Uranium Mill Tailings spill**
  - 94 million gallons; pH = 1.5; one-time "shock loading"
- **Gallup Wastewater Treatment Plant (1958-present)**
  - 6.1 million gallon release of raw sewage in 1988
  - 2.4 million gallons treated effluent per day since 1989
- **Natural runoff**
  - Wirt: "high sediment concentrations cause streamflow to exceed Federal standards for radioactive…and nonradioactive elements"

So where did the uranium go?

Our results suggest that the low sediment uranium concentrations likely resulted from the dissolution and flushing of uranium during precipitation events. Surficial, weathered sediments are depleted of more soluble uranyl phases <u>relative to deeper (>~20 cm) sediments.</u>



Source: J. DeLemos, et al. Rapid Dissolution of Soluble Uranyl Phases in Arid, Mine-Impacted Catchments near Church Rock, NM. *EST*, 2008.

1st Law of Thermodynamics, “Conservation of Energy,” suggests that uranium and other contaminants are concentrated *somewhere* in the Puerco-LCR system.

What are Options for Bringing Clean Water To Park Estates Subdivision?

- Haul in water from clean sources
  - National Guard?
  - NNDWR water trucks
- Buy bottled water
- Ask NTUA to connect its system
- Drill new well