Department of Energy
Washington, DC 20585

February 1, 2017

U.S. Nuclear Regulatory Commission
Attn: Document Control Desk
Deputy Director
Mail Stop T8-F5
Washington, DC 20555-0001

WM-00058

Subject: U.S. Department of Energy Office of Legacy Management Position Paper Regarding Many Devils Wash at the Shiprock, New Mexico, Site

To Whom It May Concern:

Attached for U.S. Nuclear Regulatory Commission (NRC) review is a Position Paper prepared by the U.S. Department of Energy, Office of Legacy Management (DOE-LM) entitled *Origin of Contamination in Many Devils Wash, Shiprock, New Mexico.*

A desert arroyo named Many Devils Wash is located about 0.5 mile east of the Shiprock disposal cell. Water in the arroyo is contaminated with constituents similar to contaminants associated with the former Shiprock mill site.

Scientific investigations conducted since 2000 have resulted in an expanded understanding of hydrological and geochemical conditions in the vicinity of Many Devils Wash. Based on these investigations, DOE-LM's position is that contamination in Many Devils Wash is from the natural interaction of water with the Mancos Shale and is not related to the mill site.

Please call me at (970) 248-6018 if you have any questions. Please address any correspondence to:

U.S. Department of Energy
Office of Legacy Management
2597 Legacy Way
Grand Junction, CO 81503

Sincerely,

Mark Kautsky

Mark Kautsky
Site Manager

Enclosure

NMSS01

cc w/enclosure:
D. Orlando, NRC
S. Austin, NNEPA (e)
M. Roanhorse, NN UMTRA/AML (e)
J. Tallbull, NN UMTRA/AML (e)
M. Yazzie, NN UMTRA/AML (e)
J. Carman, Navarro (e)
B. Cook, Navarro (e)
S. Marutzky, Navarro (e)
D. Miller, Navarro (e)
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Position Paper:
Origin of Contamination in Many Devils Wash, Shiprock, New Mexico

The Shiprock Uranium Mill Tailings Remedial Action (UMTRA) Project site is in the Navajo Nation in San Juan County in the northwest corner of New Mexico, approximately 28 miles (mi) west of Farmington (Figure 1). The site is just south of the San Juan River and east of U.S. Highway 491, on an elevated gravel-covered terrace overlooking the river and its floodplain. The U.S. Department of Energy (DOE) completed remediation of surface and near-surface contamination in 1986. Contaminated materials were stabilized onsite in a disposal cell that covers approximately 76 acres. The former milling operation contaminated groundwater in the floodplain with uranium, selenium, nitrate, and sulfate. A desert arroyo named Many Devils Wash is located about 0.5 mile east of the disposal cell and water in the arroyo is contaminated with these same constituents. Many Devils Wash drains into the San Juan River about 0.5 mile east and upstream from the mill site (Figure 1). In 2000, the similarity of contaminants and proximity to the mill site were deemed to be sufficient evidence that the contamination in Many Devils Wash originated from the mill site, and DOE accepted responsibility for its clean up (DOE 2000).

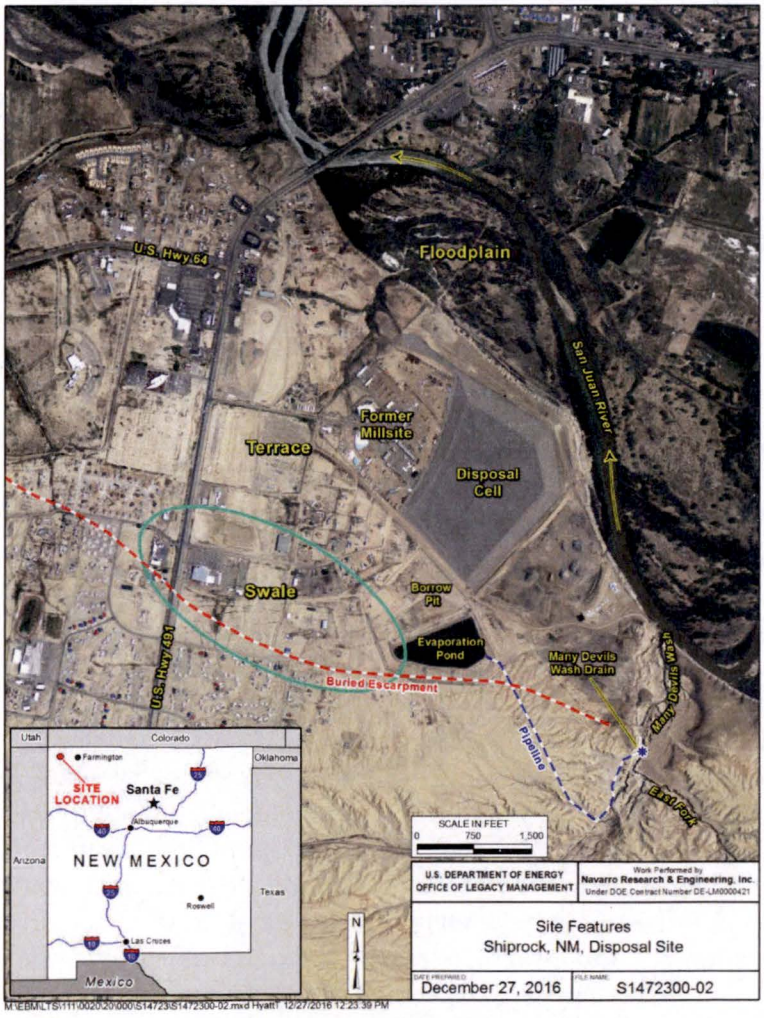


Figure 1. Location Map and Site Features

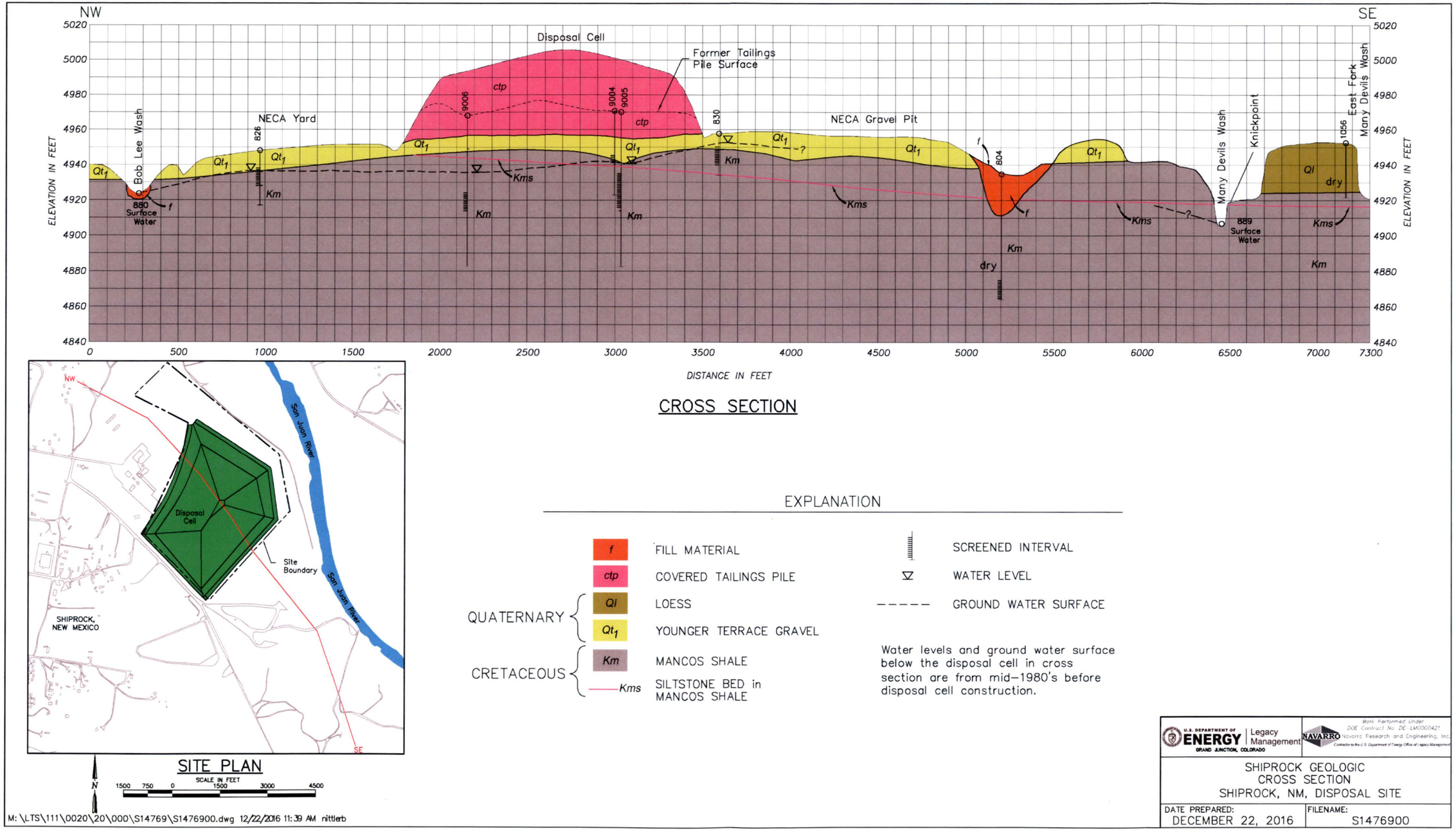
Scientific investigations conducted since 2000 have resulted in an expanded understanding of hydrological and geochemical conditions in the vicinity of the site. A key component of the updated hydrogeological conceptual model for the site is that the contaminants in Many Devils Wash, which are common to those associated with mill-related site groundwater contamination, do not originate from the mill site but rather from natural chemical processes occurring as groundwater in the arroyo interacts with Mancos Shale. This Position Paper documents DOE's agreement with this conclusion and summarizes the supporting evidence.

Three key observations made by DOE prior to 2000 contrast with the concept that contaminants observed in Many Devils Wash are from the mill site (DOE 2000).

1. Compounds and elements typically common to mill-related site groundwater contamination are discharged to Many Devils Wash from seeps along the east side of the arroyo, which is the side opposite the mill site. Groundwater flow paths that would result in site related contaminants discharging at these locations are not supported by observed gradients.
2. The activity ratios (ARs) of uranium-234 (^{234}U) to uranium-238 (^{238}U) in water samples collected from Many Devils Wash were much higher than those in samples collected at the mill site, indicating that the host groundwater is not characteristic of mill-related site groundwater contamination. AR values for ^{234}U to ^{238}U in mill-related site groundwater contamination are typically near 1 whereas AR values for ^{234}U to ^{238}U in Many Devils Wash groundwater samples were between 2 and 3.
3. Although the suite of contaminants (uranium, selenium, nitrate, and sulfate) was the same as that at the mill site, the concentrations in Many Devils Wash were different with decreased concentrations of uranium and increased concentrations of selenium, nitrate, and sulfate.

Although significant, these three observations were insufficient to prove a non-mill related origin. The similarity of contaminants and proximity to the mill site remained a strong argument that the contamination could be from the mill site. Many Devils Wash is located down the geologic dip of the Mancos Shale Formation that underlies the former mill site, and it was thought that contaminants might migrate towards Many Devils Wash within the Mancos Shale Formation (Figure 2). The simplest explanation was that water from the milling operation migrated through fractured bedrock (Mancos Shale) and was seeping into the arroyo from the east bank. Despite little empirical evidence of fracture flow, this hypothesis was bolstered by the observation that Many Devils Wash is only 0.5 mile from the former mill site, and the assumption that the contaminant signature in the wash is unique to groundwater contaminated by mill-related activity.

DOE's current position on the origin of contamination in Many Devils Wash is based on results of investigations completed since 2000. These investigations show that Many Devils Wash is not the only arroyo with this characteristic suite of contaminants (uranium, selenium, nitrate, and sulfate). More than nine non-mill related sites in the Colorado Plateau region of the southwestern United States were found to have these same chemical characteristics (DOE 2011, Morrison et al. 2012). Similar to Many Devils Wash, water in these analog arroyos typically flows at less than a gallon per minute and are fed from groundwater seeps. Surface water consists of narrow streams of less than a few feet (ft) wide with intermittent pools ranging up to about 10 ft across. As in Many Devils Wash, the water is commonly a deep red color from dissolved



CROSS SECTION

SITE PLAN

EXPLANATION

- f — FILL MATERIAL
- ctp — COVERED TAILINGS PILE
- QUATERNARY
  - Ql — LOESS
  - Qt_1 — YOUNGER TERRACE GRAVEL
- CRETACEOUS
  - Km — MANCOS SHALE
  - Kms — SILTSTONE BED in MANCOS SHALE
- SCREENED INTERVAL
- WATER LEVEL
- GROUND WATER SURFACE

Water levels and ground water surface below the disposal cell in cross section are from mid–1980's before disposal cell construction.

U.S. DEPARTMENT OF ENERGY | Legacy Management — GRAND JUNCTION, COLORADO

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NAVARRO Navarro Research and Engineering, Inc. — Contractor to the U.S. Department of Energy Office of Legacy Management

SHIPROCK GEOLOGIC CROSS SECTION
SHIPROCK, NM, DISPOSAL SITE

DATE PREPARED: DECEMBER 22, 2016
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Figure 2. Shiprock Geologic Cross Section

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humic-like organic compounds (DOE 2012c, Morrison et al. 2014). The water is highly saline with specific conductivity values often exceeding 10,000 micro-Siemens per centimeter (µS/cm), and the chemistry is dominated by sodium sulfate. Similar to Many Devils Wash, the contamination at all of these sites is naturally occurring and is derived from the interaction of groundwater with Mancos Shale.

Detailed sample collection and chemical analyses were conducted on two of these analog sites (Salt Creek Wash and Upper Eagle Nest Arroyo) that are near Many Devils Wash. Both sites are located about 5 to 7 miles from Many Devils Wash and are well beyond any influence from the former mill site and are not proximal to any other uranium mill sites (Figure 3). Multivariate statistical methods, such as cluster analysis, were used on the major ion concentration data to assess correlations of Many Devils Wash, the two analogs sites, and mill-related samples collected from the tailings and the swale (a predominant paleochannel that abuts and is subparallel to the buried escarpment [Figure 1]). The major ion concentrations in samples from the Many Devils Wash cluster align closely with those from the two analog sites, and are clearly separated from the mill-related samples (DOE 2012a, Kamp and Morrison 2014). Activity ratios of ^{234}U to ^{238}U also showed a clear separation. Many Devils Wash samples and the two analog sites have AR values between 2 and 4. In contrast, AR values in samples from the mill site are near 1, which is consistent with the derivation from the uranium ores milled at the site (DOE 2012b, Kamp and Morrison 2014).

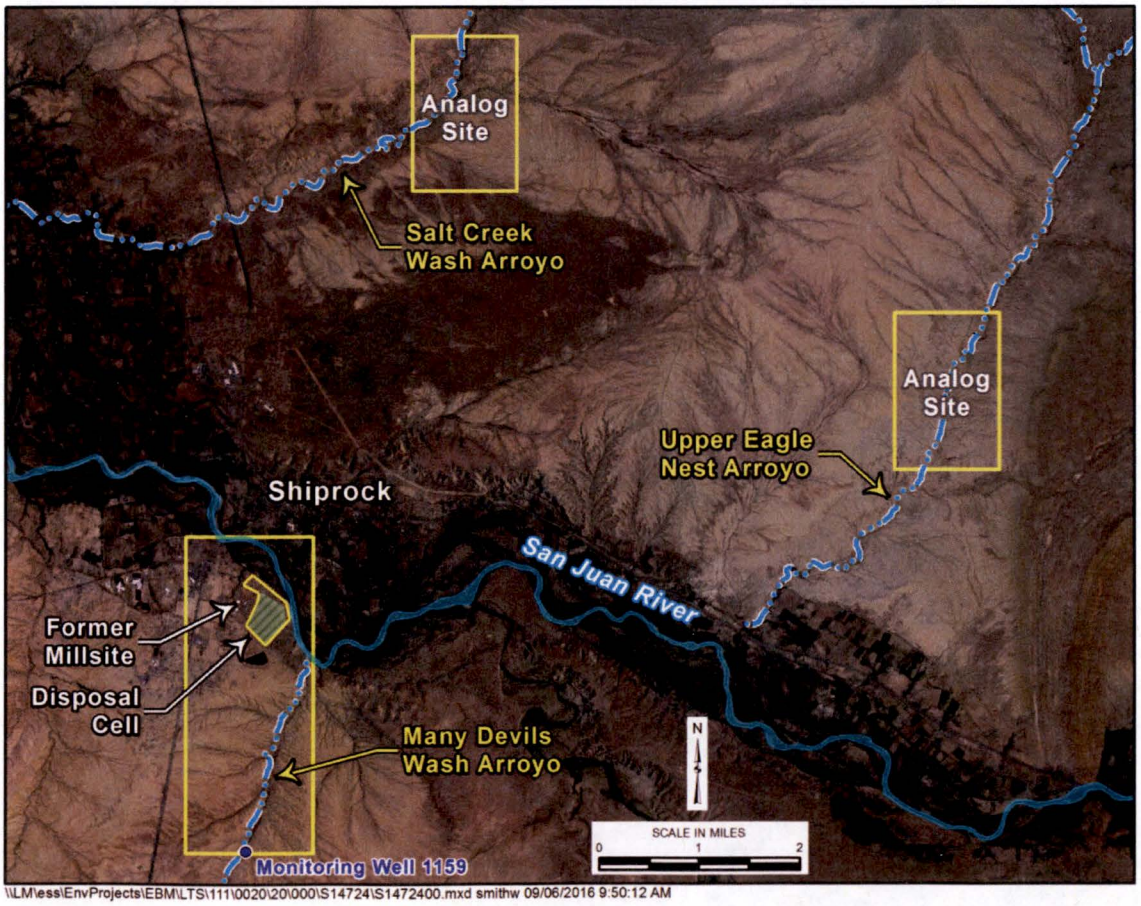

Figure 3. Locations of Many Devils Wash, Shiprock Site, and Salt Creek Wash and Eagle Nest Arroyo Analog Sites with Monitoring Well 1159

Tritium concentrations in the mill-related groundwater samples are distinctively higher than those from Many Devils Wash or the analog sites (Figure 4) (DOE 2012b). The higher tritium concentration in the tailings is due to the use of San Juan River water in the 1950s and 1960s when tritium was high in surface water from above ground nuclear testing. Sulfur isotope ratios ($\delta^{34}S$: the ratio of sulfur-34 (^{34}S) to sulfur-32 (^{32}S) compared to a standard) in dissolved sulfate are considerably lower in groundwater samples from Many Devils Wash and the analog sites than from samples representative of the mill tailings (Figure 5). Lower δ34S values occur because the sulfate in Many Devils Wash and analog site groundwater is derived from oxidation of pyrite in the Mancos Shale. Tuttle et al. (2007) shows that Mancos Shale pyrite has strongly negative $\delta^{34}S$ values.

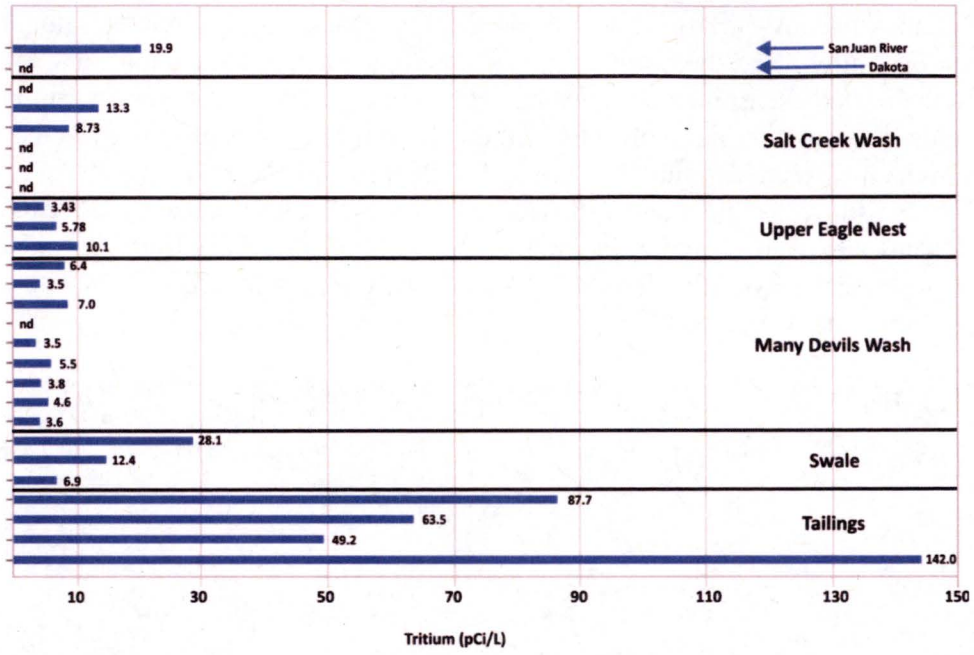

Figure 4. Tritium Results
nd = not detected

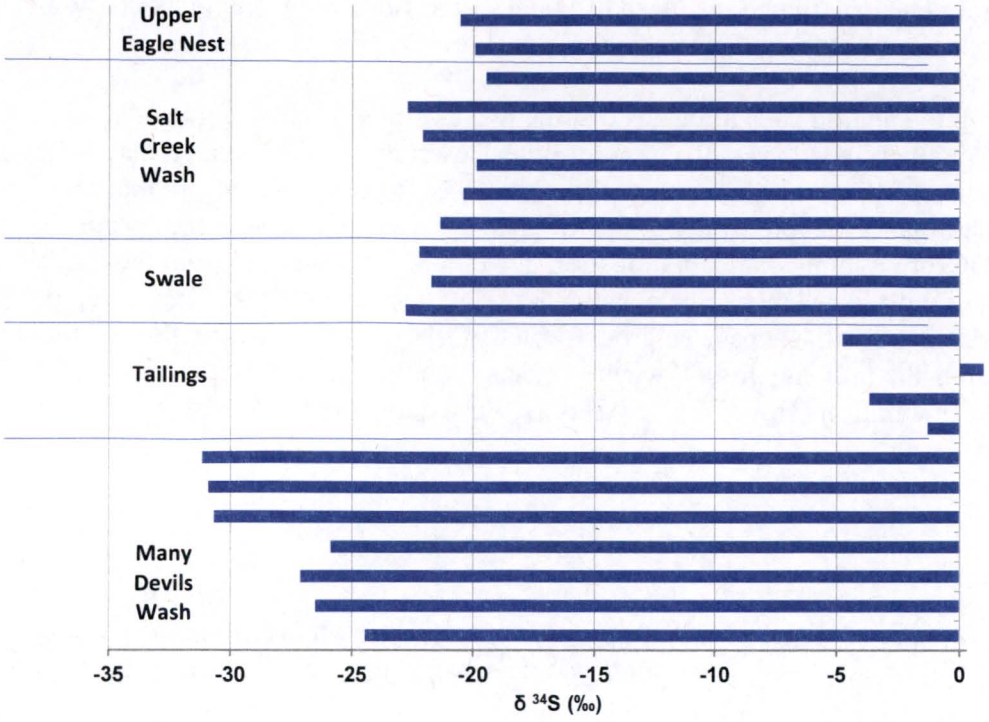

Figure 5. δ34S (‰) values in groundwater samples collected in March 2012

Water levels in a series of wells drilled by DOE in 2011 also provide conclusive evidence that the groundwater could not have come from the mill site. The water level in the raffinate pond at maximum capacity during milling represents the highest water elevation that could have occurred at the mill site. Based on engineering drawings, this elevation is 4985 ft above mean sea level (amsl). Contaminated groundwater in well 1159 at Many Devils Wash has an elevation of 5020 ft amsl, which is 35 ft above this maximum level, indicating that groundwater at well 1159 could not be derived from the mill site (Figure 3).

Two additional studies conducted on groundwater at Many Devils Wash also conclude that the contamination is not related to the mill site. Based on nitrogen ($\delta^{15}N$) and oxygen isotopic signatures ($\delta^{18}O$) in dissolved nitrate, Garvin (2012) suggested that the most likely source of contamination in Many Devils Wash is not from the mill site. Robertson et al. (2016) used evidence from chloride concentrations, chlorofluorocarbon concentrations, and $\delta^{18}O$ and hydrogen isotopes (δD) in the groundwater to conclude that the groundwater in Many Devils Wash is from focused meteoric precipitation, and thus is not from the mill site.

After accepting responsibility for the constituents in Many Devils Wash, DOE initiated active groundwater remediation. The remediation system consists of a 400 ft long collection drain and a dam to collect contaminated groundwater and surface water from the arroyo. A pumping and piping network is used to transfer contaminated water to an evaporation pond located near the disposal cell. Gravel riprap was placed along a portion of the wash to cover up the contaminated water to mitigate access by wildlife. These engineering controls have been only marginally effective. The rip rap was soon eroded by forceful runoff from occasional intense storm events.

The collection drain has experienced reduced efficiency, and flows from Many Devils Wash to the evaporation pond have slowed to a trickle.

The similarity with the analog sites indicates that the groundwater discharging to Many Devils Wash is naturally contaminated, as is the case for other desert arroyos in the area that are not impacted by uranium milling. This finding positively refutes the original concept that the similarity of contaminants and proximity to the mill site are a sufficient burden of proof for a mill site origin. DOE maintains that contamination in Many Devils Wash is from the natural interaction of water with the Mancos Shale and is not related to the mill site. Therefore, the contamination associated with seepage of groundwater in Many Devils Wash will continue in perpetuity even after the mill site ground water is cleaned up. Based on this information DOE should terminate remediation efforts in Many Devils Wash and the structures that were emplaced should be removed.

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