

Secondary Uranium Sources and Release Along Contaminant Flow Paths: Shiprock, New Mexico, Disposal Cell

Dr. Charles Doc Richardson

RSI

Contractor to the U.S. Department of Energy (DOE)
Office of Legacy Management (LM)

Battelle

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25 minutes total: 18 min. (presentation) + 5 min. (Q&A) + 2 min. (transition to next speaker)



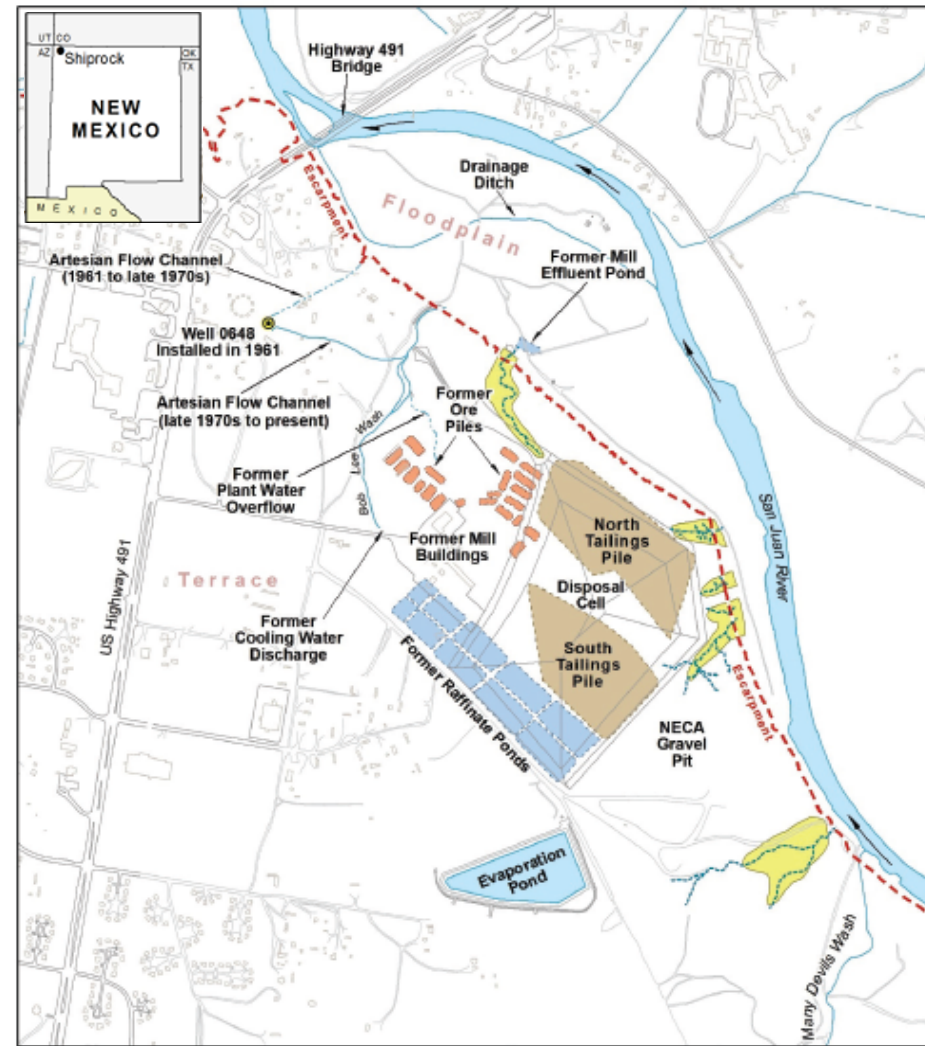
Scope and Outline

- Site overview
- Conceptual contaminant transport
- Dissolved uranium distribution
- Solid-phase depth profiles
- Uranium release properties



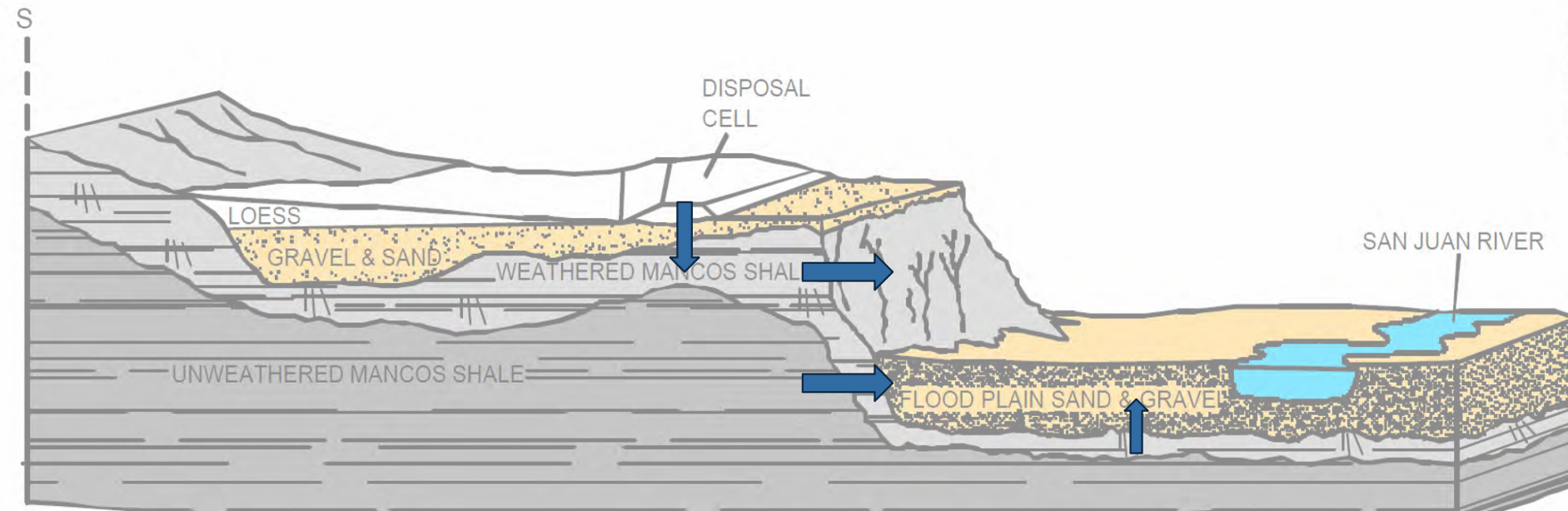
Site Overview

- Located on the Navajo Nation
- Managed by DOE-LM
- Uranium and vanadium mill site (1954-1968)
- Infiltration of contaminated liquids likely occurred between 1954 and 1986 (completion of surface remediation)
- Disposal cell located along 60-foot-high escarpment separating the terrace from the floodplain



Contaminant Flow Paths at Terrace

- Tailings seepage migrated horizontally within permeable alluvium, weathered Mancos shale
- Discharge is directed at alluvium/Mancos shale contact, seeps, buried arroyos
- Represents significant pathways that are focused along escarpment on floodplain



Geology and Physical Properties

Alluvium

- Unconsolidated loess and alluvium
- ~10-20 ft bgs
- Variable saturated thickness

Mancos Shale (transmissive)

- ~5-10 ft weathered zone, bedding plane separations
- Overlying low-permeable competent shale
- Impermeable, thin siltstone marker bed

Buried Arroyos

- Located along terrace escarpment
- Consists of material from ore storage area
- Silty clay to sandy gravel



Dissolved Uranium Plume

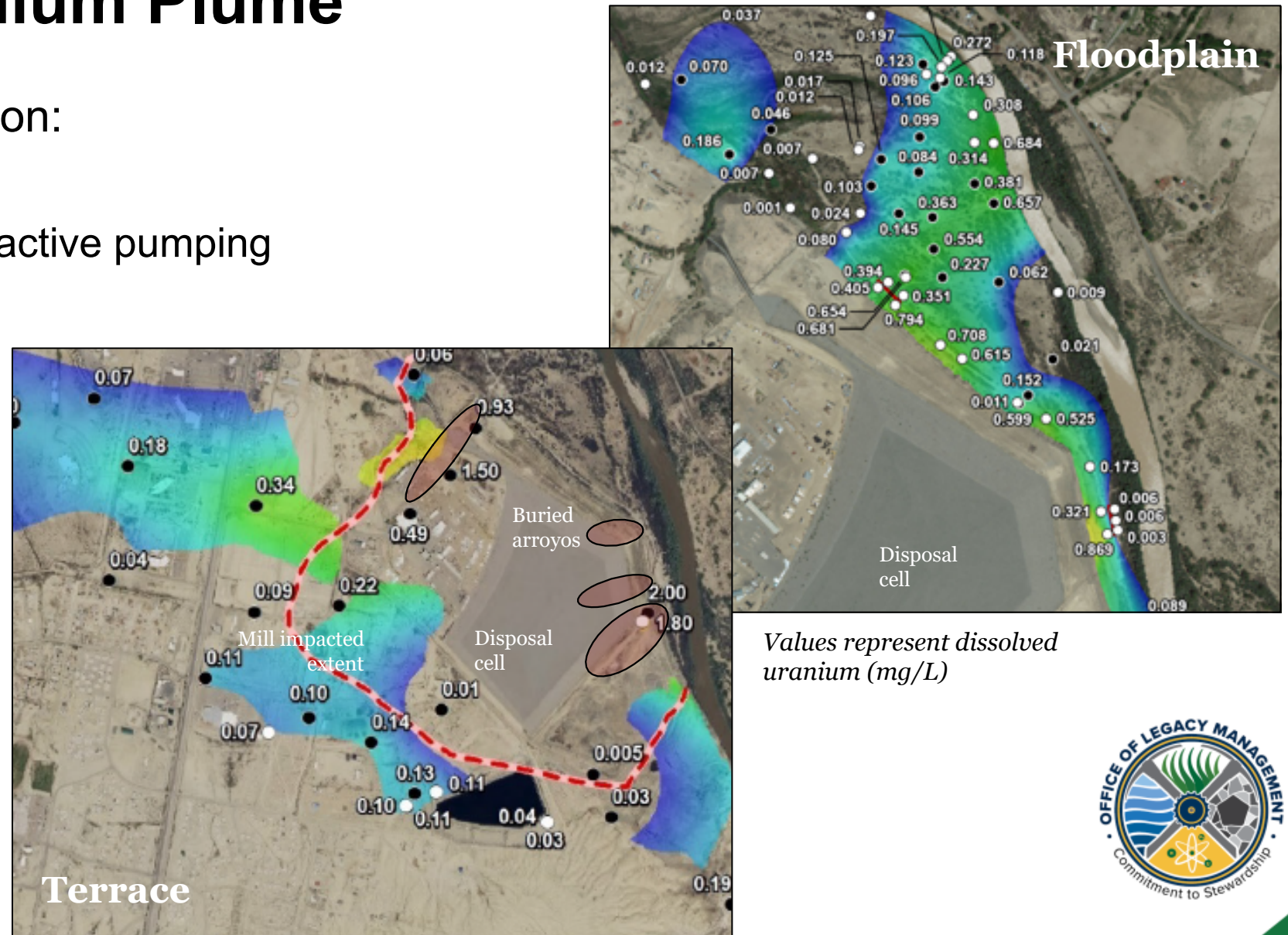
Dissolved uranium distribution:

- Terrace

- Lowered water table by active pumping
- Mill impacted extent
- Beneath buried arroyos

- Floodplain

- Below escarpment
- Along river



Field Campaign — Secondary Contaminant Sources

- Distribution and geologic heterogeneity
- Determine susceptibility of contaminant uptake versus release
- Volumetric/mass calculations by 3D interpolation
- Input parameters for reactive transport modeling for remedial strategy



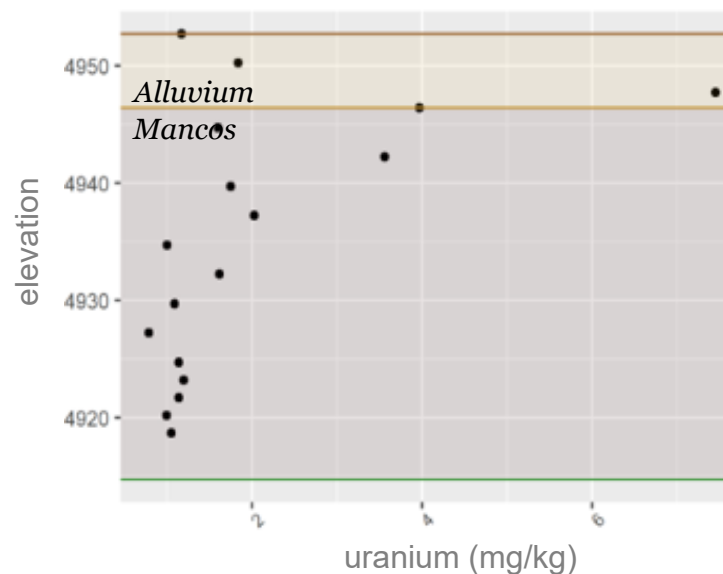
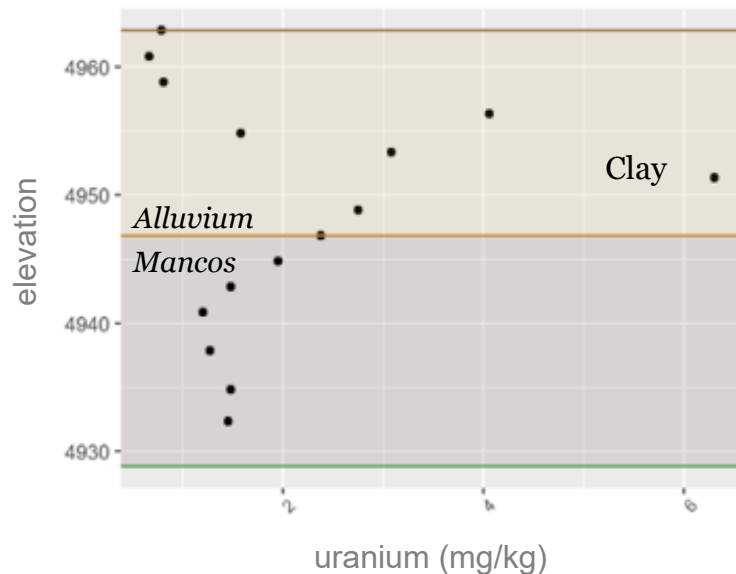
Secondary Source Distribution Near Disposal Cell

Alluvium

- Clay zones
- At Km-Qal contact

Mancos shale

- Low concentrations, near naturally-occurring background



Alluvium background ~ 1 mg/kg
Mancos background ~ 2-3 mg/kg

*Future drilling campaign
through and below disposal cell*



Secondary Source Distribution at Alluvium/Arroyos

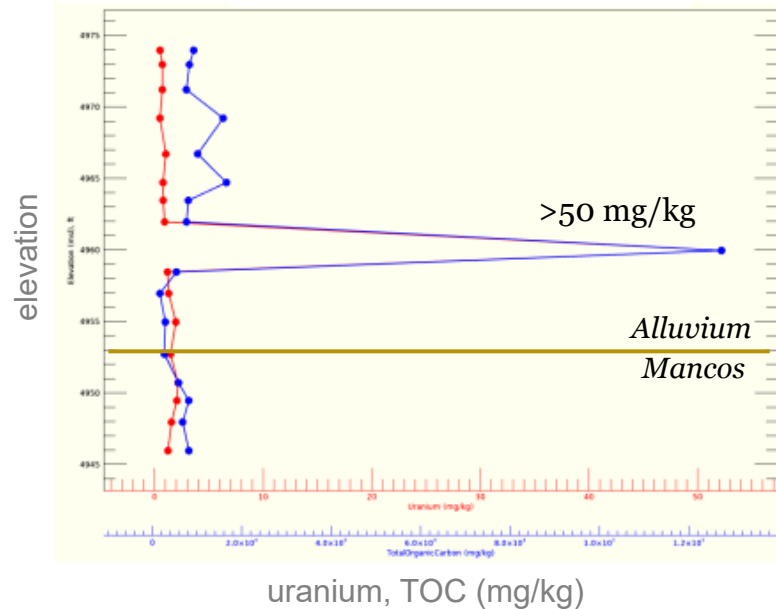
Heterogenous distributed

- Clay zones
- Iron oxide
- Organic matter
- At Km-Qal contact

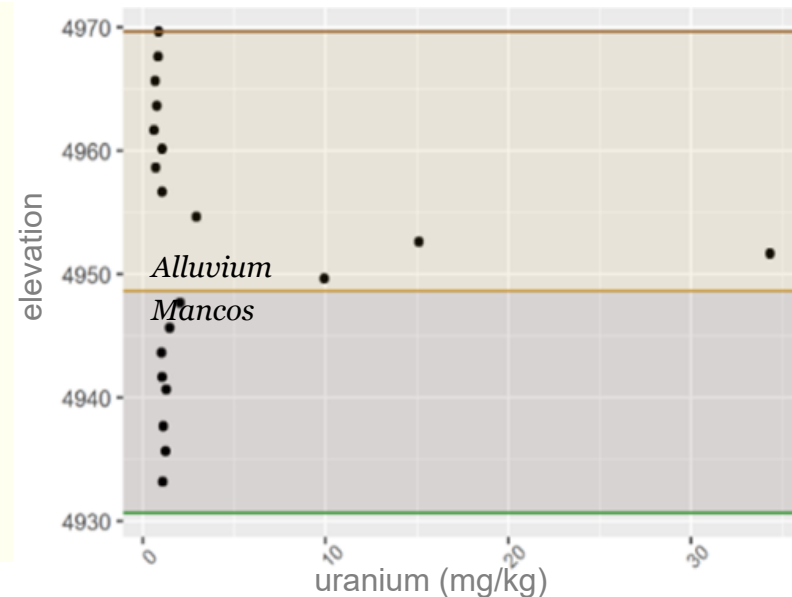


background ~ 1
mg/kg

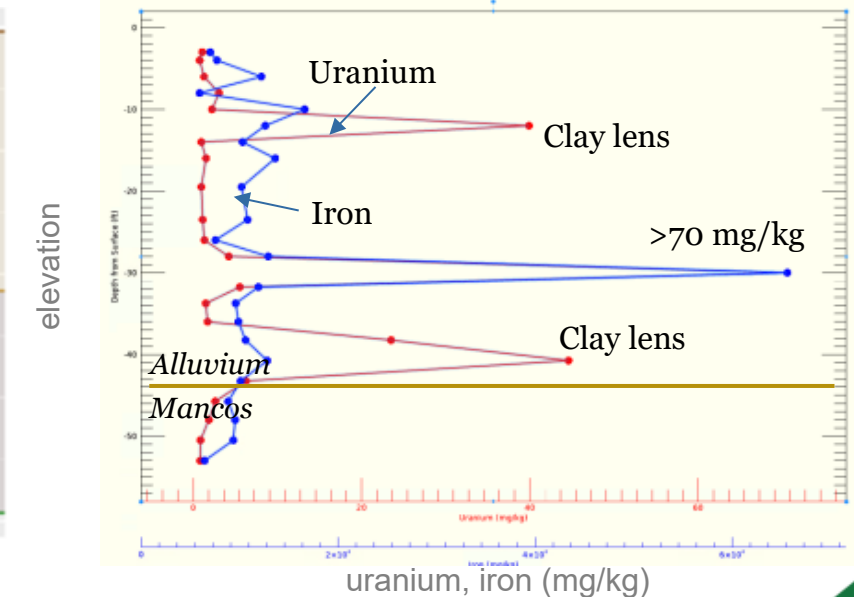
Organic Matter



Km-Qal Contact



Clay and Fe



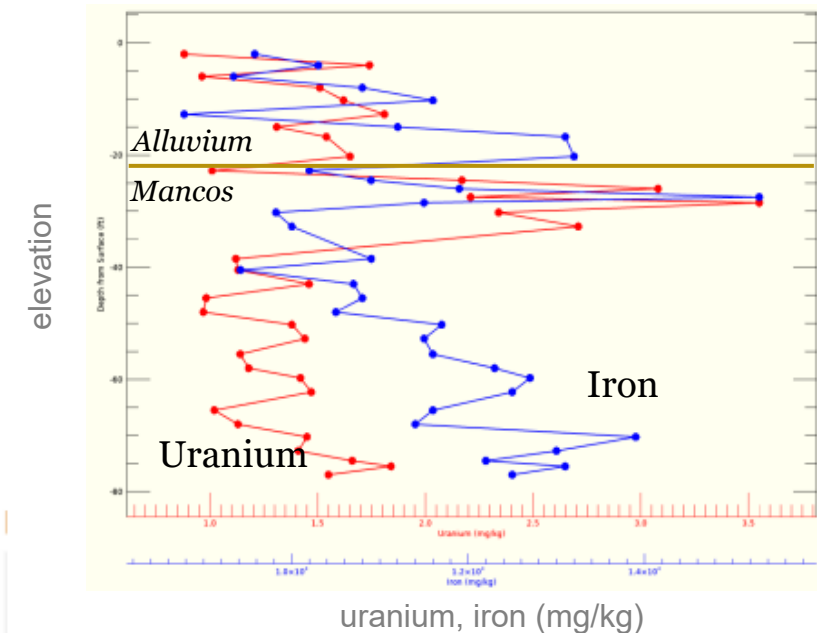
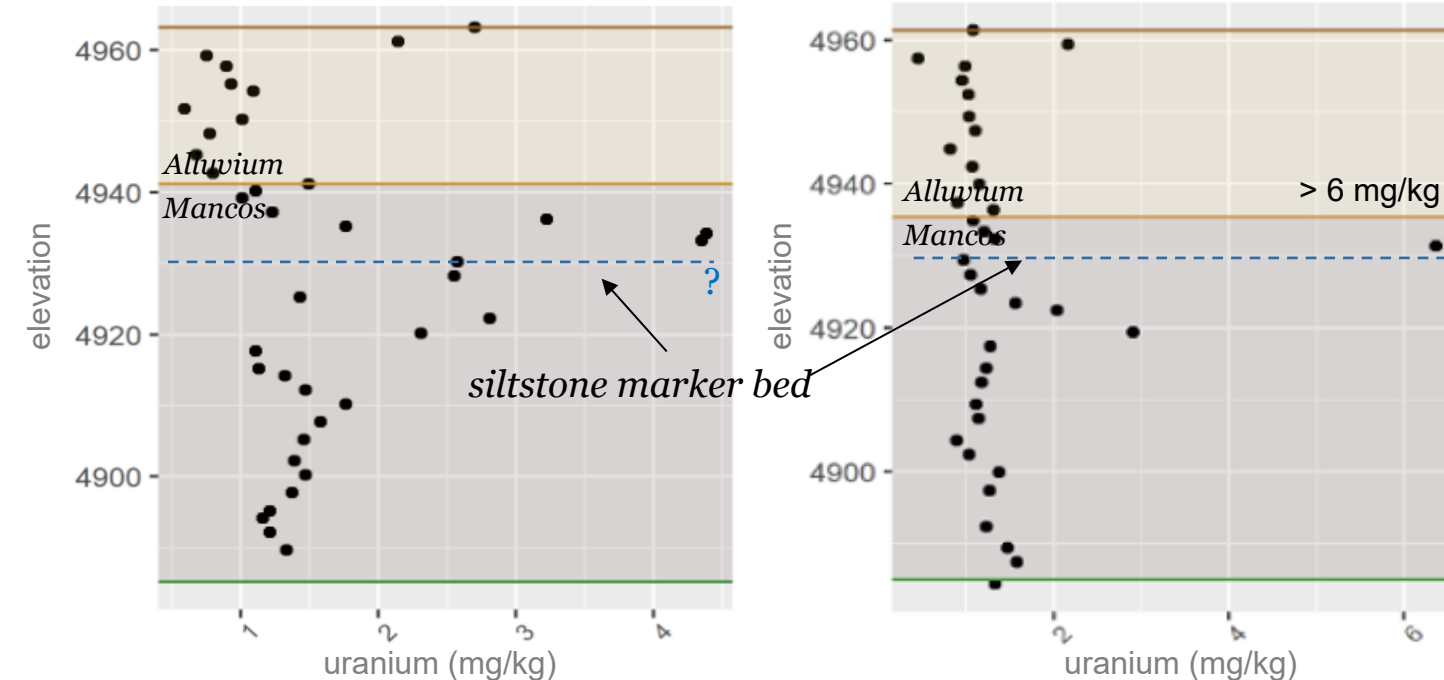
Secondary Source Distribution in Mancos Shale

Heterogeneous distributed

- Above siltstone marker bed contact
- Iron-oxide
- Naturally-occurring



Background ~ 2-3
mg/kg



Visualization and Mass Estimates

- Utilize 3D software for spatial extent
- Quantify mass estimates of contaminants and constituents that control contaminant mobility

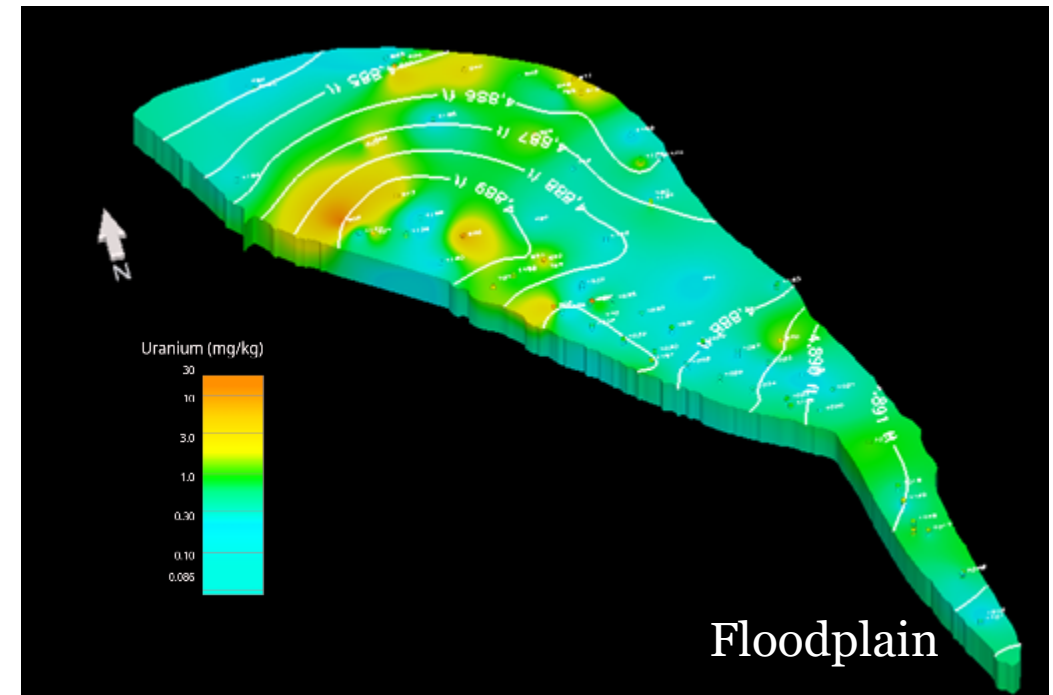
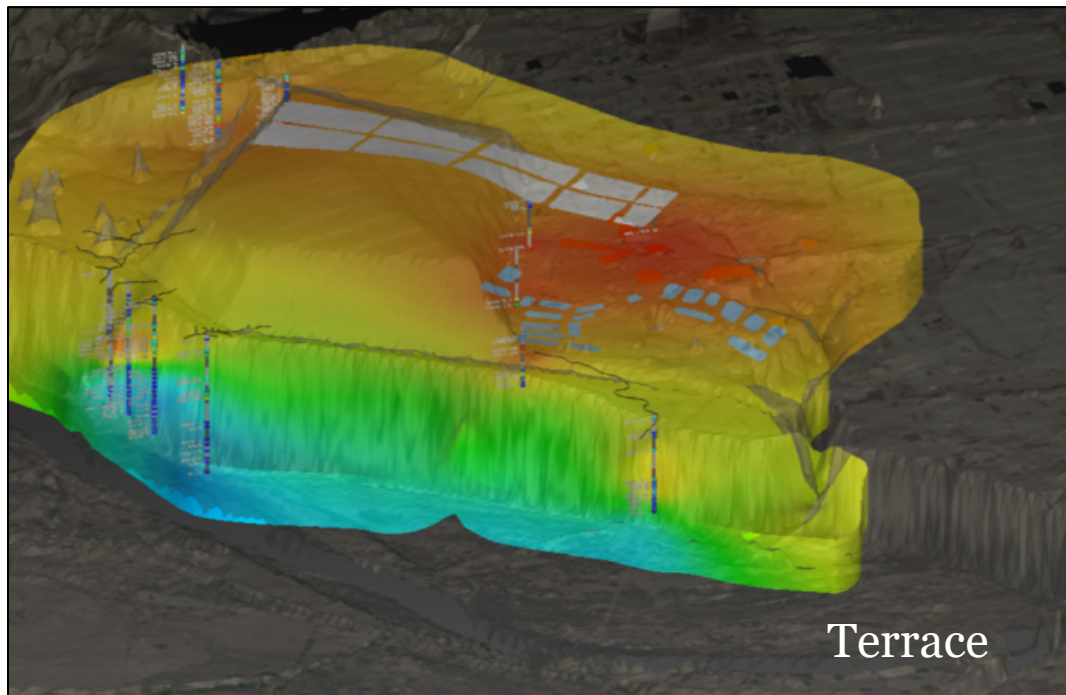
Floodplain

Unsaturated zone:

- Total mass ~ 7,500 kg
- Average ~ 1.9 mg/kg

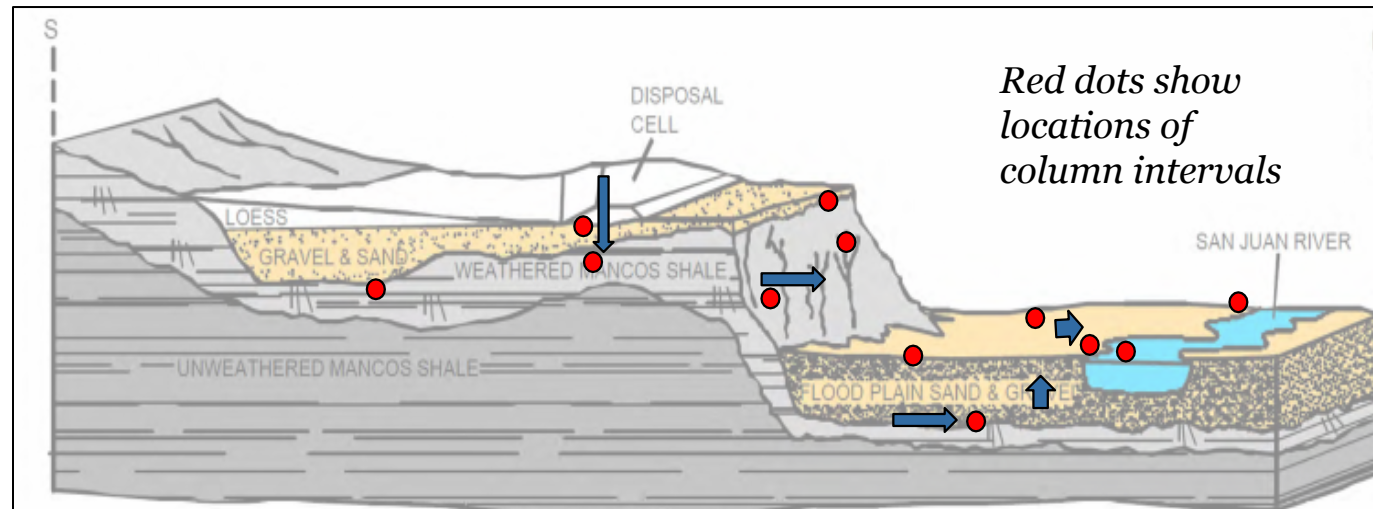
Saturated zone:

- Total mass ~ 2,700 kg
- Average ~ 2.2 mg/kg



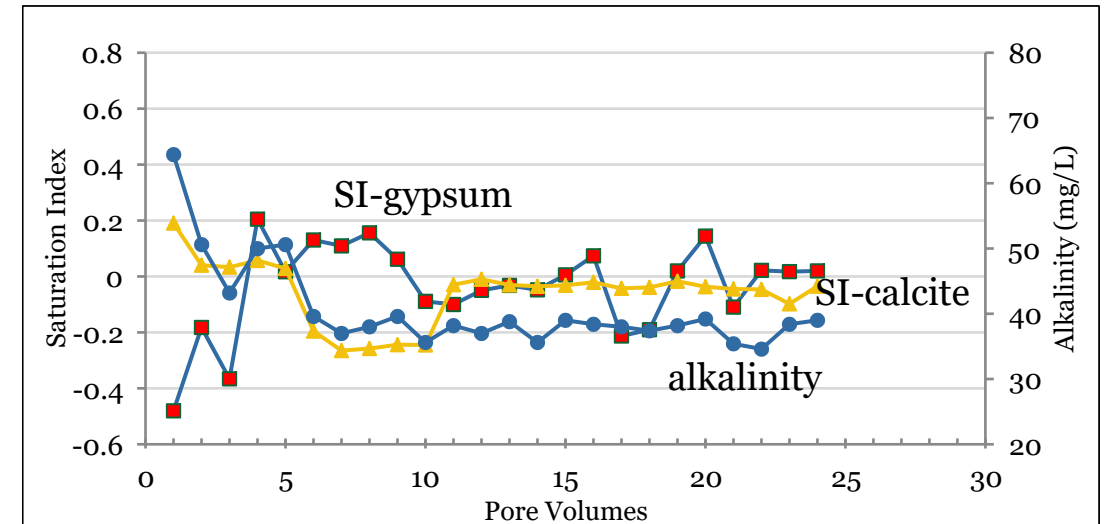
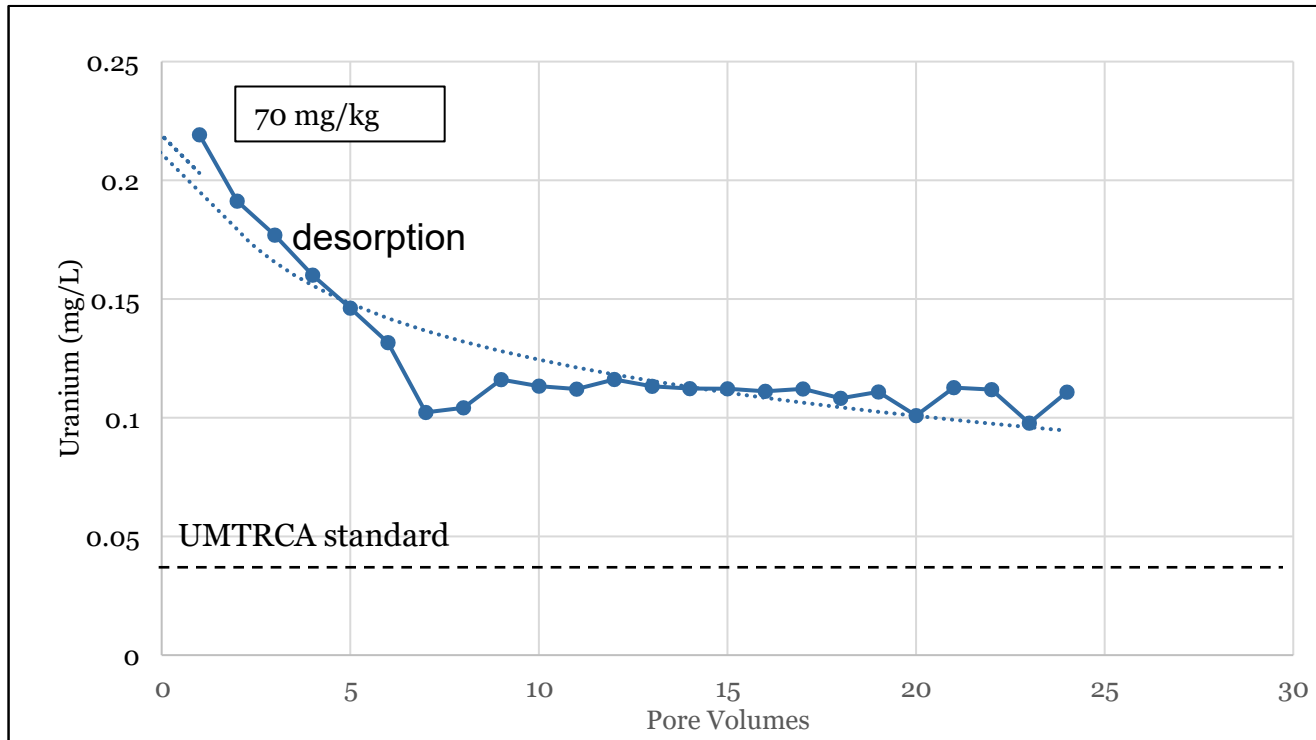
Uranium Release — Column Testing

- Simulate saturated and unsaturated interactions with soil/sediment with difference influent waters
 - Release rate and mass loading conditions



Buried Arroyo — Column Testing

- Influent: DI
- Uranium source to underlying Mancos shale? Yes
- Persistent plume source = Yes

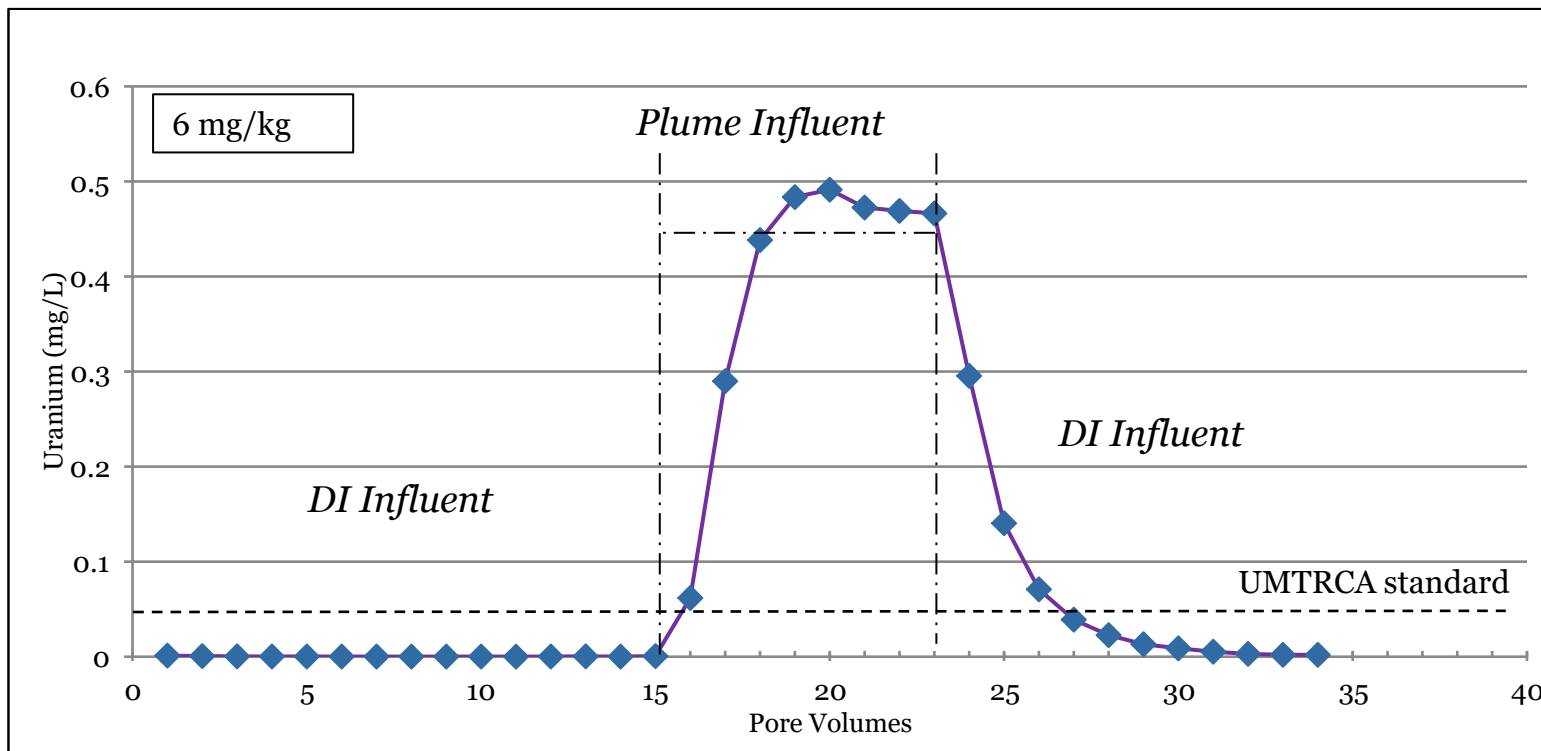


Natural flushing estimates
from rainfall ~ 1,000 yrs



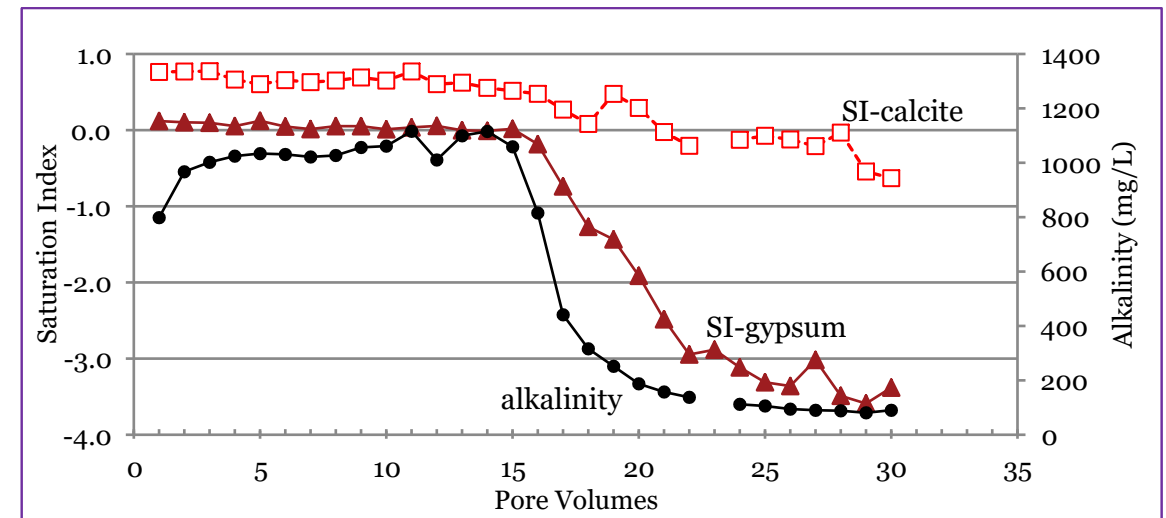
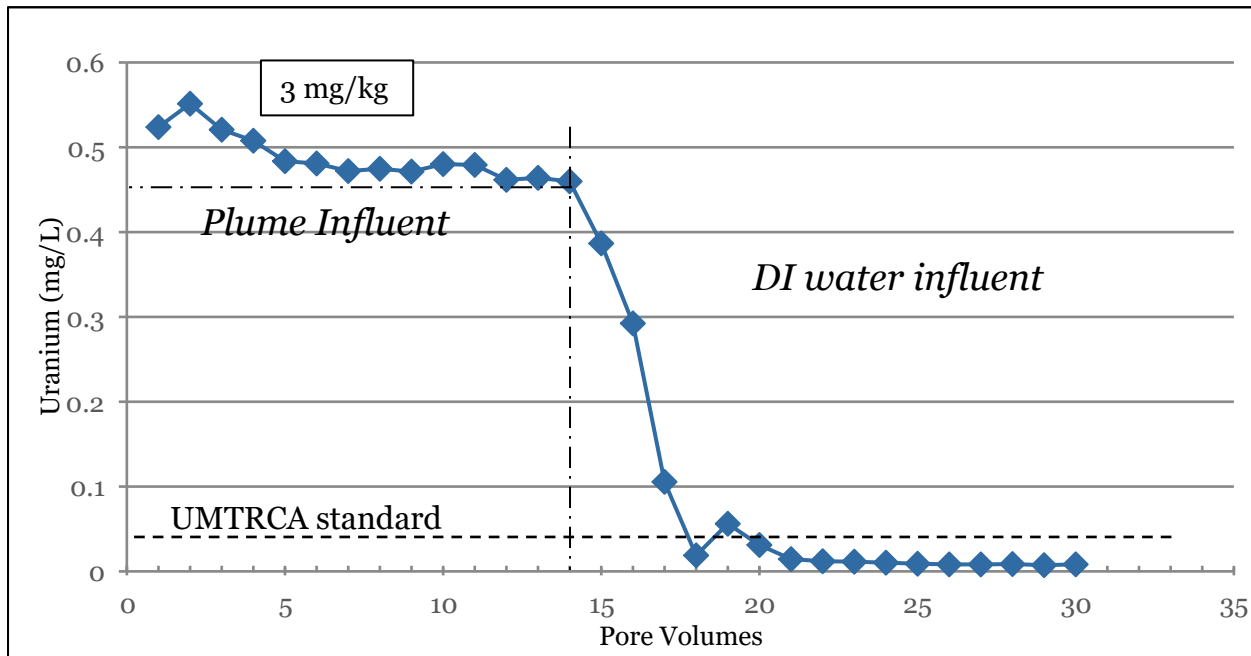
Unsaturated Mancos Shale — Column Testing

- Influent: DI, plume water, DI
- Persistent plume source = No
- Uranium is fixed without presence of alkalinity



Saturated Zone Mancos Shale — Column Testing

- Influent: Plume water, DI
- Persistent plume source = No
- Repository for attenuated uranium = No



Final Observations

- Solid-phase uranium is localized, associated with high sorption material
- Secondary uranium mobility is dependent on alkalinity
- Mancos shale not be a continual uranium source

