Department of Energy
Washington, DC 20585

September 26, 2019

WM-00062

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

Subject: U.S. Department of Energy Office of Legacy Management Response to U.S. Nuclear Regulatory Commission Letter Dated July 21, 2017, New Rifle, Colorado, Processing Site – Request for Additional Information RE: Draft Groundwater Compliance Action Plan (Docket No. WM-00062)

To Whom It May Concern:

The U.S. Department of Energy Office of Legacy Management (LM) has received U.S. Nuclear Regulatory Commission's (NRC) Request for Additional Information (RAI) for the *New Rifle, Colorado, Processing Site Groundwater Compliance Action Plan*. NRC provided comments along with a basis statement and proposed path forward for each comment. LM's responses and proposed actions are embedded in the RAI. We look forward to NRC's review and concurrence with the proposed actions, to continue the review process for the New Rifle GCAP.

Please contact me at (970) 248-6378 or Tashina.Jasso@lm.doe.gov, if you have any questions. Please address any correspondence to:

U.S. Department of Energy
Office of Legacy Management
2597 Legacy Way
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Sincerely,

Tashina R. Jasso
Site Manager

Enclosures

cc w/enclosures:
L. Cummins, Navarro (e)
K. Lott, Navarro (e)
DOE Read File
File: RFN 3500-0404

NMSS01
NMSS

Request for Additional Information
Draft Groundwater Compliance Action Plan
New Rifle, Colorado, Processing Site
Docket No. WM 00062

1.0 Introduction

By letter dated January 19, 2017, the U. S. Department of Energy (DOE) submitted the Draft Ground Water Compliance Action Plan (GCAP) for the New Rifle, Colorado, Processing Site, to the U. S. Nuclear Regulatory Commission (NRC) staff for review and comment (DOE 2017).

NRC responded to the submittal of the draft GCAP by letter dated July 21, 2017, with a Request for Additional Information (RAI) and stated that the "additional information is required to complete its review." NRC's comments, basis and path forward as provided in the RAI, are presented below, along with DOE's responses and planned actions.

2.0 Comments and Responses

NRC Comment 1: Additional receptor scenarios should be considered to determine that the proposed alternative concentration limits (ACLs) will be protective. The point of exposure (POE) evaluated by DOE are the Roaring Fork Ponds. The receptor is a member of the public who swims in the ponds and spends time on the banks of the ponds. DOE identifies some locations on the site (0452, 0453, 0320) that dry up during periods of low-water flow, but DOE did not evaluate the risk associated with direct exposure and inhalation that may occur from land use in these areas. Uranium and its daughter products should be included.

- **Basis:** The GCAP submitted by DOE proposes to meet the regulatory standards of 40 CFR Part 192 (Health and Environmental Protection Standards for Uranium and Thorium Mill Tailings) by changing from a natural flushing and alternate concentration limit (ACL) strategy for contaminants of concern (COCs) to no remediation with application of ACLs. Derivation of ACLs requires an assessment to determine that levels of contaminants that will not pose a substantial present or potential hazard to human health and the environment. 40 CFR Part 192, Subpart A, §192.02 (c)(3)(ii)(B)(2), specifies that an evaluation of potential hazards from proposed ACLs must consider several factors, including potential adverse effects on hydraulically-connected surface-water quality.
- **Path Forward:** Evaluate the risks associated with land use of the portions of the site where groundwater discharges to onsite surface water bodies and then evaporates (page 9).

DOE Response 1: There are locations, as noted, where groundwater reaches the surface and evaporates. However, evaporation does not result in these areas being dry for significant periods of time. Based on observations during semiannual sampling events, these locations are normally saturated. In the past 10 years, only one location was observed to be dry on one occasion.

The locations (0452, 0453, and 0320) are in the reconstructed wetland, and there is no regular land use of these areas other than the monitoring done by DOE. Much of the area is heavily vegetated, which mitigates suspension and inhalation of surface soils (see photos below). Any incremental risk at these sites is negligible in comparison with the risk level at the Roaring Fork ponds POE. No actual soil data are available for the wetland locations. However, soil data are available for other areas of the site that are expected to have much higher concentrations than the wetland areas (see discussion below).

To better quantify risks associated with exposures to radioactive materials at abandoned uranium mines, the U.S. Environmental Protection Agency (EPA) has developed uranium screening levels for external exposure for different frequencies of exposure (EPA 2008; screening levels include decay products). The 1-day screening level that equates to a 1×10^{-6} incremental risk level is 1704 picocuries per gram (pCi/g). A 1×10^{-4} 1-day screening level is approximately 170,400 pCi/g. These screening levels correspond to about 2520 and 252,000 milligrams per kilograms (mg/kg) of uranium, respectively (using a conversion factor of 0.67 picocurie per microgram [pCi/µg]). The highest concentration of uranium observed in residual soils at the site was 65 mg/kg in the vicinity of the former raffinate pond where highly concentrated milling fluids were disposed (DOE 2000). From a chemical standpoint, EPA's regional screening level for uranium for industrial workers is 230 mg/kg (for 250 days of exposure). (This screening level is based on EPA's recommended lower reference dose for uranium; EPA 2016.) It is unlikely that evaporation of surface water in wetland locations (with uranium concentrations well below 1 mg/L in surface water) will lead to uranium concentrations of any concern in soils for a reasonable exposure scenario.

DOE Action Planned: The GCAP text will be revised to more clearly describe the conditions at these locations and the exposure risks associated with them.

Figure 1. Photograph of Marshy Area at New Rifle Site (from DOE 2010a)

Figure 2. Photograph of a Saltgrass-Dominant Area at New Rifle Site (from DOE 2010a)

NRC Comment 2: In an environment with moderate to high evaporation, concentrations of contaminants may build up over time if the rate of addition exceeds the rate of loss, or if the geochemistry of the discharge point is sufficiently different from the geochemistry of the aquifer. As a result of the long half-life and persistence of the COCs, protection of human health and the environment may be necessary for an indefinite period of time.

- **Basis:** The GCAP submitted by DOE proposes to meet regulatory guidelines by using a natural flushing and ACL strategy for COCs. 40 CFR Part 192, Subpart A, §192.02 (c)(3)(ii)(B)(2), specifies that an evaluation of potential hazards from proposed ACLs must consider several factors, including the potential for health risks caused by human exposure to constituents.
- **Path Forward:** Analyze the potential buildup of contaminant concentrations in the Roaring Fork ponds and other locations where contaminated groundwater may discharge and then evaporate. Determine maximum risk-based concentrations (RBCs) associated with the scenario. Determine if additional controls or physical barriers to restrict use are necessary. Describe monitoring that will be performed to ensure buildup is not occurring.

DOE Response 2: Table 3 of the GCAP includes RBCs calculated for a conservative recreational scenario. For each constituent of concern, the maximum concentrations in surface water are less than their respective RBCs. Constituent concentrations in the ponds are not expected to increase as water lost to evaporation is replaced by influx of groundwater and rainfall and both inflows provide dilution. Elevated concentrations observed in the past may be attributed to disruption of groundwater flow, contaminant distribution, and geochemical conditions at the time of pond construction. Pond monitoring will continue as part of the long-term monitoring program.

It should be noted that at the time the GCAP was submitted to NRC, EPA came out with a recommendation that a lower reference dose be used for uranium than the one currently in the Integrated Risk Information System (IRIS). The IRIS reference dose was used in computing the uranium RBC in the GCAP. Using EPA's recommended lower reference dose would result in a uranium RBC of 3.84 milligrams per liter (mg/L) compared to the GCAP value of 59.4 mg/L. Observed concentrations in the ponds are nearly an order of magnitude lower than the recomputed RBC, so it is still considered protective for the evaluated scenario. Because there are continuous sources of inflow to the ponds with lower uranium concentrations, it is unlikely that evaporation could result in a tenfold increase in uranium concentration and, therefore, an exceedance of the recommended RBC. The time-concentration plot below shows uranium results for the pond sampling locations. Concentrations are variable over time, but do not show any increasing trends.

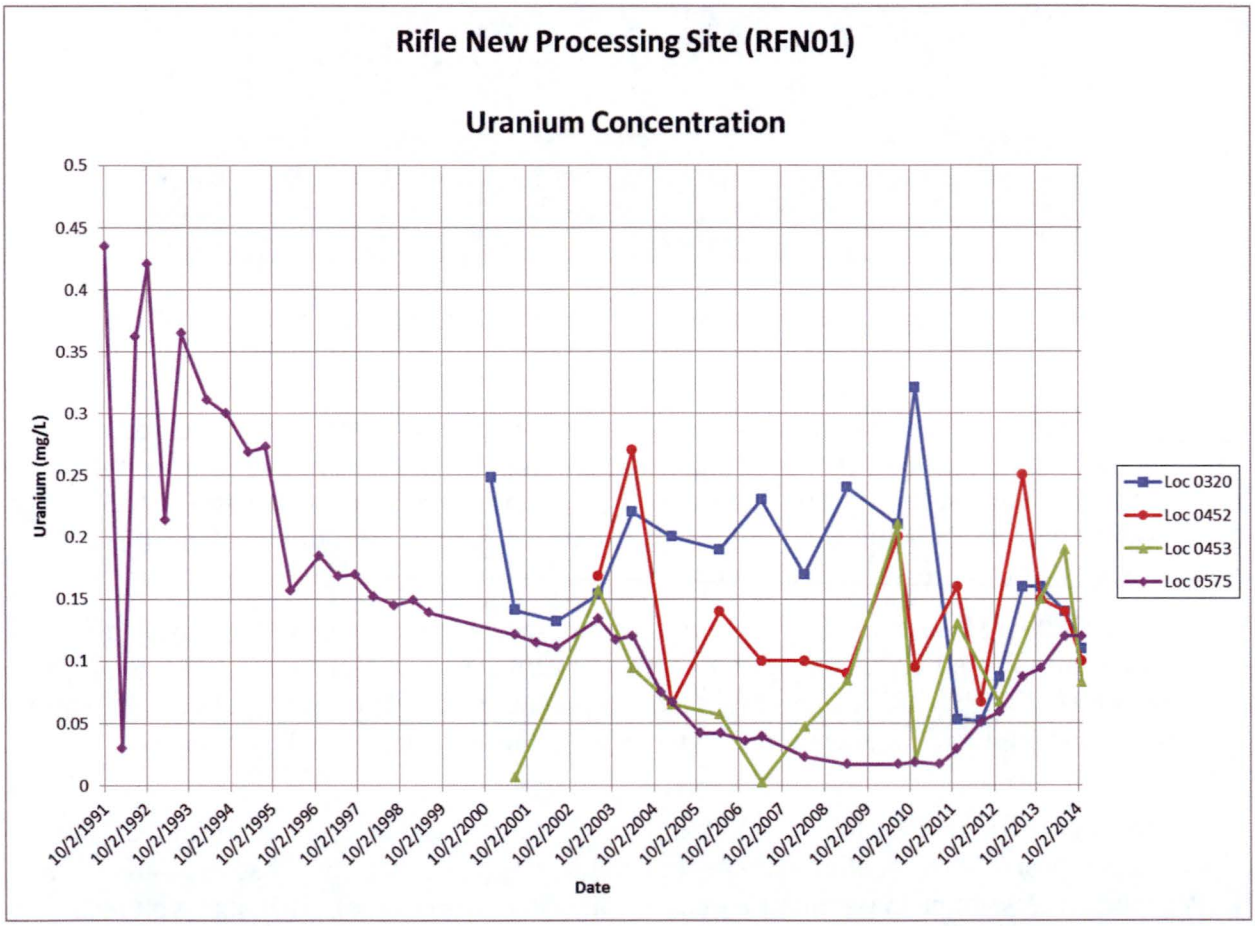

Figure 3. Time-Concentration Plot for Uranium for Pond Sampling Locations

DOE Action Planned: As an additional level of conservatism in the risk analysis, EPA's current recommendation for a lower uranium reference dose (proposed) and RBC will be included in the final GCAP.

NRC Comment 3: The site and Roaring Fork ponds are located within the 100 year floodplain of the Colorado River. While the ponds may not be a current source of recreational fishing, flooding of rivers is commonly observed to result in transferal of fish to nearby surface water bodies.

- **Basis:** The GCAP submitted by DOE proposes to meet regulatory guidelines by using a natural flushing and ACL strategy for COCs. 40 CFR Part 192, Subpart A, §192.02 (c)(3)(ii)(B)(2), specifies that an evaluation of potential hazards from proposed ACLs must consider several factors, including the potential for health risks caused by human exposure to constituents.
- **Path Forward:** Evaluate the risks associated with fishing in the ponds or describe the controls in place that will prohibit use of the ponds for future recreational fishing. Determine maximum risk-based concentrations (RBCs) associated with the scenario. Determine if additional controls or physical barriers to restrict use are necessary.

DOE Response 3: Because of the numerous assumptions involved and the unlikely nature of the scenario, quantifying potential risks due to consumption of fish from the Roaring Fork ponds has a high degree of uncertainty. Based on current site conditions and uses, the risks are considered to be very low, as the ponds are on private property and fish consumption is expected to be infrequent if at all. As a point of departure for discussion purposes, risks were calculated assuming fish tissue concentrations (mg/kg) were the equivalent of the highest concentrations observed in surface water (mg/L) in the Roaring Fork ponds for the five metals of concern (arsenic, molybdenum, selenium, uranium, vanadium). Note that the lower reference dose recently recommended by EPA for uranium was used in the calculations. Only data from locations 0323 and 0575 were used as these are the only locations likely to support fish for any period of time. It was assumed that an adult would eat 0.25 kg of fish each week of the year for a period of 30 years. This rate of fish ingestion is higher than the mean per capita consumption rate for the United States but less than the 95th percentile (EPA 2011). Results are shown in the table below.

Contaminant	Concentration in Fish (mg/kg)	Hazard Quotients
Arsenic	0.0017	0.003
Molybdenum	3.02	0.269
Selenium	0.014	0.001
Uranium	0.353	0.786
Vanadium	0.0064	0.003
"Hazard Index"		1.062

All of the hazard quotients are less than 1. Though the maximum concentrations of each analyte were observed at different points in time, individual hazard quotients were summed to estimate an overall hazard index. At slightly more than 1, these conservative calculations indicate that regular consumption of fish from the Roaring Fork ponds, would likely be acceptable.

Of the metals elevated in the ponds, it is unlikely that uranium, molybdenum, and vanadium would accumulate in fish to a higher degree than they are present in the water

(ATSDR 2012, 2013, 2017). Selenium and arsenic have the greatest potential to bioaccumulate, and surface water standards take this into account. Colorado has surface water standards for arsenic and selenium of 7.6 μg/L and 4200 μg/L for streams classified for "fish ingestion." Surface water concentrations in the Roaring Fork ponds have not exceeded these standards. Considering all of these factors, occasional consumption of fish from the Roaring Fork ponds (if they are present) is unlikely to pose any potential risk that would warrant additional controls or restrictions.

DOE Action Planned: Include the risk analysis for human consumption of fish to the GCAP. Include discussion of administrative controls and physical barriers, in place or proposed.

NRC Comment 4: The revised GCAP was necessary, in part, because vanadium and other contaminants were observed to be elevated and mobilized as a result of surface and subsurface disturbance. The previous GCAP had institutional controls providing for a "no dig zone" and a "limited disturbance zone", however these controls were "not formally implemented." Because the strategy for protection of human health and the environment relies significantly on institutional control of the site, assurance of fulfillment of the controls is essential.

- **Basis:** Subpart B, §192.12 (c)(2)(i)(B), describes institutional control as having a high degree of permanence and which will effectively protect public health and the environment. Institutional controls must be enforceable by administrative or judicial branches of government entities and must be instituted and maintained.
- **Path Forward:** Provide a description of administrative actions, inspection procedures, and other actions that will ensure institutional controls are being properly implemented and are effective. Provide a description of private properties that previously had wells within the Zone Overlay boundary, and how it is ensured that those wells are not being used.

DOE Response 4: Highly elevated concentrations of some constituents were observed after subsurface disturbances during construction activities on the site. A subsequent study conducted by DOE (DOE 2010b) determined that these concentrations were mainly the result of a very limited volume of groundwater being in contact with highly contaminated soils during dewatering activities. After cessation of dewatering activities, recovery of groundwater elevation resulted in reduced concentrations. It was determined that effects of subsurface disturbances would be short-lived and not have a significant impact on downgradient groundwater or surface water and that a blanket restriction on subsurface disturbances was not warranted.

There are several institutional controls (ICs) placed on the former mill site itself, including the City of Rifle quitclaim deed and the Uranium Mill Tailings Remedial Action (UMTRA) overlay zone district, Garfield County zone overlay, and the State of Colorado environmental covenant with Umetco. Copies of these instruments are included in Appendix A of the GCAP. The quitclaim deed requires that the City obtain DOE approval before performing any construction, excavation, or exposure of groundwater. The County zone overlay includes the entire IC boundary to the west and encompasses the alluvial aquifer at the site, pinching out against bedrock at the western end of the IC boundary. The County zone overlay requires property owners to demonstrate a potable source of water before developing any property within the zone overlay. The State environmental covenant prohibits use of the alluvial and Wasatch aquifers for domestic and livestock use. The western boundary of the State environmental covenant encompasses the Roaring Fork ponds.

GCAP Section 4.2.5, "Institutional Controls Monitoring," describes how DOE will monitor the controls through contact with City officials and visual observations during inspection and monitoring events. The City, County, and State share in the monitoring and enforcement of ICs through permitting and other processes.

There was one private well in use within the zone overlay boundaries at the time of DOE developing the *Final Site Observational Work Plan for the UMTRA Project New Rifle Site* (DOE 1999). The private well was located 1.5 miles downgradient of the site at location 442 southwest of the Interstate 70 interchange. This well was constructed in the alluvial aquifer and was equipped with a reverse osmosis unit to treat water for potable use. The 2008 verification monitoring report for the Rifle sites documented there were no longer any private well users within the IC boundary.

Ultimately, the City of Rifle and the Colorado Department of Public Health and Environment (CDPHE) are the regulatory agencies with the responsibility and authority to enforce the ICs. DOE will work closely with the City and the State toward the successful implementation of ICs, in a supporting role.

DOE Action Planned: Expand discussion in Section 4.2.5 of DOE inspection and monitoring events and interaction with the agencies empowered by and responsible for IC compliance.

NRC Comment 5: The GCAP document does not address the potential for groundwater contamination by organic chemicals listed in Appendix I to Part 192. Past sampling at the site indicated the presence of some chemicals in monitoring wells (e.g. toluene) (DOE, 1992). It was speculated that toluene was possibly used for cleaning of equipment, though it was not used in the milling process. In addition, large amounts of kerosene and tributyl phosphate were used in processing operations (DOE, 1996).

- **Basis:** Subpart B, §192.12 (c)(1), states that the Secretary shall determine which of the constituents listed in Appendix I to Part 192 are present in or could reasonably be derived from residual radioactive materials at the site. These constituents can be a source of groundwater contamination.
- **Path Forward:** Describe the historical use of organic chemicals at the New Rifle Site including the types and quantities used. Provide a summary of characterization done to identify the potential presence of organic chemicals including the sampling dates, locations, depths, types of environmental media sampled, and analytical results.

DOE Response 5: Inspection of all known reports on the New Rifle site indicates that detailed historical information on the presence of organic chemicals and relevant characterization data is unavailable. Data regarding sampling dates, locations, depths, types of media sampled, and tabulated analytical results are not contained within the New Rifle reports. Rather, general descriptions are given for the organic chemical species and their historical distribution in the subsurface, as well as recent sampling results that indicate the concentration of all organic species that were once present are now below detection limits. The following paragraphs summarize the information that is available in New Rifle reports.

The milling process at the New Rifle site used large amounts of bis(2-ethylhexyl)phosphoric acid (EHPA) and tributyl phosphate from 1958 to 1972 for an organic solvent extraction process

designed to separate and purify uranium and vanadium (DOE 1996; DOE 1997). Kerosene was heavily used as a transport carrier chemical (DOE 1996).

Three sampling campaigns were conducted at the New Rifle site in 1986, 1989, and 1996 to identify organic chemical contamination that could be related to mill operations. A study conducted in late 1996 summarized the results of the three sampling campaigns and provided an assessment of organic chemical contamination at the site.

The 1986 sampling campaign included analyses for priority pollutants. One alluvial well near the location of well 0659 and one Wasatch Formation well about 1500 feet west of the site's west boundary were sampled. Toluene and 1,1,1-trichloroethane (TCA) were detected in the alluvial well at relatively low concentrations. Acetone, toluene, and phthalate were detected in the Wasatch well, also at low concentrations. Because of TCA detections in field blanks and concerns about laboratory contaminants, it was concluded that significant concentrations of the detected compounds in the alluvial well and the Wasatch formation well were unlikely.

The 1989 sampling campaign focused on the collection and analysis of water samples at three alluvial wells, near the southern edge of the former southwest tailings pile, and an alluvial well about 2500 feet northeast of the first three, near the location of well 0169. Toluene was measured at relatively low concentrations in samples from two of the three wells on the southern edge of the tailings pile, and the herbicide 2,4,5-T was detected at the third well in that area, also at a low concentration. None of the organic chemical detections suggested the presence of a major source of organic contamination.

Five alluvial wells were sampled in 1996, for characterization of organic contamination, expanding on the 1986 and 1989 campaigns. Groundwater samples were analyzed for volatile and semivolatile organic compounds. At well 0658 (at the former north gypsum pond) and at well 0659 (near the southern edge of the former southwest tailings pile), no compounds were detected above their respective practical quantitation limits (PQLs). Analytical data for well 659 suggested that the organics detected in 1989 near the southern edge of the tailings pile were either due to laboratory contamination or contamination from site investigations. No detectable concentrations of organic compounds were found at a third well located about 200 feet northeast of well 0658, on the northeast side of the former north gypsum pond. Total petroleum hydrocarbons (TPH) were detected at two wells, north of the former northwest tailings pile and near the site's north boundary. EHPA was also detected at these two wells, along with compounds indicative of kerosene degradation.

Additional sampling was conducted in 1996 to determine the presence of kerosene and EHPA. Samples were collected in the northwest corner of the site, north of the former northwest tailings pile and the northern gypsum pond. Sampling was also conducted in an area extending west-southwest of well 0664, to 750 feet west of the site's west boundary. Twenty boreholes were drilled, from which 81 alluvium or rock samples were collected. Eight alluvial boreholes and one Wasatch Formation borehole were completed as monitoring wells.

Sediment samples from two boreholes, in an area formerly used for kerosene storage and a building where kerosene was used, revealed residual hydrocarbons in the unsaturated zone. The boreholes were located about 1000 feet directly north of well 0658. Groundwater sampling at six wells downgradient from the boreholes showed the presence of kerosene degradation

products. A dissolved hydrocarbon plume, about 150 feet wide and extending 1750 feet southwest from the apparent kerosene spills, was delineated using the groundwater chemical data from these and additional nearby wells. A quarter-inch layer of light nonaqueous liquid (LNAPL) was observed in a single well about midway between the edges of the hydrocarbon plume. The areal extent of the LNAPL layer was limited to a small radius around a single well.

Though there were several volatile organic compounds detections within the plume, most were measured at concentrations that were only slightly above their respective PQLs. The exception was 1,2,4-trimethylbenzene, which was detected at a level of 66 micrograms per liter (μg/L) at one well and 27 μg/L at another. All detected volatiles can be associated with kerosene degradation.

Water samples collected from wells within the plume were also analyzed for semivolatile organic compounds. The semivolatile EHPA was detected, but at concentrations less than its PQL. Other semivolatile compounds were also detected, but all concentrations were less than the corresponding PQLs. Samples collected from a new well with screened depth in the Wasatch Formation were analyzed for volatile and semivolatile organic compounds. All analyses for samples drawn from the new well showed nondetectable results.

Subsequent to the investigations described above, analyses for organics have been intermittently performed as part of the semiannual groundwater sampling events. When sampled, all organic compound concentrations have been below detection limits. Given the limited area impacted by organic contaminants, the relatively low concentrations that were reported in the investigations, and the non-detects that have since been recorded, organic contamination in groundwater at concentrations of concern is unlikely.

DOE Action Planned: No changes to the GCAP are planned in response to this comment. There is no known historical record for use of organic chemicals at the New Rifle Site. The requested summary of the efforts to characterize organic chemical contamination is provided above, and there is no indication that organic contamination should be considered in the site's compliance strategy.

NRC Comment 6: The groundwater model and associated geochemical analyses do not have sufficient accuracy to support the argument that the POE can be limited to the Roaring Fork ponds, and monitoring at the western edge of the institutional control zone is not necessary. The previous DOE GCAP strategy of natural flushing is being revised because model predictions of natural flushing are unlikely to be achieved. Though that modeling has been shown to be inaccurate, new modeling is used to support the revised GCAP strategy. Without additional model validation, other actions may be necessary to account for uncertainty in the modeling.

- **Basis:** From early hydrogeological modeling to the present, the preponderance of flow direction has changed from mostly south (directly towards the river) to mostly west (parallel to the river). Limited information is available to accurately define the flow direction west of the past gravel mining operations. DOE states that "it is likely that existing groundwater flow processes will cause remaining groundwater contamination to discharge to the river several thousand feet upgradient of the IC area's west boundary." This is a key assumption to the strategy. If accurate, then the POE location (subject to the other comments provided in this document), is reasonable. However, if groundwater continues on a westerly direction

paralleling the river then contaminated groundwater can eventually reach the western boundary of the IC zone where there are not limitations on normal groundwater usage. The risk assessment of the ponds evaluated children swimming for a limited period of time each year. Normal water usage at an offsite location may result in much higher risk even if the concentrations of contaminants are lower due to dilution and dispersion. The adequacy of the proposed ACL's to protect human health and the environment must be demonstrated.

- **Path Forward:** Provide additional technical basis to support the assumption that all contaminated water will discharge into the Colorado River prior to reaching the western edge of the IC zone, or provide a risk assessment demonstrating the adequacy of the ACL's if contaminated water at the point of compliance (POC) were to be transported out of the IC zone and used for normal purposes. Establish a monitoring point at the western edge of the IC zone to verify the assumption that contaminated water will not exit the IC zone.

DOE Response 6: It is important to clarify that the draft GCAP does not contain new modeling, such as numerical or analytical simulations of groundwater flow and contaminant transport. Rather, the document simply presents an updated assessment of the conceptual model of groundwater processes occurring at the New Rifle site, and this new assessment is not part of a strategy to address potential issues with previous numerical modeling.

DOE realizes that currently available data are not sufficient for supporting detailed technical evaluations that demonstrate that all contaminated water will discharge to the Colorado River prior to reaching the western edge of the IC zone. The limited number of wells west of the Roaring Fork Ponds and their wide spatial distribution are not conducive to the determination of local flow directions using methods such as flow net construction. DOE will continue to manage the New Rifle site and downgradient areas using the existing IC area. In addition, the GCAP states that monitoring will continue at the two westernmost wells at the site, 0620 and 0172, and at wells 0195 and 170, located west of the gravel pits. As discussed in the GCAP, the water chemistries at wells 0620 and 0172 appear to be impacted by processes that are completely different from westward migration of mill-generated contaminants in groundwater (DOE 2016), resulting in slightly elevated concentrations of dissolved constituents, including uranium. Nonetheless, uranium concentrations at both wells are less than 0.067 mg/L, the background concentration determined from groundwater sampling east of the Old Rifle site, suggesting that uranium in the westernmost part of the IC area is generated by naturally occurring processes in Wasatch Formation sediments north of the floodplain.

DOE Action Planned: No changes to the GCAP are planned in response to this comment. DOE will continue to manage the New Rifle site and downgradient areas using the existing IC area.

NRC Comment 7: DOE indicated that site field investigations have shown that the alluvial aquifer is the only aquifer affected by the former milling operations (page 15). This conclusion seems to contradict previous characterization data.

- **Basis:** Data from DOE's 1992 remedial action plan (DOE, 1992) shows contamination of the Wasatch formation by a variety of COC's. That document indicates that groundwater was contaminated to depths of 27 m [90 ft] and distances of 1100 m [3500 ft]. The figures below provide isopleths for sulfate, uranium, and molybdenum. In the case of uranium and molybdenum, it appears there is limited characterization data to estimate contaminant concentrations south of interstate 70 from the previous location of the tailings pile. The

closest well is 0217, which showed the second highest uranium value in the alluvium [0.13 mg/L] as of November 2015 in Figure B-2 of the draft GCAP. DOE indicated that the Shire Member (uppermost layer of the Wasatch Formation) is hydraulically connected to the overlying alluvium though flow is not dominant from one unit to the other. During milling operations, very large quantities of water were used compared to the present day, which may confound the development of a conceptual model to describe the extent of groundwater contamination. High water usage may have driven contamination much deeper in the system than would be anticipated by present day hydrologic measurements.

- **Path Forward:** Provide a description of monitoring data collected for the Shire and Molina Members of the Wasatch Formation. Reconcile the characterization data presented in the 1992 remedial action plan with the present day GCAP summary. If necessary, revise the monitoring network, and POE locations and analysis to account for contamination of the Wasatch Formation.

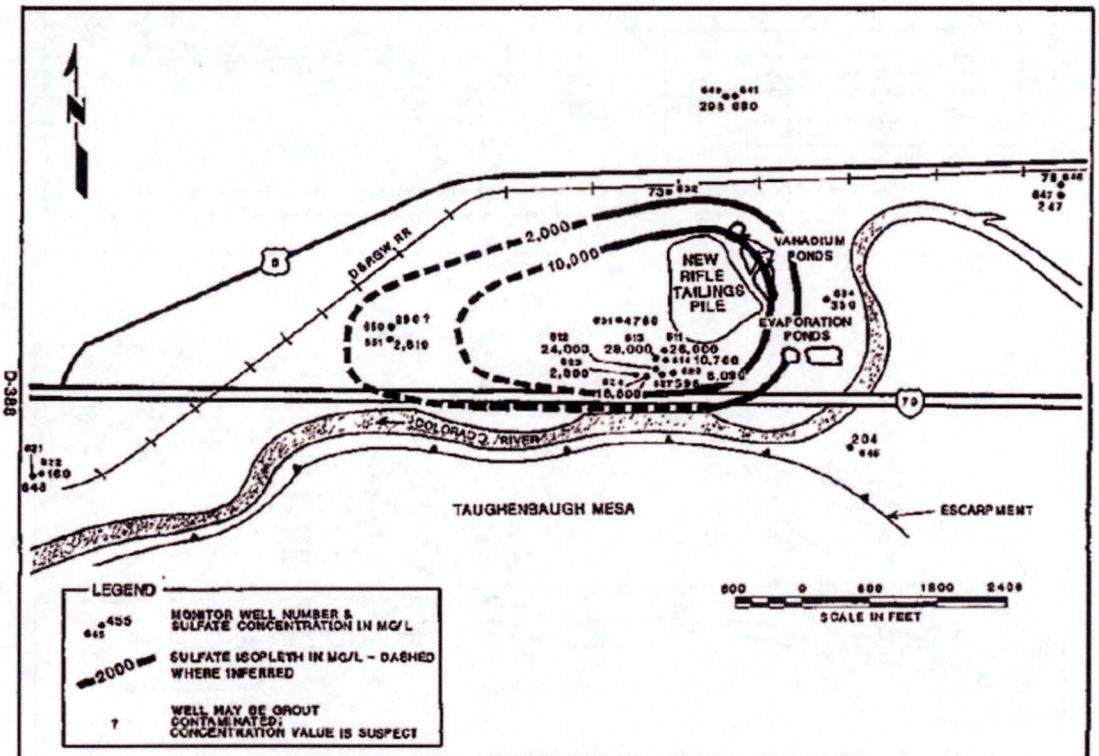

FIGURE D.7.34
SULFATE CONCENTRATIONS IN THE WASATCH FORMATION, NEW RIFLE SITE

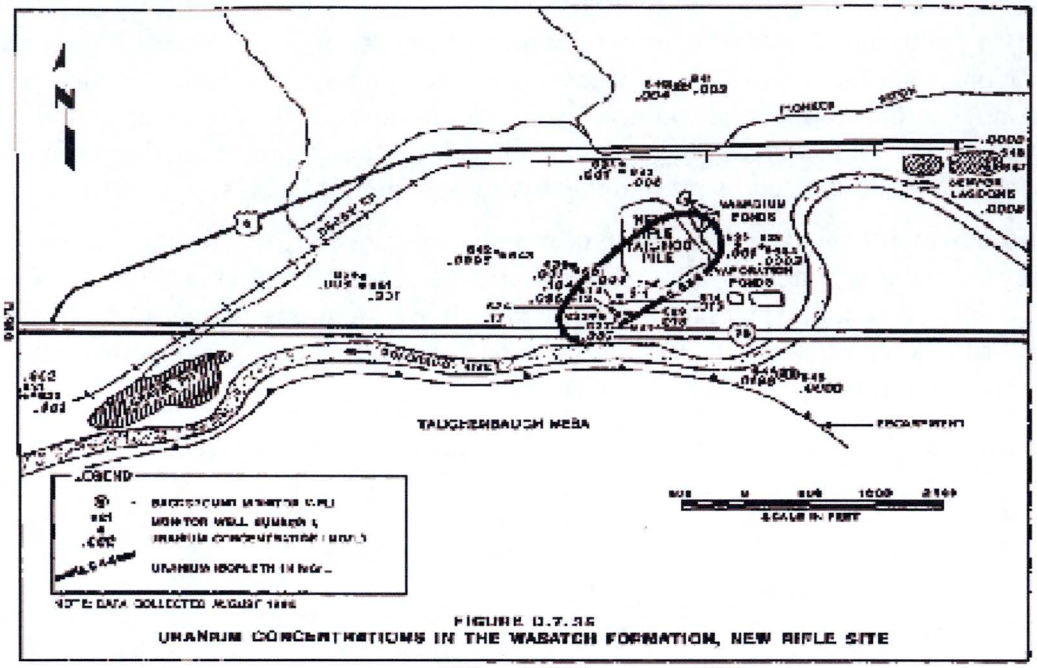

FIGURE D.7.35
URANIUM CONCENTRATIONS IN THE WASATCH FORMATION, NEW RIFLE SITE

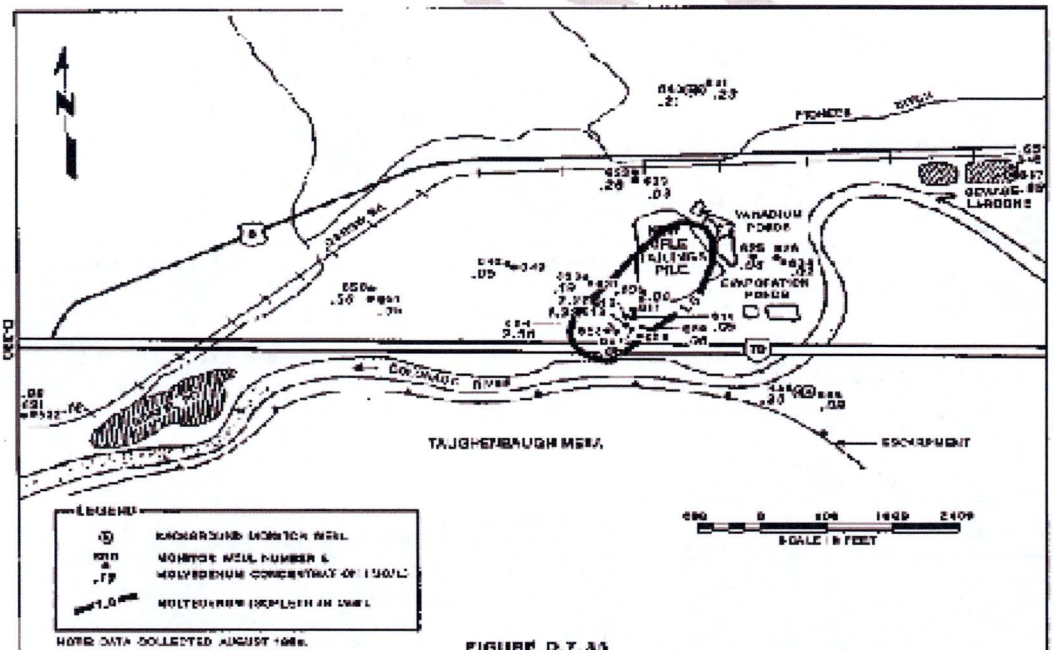

FIGURE D.7.36
MOLYBDENUM CONCENTRATIONS IN THE WASATCH FORMATION, NEW RIFLE SITE

DOE Response 7: The Wasatch Formation is described as bedrock (DOE 1999) that defines the base of the alluvial aquifer. The uppermost part of the Wasatch at the New Rifle site is the Shire member, which consists mostly of low-permeability claystones and siltstones and is described as an aquitard rather than an aquifer. Unweathered claystones and siltstones in the Shire member transmit water slowly. However, the uppermost 8 to 13 feet of the Wasatch Formation is weathered in some places, and the weathered rock is relatively permeable and capable of

transmitting water more quickly than in the deeper bedrock. In many locations the weathered zone and alluvium readily exchange water and have similar hydraulic characteristics. For this reason, the upper sediments of the Shire member with good hydraulic connection to the alluvium are considered part of the surficial flow system. Generally, however, the hydraulic conductivity of the unweathered claystones and siltstones in the Wasatch Formation are about 2 to 3 orders of magnitude lower than conductivities derived for the alluvium via aquifer pump tests (DOD 1999), indicating that the Shire member acts as an aquitard.

The much lower hydraulic conductivities of the Shire member sediments impede the horizontal transport of any contaminants through this aquitard. Thus, the apparent migration of sulfate contamination as much as 3500 feet to the west of the former mill site (DOE 1992) was, to a large extent, the result of relatively rapid horizontal migration of this contaminant in the alluvium followed by downward movement into the Wasatch Formation (DOE 1992).

In all of the investigations conducted by DOE, neither hydraulic heads nor water-chemistry data for the Molina Member of the Wasatch Formation, located directly below the Shire member, has been collected. This is because the Molina Member lies deeper than any of the Wasatch wells installed at the site, the deepest of which was well 0640 at 149 feet. Nor has it been encountered in any known wells drilled near the site (DOE 1999). Though the thickness of the Shire member at the site is unknown, the Site Observational Work Plan (SOWP) (DOE 1999) discusses measured thicknesses of its stratigraphic equivalent that are on the order of thousands of feet in other parts of the area surrounding Rifle. Sampling of the water quality in Shire member wells at the New Rifle site indicate that any contamination derived from the site's former mill operations is limited to the uppermost part of the Shire and has not affected the Molina member.

The 1992 remedial action plan (DOE 1992) reports that 28 monitor wells were installed in the Shire member in 1985. No contamination was detected in Wasatch Formation wells installed south of the Colorado River. This was expected south of the river partly because the Wasatch Formation dips between four to ten degrees to the northwest in the vicinity of the New Rifle site.

As expected, contamination was detected at onsite Shire member wells, with measured uranium concentrations ranging from 0.0003 to 0.91 mg/L, and averaging about 0.001 mg/L (DOE 1992). The highest uranium concentrations in Wasatch Formation wells were measured at locations near the southwest corner of the former Southwest tailings pile, where most recorded concentrations exceeding the uranium MCL (0.044 mg/L) fell in the range of 0.2 to 0.5 mg/L.

In support of the SOWP (DOE 1999), groundwater samples were collected in August 1998 and January 1999 at 13 on-site and downgradient monitor wells completed in the Wasatch Formation. The concentrations of nitrate, molybdenum, uranium, and gross alpha radiation were the only regulated constituents that exceeded their UMTRCA groundwater standards. Rather than measuring very high uranium concentrations at Wasatch wells in the vicinity of the former tailings piles, the highest uranium concentrations were detected in groundwater samples at wells 0208 and 0226, both of which are thousands of feet west of the piles. Most uranium concentrations at the two wells were just slightly above the 0.044 mg/L uranium standard. Uranium concentrations observed at well RFN–208 ranged from 0.056 mg/L in summer 1998 to 0.061 mg/L in early winter 1999. The maximum uranium concentration of 0.106 mg/L was detected in August 1998 at well 0226, where the concentration subsequently decreased to 0.078 mg/L the following January.

The possible migration of uranium and molybdenum in the Wasatch Formation south of Interstate 70 can be analyzed by examining concentration data for these contaminants collected in 1999 at a cluster of wells located just north of Interstate 70, within the southernmost point of the uranium and molybdenum plumes shown in the attached Figures D.7.35 and D.7.36 from the 1992 remedial action plan (DOE 1992). The cluster consists of one alluvial well (0217) and four Wasatch wells (0206, 0627, 0628, 0529) screened at various depths, with the deepest well screen extending from 63 to 83 feet below the alluvial-Wasatch contact. The uranium concentration at alluvial well 0217 was 0.107 mg/L (DOE 1999) and the four uranium values in the deeper Wasatch wells were much lower, ranging from 0.001 to 0.006 mg/L. Similarly, the molybdenum concentration at well 0217 of 1.54 mg/L was much higher than molybdenum concentrations at the four screened intervals in the Wasatch Formation, which varied from 0.02 to about 0.07 mg/L. These results suggested that if relatively high concentrations of these constituents were at the time present in alluvium south of Interstate 70 and just north of the Colorado River, the comparable concentrations in the underlying Shire member sediments were likely to be much lower. Taking into account the mentioned uranium concentration of 0.13 mg/L at alluvial well 0217 in 2015, it is logical to estimate that current concentrations in the Wasatch Formation south of Interstate 70 are still very low. Moreover, the low uranium and molybdenum concentrations measured in 1999 in the Shire-member wells in the cluster associated with alluvial well 0217 indicates that some of the elevated concentrations for these two constituents in the south end of their Wasatch Formation plumes shown in the 1992 remedial action plan (attached Figures D.7.35 and D.7.36) were greatly reduced years later during the SOWP investigation (DOE 1999).

The hydrogeology of the New Rifle site can be used to explain why a new POE location in the Wasatch Formation south of Interstate 70 is not practical. The Colorado River, with very large flows in comparison to the groundwater flows beneath the New Rifle site, is an exposure medium for all contamination migrating south from the site. As discussed in the current draft GCAP, the Colorado River acts as a regional sink, capturing all groundwater flow on both sides of and from beneath the river, including all flow in the Shire member of the Wasatch Formation as well as from the alluvial aquifer. As described in the SOWP (DOE 1999), the dilution provided by the flowing surface water reduces the contaminant concentrations in groundwater discharging from the site to levels that are indistinguishable from background river concentrations. Thus a POE well screened in the Wasatch Formation just several tens of feet north of the north bank of the river, which coincides with the south boundary of the IC area, would be monitoring contaminant levels that are almost immediately reduced to non-risk levels in the river.

With the Colorado River acting as a regional sink, it is unrealistic for any contaminated groundwater to flow under the river from the New Rifle Site to the south side of the river, in either the alluvium or the Wasatch Formation. This can be seen in the attached Figure 5-9 from the SOWP (DOE 1999), which shows a north-south cross section extending from the south border of the Taughenbaugh Mesa on the south side of the river Prefontaine Mesa north of Highway 6. As depicted in this figure, the thin layer of alluvium underlying the river is terminated on the south side of the river where it abuts against Wasatch Formation sediments.

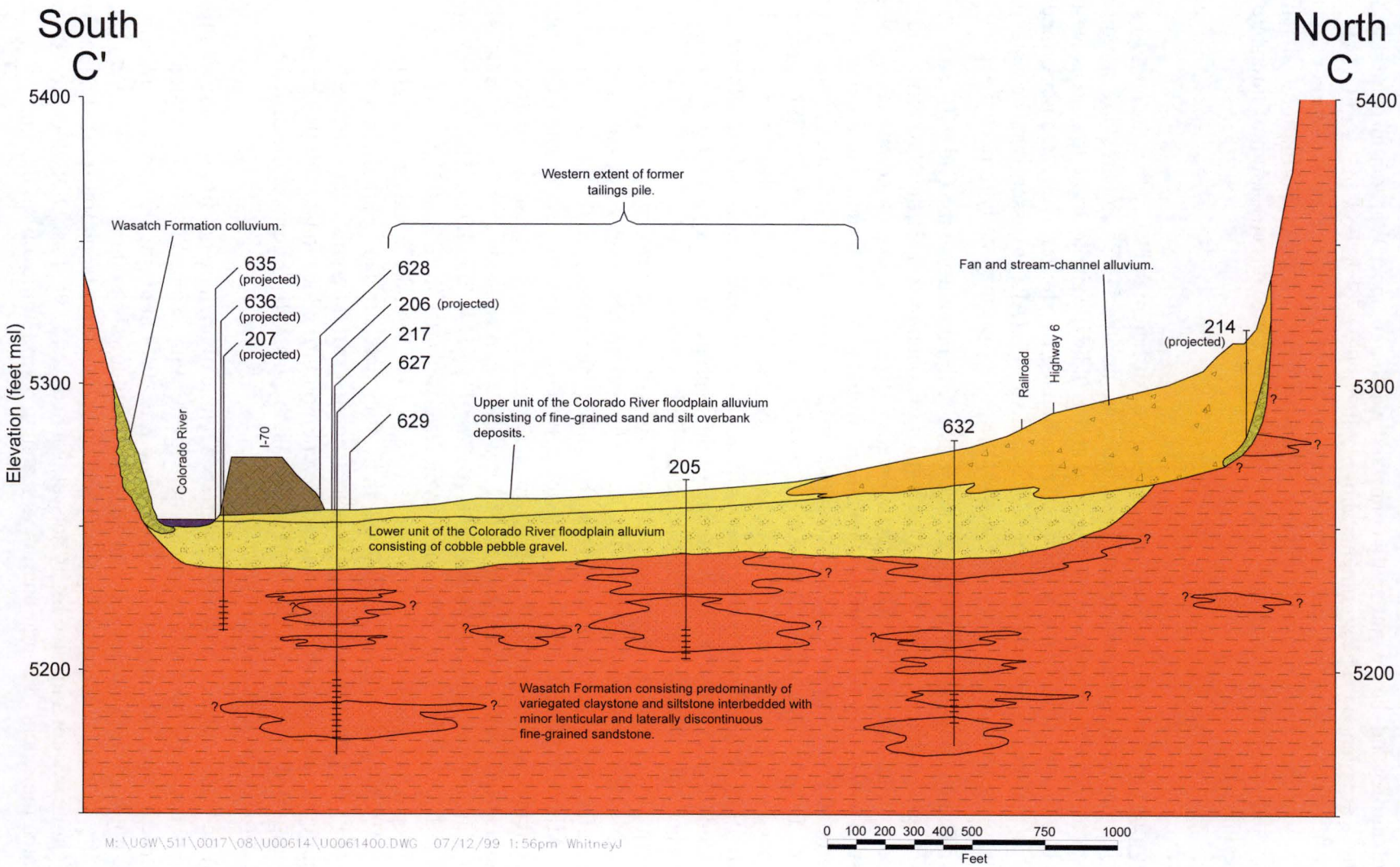

Figure 4. "Geologic Cross Section of the New Rifle Site," Figure 5–9 from the Site Observational Work Plan (DOE 1999)

DOE Action Planned: The GCAP will be revised to state that the surficial aquifer is the only aquifer affected by the former milling operations. It will clarify that the surficial aquifer incudes the alluvial aquifer and the hydraulically connected weathered upper Wasatch formation. No other changes are planned. The arguments above collectively explain how the draft GCAP summary can be reconciled with the characterization data in the 1992 remedial action plan. The hydrogeology of the site along with measured concentrations in Wasatch Formation wells in recent years indicate that contaminant levels in the exposure area directly south of Interstate 70 pose no health risks.

NRC Comment 8: The technical basis provided is not sufficient to justify that the area west of the ponds has not been impacted by contaminated groundwater. DOE compares downgradient monitoring data to background values measured at the Old Rifle site to argue that areas west of the ponds has been minimally impacted by contaminated groundwater. DOE also performed geochemical analyses using stiff diagrams and activity ratios (ARs) to assert that the water east of the ponds was impacted but the water west of the ponds was minimally impacted.

- **Basis:** There is no basis for using maximum background values at the Old Rifle site (0.067 mg/L uranium) to justify that the impact of contamination at the New Rifle site is limited in areal extent. New Rifle has two wells (0169, 0173), that based on the hydrologic data such as the flow direction and magnitude, would appear to be suitable for establishing background concentrations. As of November 2015 well 0169 had a uranium concentration of 0.02 mg/L, below the MCL of 0.044 mg/L. Activity ratios (ARs) of 234U/238U were developed by DOE to help identify if observed contamination can be attributed to milling operations of if the contamination results from natural or other sources. The ARs are a useful tool to help develop understanding of the hydrogeological system. For example, as of November 2012 upgradient well 0169 had the highest observed AR of 1.87, again supporting its use as a background well for New Rifle. Wells proximate to the old mill site and tailings locations had ARs of ~1.0. However there is uncertainty associated with intermediate AR values (1.2 to 1.5) and their interpretation, especially for the more distant wells. ARs can reflect the degree of mixing between contaminated water and fresh water. DOE referenced Zielinski 1997, who used an AR of 1.3 to distinguish the source of contamination. DOE selected a value of 1.2 without explaining why the lower value is appropriate. The still active distant wells (0170, 0172, 0195, 0620) had ARs ranging from ~1.26 to 1.7 as of 2012. In 1998, the intermediate wells (0171, 0220, 0210, 0211) that have since been decommissioned had ARs of ~1.18 to 1.68. Well 0172 had an AR value of 1.33 in 1998 and a value of 1.7 in 2012, indicating that there can be significant volatility in a relatively short amount of time. DOE also generated stiff diagrams in an attempt to determine geochemical differences in different monitoring locations. Well 0172 does appear to be impacted by activity associated with a nearby gas well. Otherwise the differences in the stiff diagrams are not significant.

  The time history plot of well 0195 suggests a plume of uranium has moved past well 0195 location and is likely now in the area where the decommissioned wells are located and therefore no data is being collected. Uranium was >0.14 mg/L in 2002 and is currently <0.02 mg/L. Nitrate displays similar behavior (Nitrate was > 60 mg/L in 2002 and is currently <1 mg/L). More strongly sorbing contaminants are being transported more slowly through the system and have likely not yet reached well 0195. Past DOE documents have indicated the extent of contamination as reaching 5 km (3 miles) from the site.

- **Path Forward:** Provide additional technical basis to support the use of an Old Rifle site maximum background value when the New Rifle site has existing upgradient wells. Otherwise, revise the extent of contamination attributed to past site operations in the GCAP to be consistent with previous documentation and currently observed time history plots and concentrations. As discussed in Comment 6, the protectiveness of the ACL's for a POE at the western boundary must be established.

DOE Response 8: Identification of a representative background uranium concentration for the 3.5-mile-long alluvial aquifer at the New Rifle site is not as simple as adopting a measured concentration at a single up-gradient well, or just two up-gradient wells, adjacent to the site's northeast corner. This is because there are other upgradient water sources of the groundwater in the alluvial aquifer, including the recharge from spring-fed surface water emptying onto the floodplain from northwest-trending watercourses incising Wasatch Formation sediments on Webster Mesa and Prefontaine Mesa, and direct groundwater discharge from the Wasatch Formation to the alluvial aquifer along the Wasatch Formation-alluvium contact. Though the AR values in water from these natural sources are expected to also be much larger than 1, the general chemistry of the water and the concentrations of metals such as uranium can differ significantly from the water chemistry at wells 0169 and 0173. This has bearing on the uranium concentrations used to represent background at the site, especially given that the mixing of water from these latter sources with groundwater stemming from recharge of river water on the east side of the site increases with distance to the west. Accordingly, the determination of a background uranium concentration for the New Rifle site involves more study than simply selecting measured concentrations near the site's northeast corner at well 0169, which appears to be screened in groundwater that is supplied only by very fresh river water a short distance upriver from its location.

The background value for uranium determined from a representative well associated with the Old Rifle site is illustrative of the fact that conditions in the alluvium near the Wasatch Formation–alluvium contact can exhibit uranium levels higher than the maximum contaminant level (MCL) of 0.044 mg/L. Data collected in support of DOE study on natural flushing at Old Rifle site (DOE 2011) helped to make this point clear. A background uranium concentration based on concentrations at wells in the floodplain area upgradient of the Old Rifle site are representative of the New Rifle site because they are the result of a mixture of waters from both the river and the Wasatch Formation along the floodplain's north border.

DOE has avoided using the temporal history of concentration data for well 0195, about 400 feet west of west Roaring Fork Pond, in an attempt to explain why the uranium concentration at this location dropped significantly since 2005. This drop can just as easily be explained by processes other than the passage of a uranium plume farther to the west in an area that contains decommissioned wells. For example, the declining uranium concentration could be attributed solely to natural dispersion and dilution processes in the aquifer. DOE disagrees with the use of historical concentrations at well 0195 to suggest the presence of high contaminant concentrations farther to the west of the well when there are no wells available to support such a hypothesis.

DOE Action Planned: As requested, an explanation of the technical basis for supporting the use of an Old Rifle site maximum background level rather than existing New Rifle upgradient wells will be added.

NRC Comment 9: The quitclaim deed for the former mill site indicates that any habitable structures constructed on the property shall employ a radon ventilation system or other radon mitigation measures. The city of Rifle constructed a waste water treatment facility and associated structures on the former mill site. The radon mitigation measures and monitoring data for radon resulting from residual radioactive material and contaminated groundwater is not provided in the GCAP.

- **Basis:** Subpart A, §192.02 (b)(2), states that releases of radon to the atmosphere must not result in an increase in the annual average concentration of radon-222 in air at or above any location outside the disposal site by more than one-half picocurie per liter.
  Subpart B, §192.12 (b)(1), states that radon decay product concentrations must not exceed 0.02 WL in any occupied or habitable building.
- **Path Forward:** Describe the radon mitigation measures taken at the city of Rifle waste water treatment facilities as well as the results of radon monitoring performed within these structures. Provide inspection procedures used to verify that the requirements for protection from radon are being achieved.

DOE Response 9: Ultimately, the City of Rifle and the Colorado Department of Public Health and Environment (CDPHE) are the regulatory agencies with the responsibility and authority to enforce the ICs.

DOE Action Planned: DOE will contact City of Rifle personnel. This contact will provide descriptions of the radon mitigation measures and monitoring practices for the wastewater treatment plant buildings and support structures. DOE will work closely with the City and the State, in a supporting role, toward the successful implementation of ICs.

NRC Comment 10: The proposed location of the POC wells may not account for uncertainty in the present groundwater flow directions or for future groundwater flow patterns. In addition, areas of highest residual radioactive material (which could result in future groundwater contamination) should be described.

- **Basis:** DOE indicated that wells 0664, 0669, 0659, and 0217 are located outside and downgradient from the secondary source areas. There are no active monitoring wells located due south of the former mill site area, which may be a flow direction for contaminated water depending on the climatic conditions and associated river stage. Appendix D of the DOE RAP identifies stream sediments contaminated at up to 149 pCi/g Ra-226 (DOE, 1992). It is not clear if those sediments were remediated or exactly where on the site the contamination was observed. If those locations coincide with the locations of discharge of contaminated groundwater, then residual radioactive material would contribute to the risk at this POE.
- **Path Forward:** Include a POC monitoring well in the area due south of the former mill site. Describe the final status of the site after surface reclamation with an overlay map from verification activities showing Ra-226 concentrations in each survey unit.

DOE Response 10: Historical records of hydraulic head and contaminant concentrations in soil and groundwater at the New Rifle site do not support the recommendation to include a point of compliance (POC) monitoring well in the area due south of the former mill site. Unlike the existing POC locations of wells 664, 669, 658, and 217, areas directly south of the former mill site are not immediately outside of and downgradient of the locations that contain the greatest

amounts of residual contamination. Accordingly, some of the highest concentrations in groundwater have regularly been monitored at the four existing POC wells over the past 15 years, whereas the concentrations are substantially less at well 0216, which lies more directly south of the former mill site, on the southeast corner of the former evaporation ponds and directly south of the former ore storage area.

Contaminant concentrations collected at site wells, particularly the four proposed POC wells, support the historical observations that dominant groundwater flow direction in the vicinity of the former mill site is toward the south-southwest, southwest, and west-southwest. This can be observed at POC well 0217, located immediately southwest of the former Southwest tailings pile, where uranium concentrations persistently range between 0.1 and 0.16 mg/L (Figure B-37 in the GCAP). In contrast, uranium concentrations at well 0216 generally range between 0.01 and 0.04 mg/L.

In the unlikely event that flow directions in the alluvial aquifer on and near the former mill site were to permanently change to a due-south direction, contaminants migrating directly south of the former tailings piles, the gypsum and vanadium pond footprints, and the former evaporation ponds, would not create exposures that pose health or environmental risks. As described in the response to NRC Comment 7, the Colorado River is the medium of exposure for any contaminants migrating southward from the former mill site. Correspondingly, it is widely understood that dilution of contaminated water discharging to the river along its north bank renders the concentrations of any constituents, such as radium-226 (^{226}Ra), to benign levels that are indistinguishable from the background concentration in river water. The response to Comment 7 also describes how the Colorado River acts as a regional sink for groundwater in both the alluvium and the Shire member of the Wasatch on both sides of the river, which eliminates any possible exposures in Wasatch Formation sediments south of the river. Given that the north bank of the river coincides with the south boundary of the IC area, selection of a POC well directly south of the former mill site appears impractical.

DOE Action Planned: DOE will expand the discussion of proposed POC wells in the GCAP.

NRC Comment 11: DOE selected a reference dose (RfD) for vanadium (0.0009 mg/kg-d) that has been under review since 2011 and is an order of magnitude less the value that would be obtained from the Integrated Risk Information System (IRIS).

- **Basis:** A reference dose for vanadium that has been under review since 2011 was selected rather than, as will all other COC's, selecting the current value from IRIS. If the current value from IRIS is selected, then the maximum RBC (1.74 mg/L) would be approximately equal to the maximum observed in persistent ponds (1.68 mg/L) and substantially less than the maximum observed in upgradient groundwater (14.3 mg/L). The proposed vanadium ACL of 52 mg/L would be much higher than the maximum RBC.
- **Path Forward:** Provide a basis for using a reference dose that is under review, including a plan to revise the vanadium RBC if the under review reference dose is not formally adopted. Demonstrate how the proposed vanadium ACL of 52 mg/L will result in concentrations at the POE that will not exceed the RBC.

DOE Response 11: If the current IRIS RfD were used to calculate a maximum RBC, that RBC would be an order of magnitude higher than the one included in the GCAP (i.e., 174 mg/L). DOE

used the lower RfD to be more conservative and more protective in the evaluation. The RfD is essentially the maximum safe intake of a chemical. The lower the RfD, the lower the concentration that is considered safe. If the lower RfD is adopted by EPA, pending completion of their review of vanadium, results of the GCAP evaluation should still remain valid.

DOE Action Planned: The use of a conservatively lower RfD for vanadium, though the value is still under review, will be clarified in the GCAP.

NRC Comment 12: DOE's groundwater monitoring program indicates that downgradient monitoring wells will be analyzed for ammonia, nitrate, molybdenum, and uranium only, as other COCs have never been detected in the wells. Other far-downgradient wells may be eliminated or monitored less frequently. DOE also indicated that if monitoring indicates that the plume has spread beyond current plume boundaries that the sampling plan can be reevaluated and adjusted. DOE did not provide adequate technical basis for the proposed compliance implementation strategy.

- **Basis:** The plan does not address why it is appropriate to eliminate slower moving contaminants from the monitoring program. Just because slower moving contaminants have not been observed to date, does not mean they are not expected to be observed in the future. DOE did not provide contaminant plume maps (such as those generated in 1992) to justify the current extent of contamination and therefore provide support for the proposed monitoring strategy. In addition, it is not clear how DOE would determine that the plume has spread beyond current boundaries if the monitoring system is not around the boundaries of the current plumes.
- **Path Forward:** Provide additional basis for removing the slower-moving contaminants from the monitoring program or otherwise include them. Provide contaminant plume maps demonstrating the current extent of contamination. Describe how the proposed monitoring system is sufficient to identify when the plume has spread beyond the current plume boundaries.

DOE Response 12: DOE is not proposing to eliminate the slower moving constituents completely from the monitoring network. DOE proposes to monitor for these constituents in onsite and immediately downgradient wells, including proposed POC wells, as well as in POE locations. If concentrations of slow-moving constituents begin to increase in downgradient wells, these constituents will be added as analytes in the farthest downgradient wells in the monitoring network. Suggested changes for the analyte list are based on cost efficiency—reducing field labor for sample collection and analytical costs, while maintaining the locations that will reveal constituent movement. Spot plots and time-concentration graphs for all COCs are provided in Appendix B.

DOE Action Planned: DOE will continue analyses for all analytes at all well locations.

NRC Comment 13: The dynamic nature of the groundwater flow in the alluvial aquifer was not adequately addressed in the report. A general description of the alluvial (e.g., groundwater occurrence, depth, flow direction, hydraulic conductivities, recharge, and groundwater interaction with the Colorado River) is provided in the report as part of its site conceptual model, but field groundwater level monitoring data and a detailed evaluation of ground water flow are not included or discussed in DOE's strategy.

- **Basis:** The GCAP provided by DOE indicates a significant transient nature of the groundwater flow and raises concerns about the ability of natural flushing as the groundwater remedial strategy for meeting site protection standards within the remaining compliance period at the site. This concern arises because the large increase in groundwater level (e.g., 5 ft or more) causes additional leaching of residual contamination located in the fine-grained materials as they become saturated. NRC staff is also concerned about the impact of an elevated water level in the Colorado River during each spring on the movement of the contaminated groundwater near the river and effectiveness of the natural flushing at the site. The groundwater discharges to the Colorado River along the southern site boundary. As the water level in the Colorado River rises above the water level in the adjacent aquifer during each spring, the groundwater reverses its flow direction near the river as the river begins to recharge the aquifer, which may create an immobile or stagnation zone in the alluvial aquifer along the river. This immobile zone with contaminated groundwater may adversely impact the site flushing strategy, with the extent of impact depending on the persistence of the immobile zone.
- **Path Forward:** Provide groundwater level measurement data collected from the site, including the elevation contour maps, and perform an evaluation on the spatial and temporal variation of groundwater flow. In order to evaluate the spatial and temporal characteristics of a potential immobile zone in the alluvial aquifer along the river, it may be necessary to collect additional water levels through installing multi-level piezometers near the river to assess the vertical hydraulic gradient.

DOE Response 13: It is important to point out that, in contrast to the mention of a flushing strategy in the Basis statement above, the compliance strategy described in the draft GCAP revision is ACLs with continued monitoring and institutional controls. Natural flushing is not part of the revised compliance strategy.

DOE believes that a detailed evaluation of changing water levels over time will not provide evidence for contaminant mobilization that has not already been described. The secondary sources exist in a variety of forms and are likely to be seen not only in the area of former milling activity or in fine-grained sediments above the coarser alluvium, but also in alluvial sediments that are relatively short distances downgradient of the former tailings and mill locations. There are no increased risks to human health or the environment resulting from the presence of secondary sources or from contact of groundwater with secondary sources during seasonal high-river flows in the Colorado River because the secondary sources are confined within the IC area.

The draft GCAP adequately described the effect of rising river levels each spring and early summer on concomitant changes to groundwater levels and how these seasonal influences are reversed relatively quickly as river flows return to those observed in nonsnowmelt months. The GCAP did not mention the formation of any stagnation or immobile zones in response to the seasonal high-river conditions, because no such zones are created. As stated in the draft GCAP,

the penetration of river water into the aquifer is limited to several tens of feet during the increase in river elevation. This is because the water entering the aquifer from the river is traveling at a much slower rate than the pressure pulse from the river that raises groundwater levels. In a previous study of the Old Rifle site, observations of the concentrations of constituents representative of river water at a well located about 100 feet from the river indicated that the river water never reached the well, including during a year of persistently high snowmelt runoff in the river. The flushing of groundwater contamination to the Colorado River begins again with the passage of spring snowmelt runoff in the river. If solid-phase contamination in fine-grained alluvium is mobilized as a solute as a result of the temporary increases in groundwater elevation, concentrations in the groundwater discharged to the river can also temporarily increase. A detailed study of how flow directions change in response to hydrologic stresses and contribute to a dynamic groundwater system will have no bearing on the "no remediation and ACLs" strategy that is proposed for the New Rifle site.

DOE Action Planned: Seasonal changes in groundwater level related to snowmelt and river flow and associated potential secondary sources of contamination will be described in more detail. However, the compliance strategy of no remediation with ACLs will not be impacted by the results.

NRC Comment 14: The discussion on the site conceptual groundwater flow model in the GCAP does not include any results of hydrogeologic investigation for the area across from the site (south of the Colorado River). There is no indication of presence of any monitoring wells (e.g., Figure 4).

- **Basis:** As illustrated in Figure 5 of the GCAP, the site alluvial aquifer is recharged at the east site boundary from the Colorado River. The aquifer also may receive a significant amount of water from the Wasatch Formation along its north border. There is possibility that part of the impacted groundwater in the alluvial aquifer from the site may migrate underneath the Colorado River, depending on the magnitude of groundwater hydraulic gradients in the alluvial aquifer system. It's not clear whether this hypothesis has been addressed.
- **Path Forward:** Submit results or analysis from previously conducted site hydrogeologic characterization of the alluvial aquifer in the area south of the river, if they exist, and demonstrate that the impacted groundwater from the site will not likely migrate off site and impact the alluvial aquifer across the river. Otherwise, install monitoring wells to determine the groundwater flow and other hydraulic parameters if necessary (also see RAI Comment 10).

DOE Response 14: As discussed in the DOE response to Comments 7 and 10, the Colorado River acts as a sink for all alluvial and Wasatch Formation groundwater in an expansive region encompassing the New Rifle site. This includes the groundwater flowing northward to the river in the Wasatch Formation on the river's south side, beneath Taugenbaugh Mesa. This discharge mechanism, from both sides and beneath the river, assures that contaminants beneath the New Rifle site will not flow under the river and impact alluvium on the river's south bank. The sharp escarpment on the river's south side consists of the Taugenbaugh Mesa and Mancos Shale formations. No alluvium is present on the river's south bank above the river stage. This observation is illustrated in the geologic cross section presented in Figure 5-9 of the SOWP. As

a result, there is virtually no alluvial groundwater south of the river that could receive contamination from river underflow.

DOE Action Planned: The hydrogeologic setting for the south side of the river will be given a more detailed description in the GCAP.

NRC Comment 15: The subsurface contamination source at the site is not adequately characterized. The current concentrations of chemical of concerns in the groundwater based on the on-site monitoring wells have not been decreasing at the originally projected rate after a decay of monitoring. High levels of contaminant concentrations are persistent in the groundwater in the source areas at the site (e.g., wells 0855 and 0658). As discussed in the DOE GCAP, the previous removal of tailings and contaminated surface soils and other materials based on radium-226 cleanup standard have left elevated levels of arsenic, molybdenum, selenium, uranium, and vanadium beneath the former tailings piles and other areas (e.g., former evaporation, gypsum and vanadium ponds). There has a limited investigation conducted to understand the magnitude and extent of this residual soil contamination at the site.

- **Basis:** The currently proposed ACLs as discussed in the GCAP were based on a statistical analysis of groundwater monitoring data from source area of the site. As indicated by the GCAP, NRC-approved ACLs for Title II sites are most commonly set based on maximum groundwater concentrations associated with source areas at a site. The source term for all contaminants of concern is required to be adequately characterized (NRC 2003), which should provide reliable estimates of the release rates of hazardous constituents. Given the limited characterization of the residual contamination source and geochemical process in the aquifer system, a further definition of the contamination source term and understanding of geochemical reactions in the aquifer may help evaluate the natural flushing strategy and increase the confidence on the proposed ACLs for the site.
- **Path Forward:** Conduct a targeted field soil sampling in the source areas at the site to further define the magnitude and extend of contaminants, including arsenic, molybdenum, selenium, uranium, and vanadium.

DOE Response 15: In response to the mention of a natural flushing strategy in the basis portion of this comment, it bears repeating that this GCAP is not proposing a flushing approach to compliance. Rather the proposed strategy is ACLs with continued monitoring and institutional controls.

The reasons for the persistence of relatively high contaminant concentrations associated with former source areas (i.e., tailing piles and mill-related ponds) were described in the SOWP and other investigations of groundwater at the New Rifle site, such as the 2010 analysis of vanadium contamination beneath the former mill site (DOE 2010). Sections 4.5 through 4.5.2 of the SOWP (DOE 1999) discusses the methods used to collect subpile soil samples in 1996 and determine their weight-per-unit-weight concentrations of arsenic, molybdenum, selenium, uranium and vanadium. The investigation involved the collection of three samples, one each from three boreholes. Two of the boreholes were drilled close to well 0658 in the former footprint of the tailings pile and the third was near well 0216, in the center of the former evaporation ponds. The derived concentrations suggested that continued leaching of the subpile soils would produce elevated aqueous concentrations of the evaluated contaminants for many years. The precise mechanisms by which mobilization of the contaminants would occur were not identified.

Though geochemical reactions might be involved in the release of contaminants from the solid phase to the aqueous phase, there are many mechanisms, some of which are strictly physical, that are potentially responsible for mobilizing dissolved forms of contamination. Most of these are typically slow processes relative to the total time required to completely remove the solid-phase constituents.

DOE agrees that it is important to identify release rates from the secondary sources underlying the former mill site. Unfortunately, it has been DOE's experience that such rates cannot be adequately quantified from laboratory studies or at the experimental-plot scale encompassing 2500 square feet or less. Instead, the release rates become more evident through the modeling of contaminant transport at the site scale, using trial-and-error methods to identify which source-term parameters produce plumes that approximate those observed in the field. The flow and transport model that was used to match observed uranium plume movement in support of the SOWP (Appendix D in DOE 1999) was calibrated by attempting to match uranium concentrations collected at the Roaring Forks gravel pond between October 1991 and January 1999. Unfortunately, the method used to simulate source releases and the resulting release rates for uranium were not identified.

Quantification of source terms in groundwater transport is further complicated by the fact that release rates typically vary over time, both in response to changing solid-phase concentrations and total volume as well as seasonal or yearly variations in hydrologic conditions. Accordingly, as suggested in this NRC comment, it is important to identify and quantify the extent (i.e., volume) of the contaminants as well as the concentration magnitudes that characterize the source term. The methods applied in the SOWP (DOE 1999) to measure subpile source concentrations at the site were not intended to produce reliable estimates of source volumes or total source mass.

Further detailed studies of the physical and geochemical phenomena associated with slow contaminant mobilization will not change the general conclusion that contaminant concentrations are likely to exceed applicable standards for many decades in the future, and that a compliance strategy of no remediation and ACLs makes the most sense for the New Rifle site.

DOE Action Planned: DOE will develop a more-detailed description of methods used to quantify subpile soil concentrations at the New Rifle site and the calculated results.

3.0 References

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