Department of Energy
Office of Legacy Management

DEC 2 9 2005

WM-62

Mr. William Von Till
U.S. Nuclear Regulatory Commission
Mail Stop: T8A33
11545 Rockville Pike
Two White Flint North
Rockville, MD 20852-2738

Subject: *The Ground Water Compliance Action Plan (GCAP) for the New Rifle, Colorado, Processing Site*

Dear. Mr. Von Till:

Enclosed for your review are two draft copies of the *Ground Water Compliance Action Plan (GCAP) for the New Rifle, Colorado, Processing Site.* We have incorporated previous comments from you and the Colorado Department of Public Health and Environment. In addition, we have reevaluated the current risks in light of the institutional controls implemented at the site and have modified the document accordingly.

Please return your comments as soon as possible or give me a call to discuss them. If you need extra copies or other information, you may contact me at (970) 248-6073.

Sincerely,

Richard P. Bush

Richard P. Bush
Site Manager

Enclosures (2)

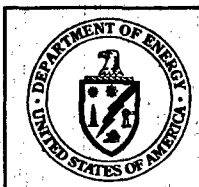
cc w/o enclosures:
R. Dayvault, Stoller
Project File RFN 110.02 (D. Roberts)

Bush/MrVonTillGCAP.doc

DOE–LM/GJ942–2005

Ground Water Compliance Action Plan for the New Rifle, Colorado, Processing Site

December 2005



U.S. Department of Energy

Office of Legacy Management

Work Performed Under DOE Contract No. DE–AC01–02GJ79491
for the U.S. Department of Energy Office of Legacy Management.

DOE-LM/GJ942–2005

Ground Water Compliance Action Plan for the New Rifle, Colorado, Processing Site

December 2005

Work Performed by S.M. Stoller Corporation under DOE Contract No. DE-AC01-02GJ79491
for the U.S. Department of Energy Office of Legacy Management, Grand Junction, Colorado

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Executive Summary

The New Rifle site is one of 24 former uranium-ore processing sites identified in the Uranium Mill Tailings Radiation Control Act of 1978 for study and potential remedial action. The site is located in western Colorado approximately 2.3 miles west of the City of Rifle, Colorado. The U.S. Department of Energy (DOE) completed surface remediation at the site in 1996 in compliance with regulatory requirements. Ground water in the surficial aquifer at the site is contaminated as a result of historical processing of uranium and vanadium ore. This *Ground Water Compliance Action Plan for the New Rifle, Colorado, Processing Site* (GCAP) serves as a stand-alone document from DOE to the U.S. Nuclear Regulatory Commission (NRC) for their concurrence in the proposed compliance strategy.

DOE conducted studies from 1997 to 1999 at the New Rifle site to understand the types, distributions, interactions, and movement of contaminants in ground water and to evaluate the risks to human health and the environment from these contaminants. A site conceptual model incorporating results of the studies was used to propose a compliance strategy for the site. On the bases of these results, additional studies regarding vanadium behavior were conducted (DOE 2000, 2002a, and Appendix D). Consistent with the observational approach and U.S. Environmental Protection Agency guidance (EPA 1991), DOE reexamined the human health and ecological risks and the site conceptual model again in 2004 and 2005 after implementing institutional controls (ICs). Based on this evaluation, DOE proposes a compliance strategy for the contaminants of concern (COCs) that will be protective of human health and the environment. This strategy is natural flushing of the five COCs - arsenic, molybdenum, nitrate, selenium, and uranium - in combination with ICs and continued monitoring.

ICs have been established for real estate properties within the areal extent of the ground water contaminant plumes. The controls are legal administrative actions consisting of a deed restriction covering the former millsite property and city and county ordinances restricting the use of contaminated ground water. Garfield County requires owners of property within the IC boundary to provide proof of a source of potable water in order to develop the property. The County also established a drinking water constraint zone within the IC boundary in which any source of water intended for human consumption must meet applicable standards. The City of Rifle requires residents within the IC boundary to tap into the municipal water system if the property is annexed to the city. To compensate property owners for limiting the beneficial uses of the ground water, DOE funded two water line extensions to the current municipal system to ensure the availability of potable water to properties affected by site-related contamination. Because the second water line extension did not cover the full extent of the IC boundary, DOE has provided reverse osmosis systems for alluvial ground water users within the IC boundary but beyond the reach of the water line. In addition, an environmental covenant will prohibit livestock access to water in the former Roaring Fork ponds.

Continued monitoring consists of sampling 22 monitor wells and one domestic well until COC concentrations have decreased to their respective maximum concentration limits or background levels. Eight surface water locations will be sampled to confirm that site-related contamination does not have an adverse impact on any complete exposure pathways.

For the purpose of evaluating natural flushing at the New Rifle site, wells in the monitoring network were placed into three groups on the basis of geochemical and hydrological characteristics of the area. The first group represents ground water on site, the second group represents ground water between the site and the Roaring Fork ponds, and the third group represents ground water downgradient of the Roaring Fork ponds. Background locations will continue to be sampled. Samples of treated and untreated water will be collected at private wells in the alluvial ground water system where reverse osmosis units were installed. Wells where vanadium concentrations are highest have been sampled twice per year since 2002 as a best management practice and will continue to be sampled for 2 years following transmittal of this GCAP to the NRC. After that time, DOE will reevaluate monitoring at all wells to determine if sampling frequencies and the number of sampling locations should be modified.

1.0 Introduction

This Ground Water Compliance Action Plan (GCAP) will serve as a stand-alone modification to Section E.3.6 of the *Final Remedial Action Plan and Site Design for Stabilization of the Inactive Uranium Mill Tailings Sites at Rifle, Colorado* (DOE 1992) and is the concurrence document for compliance with Subpart B of Title 40 *Code of Federal Regulations* Part 192 (40 CFR 192) for the New Rifle site.

The New Rifle site is one of two former uranium-ore processing sites at Rifle, Colorado, assigned to the U.S. Department of Energy (DOE) Office of Legacy Management.

2.0 Site Information

2.1 Location

The New Rifle site is located approximately 2.3 miles west of the city of Rifle in Garfield County, Colorado. The 142-acre site, which is accessible by U.S. Highway 6, is the location of a former vanadium and uranium mill that operated from 1958 through 1984. It is adjacent to and north of the Colorado River near the northeastern edge of the Colorado Plateau physiographic province.

2.2 Remedial Action History and Current Land Status

Surface remedial action at the site began in 1989 and was completed in 1996. All tailings, residual radiological materials, and associated process buildings and structures were removed from the site and disposed of offsite in the Rifle Disposal Site approximately 6 miles north of the New Rifle Processing Site. Investigations of the site ground water began in 1997. During ground water characterization and preparation of the Site Observational Work Plan (SOWP) (DOE 1999), it was determined that site-related contaminant plumes affected ground water downgradient of the site on private land. Because the alluvial aquifer is used as a source of drinking water from private wells in and around the Rifle area, it was determined that controls were needed to prevent the use of contaminated ground water. Restrictions were placed on the use of on-site and downgradient contaminated ground water (see Section 3.1.1) and will remain in effect in perpetuity. A restriction on subsurface disturbance is also in effect for the site itself. DOE transferred the site property to the City of Rifle in 2004. Downgradient properties are privately owned. All property affected by site-related ground water contamination is zoned agricultural/industrial.

2.3 Hydrology

The site is located on an alluvial floodplain that consists of a complex interfingering of fine- and coarse-grained materials composed of sand, silt, gravel, and cobbles, with a thickness of 20 to 30 feet (ft). Depth to ground water ranges from 5 to 10 ft below land surface. The alluvium directly overlies an 8- to 13-ft-thick section of weathered Wasatch Formation claystone that appears to be hydraulically connected to, and of similar hydraulic characteristics as, the finer-grained portions of the alluvium. Saturated thicknesses generally range from 10 to 20 ft in the vicinity of the site.

Surface water features at or near the New Rifle site include the Colorado River, the Roaring Fork gravel ponds, a mitigation wetland, the Pioneer irrigation ditch, several unnamed, intermittent tributary streams that drain toward the Colorado River, and the city of Rifle wastewater treatment ponds. Some of these features are shown on Figure 1.

The Colorado River forms the southern boundary of the New Rifle site and is the dominant surface water feature, ultimately receiving most of the surface drainage from the site. Precipitation falling on the site drains south directly into the river and into the mitigation wetland pond south of the site. During periods of low river flow, the river also receives ground water discharge from the alluvial aquifer along the southern portion of the site.

Ground water beneath the site generally flows in a west to southwest direction with a hydraulic gradient ranging from 0.0019 to 0.004 ft/ft. Hydraulic conductivity ranges from 53 to 275 ft/day and averages 114 ft/day. Recharge to the alluvial aquifer occurs mostly as infiltration of precipitation, leakage from the intermittent tributaries and Pioneer Ditch north of US Highway 6, and inflow from the Colorado River, especially along the north-south reach of the river east of the site; the river appears to be a ground water recharge source throughout most of the year. During spring runoff in May and June, the Colorado River also temporarily recharges the alluvial aquifer along the southwestern portion of the site when high river flows start to exceed ground water elevations in the alluvial aquifer.

Wells in the monitoring network associated with the New Rifle site can be placed into one of three groups in which the ground water was affected by distinctly different hydrological and geochemical processes.

Wells in the first or on-site group (0215, 0216, 0658, 0659, 0664, 0669, and 0670) represent ground water that was in direct contact with the primary source at the site (tailings and processing fluids) and that continues to interact with residually contaminated soils. Though soil was cleaned up to meet radiological criteria, it is known that other constituents, particularly vanadium, remain in the subsurface soils in areas where former disposal/evaporation ponds were located. Likewise, soil sampling in the vicinity of the former tailings piles conducted for preparation of the SOWP indicated the presence of some soils contaminated by the migration of fluids from the piles. Ground water from this group of wells may therefore be affected by interactions of ground water with the soil matrix. Large fluctuations in ground water concentrations were observed in wells in this area for some contaminants in response to subsurface disturbances during surface remediation and operation of the vanadium pilot study (DOE 2000; DOE 2002).

Wells in the second group (wells 0201, 0217, 0590, and 0635) are adjacent to and downgradient of the site and upgradient of the Roaring Fork ponds. These wells represent ground water contaminated by off-site migration of contaminants from the site. This ground water was contaminated strictly by downgradient movement of constituents through the ground water system. These wells could also have been affected by disposal of effluent from the pilot study operation; an infiltration gallery was located just west of the southwest site boundary during pilot study operation.

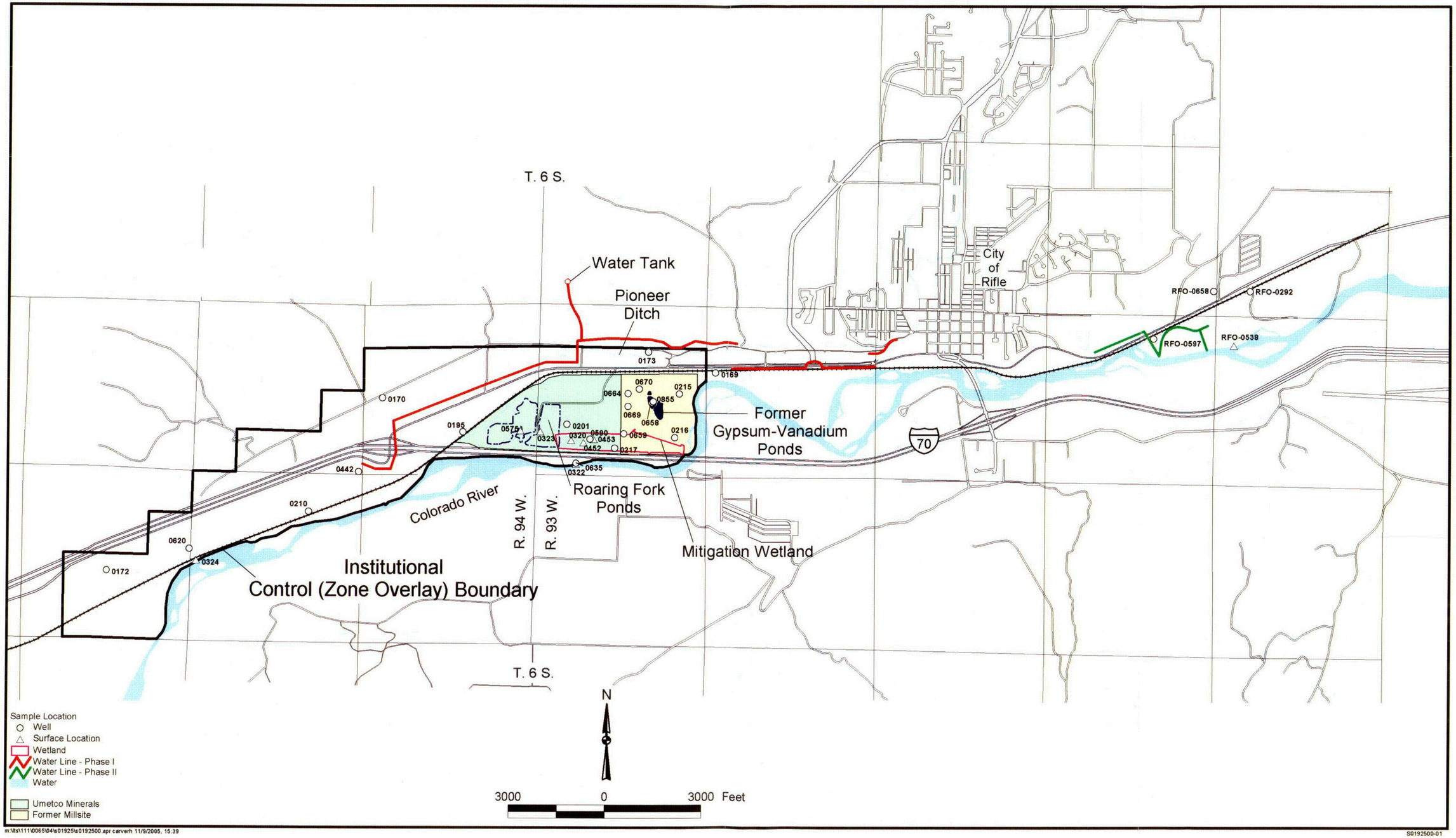

Figure 1. Physical Features, Sample Locations, and Institutional Controls Boundary

Wells in the third group (wells 0170, 0172, 0195, 0210, and 0620) are located downgradient of the Roaring Fork ponds and have been historically somewhat isolated from the wells in the second group because of historical gravel-mining operations at the Roaring Fork ponds. The process of pumping ground water from one pond and discharging it to the adjacent pond as part of the mining operation caused decreased ground water flow in some areas and mounding of ground water in others, which essentially created a divide in the ground water system in this area. Ground water flows were disrupted, and some separation of the main ground water plume took place. Movement and attenuation of constituents in ground water upgradient from the gravel operation have therefore occurred under different sets of conditions than those downgradient.

Though the Roaring Fork gravel mine closed down in 2003, its past operations have had a lasting effect on contaminant patterns downgradient of the site. It is therefore useful to consider wells from these three groups separately in evaluating and interpreting contaminant trends and distributions in ground water.

2.4 Contaminants of Concern

2.4.1 Ground Water

Ground water beneath the New Rifle site was contaminated by former vanadium and uranium ore-processing operations that were ongoing from 1958 through 1972, from lignite ash processing from 1964 to 1967, and from vanadium processing (which did not produce tailings but may have produced milling solutions) from 1973 to 1984. Site field investigations have shown that the alluvial aquifer is the only aquifer affected by the former milling operations. Constituents in the alluvial aquifer with concentrations that exceed ground water standards of 40 CFR 192 are arsenic, molybdenum, nitrate, selenium, and uranium. From a compliance standpoint, these are considered to be the ground water contaminants of concern for the site.

In the SOWP and the initial draft of the GCAP, ammonia, fluoride, manganese, and vanadium were also considered to be COCs. For the purposes of developing final remediation goals for the site, they have been dropped on the bases of the following considerations. Initial risk-based COCs were developed from the 1996 human health risk assessment (DOE 1996a), which assumed untreated ground water could be used for drinking water in a residential setting. This was a plausible use of ground water at the time, but since then, institutional controls have been implemented that prevent anyone from drinking contaminated water. Therefore, the only currently complete exposure pathways are where ground water is present at the surface. Potential human health and ecological risks for those pathways are discussed in section 2.5.1. Identification of COCs is based solely on the ground water regulations and maximum concentration limits (MCLs) established by 40 CFR 192. For selenium, the maximum background value of 0.036 milligrams per liter (mg/L) was substituted for the 40 CFR 192 value of 0.01 mg/L. COCs previously identified based on risk—ammonia, fluoride, manganese, and vanadium—which have no MCL under 40 CFR 192, were dropped as compliance-based COCs. However, because of the known presence of site-related vanadium in subsurface soils (DOE 2000, 2002) and its potential for remobilization, a "no disturbance area" for on-site vanadium-contaminated soils was established and agreed upon by the City of Rifle. This additional institutional control will allow vanadium concentrations to attenuate. For the time being, vanadium is included in the ground water monitoring requirements of the site as a best management practice.

2.4.2 Surface Water

Ground water from the site discharges to the wetland area, Roaring Fork ponds, and the Colorado River. These areas represent the only complete pathways to site-related contamination. Concentrations of nitrate, molybdenum, and uranium have been identified in the wetland area and Roaring Fork ponds are elevated compared to background and are considered to be the surface water COCs for risk assessment purposes. In 2005, the nitrate concentration for location 0323 was 120 mg/L (nitrate plus nitrite expressed as nitrogen); the concentration at location 0575 was 11 mg/L. Concentrations in the wetland area were as high as 250 mg/L. Uranium concentrations for March 2005 were 0.23 mg/L at surface location 0323 in the eastern pond and 0.056 mg/L at surface location 0575 in the western pond. The highest concentration in the wetland was 0.20 mg/L. Molybdenum in a sample from location 0323 had a concentration of 1.7 mg/L, and a sample from location 0575 contained 0.35 mg/L molybdenum. Wetland concentrations ranged up to 2.9 mg/L molybdenum. By contrast, surface water samples collected from the Colorado River adjacent to the site were indistinguishable from background.

2.5 Risk Assessments

A recent evaluation of the Roaring Fork ponds was performed to determine potential human health and ecological risks associated with these complete exposure pathways. The gravel operation ceased in 2003, and the area containing ponds has been reshaped into two ponds. This should be the permanent configuration for this historical gravel business. One monitoring location has been established in each pond.

2.5.1 Potential Human Health Risks

To complete the human health risk calculations, it was assumed that a child (the most sensitive receptor) would use the ponds for swimming (maximum exposure) on a regular basis and would be exposed to contaminants through both dermal contact and incidental ingestion. Table 1 provides risk calculations and exposure assumptions. Highest concentrations observed in pond samples since January 2000 were used in the calculation to represent a worst-case scenario. Based on standard EPA protocols (hazard index [HI] less than 1 for noncarcinogens and risks less than 10^{-6} for carcinogens), potential recreational use of the ponds by humans would pose no unacceptable risks. Therefore, no restrictions need to be placed on human use of the ponds.

2.5.2 Potential Ecological Risks

A qualitative ecological assessment was performed by comparing 2005 data with established benchmarks for nitrate, molybdenum, and uranium (the only constituents that have migrated from the millsite to the two Roaring Fork ponds). Data from numerous state agricultural extension agencies indicate that a generally safe level of nitrate in drinking water for livestock is about 100 mg/L as N. According to the preamble published in the *Federal Register* along with the final ground water rule (40 CFR 192, published at 60 FR 2854), molybdenum concentrations higher than 0.5 mg/L in water could cause toxic effects in cattle. This is the same guideline established by other agricultural agencies (e.g., Agriculture and Agri-Food Canada-Prairie Farm Rehabilitation Administration). There are no widely agreed upon ecological benchmarks for uranium in surface water for terrestrial receptors; most established benchmarks are for aquatic species. However, a Canadian agricultural guideline for uranium in livestock water is 200 micrograms per liter (µg/L) or 0.2 mg/L (www.agr.gc.ca/pfra/water/livestck_e.htm).

Table 1. Update to Risk Assessment in the Roaring Fork Ponds Area

$$\text{Intake} = \frac{CW \times IR \times EF \times ED}{BW \times AT}$$

where[1]:

Intake is in (mg/kg-d)
CW = chemical concentration in water (mg/L); site-specific
IR = ingestion rate (L/d); 1 L/day adult
ED = exposure duration (years); 30 yrs for adult;default
EF = exposure frequency (d/yr); 250 days/yr; default
BW = body weight (kg); 70 kg adult; default
AT = averaging time; ED x 365 d/yr non-carc., 70yr x 365 d/yr carc.

Hazard Quotient (HQ) = Intake/Reference Dose (RfD)
Risk = Chronic Daily Intake (averaged over 70 years) x Slope Factor
For radionuclides, Risk = SF x CW x IR x EF x ED (slope factor accounts for average lifetime risk); concentrations expressed in pCi/L

Contaminant	Cw-max* mg/L	Sa cm2	Pc cm/hr	Cf L/cm3	ET hr/d	EF d/y	ED yr	IRw L/d	BW kg	AT d	Ingested mg/kg-d	absorbed mg/kg-d	Total dose mg/kg-d	RfD mg/kg-d	HQ mg/kg-d
Nitrate	120	497	0.001	0.001	1	114	7	0.05	38.3	2555	0.049	0.000	0.0494	7	0.007
Molybdenum	1.7	497	0.001	0.001	1	114	7	0.05	38.3	2555	0.001	0.000	0.0007	0.005	0.140
Uranium	0.23	497	0.001	0.001	1	114	7	0.05	38.3	2555	0.000	0.000	0.0001	0.003	0.032
														HI max =	0.179

Carcinogens - Surface Water Ingestion Only (Adults)

Contaminant		CW-max	IR	EF	ED	BW	AT	Intake	SF**	Risk
U234+238 (pCi/L)	max	157.78	0.05	114	7	na	na	6.30E+03	5.32E-11	3.35E-07

Surface Water Incidental Ingestion/Dermal Exposure Pathways--Children
*Data based on results of sampling events since 1/2000
**Reference Doses (RfD) and Slope Factors (SF) from best available EPA sources

Based on 2005 data, concentrations of all three surface water COCs exceeded benchmark values in the Roaring Fork ponds and wetland area. Because land is zoned for agriculture in this area, livestock grazing is a viable future land use. For this reason, the environmental covenant between the State of Colorado and Umetco Mineral Corporation (the current owner of the parcel containing the Roaring Fork ponds) will prohibit the use of the alluvial aquifer ground water, including the Roaring Fork ponds, for stock watering purposes. Fencing of the ponds is likely.

Water in the wetland area would not be a major source of livestock or wildlife watering, particularly with the proximity of the Colorado River. However, It is expected to attract some amount of wildlife as it redevelops. A large portion of the New Rifle wetland has been reconstructed over the last several years including the oxbow lake section. Although construction is complete, site-related contamination has limited the types of vegetation that have been able to establish in the area. Undoubtedly the same limitations will affect aquatic organisms as well. However, as contamination decreases through time, the New Rifle wetland can be expected to support a greater variety of plant and animal species. Thus, site-related contamination probably represents more of a short-term hindrance to wetland species diversification than a threat to existing viable populations. Risks associated with the New Rifle wetland are generally low, especially in terms of probable population effects. The most recent Section 404 permit monitoring report concludes that the New Rifle wetland has acquired a net gain in wetland area that is of higher quality for wildlife than undisturbed wetlands and a greater total area than required in the permit (DOE 2005b). The 2005 report also requests termination of the 404 permit.

In summary, currently complete exposure pathways pose no unacceptable risk to either human or ecological receptors. No evidence has been observed to date that site-related contamination has resulted in environmental degradation. Risks would be expected to decrease further as contaminant concentrations naturally flush. Based on this analysis, the only driver for ground water remediation at the New Rifle site is the achievement of regulatory standards. Current site conditions, which incorporate the use of ICs, are protective of human health and the environment for present and projected future site uses.

2.6 Evaluation of Natural Flushing

An evaluation was completed to determine whether natural flushing alone would successfully remediate the alluvial aquifer within the permitted 100-year period. Results of ground water contaminant transport modeling using the U.S. Geological Survey MODFLOW software package (Harbaugh and McDonald 1996) and the MT3D transport code (Zheng 1990) are presented in Section 5.0 and Appendix D of the SOWP (DOE 1999). These codes are fully described in the references cited and have been verified, benchmarked, and approved for use by most government and regulatory agencies. Predicted concentrations for arsenic, molybdenum, nitrate, selenium, and uranium after 100 years of natural flushing are summarized here. The modeling did not include the influence of the Roaring Fork gravel ponds; however, the gravel-mining operation ceased production in 2003. Modeling was performed using data through January 1999.

2.6.1 Ground Water Modeling and Changes to COCs

Ground water modeling using MODFLOW-96 (Harbauth and McDonald 1996) was performed in 1999 for arsenic, molybdenum, nitrate, selenium, and uranium. Table 2 shows the predicted times for natural flushing to reduce concentrations of these constituents to levels at or below the remediation goals.

Appendix B shows plume maps generated in 1998 for arsenic, molybdenum, nitrate, selenium, and uranium. Nitrate was reported as NO_3 instead of nitrate plus nitrite as nitrogen. Appendix B also contains spot plots for all COCs generated from the March 2005 sampling results. DOE currently reports both ammonia and nitrate as N (multiply ammonia reported as NH_4 by 0.776; multiply nitrate reported as NO_3 by 0.226). Comparing plume maps from 1998 and spot plots from 2005 provides the easiest method of observing areal changes in the distribution of COCs.

Table 3 shows concentrations of these COCs in the main portion of the plume from the time of data collection to just before the start of surface remedial action (1987–1994), just after remedial action (which was completed in 1996) and during preparation of the SOWP (1998–1999), and from the March 2005 sampling data. Table 3 shows that, except for selenium, COC concentrations have decreased since surface remedial action.

Original plume maps developed for the New Rifle SOWP in 1998–1999 are shown in Appendix B of this GCAP. Also in Appendix B are 2005 COC spot plots for all of the wells currently being sampled.

Table 4 shows the March 2005 COC concentrations, maximum background concentrations, and the concentration limits to be used for remediation goals at the New Rifle site. The following discussion is based on results from the most recent (March 2005) sampling round.

Table 2. Predicted Time for Natural Flushing to Reduce COC Concentrations to Remediation Goals

COC	Maximum Concentration Detected in March 2005 (mg/L)	Remediation Goal (mg/L)	Predicted Time to Reach Remediation Goal	Comments
Arsenic	0.42	0.05[a]	20 years	Modeling result is consistent with observed decreases to date. Arsenic concentrations exceed the 40 CFR 192 MCL in only two wells (0855 and 0659).
Molybdenum	6.3	0.1[a]	25 years	Background conc. of 0.019 mg/L used for modeling. Concentrations in background wells are all below the MCL.
Nitrate (NO_3+NO_2 as N)	130	10 (as N)[a]	10 years	Modeling did not account for geochemical and biological reactions that could affect nitrate behavior (ammonia oxidizing to nitrate). Conservative approach used; concentrations expected to be below MCL well within 100 years.
Selenium	1.4	0.036 (or max. bkg. Value)	About 100 years or less	Because background values have ranged up to 0.036 mg/L, compliance will be achieved when site ground water concentrations are within the range of max. background.
Uranium	0.32	0.067 (or max. bkg. value)	40 years	Because background values have ranged up to 0.067 mg/L, compliance will be achieved when site ground water concentrations are within the range of max. background.

[a]MCL in 40 CFR 192

Table 3. New Rifle Site Ground Water Chemistry Trends

COC	Historical Range (1987–1994)	Mean	SOWP Range (1998–1999)	Mean	Current Concentration (March 2005)	Mean	Difference of Means, Historical to Current	Difference of Means, SOWP to Current
As	0.97–1.3	1.1	0.0001–0.304	0.0391	0.0001–0.42	0.027	–1.07	–0.012
Mo	2.3–3.7	2.9	0.010–6.84	2.2	0.0016–6.3	1.07	–1.83	–1.13
NO_3+ NO_2 as N	124–251	177	0.02–73	5.6	0.01–130	22	–155	+16.4
Se	0.005–0.2	0.06	0.001–0.782	0.09	0.00023–1.40	0.109	+0.049	+0.019
U	0.24–0.37	0.29	0.010–0.395	0.11	0.013–0.32	0.083	–0.207	–0.027

Notes: Wells 0169, 0173, 0195, 0201, 0215, 0216, 0217, 0590, 0635, 0644, 0658, 0659, 0669, 0670, and 0855 were used to show contaminant trends in the main millsite area because these wells have long-term data. The following substitute wells located closest to these wells were used for fluoride and selenium during the 1987 to 1994 time period because analyses were not available for these constituents at the other wells: 0584, 0587 (for 0659); 0590, 0594 (for 0658); and 0625 (for 0216). Wells 0172, 0210, and 0442 were added to evaluate downgradient migration of molybdenum, nitrate, and uranium.

For concentrations below detection limits, half of the detection limit was used.

All concentrations are in milligrams per liter.

Table 4. Concentration Ranges, Background, and Remediation Goals for COCs in Ground Water at the New Rifle Site

COC	Current Concentration (March 2005) (mg/L)	Maximum Background Conc. (mg/L)	Remediation Goal (mg/L)	Basis for Remediation Goal
Arsenic	0.0001–0.42	0.03	0.05	40 CFR 192 MCL
Molybdenum	0.0016–6.3	0.03	0.1	40 CFR 192 MCL
Nitrate (NO_3 + NO_2 as N)	0.01–130	5.22	10 (as N)	40 CFR 192 MCL
Selenium	0.00023–1.40	0.036	0.036	40 CFR 192 MCL is 0.01 mg/L; use max. background, currently 0.036 mg/L
Uranium	0.013–0.32	0.067	0.067	40 CFR 192 MCL is 0.044 mg/L; use max. background, currently 0.067 mg/L.

Arsenic concentrations at most wells are below 0.05 mg/L. Only three locations; 0855 at 0.42 mg/L, 0659 at 0.057 mg/L, and 0658 at 0.065 mg/L; exceed the EPA ground water standard of 0.05 mg/L. Mean arsenic concentrations have decreased by about 75 percent in millsite ground water during the past 15 years.

The maximum current molybdenum concentration is 6.3 mg/L in well 0658, located near the former tailings area and the former gypsum-vanadium evaporation pond. This value exceeds the EPA ground water standard of 0.1 mg/L. The plume extends off site in a west-southwest direction downgradient past the Roaring Fork ponds. The main downgradient extent of the molybdenum plume is in the vicinity of monitor well 0195, where concentrations were 0.29 mg/L during the March 2005 sampling event. Table 3 shows that mean molybdenum concentrations for the former millsite area are less than one-third of what they were before remedial action.

Nitrate (reported as nitrate + nitrite as nitrogen) contamination has migrated almost completely offsite in a west-southwest direction. The maximum nitrate concentration detected on site in the most recent sampling round was at well 0658, which measured 52 mg/L as N. In contrast, the highest off-site concentration was 130 mg/L in well 0590. This contaminant distribution indicates that the nitrate plume is flushing through the alluvial aquifer. Nitrate in the former millsite area decreased about 84 percent from pre-remediation to post-remediation time but has increased by a factor of five during the past 5 years (Table 3). This may be due to continuing oxidation of ammonia in this area. Another possible cause of the elevated nitrate is the continuing drought in the area that lowers the water table and allows greater oxidation of subsurface sediments.

The distribution of selenium contamination exceeding the 0.036 mg/L maximum background, which is the proposed cleanup level for alluvial ground water at the New Rifle Site, is generally confined to the site. This final cleanup level is proposed because natural background concentrations exceed the 40 CFR 192 standard of 0.01 mg/L. The maximum selenium concentration of 1.4 mg/L was detected at well 0659 in March 2005. This was an increase from the previous maximum concentration of 0.08 detected in December 2004. A cause for this significant increase is not readily apparent. Behavior of selenium in on-site wells will be carefully evaluated with data from future monitoring events.

Uranium contamination extends over the greatest area in the alluvial ground water. Uranium has migrated a significant distance off site past the Roaring Fork ponds (see Appendix B). The March 2005 maximum uranium concentration of 0.32 mg/L at well 0658 near the former raffinite pond is more than seven times the 40 CFR 192 standard of 0.044 mg/L (assuming equilibrium of the uranium isotopes) and almost five times the highest background concentration of 0.067 mg/L. Table 3 shows the overall decreasing trend for uranium during the past 15 years in the millsite area. Concentrations are down about 70 percent from historical highs and down about 20 percent since the SOWP was completed in 1999.

Vanadium was previously considered to be a COC (Appendix C). Considerable efforts were expended to determine if it could be removed from the ground water, and additional studies about its geochemical characteristics were also performed. A discussion of vanadium is provided in Appendix C. These studies have produced considerable local interest in this constituent, for this reason, vanadium is retained as an analyte for monitoring purposes as a best management practice. However, as previously mentioned, because no ground water standards have been established for vanadium, and institutional controls have been implemented to prevent exposure to humans and the environment, vanadium has been removed as a COC.

3.0 Ground Water Compliance

DOE developed the proposed compliance strategy for the New Rifle site from the compliance strategy selection framework described in Section 2.1 of the *Final Programmatic Environmental Impact Statement for the Uranium Mill Tailings Remedial Action Ground Water Project* (PEIS) (DOE 1996b) (Figure 2). The proposed action is based on information presented in he SOWP (DOE 1999) and further studies conducted on vanadium in the alluvial aquifer at the site.

DOE followed the PEIS ground water compliance strategy selection framework summarized in Figure 2 in selecting the appropriate compliance strategy to clean up ground water in the uppermost aquifer affected by former ore-processing activities at the New Rifle site. The uppermost aquifer is the alluvial aquifer at New Rifle. The compliance strategy focuses on COCs retained for further evaluation after completion of the updated (2004/2005) human health and ecological risk evaluation processes.

The proposed compliance strategy for the alluvial aquifer at the New Rifle site is natural flushing to EPA MCLs established in 40 CFR 192 for applicable contaminants and with the implementation of institutional controls and continued monitoring. An explanation of the targeted strategy process is summarized in Table 5.

3.1 Compliance Strategy Selection

Ground water modeling and observed contaminant trends support the conclusion that natural attenuation processes can result in decreased contaminant concentrations in the ground water. It is anticipated that MCLs or background concentrations can be met within the 100-year time frame permitted for natural flushing in 40 CFR 192. DOE has determined that natural flushing combined with ICs and continued monitoring is the appropriate compliance strategy for remediation of all contaminants at the New Rifle site. This approach will be protective of human health and the environment.

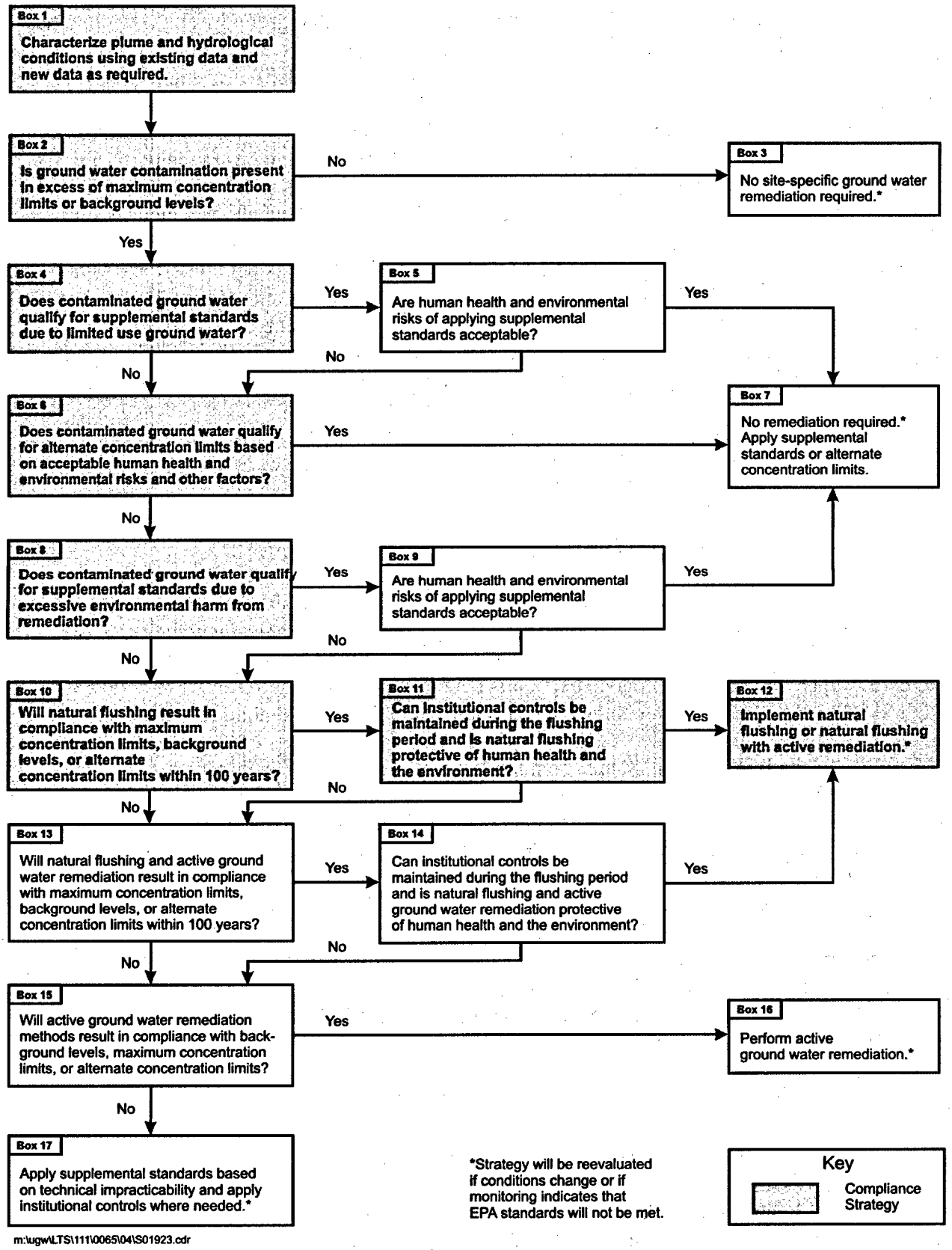

Figure 2. Compliance Strategy Selection Framework for the New Rifle Site

Table 5. Explanation of Compliance Strategy Selection Process

Box (Figure 1)	Action or Question	Result or Decision
1	Characterize plume and hydrological conditions.	See conceptual site model presented in Section 5.0 and contaminant screening presented in Section 6.0 of the New Rifle SOWP. Move to Box 2.
2	Is ground water contamination present in excess of 40 CFR 192 MCLs or background?	Arsenic, molybdenum, nitrate, selenium, and uranium exceed the 40 CFR 192 MCLs at one or more monitoring points. Move to Box 4.
4	Does contaminated ground water qualify for supplemental standards due to its classification as limited use ground water?	Alluvial ground water is a potential source of drinking water and therefore is not classified as limited use. Move to Box 6.
6	Does contaminated ground water qualify for alternated concentration limits (ACLs) based on acceptable human health and environmental risk and other factors?	Ground water does not currently qualify for ACLs on the basis of acceptable human health and environmental risk. Move to Box 8.
8	Does contaminated ground water qualify for supplemental standards due to excessive environmental harm from remediation?	Although the applicability has not been formally assessed, it is unlikely that remedial action would cause excessive harm to the environment. Move to Box 10.
10	Will natural flushing result in compliance with 40 CFR 192 MCLs, background, or ACLs within 100 years?	Ground water modeling shows that natural flushing will reduce these constituents to concentrations allowing unrestricted access within the 100-year time frame. Move to Box 11.
11	Can ICs be maintained during the flushing period and is natural flushing protective of human health and the environment?	The final compliance strategy is protective of human health and the environment. A zone overlay and City resolution will prevent use of water for the 100-year natural flushing period. Ground water can be used without restriction after 100 years and will be protective of human health and the environment at that time. Move to Box 12.
12		Implement natural flushing or natural flushing with active remediation. Natural flushing is selected.

3.1.1 Institutional Controls

ICs are restrictions that effectively protect public health and the environment by limiting access to a contaminated medium; at the New Rifle site, the medium is alluvial ground water. If natural flushing is to be protective of human health and the environment, ICs must be maintained during the flushing process to prevent improper use of the ground water. An institutional control boundary is shown on Figure 1.

A comprehensive ICs program was implemented to prevent future use of contaminated ground water associated with the New Rifle site (Appendix A, Parts A1 through A4). Regulators require ICs for the constituents that will flush to acceptable levels during the 100-year natural flushing period. The ICs program consists of a combination of legal administrative actions, including a deed restriction covering the former millsite property, and City of Rifle and Garfield County ordinances enacting zone overlays covering the extent of the contamination plume. Where these restrictions are required, DOE must ensure that the beneficial uses, which the ground water could have satisfied, are provided. DOE funded two water line extensions to the current municipal system to ensure the availability of potable water to properties affected by site-related contamination. Because the water line extension did not quite cover the full extent of the contaminated ground water plume, DOE has provided reverse osmosis systems for users within the ICs boundary but beyond the reach of the water line.

3.1.1.1 Deed Restriction

The State of Colorado and DOE anticipated the need for ICs at the millsite at completion of surface remediation when the property was slated for transfer to the City of Rifle. Deed restrictions have been imposed on the property title that prohibit use of contaminated ground water and prohibit excavation of contaminated soil that may cause surface expression of the ground water. The deed restriction contains the following language:

> "Grantee [City of Rifle] covenants...(ii) not to use ground water from the site for any purpose, and not to construct wells or any means of exposing ground water to the surface unless prior written approval for such use is given by the Grantor [Colorado Department of Public Health and Environment] and the U.S. Department of Energy."

This language was effective upon transfer of the site from the State to the City of Rifle in August 2004, ensuring that any future landowner is subject to the same restrictions. This title transfer fulfills the deed restriction requirement for permanence and enforceability by government entities and serves as a perpetual IC. A copy of the deed restriction is included in Appendix A (as Part A1).

3.1.1.2 Zone Overlay

Ground water modeling showed that COCs in the ground water from former milling activities would flush to acceptable levels in the 100-year time frame allowed by regulations for a natural flushing compliance strategy. DOE asked the local governmental agencies to apply a zone overlay with ground water restrictions to the affected area for a period not to exceed 100 years. DOE defined the ICs boundary for a zone overlay on the basis of an evaluation of the extent of uranium contamination, the most widespread contaminant associated with the site. To ensure that the area is protective of human health, a small buffer zone was included. The zone overlay boundary follows quarter-quarter section lines and natural features such as the Colorado River for easy delineation. The zone overlay boundary, defined as the Institutional Control Boundary, is shown in Figure 1.

The zone overlay (IC) boundary encompasses property currently under jurisdiction of Garfield County. Garfield County passed a resolution requiring residents to prove a potable source of water in order to develop property within the defined area. The resolution does not require connection to the city water system but does establish a drinking water constraint zone in which any source of water intended for human consumption must meet applicable standards.

Most of the land within the IC boundary has been identified as a growth corridor for the city of Rifle and will likely be annexed by the city when controls are needed. To ensure a safe source of domestic water, the City of Rifle passed an ordinance requiring any resident within the IC boundary to tap into the city's municipal water system when annexation occurs. Copies of the city and county ordinances are included in Appendix A (Part A2).

DOE, the City of Rifle, and Garfield County entered into a cooperative agreement, No. DE-FC13-01FJ79492, to provide potable water to residents along a corridor within the IC boundary west of Rifle. The agreement addresses the Phase I installation of a water line and provisions for supplying reverse osmosis systems to users along US Highway 6&50 to the West Rifle interchange and south under I-70 for about 300 yards. An agreement between DOE and

Rifle interchange and south under I-70 for about 300 yards. This system provides potable water for current and future residents in an area affected by ground water contamination from the New Rifle site. DOE is provided 90 percent of the funding, and the Colorado Department of Local Affairs is provided 10 percent. Phase II provides for additional related water system infrastructure improvements, including construction of a raw water pump house and settling pond, and transmission lines to the treatment facility (Figure 1). Phase I was completed in December 2002, and Phase II construction continues in 2005.

3.1.1.3 Environmental Covenant

Uranium, molybdenum, and nitrate contamination have migrated downgradient from the New Rifle Processing Site to Umetco Mineral Corporation property containing a former gravel pit operation. Concentrations of these contaminants are above EPA 40 CFR 192 standards in the on-site ponds and therefore represent a complete exposure route. To prevent inappropriate water use, an Environmental Covenant is being adopted between Umetco and Colorado Department of Public Health and Environment (CDPHE).

Four conditions are discussed in the covenant including 1) no installing of new wells in the alluvial aquifer; 2) restricting access by livestock to the former gravel pit ponds; 3) allowing existing monitoring wells to remain intact and undamaged; and 4) allowing DOE access to continue monitoring activities. The covenant has been discussed and agreed upon by Umetco and CDPHE. A copy of the unsigned agreement is shown in Appendix A. A signed copy will be obtained in the near future.

3.2 Ground Water and Surface Water Monitoring Requirements

Figure 3 shows the ground water and surface water locations included in the New Rifle site-monitoring network. On-site wells include 0215, 0216, 0658, 0659, 0664, 0669, 0670, and 0855. Wells between the site and the Roaring Fork ponds include 0201, 0217, 0590, and 0635. Wells downgradient of the Roaring Fork ponds include 0170, 0172, 0195, 0210, and 0620. Sample monitoring is conducted according to procedures in the *Ground Water and Surface Water Sampling and Analysis Plan for U.S. Department of Energy Office of Legacy Management* (DOE 2005a).

Background wells to be sampled at New Rifle include 0169 and 0173 (Figure 3). Additional background wells at the Old Rifle Site used historically in the Baseline Risk Assessment will continue to be sampled. These include RFO 0292, RFO 0597, and RFO 0658 (Figure 1). One alluvial domestic well equipped with a reverse osmosis system will also be sample, before and after treatment.

Surface water locations to be monitored include locations 0320, 0322, 0323, 0324, 0452, 0453, 0538, and 0575 (Figure 3). These are considered to be point-of-exposure locations. Water quality will be monitored in the Colorado River at background location 0538, at downgradient location 0322, and at the new downgradient location 0324 (as requested by the U.S. Nuclear Regulatory Commission). It will also be monitored in the mitigation wetland (locations 0320, 0452, and 0453), and in the two Roaring Fork ponds (new location 0323 and previously established location 0575). All COCs are being analyzed at all surface locations to verify that ground water discharging to surface water does not create points of exposure.

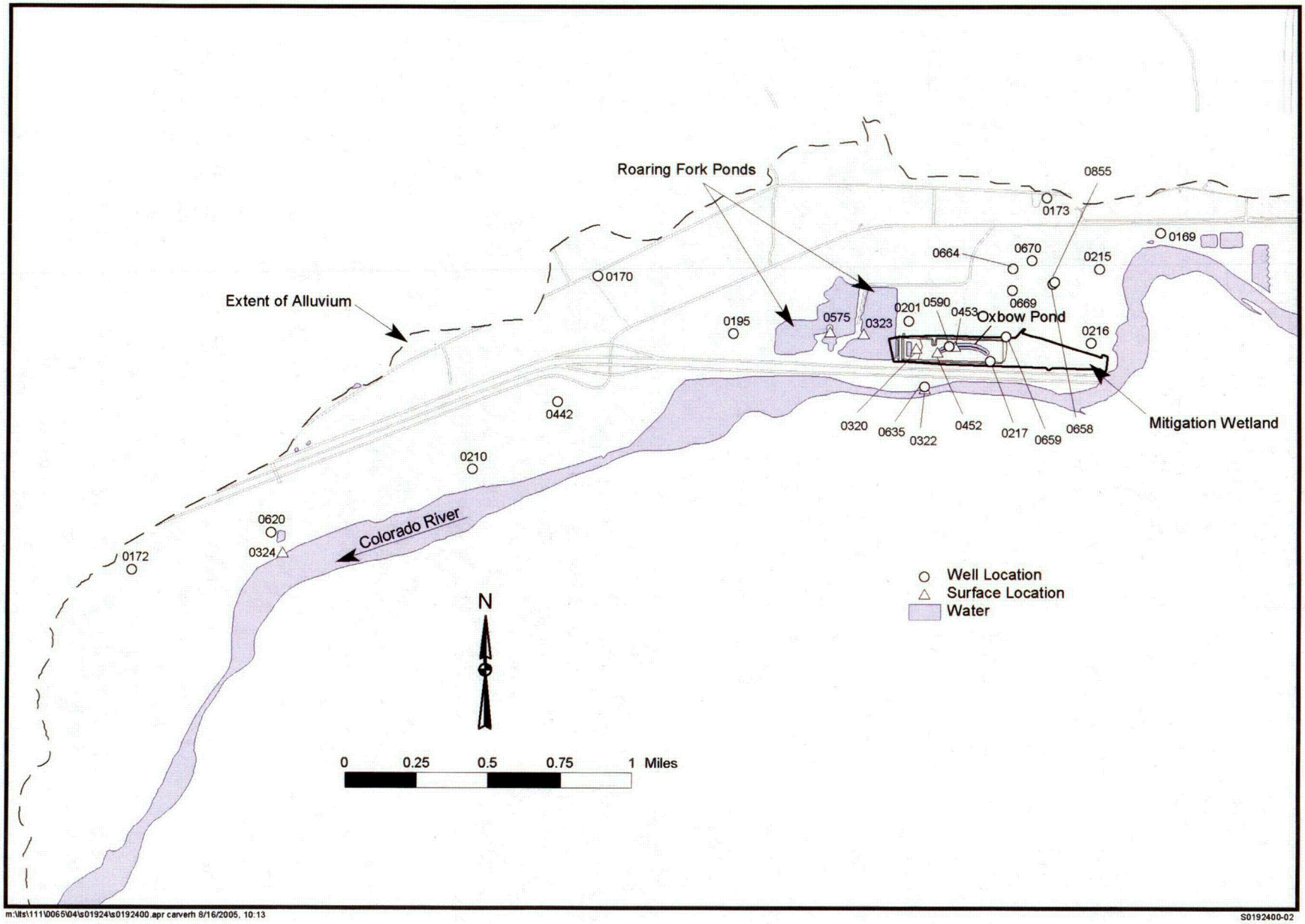

Figure 3. Proposed Monitoring Locations for the New Rifle Site

C02

Sampling of the wells in the hot-spot areas for vanadium will be twice per year until 2007. After that time, monitoring of wells in this area will be reevaluated to see if frequencies can be coordinated with other sampling, and the number of locations might be decreased.

Otherwise, sampling of each well or surface location will take place annually for 5 years following concurrence of this GCAP. After the first 5 years of monitoring, the monitoring strategy will be reevaluated and adjusted as appropriate based on previous results. It is anticipated that further monitoring will take place at a frequency of no less than once every 10 years. If the monitoring of wells at the perimeter of the contaminant plumes shows that contaminants have begun to spread beyond the current plume boundaries, or if some other changes in contaminant trends are noted, the sampling plan may also be reevaluated and adjusted at that time. If monitoring indicates that concentrations of contaminants in one of the three areas used for measuring success have decreased below cleanup goals, ICs may be lifted in those areas. As part of the monitoring program, DOE will also evaluate the effectiveness of the ICs on a regular basis (e.g., periodic surveys pertaining to changes in water use in the area). Monitoring requirements are summarized in Table 6 along with the rationale for the monitoring locations.

Monitor wells that are not required as part of the monitoring network will be decommissioned according to applicable State of Colorado regulations. Decommissioning will be accomplished in the near future under the Legacy Management Program.

Table 6. Summary of Monitoring Requirements

Location	Monitoring Purpose	Analytes	Frequency
0170, 0172, 0210, 620	Monitor middle and leading edge of molybdenum, uranium, and nitrate plumes.	Molybdenum, uranium, nitrate	All wells and locations, *annually until* 2010. Monitoring requirements will be reevaluated at that time.
0169, 0173 (upgradient New Rifle site); RFO-0597, RFO-292, RFO-658 (upgradient Old Rifle site)[a]	Monitor background to establish appropriate standards for uranium and selenium.	Arsenic, molybdenum, nitrate, selenium, uranium	
0195, 0201, 0215, 0216, 0217, 0590, 0635, 0658, 0659, 0664, 0669, 0670, 0855	Monitor flushing in main body of plumes.	Arsenic, molybdenum, nitrate, selenium, uranium	
0320, 0322, 0323, 0324, 0452, 0453, RFO-538, 0575	Monitor surface water to determine impact of ground water discharge to surface water and ecological receptors; 0538 is background location shown on Figure 1.	Arsenic, molybdenum, nitrate, selenium, uranium	
0442/0446	Private wells before and after reverse osmosis treatment; 0442 is pre-treatment, 0446 is post-treatment. Until domestic users connect to municipal water	Arsenic, molybdenum, nitrate, selenium, uranium	
0215, 0216, 0217, 0590, 0658, 0659, 0664, 0669, 0670, 0855	Monitor vanadium plume area as a best management practice.	Vanadium, (and other COCs)	Semiannually through 2007 for wells monitoring vanadium plume. Results reevaluated at that time. *Monitoring will likely* become same as for COCs after that time.

[a]Figure 1 shows the background monitor well locations at Old Rifle.

4.0 Performance Monitoring

Performance monitoring is an important part of any ground water remediation project. However, because of the long time frames and many uncertainties involved, it is especially important for remedies relying on natural attenuation or natural flushing (EPA 1992). Two different aspects of performance monitoring are important: evaluating progress toward achieving remediation goals (i.e., remedy is proceeding as expected) and determining when that goal has been attained and remediation is deemed complete. The first typically involves some type of trend analysis to ensure that contaminant concentrations are progressing in the right direction; the second involves a comparison of observed concentrations with final remediation goals (Gilbert 1987).

Time-concentration plots can be used qualitatively or quantitatively to determine if cleanup of ground water is progressing and if contaminant concentrations are decreasing over time. However, if observations are made at locations downgradient from the most contaminated portion of a ground water plume, increases in contaminant concentration may be expected before decreases occur. This is particularly true if passive remediation is the selected remedy. Time-concentration plots for upgradient, on-site, and downgradient monitor wells for the New Rifle site are shown in Appendix B for selected COCs. Concentrations for some wells appear to be decreasing overall, whereas trends for other locations are more ambiguous. A discussion of each COC and an interpretation of these trends is provided in the *Verification Monitoring Report for the Old and New Rifle, Colorado, Processing Sites* (DOE 2005c). Generally, the trends indicate that natural flushing is occurring.

Another method of data evaluation is the nonparametric Mann-Kendall test for trend (Gilbert 1987). The test does not require any particular data distribution and will accommodate missing values and data reported as less than the detection limit. Essentially, it analyzes a series of data by subtracting the values of data collected earlier from those of later data. The method results in a test statistic that is a positive or negative (meaning increasing or decreasing trend) and is used to estimate the probability that the trend is real.

To date, this statistic has not been used to evaluate the progress of natural flushing because few data have been collected since the alluvial system has been free of outside stresses. Based on data in the SOWP (DOE 1999), it has been demonstrated that the former gravel mining at the Roaring Fork ponds had a significant influence on ground water flow and contaminant migration; this operation ceased in early 2003. In addition, the operation of the pilot study at the site occurred through 2001 and involved extraction and infiltration of ground water in different locations, which affected plume behavior. It may be useful to apply the Mann-Kendall test statistic in the future after sufficient data have been collected to perform a meaningful trend analysis for evaluating natural flushing.

While EPA regulations (including those 40 CFR 192) require monitoring and mandate that remedial actions meet cleanup or other applicable standards, they do not specify how data are to be evaluated and interpreted. EPA guidance (EPA 1992) provides several different approaches that can be used to evaluate trends and demonstrate attainment; site-specific characteristics must be considered in determining which are appropriate. These characteristics include such things as contaminant toxicity, contaminant distribution, and current and potential future land use. Among choices to be made in evaluating monitoring data are whether to evaluate individual wells or groups of wells; which test statistic to use in evaluating data (e.g., mean versus percentile); and

whether one or multiple attainment criteria should be applied. Table 7 shows average concentrations for COCs for groups of wells identified at the New Rifle site. Each group of wells was likely influenced by a distinct set of surface and subsurface processes. Not all monitoring wells are included in these groupings; only those with historical data are used. It may be more useful to evaluate progress toward and attainment of remediation objectives using these well groupings than by evaluating results at individual location. Specific details regarding data interpretation and evaluation will be included in the long-term monitoring plan (LTMP) for the Rifle sites.

Table 7. Concentrations in Ground Water—1998/1999 and late 2004/2005 for the New Rifle Site

COC	Remed. Goal (mg/L)	On Site[a]		Adjacent to Site[b]		Downgradient[c]	
		1998–99 Range/Mean (mg/L)	Late 2004/2005 Range/Mean (mg/L)	1998–99 Range/Mean (mg/L)	Late 2004/2005 Range/Mean (mg/L)	1998–99 Range/Mean (mg/L)	Late 2004/2005 Range/Mean (mg/L)
Arsenic	0.05[d]	<0.0001–0.304/0.061	0.00075–0.042 /0.0226	<0.0001–0.0041/0.0009	0.00013–0.00073 /0.00047	<0.0001–0.0014 /0.00058	0.00019–0.0014 /0.00055
Molybdenum	0.1[d]	0.0237–6.84 /2.50	0.024–6.3/ 1.75	0.61–3.15 /1.93	0.58–2.6 /1.70	0.0041–0.231/ 0.035	<0.0048–0.29/ 0.090
Nitrate (NO_3 +NO_2 as N)	10[d]	<0.003–83.1 /13.8	<0.01–52/ 11.0	0.089–188 /51.9	1.7–130/59	0.012–85.2/ 17.1	<0.01–34/ 9.9
Selenium	0.036[e]	<0.001–0.782/ 0.135	0.00006–1.4 /0.172	0.0018–0.0197 /0.0096	0.002–0.066/ 0.019	<0.0001–0.0039/0.0012	<0.00023–0.003/ 0.00146
Uranium	0.067[e]	0.0103–0.284 /0.101	0.008–0.32 /0.094	0.0837–0.120 /0.097	0.015–0.13 /0.078	0.054–0.177 /0.0752	0.054–0.17 /0.099

[a]Wells 0215, 0216, 0658, 0659, 0664, 0669, 0670
[b]Wells 0201, 0217, 0590, 0635
[c]Wells 0170, 0172, 0195, 0210, 0620
[d]EPA ground water standard in 40 CFR 192
[e]Maximum background concentration, 1987–2005

For the purpose of evaluating natural flushing at the New Rifle site, data from the three groups of wells discussed in Section 2.3 along with time/concentration plots were used. This approach is consistent with those described in *Methods for Eliminating the Attainment of Cleanup Standards, Volume 2: Ground Water* (EPA 1992). Table 7 provides summary statistics for those three well groupings.

5.0 References

40 CFR 192. U.S. Environmental Protection Agency, "Health and Environmental Protection Standards for Uranium and Thorium Mill Tailings," *Code of Federal Regulations,* July 1, 2002.

60 FR 2854, 1995. U.S. Environmental Protection Agency, "Groundwater Standards for Remedial Actions at Inactive Uranium Processing Sites," *Federal Register,* January 11, 1995.

DOE (U.S. Department of Energy), 1990. *Final Environmental Impact Statement for Remedial Actions at the Former Union Carbide Corporation Uranium Mill Sites, Rifle, Garfield County, Colorado,* DOE/EIS–0132–F, prepared by the U.S. Department of Energy, UMTRA Project Office, Albuquerque Operations Office, Albuquerque, New Mexico, March.

DOE (U.S. Department of Energy), 1992. *Final Remedial Action Plan and Site Design for Stabilization of the Inactive Uranium Mill Tailings Site at Rifle, Colorado*, prepared by the U.S. Department of Energy, UMTRA Project Office, Albuquerque Operations Office, Albuquerque, New Mexico, February.

———, 1996a. *Baseline Risk Assessment of Ground Water Contamination at the Uranium Mill Tailings Sites Near Rifle, Colorado,* DOE/AL/62350–179, Rev. 2, February.

———, 1996b. *Final Programmatic Environmental Impact Statement for the Uranium Mill Tailings Remedial Action Ground Water Project,* DOE/EIS–0198, prepared by the U.S. Department of Energy, UMTRA Project Office, Albuquerque Operations Office, Albuquerque, New Mexico, October.

———, 1999. *Final Site Observational Work Plan for the UMTRA Project New Rifle Site,* GJO-99-88-TAR, Rev. 1, prepared by the U.S. Department of Energy Grand Junction Office, Grand Junction, Colorado, November.

———, 2000. *Work Plan to Determine Vertical and Lateral Extent of Vanadium in Soil and Ground Water at the New Rifle UMTRA Site*, MCA-GWRFL 1.8, prepared by the U.S. Department of Energy Grand Junction Office, Grand Junction, Colorado, January.

———, 2002. *Performance Report on the Operations of the Pilot Plant for the Treatment of Vanadium in Ground Water, New Rifle UMTRA Site, Rifle, Colorado,* GJO-2001-278-TAR, MAC-GWRFL-10.6.5-1, prepared by the U.S. Department of Energy Grand Junction Office, Grand Junction, Colorado, December.

———, 2003. *Final Environmental Assessment of Ground Water Compliance at the New Rifle, Colorado, UMTRA Project Site,* DOE/EA-1406, U.S. Department of Energy Grand Junction Office, Grand Junction, Colorado, July.

———, 2005a, *Ground Water and Surface Water Sampling and Analysis Plan for U.S. Department of Energy Office of Legacy Management Sites*, DOE-LM/GJ863-2005, U.S. Department of Energy Grand Junction Office, Grand Junction, Colorado, April.

———, 2005b. *2004 Section 404 Monitoring Report for the Rifle, Colorado, Processing Sites*, Revision 7, DOE-LM/GJ983-2005, prepared by the U.S. Department of Energy, Legacy Management Office, Grand Junction, Colorado, September.

———, 2005c. *Verification Monitoring Report for the Old and New Rifle, Colorado, Processing Sites*, DOE_LM/GJ954-2005, December

EPA (U.S. Environmental Protection Agency), 1991. *Risk Assessment Guidance for Superfund: Volume 1—Human Health Evaluation Manual,* Part B, Development of Risk-based Preliminary Remediation Goals, Publication 9285.7-01B, October.

———, 1992. *Methods for Evaluating the Attainment of Cleanup Standards, Volume 2: Ground Water*, EPA 230-R-92-014, July.

EPA (U.S. Environmental Protection Agency), 2004. Human Health Risk Assessment, Risk-Based Concentration Table, October 2004 update, available on the Internet at http://www.epa.gov/reg3hwmd/risk/human/index.htm.

Gilbert, 1987. *Statistical Methods for Environmental Pollution Monitoring,* Van Nostrand Reinhold Company, New York.

Harbaugh, A.W., and M.G. McDonald, 1996. *Programmer's Documentation for MODFLOW-96, An Update to the U.S. Geological Survey Modular Finite-Difference Ground-Water Flow Model,* United States Geological Survey Open-File Report 96—486, 220p.

Leij, F.J., and S.A. Bradford, 1994. *3DADE: A Computer Program for Evaluating Three-Dimensional Equilibrium Solute Transport in Porous Media,* Research Report No. 134, U.S. Salinity Laboratory, U.S. Department of Agriculture.

STO 6. *Environmental Procedures Catalog,* continuously updated, maintained by S.M. Stoller Corporation for the U.S. Department of Energy Office of Legacy Management, Grand Junction, Colorado.

Zheng, C., 1990. *MT3D, A Modular Three-Dimensional Transport Model,* Documentation and User's Guide, First Edition, S.S. Papadopulos and Associates, Inc., Bethesda, Maryland.

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Appendix A

Institutional Controls for the New Rifle, Colorado, Site

Part A1—Deed Restrictions for Millsite Property

Recorded at _____ o'clock _____M., _____
Reception No. _____ Recorder

QUIT CLAIM DEED

The Colorado Department of Public Health and the Environment ("Grantor"), whose address is 4300 Cherry Creek Drive South, Denver, Colorado, 80222-1530, City and County of Denver, State of Colorado, pursuant to 42 U.S.C.§ 7914 (e) (1) (B) and C.R.S. § 25-11-303, hereby donates and quit claim(s) to the City of Rifle ("Grantee"), whose address is 202 Railroad Avenue, Rifle, Colorado, 81650, City of Rifle, County of Garfield, State of Colorado, the following real property in the County of Garfield, State of Colorado, to wit: A parcel of land containing One hundred forty two (142) acres, more or less, described as follows:

That portion of land located in the S1/2 of the S1/2 of the NE1/4 of Section 18, Township 6 South, Range 93 West, of the 6th P.M. lying adjacent to and south of the South right-of-way line of the D&RG Railroad, except the east 297 feet, also Lot 5, Section 18, Township 6 South, Range 93 West. Lot 6. Section 18. Township 6 South. Range 93 West. except the east 297 feet of said Lot 6, also Lots 7 & 8 in Section 18, Township 6 South, Range 93 West, lying adjacent to and north of the Interstate 70 right-of-way line. Also two tracts of meander land situated in the S1/2 of Section 18. Township 6 South, Range 93 West, 6th P.M. described as follows:

Meander Land Tract I

Beginning at the Southeast corner of Lot 6, and the East line of said Section 18: thence North 86 degrees 45 minutes West 594 feet; thence Sooth 76 degrees 45 minutes West 660 feet: thence South 58 degrees 00 minutes West 1188 feet: thence South 75 degrees 00 minutes West 330 feet; thence South 250 feet: thence Southeasterly to the Westermost point of Lot 8 described above; thence North 49 degrees 13 minutes East 330 feet: thence North 79 degrees 45 minutes East 594 feet: thence North 45 degrees 30 minutes East 844.8 feet: thence South 69 degrees 00 minutes East 990 feet to the East line of said Section 18; thence North to the POINT OF BEGINNING.

Meander Land Tract 2

Beginning at the Southeast corner of Lot 7 and the East line of said Section 18: thence South 336.6 feet: thence South 75 degrees 55 minutes West 55.44 feet: thence South 61 degrees 00 minutes West 152.91 feet: thence South 61 degrees 00 minutes West, more or less, to the North right-of-way line of U.S. Interstate 70: thence West 810 feet to the South line of said Lot 7: thence North 62 degrees 15 minutes East 660 feet; thence North 75 degrees 30 minutes East 554.4 feet to the POINT OF BEGINNING.

Subject to: (i) any coal, oil, gas, or other mineral rights in any person: (ii) existing rights-of-way for roads, railroads, telephone lines, transmission lines, utilities, ditches, conduits, or pipelines on, over, or across said lands; (iii) court liens, judgments, or financial encumbrances such as deeds of trust for which a formal consent or order has been obtained from a court for the lien holder: (iv) other rights, interests, reservation or exceptions of record: and the following terms, conditions, rights, reservations and covenants:

Grantor reserves to (i) itself, the U. S. Department of Energy, their employees, agents and contractors the right of access to the property as may be necessary to complete activities under the Uranium Mill Tailings Radiation Control Act of 1978, 42 U.S.C. § 7901 et seq. ("UMTRCA") and for other lawful purposes, until such time as Grantor and the U.S. Department of Energy determine that all remedial activities are complete; and (ii) to itself any non-tributary groundwater underlying this parcel, the right to develop tributary groundwater, and the right to surface access for groundwater development.

Grantee covenants to hold harmless the Grantor and the Department of Energy for any liability associated with disruption of any public purpose ventures on the property conveyed by this deed, the disruption of any improvement on said property made by the Grantee, its successors and assigns, and any temporary or permanent limitations to the use of the property, should the Grantor and the Department of Energy be required to perform additional surface remedial activities on the property conveyed by this deed.

Grantee covenants (i) to comply with the applicable provisions of UMTRCA. 42 U.S.C. §7901 et. seq., as amended: (ii) not to use ground water from the site for any purpose, and not to construct wells or any means of exposing ground water to the surface unless prior written approval for such use is given by the Grantor and the U.S. Department of Energy; (iii) not to sell or transfer the land to anyone other than a governmental entity within the state: (iv) that any sale or transfer of the property described in this deed shall have prior written approval from the Grantor and the U.S. Department of Energy: and that any deed or other document created for such Sale or transfer and any subsequent sale or transfer will include information stating that the property was once used as a uranium milling site and all other information regarding the extent of residual radioactive materials removed from the property as required by Section 104(d) of the Uranium Mill Tailings. 42 U.S.C. sec. 7014(d), and as set forth in the Annotation attached hereto: (v) not to perform construction and/or excavation or soil removal of ally kind on the property without permission from the Grantor and the U.S. Department of Energy unless prior Written approval of construction plans (e.g., facilities type and location), is given by the Grantor and the U.S. Department of Energy: (vi) that ally habitable Structures constructed on the property shall employ a radon ventilation system or other radon mitigation measures; and (vii) that its use of the property shall not

adversely impact groundwater quality, nor interfere in any way, with groundwater remediation under UMTRCA activities: and (viii) to use the property and any profits or benefits derived therefrom only for public purposes as required by UMTRCA sec. 104(e)(1)(C), 42 U.S.C. 7914 (e)(1)(C).

These covenants are made in favor and to the benefit of Grantor, shall run with the land and be binding upon Grantee and its successors and assigns, and shall be enforceable by Grantor:

Grantee acknowledges that the property was once used as a uranium milling site, and that the Grantor makes no representations or warranties that the property is suitable for Grantee's purposes:

IN WITNESS WHEREOF

APPROVED AS TO FORM:

David Kreutzer – Assistant Attorney General

GRANTOR:

STATE OF COLORADO
Bill Owens, Governor
Acting by and through
The Department of Public Health and Environment

By: _____
Executive Director

By: _____
Program Approval

ACCEPTANCE OF DEED
AND COVENANTS

GRANTEE

City of Rifle, Colorado
(Full Legal Name of Agency)

By: _____
Name Keith Lambert

Title: Mayor

Signed this day of 19

STATE OF COLORADO,
} SS
county of Garfield

The foregoing instrument was acknowledged before me this 21st day of April 2004, 19 , by Keith Lambert

My commission expires 8-2004

Witness my hand and official seal.

NOTARY PUBLIC
ELLEN J. GAUGLER
STATE OF COLORADO

Notary Public.

ATTACHMENT A

LAND ANNOTATION

NEW RIFLE, COLORADO PROCESSING SITE

The Uranium Mill Tailings Radiation Control Act (Public Law 95-604), Section 104, requires that the State notify any person who acquires a designated processing site of the nature and extent of residual radioactive materials removed from the site, including notice of the date when such action took place, and the condition of the site after such action. The following information is provided to fulfill this requirement.

The New Rifle, Colorado processing site consists of one land parcel which contained a large tailings pile, the mill building, and associated structures. Approximately 3,232,000 cubic yards of contaminated materials which included 1) tailings; 2) subpile soils; 3) surficial materials in the mill yard; 4) windblown materials; and 5) mill demolition debris were removed from the mill site from 1988-1996. The remediation was conducted in accordance with regulations promulgated by the U.S. Environmental Protection Agency, in 40 CFR 192. These regulations require that the concentration of radium-226 in land averaged over any area of 100 square meters shall not exceed the background level by more than: 5 pCi/g (picocuries per gram), averaged over the first 15 cm (centimeters) of soil below the surface, and 15 pCi/g averaged over 15 cm thick layers of soil more than 15 cm below the surface. Verification measurements were conducted at the site by dividing the site into approximately 30-foot by 30-foot grids. A soil sample was collected and analyzed for contaminants from each grid to verify that the standards had been met.

After remediation was complete the site was backfilled with clean fill material, graded for drainage and revegetated. Backfill materials were routinely analyzed for radium-226 and were determined to have concentrations near background (1.5 pCi/g). To replace old wetland areas on the site, new wetlands were constructed in accordance with Army Corp of Engineer (COE) requirements. These wetland areas should not be disturbed without COE approval.

Excavation of residual radioactive material was also conducted for thorium-230 beneath the tailings pile in the subpile soils. For thorium-230, the cleanup standard was determined as a projected 1,000 year radium-226 concentration based on the eventual decay of the thorium to radium. The average thorium in-growth at depth was calculated to be 3.8 pCi/g.

All verification grids on the site met the EPA standards for radium and thorium, except grids M-08-07 and M-08-10. These areas are shown on the attached map. Additional information regarding the depth to the remaining deposits is available upon request from Colorado Department of Public Health and Environment and has been provided to Garfield County. When excavating in these areas, worker protection should be assured, and the material should be replaced at depth in the excavation. The EPA standards also allow for contamination to be left in place where removal would present a risk of injury to workers, would result in environmental harm, or where the cost of removal clearly outweighs the benefit in terms of risk reduction. At the New Rifle site, these areas where contamination was left (called "supplemental standards")

are the following. The supplemental standards areas are shown on the attached map.

1) Approximately 400 cubic yards of tailings were left under the Corps of Engineers dike east of the site. The deposit is covered with clean fill and poses no risk.

2) Deposits remain north of the site along U.S. Highway 6 and 24, and the Union Pacific right-of-way. These deposits extend approximately 1/4 mile east and west of the site boundary.

The groundwater beneath the New Rifle mill site remains contaminated and will be addressed during Phase II of the uranium mill tailings remedial action project. Several groundwater monitor wells are present on and downgradient of the site and will remain in place until the U.S. Department of Energy determines that they can be removed.

Any person who acquires a designated processing site shall apply for any permits, including U.S. Army Corps of Engineers Section 404 permits regarding construction in or near wetlands, as required by law.

Additional information concerning the remedial action, and groundwater conditions is available from the Colorado Department of Public Health and Environment, Hazardous Materials and Waste Management Division.

STATE HWY. 6 & 24

N 25000

MACAULEY PIT

OLD RIFLE

NEW RIFLE SITE

FOR DIKE AREA CROSS SECTIONS AND BORING LOCATIONS-SEE DIKE AREA SITE PLAN DRAWING NO. RFL-SSNR-0003

SUPPLEMENTAL STANDARDS DIKE AREA BOUNDARY

HWY. I-70

E 46000 E 47000 E 48000 E 48.444 E 49.592 E 50000

N 25.650 N 25000 N 24.750 N 24000 N 23.766 N 23000 N 22.782

150 FT x 150 FT (TYP FOR GRID D)

50 M x 50 M (TYP FOR GRID H AND M)

Ra-226 Supplemental Stnds

Th-230 Supplemental Stnds

REFERENCE DRAWINGS

RFL-SSNR-0003 DIKE AREA PLAN AND BOREHOLE LOCATIONS

LEGEND

- RAILROAD TRACKS
- FENCE
- NEW RIFLE SITE BOUNDARY

150FT x 150FT GRID

SAMPLE GRID NO.

A-37-19

A - SHEET NO. (SEE KEY MAP ABOVE)

37 - 150FT x 150FT GRID
19 - 30FT x 30FT SUBGRID

50M x 50M GRID

SAMPLE GRID NO.

E-42-19

E - SHEET NO. (SEE KEY MAP ABOVE)

42 - 50M x 50M GRID
19 - 10M x 10M SUBGRID

SCALE 0 50 100 150 200 METERS

SCALE 0ft 100 200 400 600 800ft FEET

NO.	DATE	REVISION	BY	CK	ENG MGR.	ENG MGR.	QA MGR.	DOE PM
4								
3								
2	2/24/97	REISSUED FINAL - ADDED DIKE AREA BOUNDARY						
1	12/5/96	ISSUED FINAL						
0	11/5/96	PRELIMINARY FOR REVIEW						

U.S. DEPARTMENT OF ENERGY
ALBUQUERQUE, NEW MEXICO

NEW RIFLE PROCESSING SITE
RIFLE, COLORADO
SUPPLEMENTAL STANDARDS FOR RIVER DIKE

DESIGNED | DRAWN | CHECKED | INSPECTED | RECOMMENDED | APPROVED | DOE PROJECT ENGINEER | DATE

DIKE AREA SITE PLAN

MORRISON KNUDSEN CORPORATION
ENVIRONMENTAL GROUP
UMTRA PROJECT

PROJECT NO. DE-AC04-83AL18796

DRAWING NO. RFL-SSNR-0002 REV. -2-

DATE 2/24/97

Part A2—Zone Overlays for Millsite Property City and County

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STATE OF COLORADO)
)ss
County of Garfield)

At a regular meeting of the Board of County Commissioners for Garfield County, Colorado, held in the Commissioners' Meeting Room, Garfield County Courthouse, in Glenwood Springs on Monday, the 8th of October, 2001, there were present:

John Martin, Commissioner Chairman
Larry McCown, Commissioner
Walt Stowe, Commissioner
Don DeFord, County Attorney
Mildred Alsdorf, Clerk of the Board
Ed Green, County Manager

when the following proceedings, among others were had and done, to-wit:

RESOLUTION NO. 2001-73

A RESOLUTION CONCERNED WITH AMENDING THE GARFIELD COUNTY ZONING RESOLUTION OF 1978 BY THE ADDITION OF SECTION 3.14, DRINKING WATER CONSTRAINT (DWC) ZONE DISTRICT.

WHEREAS, on the 2nd day of January, 1979, the Board of County Commissioners of Garfield County, Colorado, adopted Resolution No. 79-1 concerning a Zoning Resolution for the County of Garfield, State of Colorado; and

WHEREAS, the Board is authorized by the provisions of Sections 30-28-109 through 30-28-116, C.R.S. 1973, as amended, to provide for the approval of amendments to such Zoning Resolution, and the Board has so amended the said Resolution; and

WHEREAS, on December 16,1991, the Board adopted a codified version of the Garfield County Zoning Resolution of 1978 and all subsequent amendments; and

WHEREAS, on September 14,2001, the Garfield County Planning Commission recommended approval of the proposed text amendment;

WHEREAS, a public hearing was held on the 17th day of September 2001 and continued to the 24th day of September, 2001, before the Board of County Commissioners of Garfield County, Colorado, at the Commissioners meeting room, Suite 301, Garfield County Courthouse, 109 8th Street, Glenwood Springs, Colorado, as to which hearing, public notice was given in accordance with requirements of Section 10 of the Garfield County Zoning Resolution;

WHEREAS, the Board on the basis of evidence produced at the aforementioned hearing has made the following determination of fact:

1. That an application for a zone district text amendment was made consistent with the

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2 of 4 R 0.00 D 0.00 GRRFIELD COUNTY CO

requirements of Section 10.00 of the Garfield County Zoning Resolution of 1978, as amended;

2. That the Board of County Commissioners is authorized by the provisions of Section 30-28-116, C.R.S. 1973, as amended, to provide for the approval of amendments to the Garfield County Zoning Resolution;

3. That the public hearing before the Board of County Commissioners was extensive and complete, that all pertinent facts, matters and issues were submitted and that all interested parties were heard at the hearing;

4. That the Garfield County Planning Commission has reviewed the proposed zone district text amendment and made a recommendation as required by Section 10.04 of the Garfield County Zoning Resolution of 1978, as amended;

5. That the proposed text amendment are in the best interest of the health, safety, morals, convenience, order, prosperity and welfare of the citizens of Garfield County.

NOW, THEREFORE, BE IT RESOLVED by the Board of County Commissioners of Garfield County, Colorado, that the Garfield County Zoning Resolution, adopted on the 2nd day of January, 1979, and identified as its Resolution No. 79-1, as subsequently amended by this Board, shall be and hereby is amended and said language will be incorporated into the codified Garfield *County* Zoning Resolution adopted by the Board on December 16, 1991 as follows:

3.14 Drinking Water Constraint Zone (DWC)

3.14.01 uses. by right: :

Agricultural, including farm, garden, greenhouse, nursery, orchard, ranch, small animal farm for production of poultry, fish, fur-bearing and other small animals, and customary accessory uses including buildings for shelter and enclosure of persons, animals or property employed in any of the above uses; retail establishment for sale of goods processed from raw materials produced on the lot;

Buildings for shelter and enclosure of persons employed in any of the uses by right, kennel, riding stable and veterinary clinic, guiding and outfitting;

Manufactured home as the principal use of the lot meeting standards contained in Section 5.03.01(2);

Single-family dwelling; customary accessory uses only where it is accessory to the uses listed above.

3.14.02 Uses. conditional:

Aircraft landing strip, airport-utility, salvage yard, sanitary landfill and storage, Home occupation

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3.14.03 Uses, special:

Pumping facilities, electrical distribution, water impoundments, access routes, utility lines, pipelines;

Camper park, agriculture-related business, resort, airport - air carrier, plant for fabrication of goods from processed natural resources; material handling, warehouse facilities/staging areas, fabrication areas, storage areas, extraction, processing; public gatherings; commercial park; recreational support facilities; guest houses.

3.14.04 Minimum Lot Area: Two (2) acres.

3.14.05 ~~Maximum~~ Residential Lot Coverage: fifteen percent (15%).

3.14.06 Minimum Setback (Unless otherwise permitted by special use permit.)

(1) Front yard: (a) arterial streets: seventy-five (75) feet from centerline or fifty (50) feet from lot line, whichever is greater; (b) local streets: fifty (50) feet from ~~street~~ centerline or twenty-five (25) feet from front lot line, whichever is greater;
(2) Rear yard: twenty-five *(25)* ~~feet~~ from rear lot line;
(3) Side yard: ten (10) feet from side lot line, or one-half (1/2) the building height, whichever is greater.

3.14.07 Maximum Height of Buildings: Forty (40) feet. (Unless otherwise permitted by special use permit.)

3.14.08 Additional Requirements: All uses shall be subject to the provisions of Section 5 (Supplementary Regulations).
All of the uses listed a use by right, conditional use or special use, will be allowed provided any use that includes the human consumption of ground water, shall have an approved domestic water supply. An approved domestic water supply shall be either an approved community water system as defined by the Colorado Department of Health and Environment, Drinking Water Standards or from a ground water source on the property that is treated by a reverse osmosis water treatment ~~system~~ that meets the water quality standards promulgated under the criteria cited in CRS § 25-8-204 (1) & *(2)*.

Dated this 8th day of October, 2001.

ATTEST:

GARFIELD COUNTY BOARD OF COMMISSIONERS, GARFIELD COUNTY, COLORADO

GARFIELD COUNTY SEAL COLORADO

Clerk of the Board

Chairman

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Upon motion duly made and seconded the foregoing Resolution was adopted by the following vote:

COMMISSIONER CHAIRMAN JOHN F. MARTIN, Aye
COMMISSIONER WALTER A. STOWE, Aye
COMMISSIONER LARRY L. MCCOWN, Aye

STATE OF COLORADO)
)ss
County of Garfield)

I, _____, County Clerk and ex-officio Clerk of the Board of County Commissioners, in and for the County and State aforesaid, do hereby *certify* that the annexed and foregoing Resolution is truly copied from the Records of the Proceeding of the Board of County Commissioners for said Garfield County, now in my office.

IN WITNESS WHEREOF, I have hereunto set my hand and affixed the seal of said County, at Glenwood Springs, this _____ day of _____, A.D. 2001.

County Clerk and ex-officio Clerk of the Board of County Commissioners

_____

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STATE OF COLORADO)
)ss
County of Garfield)

At a meeting of the Board of County Commissioners for W e l d *County,* Colorado, held in the Commissioners' Meeting Room, Garfield County Courthouse, in Glenwood Springs on Monday, the 8th day of October, 2001, there were present:

John Martin, Commissioner Chairman
Larry McCown, Commissioner
Walt Stowe, Commissioner
Don DeFord, County Attorney
Mildred Alsdorf, Clerk of the Board
Ed Green, County Manager

when the following proceedings, among others were had and done, to-wit:

RESOLUTION NO. 2001-72

A RESOLUTION CONCERNED WITH THE APPROVAL OF A ZONE DISTRICT AMENDMENT FOR *AN* AREA W S T OF RIFLE TO DRINKING WATER CONSTRAINT (DWC).

WHEREAS, the Board of County Commissioners of Garfield County proposed to rezone the herein described property m Garfield County to Drinking Water Constraint (DWC).

WHEREAS, the Board of County Commissioners of Garfield County have heretofore adopted and enacted a Zoning Resolution for Garfield *County,* Colorado, including as a part thereof, certain zoning maps regulating permitted uses upon the lands within Garfield County, Colorado; and

WHEREAS, sections 30-28-109 through 30-28-1 16 C.R.S.. as amended, provide for the approval of all zoning plans and the adoption and amendment of regulations and resolutions to implement such w—— plans by the Board of *County* Commissioners of a given county; and

WHEREAS, the County has given notice of public hearing upon such application by publication m a newspaper of general circulation m Garfield *County* and provided notice of said hearing to all property owners adjacent to said property subject to the zone district amendment, and such hearing having been held on September 17, 2001, which was continued to September 24, 2001 and this Board having given full consideration *to* the evidence; and

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WHEREAS, bawl upon the evidence., testimony, exhibits, review of the Comprehensive Plan for the unincorporated area of the County, recommendation from the Garfield County Planning Commission, comments of the Garfield County Planning Department, comments of public officials and agencies and comments from all interested parties in connection with said application, this Board makes the following findings in respect thereto, to-wit:

1. That all applicable regulations regarding a Zone District Amendment have been complied with including, but not limited to, Section 10.00 of the Garfield County Zoning Resolution of 1978, as amended.

2. That proper publication and public notice was provided as required by law for the hearing before the Board of County Commissioners.

3. That the public hearing before the Board of County Commissioners was extensive and complete, that all pertinent facts, matters and issues were submitted and that all interested parties were heard at the meetmg.

NOW, THEREFORE, BE IT RESOLVED by the Board of County Commissioners of Garfield County, Colorado, that the following described area and the property included therein, be rezoned Drinking Water Constraint (DWC).

LEGAL DESCRIPTION

All of that property located north of the northern bank of the Colorado River located in the S1/2 of Section 18, T. 6 S., R *93* W.; and the S1/2 of Section 13; the E1/2 SE1/4; SW1/4 SE1/4, SE1/4SW1/4 of Section 14; the SE1/4NE1/4, SE1/4, E1/2 SW1/4 of Section 22; N1/2 of Section 23 and the NW1/4 of Section 24, T. 6 S., R. 94 W. of the 6th P. M. .

Dated this 8th day of October, A.D. 2001.

ATTEST:

GARFIELD COUNTY BOARD OF COMMISSIONERS, GARFIELD COUNTY, COLORADO

Clerk of the Board

Chairman

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Upon motion duly made and seconded the foregoing Resolution was adopted by the following vote:

COMMISSIONER CHAIRMAN JOHN F. MARTIN, Aye
COMMISSIONER WALTER A. STOWE, Aye
COMMISSIONER LARRY L. MCCOWN, Aye

STATE OF COLORADO)

County of Garfield)

I, _____ *County* Clerk and ex-officio Clerk of the Board of County Commissioners, in and for the *County* and State aforesaid, do hereby certify that the annexed and foregoing Resolution is truly copied from the Records of the Proceeding of the Board of *County* Commissioners for said Garfield County, now in my office.

IN WITNESS WHEREOF, I have hereunto set my hand and affixed the seal of said County, at Glenwood Springs, this ____ day of _____, A.D. 2001.

County Clerk and ex-officio Clerk of the Board of County Commissioners

_____

CITY OF RIFLE, COLORADO
ORDINANCE NO. 24
SERIES OF 2001

AN ORDINANCE OF THE CITY OF RIFLE COLORADO, AMENDING TITLES 10, 16 AND 17 OF THE RIFLE MUNICIPAL CODE PROHIBITING THE USE OF GROUNDWATER FOR POTABLE PURPOSES WITHIN THE URANIUM MILL TAILINGS REMEDIATION PROJECT RIFLE INSTITUTIONAL CONTROL BOUNDARY.

WHEREAS, past uranium mining activities in the vicinity of the City of Rifle resulted in a plume of contaminated groundwater, which plume is shown on the Rifle Institutional Control Boundary Map; and

WHEREAS, to ensure that contaminated groundwater is not consumed for potable purposes, it is necessary for the public health to prohibit such use; and

WHEREAS, the Rifle City Council finds and determines that amending the Rifle Municipal Code to require owners of property within the Rifle Institutional Control Boundary to connect to the City's potable water supply is in the best interest of the citizens of Rifle.

NOW, THEREFORE, THE COUNCIL OF THE CITY OF RIFLE, COLORADO, ORDAINS THAT:

1. The City Council incorporates the foregoing recitals as findings by the City Council.

2. Amendment. Title 10 of the Rifle Municipal Code is hereby amended as follows:

10.04.010 Definitions

[in the correct alphabetical order]

* "DOE" means the United States Department of Energy.

* "Rifle Institutional Control Boundary" means the boundary of a geographic area in and adjacent to the City of Rifle that has been identified and mapped by the United States Department of Energy within which lands are subject to non-potable polluted groundwater.

"Rifle Institutional Control Boundary Map" means a map recorded with the Garfield County Clerk and Recorder as Reception No. 600936 that depicts the Rifle Institutional Control Boundary and subject lands.

City of Rifle
Wanda Jones
202 Railroad Ave.
Rifle CO 81650

10.04.050 Service Outside City--Policy

It is the policy of the City to decline to extend water service to property lying outside the corporate limits of the City, except for areas located within the Rifle Institutional Control Boundary, unless (a) the lack of municipal water creates a real hardship upon the owner of the property, (b) the property is capable of being annexed to the City within a reasonable time, as determined by the City Council, and (c) the owners, for themselves, their successors and assigns, sign a binding agreement to annex the property to the City at such time as it becomes eligible for annexation. The City expressly reserves the right, as may be limited by state or federal law, to impose such conditions as it may see fit relative to the furnishing of such service and to refuse such service in its discretion.

All provisions of this chapter apply to those areas outside the corporate limits of the City, except those areas covered by a contract which expressly establishes other rules for the area served under the contract.

All of the provisions of this chapter also apply to those areas which were located within the boundaries of the Rifle Village South Metropolitan District on June 1, 1988, except as expressly modified by an agreement between the City and the District incorporated into Ordinance No. 1, Series of 1988 and areas which are located within the Rifle Institutional Control Boundary.

10.04.080 Connection Required

The owner of any house or other building occupied for business or residence purposes, situated within the City and abutting any street, alley or right-of-way in which there is now located or may in the future be located a water distribution main of the City, is required at such owner's expense to connect such building by means of a service line directly with the distribution main in accordance with the provisions of this chapter. Further, any such owner located within the Rifle Institutional Control Boundary is prohibited from accessing groundwater for potable purposes or from connecting groundwater in any way to the municipal water system. The point or points at which connection is made to the distribution main shall be determined by the City Manager.

10.04.090 Connection Requirement - Exception

Except for property located within the Rifle Institutional Control Boundary, connection to the water supply system of the City shall not be required for any property which is served by an existing well or other water supply system, which system is approved by the City's Public Works Director and which system serves said property in substantially the same manner as it would be served by the water supply system of the City.

This section shall apply solely to property located outside of the Rifle Institutional Control Boundary served by an existing well or other water supply system prior to connection to the

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water supply system of the City, and shall not be construed to permit any person already connected to the water supply system of the City, whose property may subsequently be served by a well or other water supply system, to disconnect from the water supply system of the City.

10.04.230 Disconnection

For the purposes of this section, "customer" shall mean the person designated on City records as the person responsible for payment of charges incurred for the use at his premises of the water supply system of the City.

Except for prouertv located within the Rifle Institutional Control Boundary, the City shall disconnect the service line of any premises at the curb stop, upon request of the customer.

***

10.04.530 Unlawful Acts

***

It shall be unlawful for any person to connect a surface or groundwater source or otherwise create a water connection or cross connection to the municipal water system.

It shall be unlawful for any person located within the area identified as the Rifle Institutional Control Boundary to access groundwater for potable purposes or in any way connect a groundwater source to the municipal water system.

3. Amendment. Title 16 of the Rifle Municipal Code is hereby amended as follows:

16.06.020 Amendments

***

(2) Section 106.4.1 entitled "Issuance" is amended to include the following paragraphs:

A building permit will not be issued in the City of Rifle jurisdiction until all construction drawings, applications, and permit fees are submitted and approved, including those for plumbing, and mechanical portions of the project. Additionally, a building permit will not be issued in the City of Rifle jurisdiction within the Rifle Institutional Control Boundary unless the plans indicate a connection to the Rifle municipal water system with no access to groundwater for potable purposes.

Notwithstanding the foregoing, a footing and foundation permit may be issued prior to reception of other permit information if adequate structural and site plan information is provided.

16.20.060 Prohibitions

***

F. No person shall occupy any new building, factory-built housing unit, manufactured home or mobile home until sewage disposal facilities, meeting the minimum standards of the Colorado Department of Health and the ordinances of the City have been installed and have been approved. No person shall occupy any building, factory-built housing unit, manufactured home or mobile home unless potable domestic water facilities have been installed and have been approved, in writing, by the City.

G. No person within the Rifle Institutional Control Boundary and within the Rifle municipal limits shall construct or occupy any structure, building, factory built housing unit, manufactured home or mobile home that requires or utilizes a water source without first connecting to the City of Rifle potable municipal water system.

16.22.020 Waiver of Permit Requirements

Except for property within the Rifle Institutional Control Boundary, the Building Official may waive any permit requirements contained within this title or the codes adopted by reference thereunder only after a determination is made that the effect of such a waiver is minor and will not affect the health, safety and welfare of the citizens of the City.

16.22.060 Permits--General Conditions

***

D. All structures within the Rifle Institutional Control Boundary that require potable water service shall be connected to the City of Rifle potable municipal water system.

16.22.100 Issuance of Certificate of Occupancy

In addition to the requirements for the issuance of a certificate of occupancy contained in the codes adopted by reference in this title, no certificate of occupancy shall be issued until the following improvements have been installed in the development where the building or structure is located and have been approved by the Public Works Director or his/her designee:

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I. For property within the Rifle Institutional Control Boundary, a connection is made to the Rifle potable municipal water system and no access is made to groundwater sources for potable purposes.

4. Amendment. Title 17 of the Rifle Municipal Code is hereby amended as follows:

17.01.200 Definitions

[in the correct alphabetical order]

* "DOE" means the United States Department of Energy.

Rifle Institutional Control Boundary means the boundary of a geographic area in and adjacent to the City of Rifle that has been identified and mapped by the United States Department of Energy within which lands are subject to non-potable polluted groundwater

Rifle Institutional Control Boundary Map means a map recorded with the Garfield County Clerk and Recorder as Reception No. 600936 that depicts the Rifle Institutional Control Boundary and subject lands.

17.02.145 Pre-annexation Agreements for Property within the Rifle Institutional Control Boundary

Any owner of property that requests municipal services within the Rifle Institutional Control Boundary, as shown on the Rifle Institutional Control Boundary Map, and outside the Rifle municipal limits, shall enter into a pre-annexation agreement with the City, which agreement shall prohibit the property from utilizing groundwater for potable purposes and require connection to the municipal water supply. Any owner of property within the Rifle Institutional Control Boundary that enters into a pre-annexation agreement will be eligible to receive water service from the City when available.

INTRODUCED on September 5, 2001, read by title, passed on first reading, and ordered published as required by the Charter.

INTRODUCED a second time at a regular meeting of the Council of the City of Rifle, Colorado, held on September 19, 2001, passed with amendment, approved, and ordered published in full as required by the Charter.

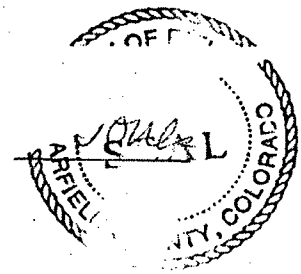
Dated this 19th day of September, 2001

600937 04/09/2002 02:07P 81344 P694 M RLSDORF
6 of 6 R 30.00 D 0.00 GRRFIELD COUNTY CO

CITY OF RIFLE, COLORADO

By _____
Mayor

ATTEST:



CITY OF RIFLE, COLORADO
I certify that this is a true copy of the original document remaining on file in the office of the City Clerk.
Dated: 03/22/04
City Clerk: Wanda

CITY OF RIFLE, COLORADO
ORDINANCE NO. 6
SERIES OF 2002

AN ORDINANCE OF THE CITY OF RIFLE, COLORADO, APPROVING THE INSTITUTIONAL CONTROL BOUNDARY MAP AS REFERENCED IN ORDINANCE NO. 24, SERIES OF 2001.

WHEREAS, the Department of Energy conducted numerous studies of a contaminated groundwater plum that is a result of uranium mining in the vicinity of the City of Rifle, which studies culminated and are referenced in a draft Environmental Assessment of Ground Water Compliance at the New Rifle Mill Tailings Site prepared by the U.S. Department of Energy Grand Junction Office dated November 2001; and

WHEREAS, the Department of Energy relied on these studies in formulating and drafting the Rifle Institutional Control Boundary Map that defines the approximate location of the contaminated groundwater plume; and

WHEREAS, the City, by Ordinance No. 24, Series of 2001, enacted Institutional Controls applicable to property within the Institutional Control Boundary as defined by the Rifle Institutional Control Boundary Map prohibiting the use of ground water for potable purposes; and

WHEREAS, the Department of Energy has finalized the Rifle Institutional Control Boundary Map dated November 15, 2001, attached hereto as Exhibit A, which the City desires to formally adopt for the application of Ordinance No. 24, Series of 2001.

NOW, THEREFORE, THE COUNCIL OF THE CITY OF RIFLE, COLORADO, ORDAINS THAT:

1. The City Council incorporates the foregoing recitals as findings by the City Council, including the studies referenced in the draft Environmental Assessment of Ground Water Compliance at the New Rifle Mill Tailings Site prepared by the U.S. Department of Energy Grand Junction Office dated November 2001.

2. The Rifle Institutional Control Boundary Map attached hereto as Exhibit A is hereby adopted by the City of Rifle for the application of Ordinance No. 24, Series of 2001.

3. The City Clerk shall record the Institutional Control Boundary Map with the Garfield County Clerk and Recorder and insert the recording information in Ordinance No. 24, Series of 2001.

INTRODUCED on March 20, 2002, read by title, passed on first reading, and ordered published as required by the Charter.

INTRODUCED a second time at a regular meeting of the Council of the City of Rifle, Colorado, held on April 3, 2002, passed without amendment, approved, and ordered published in full as required by the Charter.

Dated this 3rd day of April, 2002

CITY OF RIFLE, COLORADO

By Keith Lambert
Mayor

ATTEST:

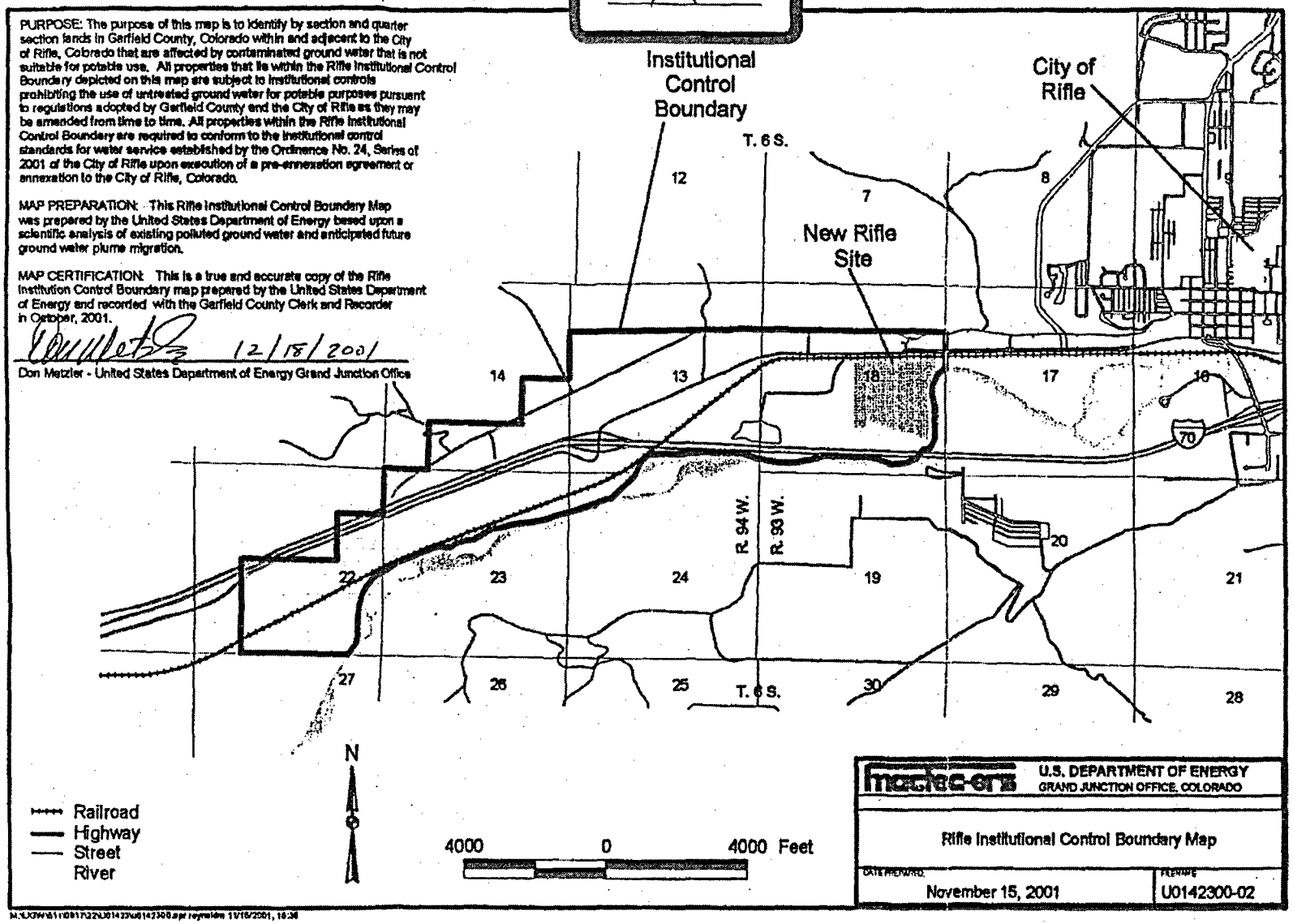
CITY OF RIFLE GARFIELD COUNTY SEAL COLORADO

Andrea Gloss
City Clerk
Deputy

EXHIBIT

tabbies

A



Part A3—Agreement with Department of Energy and Lacy Park Owners' Association

Agreement with the U.S. Department of Energy
for Restricted Use of
Surficial and Ground Water for Domestic Purposes

THIS AGREEMENT is made and entered into by and between the U.S. Department of Energy (DOE)and LACY PARK OWNERS' ASSOCIATION.

WITNESSETH:

RECITALS:

A. The DOE is implementing Institutional Controls to prevent inappropriate uses of the contaminated surficial aquifer in the vicinity of former uranium ore-processing sites near Rifle. Colorado. One of the Rifle Uranium Mill Tailings Remedial Action sites is the New Rifle Site located west of the town of Rifle on the north side of the Colorado River.

B. Institutional Controls are required during the 100-year timeframe pursuant to Title 40, Code of Federal Regulations, Part 192, to establish appropriate restrictions *to* the surficial ground water. After 100 years, surficial water is expected to return to background levels. Institutional Control actions are authorized under the Uranium Mill Tailings Radiation Control Act of 1978 to minimize potential human health and ecological risks associated with residual radioactive contaminants in the ground water that exceed regulatory threshold levels.

C. The Lacy Park Owners' Association ("Association") is a legal, non-profit entity registered with the Secretary of State of the State of Colorado on July 20, 1998 (File No. 19981131653).

D. Ths Association administers the Declaration of Covenants, Conditions and Restrictions for Lacy Park Subdivision, recorded as Reception No. 537422 of the Garfield County, Colorado, records. Lacy Park Subdivision consists of lots 1–5, as shown on the Plat thereof recorded as Reception No. 537420 of the Garfield County, Colorado. records.

E. Lacy Park. LLC. is the developer of the Lacy Park Subdivision and the Declarant under said Declaration of Covenants. Conditions. and Restrictions.

F. Lacy Park Subdivision, inclusive of lots 1–5. is situated in Sections 13, 14, and 24, Township 6 South, Range 94 West of the Sixth Principal Meridian. County of Garfield, State of Colorado. and is more particularly described as follows:

Beginning at a point on the southerly right-of-way line of U.S. Interstate Highway No. 70. whence the northwest corner of said Section 23 bears S. 87°47'24" W. 3995.88 feet; thence along said southerly right-of-way line the following eight (8) courses:

1) N. 67'31'43" E. 373.33 feet:
2) N. 72°43'30" E. 564.60 feet:
3) S. 82°13'30" E.405.90 feet:
4) S. 71°46'00" E. 343.60 feet:
5) Along a tangent curve to the left, having a central angle of 32°59'52", a radius of 627.50 feet. an arc length of 350.44 feet and of which the chord bears S. 87°46'00" E. 345.90 feet;
6) Along a non-tangent curve to the left, having a central angle of 57°37'44", a radius of 325.00 feet, an arc length of 326.80 feet and of which the chord bears N. 47'19'00" E.313.20 feet;
7) N. 86'20'00" E., 767.70 feet;
8) N. 89°35'00" E., 301.50 feet to a point on the northerly right-of-way line of the Denver and Rio Grande Western Railroad; thence leaving said southerly highway right-of-way line, at a bearing of S. 51°44'50" W. 519.14 feet along said northerly railroad right-of-way line; thence continuing along a curve to the right, having a central angle of 08°38'48", a radius of 2815.00 feet, an arc length of 424.82 feet and of which the chord bears S. 56°04'14" W., 424.41 feet; thence N. 86°13'14" W., 2501.87 feet to the Point of Beginning, and containing 21.777 acres, more or less.

G. The Association acknowledges receipt of notice from the DOE that the surficial ground water contains contaminants that exceed State of Colorado regulatory thresholds for drinking water as provided in Title 5, Colorado Code of Regulations, sections 1002–1041, and chooses *to* use the water after it undergoes treatment.

H. The Association currently maintains and operates a well located in Township 6 South, Range 94 West, Section 14, that pumps water from the surficial aquifer for domestic use, after treatment. on the subject properties, lots 1–5. Lot owners in the Association understand that the source of the domestic water is the treated effluent from the reverse osmosis (RO) unit installed at the previously identified well and operated and maintained by the Association.

I. This document defines the obligations to establish, operate, and maintain institutional controls on the identified property and will serve as an agreement by the signing parties

AGREEMENT

NOW, THEREFORE for and in consideration of the promises and agreements herein contained. the sufficiency of which is hereby acknowledged. the parties hereby agree as follows:

1. The DOE agrees io reimburse Lacy Park, LLC, a recognized third party beneficiary of this Agreement, the sum of Thirty-three Thousand One Hundred Dollars and Seventy Cents ($33,100.70) for the fair and reasonable costs incurred and actually paid by Lacy Park, LLC, to purchase a RO treatment system and install it at the wellhead that currently provides domestic water to lots 1–5.

2. The RO system installed by Lacy Park. LLC. will become the property of the Association. The Association shall maintain an operating system that treats water to standards that meet or exceed the State of Colorado drinking water standards for the duration of this Agreement. Should the RO system no longer be required. the Association agrees to provide the DOE the first right of refusal for return to the DOE,

3. The Association agrees to notify the DOE if, at any time. this mandated condition is not being met and shall take immediate action to correct the situation.

4. Upon reasonable advance notice, ths Association shall permit the DOE, or its designee, to conduct sampling at the wellhead and RO system effluent to verify compliance with State of Colorado drinking water standards.

5. The backwash from the RO system will be collected in a lined retention pond that may be used for fire suppression or other purposes. Any sludge that must be removed to maintain pond capacity may be tested by the DOE prior to disposal at the Cheney disposal cell. All backwash handling should adhere to Colorado Department of Public Health and Environment recommendations, as provided in Attachment A, and must meet State of Colorado and all other legal requirements for waste handling, transportation. ancl disposal.

6. The DOE will consider reimbursing the Association for any additional costs based upon a negotiated cost sharing for operations an3 maintenance. The additional costs contemplated may include testing and such othsr appropriate nominal costs. The amounts of these costs will bs negotiated at the end of the first year of operation of the RO system.

7. The Declaration of Covenants. Conditions. and Restrictions for the Lacy Park Subdivision shall be amended by an executed and recorded document in the form and substance of Attachment B. The Association will provide the DOE with a copy of such Amendment following recordation.

8. This Agreement will remain in full effect for 101 years from ths date hereof or until such time as DOE sampling data show that any residual contamination no longer poses a potential human health or ecological risk. and Institutional Controls are deemed no longer necessary. This Agreement may also be terminated in the event that an alternative Institutional Control. such as a public water system. is installed to provide a domestic water source.

9. It is agreed that no amount of othsr effluent or sludge will be deposited in the storage pond except those residues generated from use of the RO system.

This Agreement shall inure to the benefit of and be binding upon the parties and their respective successors. assigns. and transferees.

LACY PARK OWNERS' ASSOCIATION
By Johnson Construction, Inc.

By _____
President

U.S. DEPARTMENT OF ENERGY
GRAND JUNCTION OFFICE

By _____
Donna Bergman-Tabbert, Manager
2597 B ¾ Road
Grand Junction, CO 81503

chw\lacyagr.doc

STATE OF COLORADO

Roy Romer, Governor
Patti Shwayder, Executive Director
Dedicated to protecting and improving the health and environment of the people of Colorado
HAZARDOUS MATERIALS AND WASTE MANAGEMENT DIVISION
http://www.cdphe.state.co.us/hm/
4300 Cherry Creek Dr. S.
Denver, Colorado 80246-1530
Phone (303) 692-3320
Fax (303) 759-5355
222 S. 6th Street, Room 232
Grand Junction, Colorado 81501-2768
Phone (970) 248-7164
Fax (970) 248-7198

Colorado Department of Public Health and Environment

November 1, 1998

Mr. Mark Bean
Garfield County Planning
109 8th St. Suite 303
Glenwood Springs, CO 81601

Re: Lacy Park Subdivision, Rifle, Colorado

Dear Mr. Bean:

As you requested, the Colorado Department of Public Health and Environment (CDPHE) has reviewed the various options available for the disposal of the backwash from the reverse osmosis units to be installed to provide a potable water supply for the planned Lacy Park Subdivision west of Rifle, Colorado. Of the options discussed, CDPHE favors using a lined retention pond to contain the backwash. It is our understanding that this pond will serve the dual purpose of also providing water for fire protection. In the future, due to evaporation within the pond, sludge will begin to accumulate. Over time it may be necessary to remove sludge from the pond to maintain pond capacity. When sludge disposal is necessary, we recommend that the sludge be tested for its uranium (total) and radium-226 content. These test results would then be used to determine if disposal at a landfill is appropriate. Otherwise, the sludge can be disposed of at the Cheney Reservoir site, east of Grand Junction. Please contact Jim Hams in our Grand Junction office regarding sludge handling and disposal procedures at (970) 248-7170. You can also contact me at (303) 692-3394 if you have any other questions.

Sincerely,

Wendy K. Naugle

Wendy K. Naugle, P.E.
Uranium and Special Projects Unit

cc: Joe Hope, High Country Engineering
David Hawker, Rifle City Manager
Dan Metzler, DOE-GJ
Jim Hams, CDPHE-GJ

Attachment A

3575 07/21/2000 10:02A B1198 P298 M ALSDORF
of 4 R 20.00 D 0.00 GFIRFIELD COUNTY CO

AMENDMENT TO DECLARATION OF COVENANTS, CONDITIONS AND RESTRICTIONS OF LACY PARK SUBDAISION

(Commercial - Garfield County)

KNOW ALL MEN BY THESE PRESENTS, that LACY PARK, LLC, a Colorado limited liability company. 2720 Railroad Avenue, Rifle, Colorado 8 1650 and ROCKY MOUNTAIN BAPTIST CHURCH OF RIFLE, COLORADO, 22076 Highway 6 & 24, P.O. Box 468, Rifle, Colorado 81650, the owners of all the lots within the Lacy Park Subdivision, shown on the Plat thereof recorded as Reception No. 537420 of the Garfield County, Colorado records, do hereby amend the Declaration of Covenants, Conditions and Restrictions for Lacy Park Subdivision, recorded as Reception No. 537422 of the Garfield County, Colorado records, as follows:

Amendment

Article IV - Common Well and Water Distribution is hereby amended as follows:

1. Section 4.5 is amended to read in its entirety as follows:

Section 4.5. Centralized Individual Water Treatment System. So long as the water supply for this subdivision is provided by groundwater, the potable water supply will be substandard and require treatment by a reverse osmosis process to eliminate potential radioactive and other impurities. A well, pump house, fire retention pond, a reverse osmosis water treatment filtration system capable of providing potable water per EPA standards and related water system facilities. for the use and benefit of all the lots, have been constructsd and installed by the Declarant within the private access and maintenance easement established for that purpose shown on the Plat. All such improvements are hereby dedicated by the Declarant to Lacy Park Owners Association. It shall be the responsibility of the Association to monitor and maintain the water system and all such iniprovements. The Association shall provide documented inspection and maintenance of all reverse osmosis system components as recommended by the system manufacturer in a manner consistent with industry standards and keep and maintain the same in good condition and repair at all times.

2. The following Section is added:

Section 4.6. Restrictions on Drilling Wells for Domestic Water Purposes. No lot owner shall use ground water from the Property for domestic purposes without adequate treatment meeting the State of Colorado drinking water standards. No owner shall construct any well or wells, or any means of exposing ground water to the surface, unless prior written approval for such use is given by the

6575 07/21/2000 10:02A B1198 P299 M ALSDORF
of 4 R 20.00 D 0.00 GRRFIELD COUNTY CO

Association and the Colorado Department of Health and Environment. Should the Association be required *to* take any enforcement action under this Section of the Covenants, the U.S. Department of Energy, as a third party beneficiary, and upon request from the Association may provide any necessary assistance as appropriate.

THE FOREGOING AMENDMENT IS APPROVED AND ADOPTED this 26 day of June, 2000, by the undersigned owners, which owners collectively represent one hundred percen (100%)of the lots within the Lacy Park Subdivision.

DECLARANT AND OWNER (Lois 1-5):

LACY PARK, LLC, a Colorado limited liability company

By Johnson Construction, Inc. (Manager)

By _____
Vice President

ATTEST:

_____
Secretary

(Corporate Seal)

OWNER (Lot 1):

ROCKY MOUNTAIN BAPTIST CHURCH OF RIFLE, COLORADO

By: _____
Trustee - Don Charboneau

By: _____
Trustee - ~~Wayne Pollard~~

By: _____
Trustee - Ted Monger

6575 07/21/2000 10:02A B1198 P300 M ALSDORF
of 4 R 20.00 D 0.00 GRRFIELD COUNTY CO

STATE OF COLORADO)
) SS
COUNTY OF GARFIELD)

The foregoing instrument was acknowledged before me this 26 day of June, 2000, by Anna R. Johnson as Vice President and Christ-ne Marie Overacker as Secretary of Johnson Construction, Inc., a Colorado corporation, acting in its capacity as Manager on behalf of Lacy Park, LLC, a Colorado limited liability company.

Witness my hand and official seal.

My commission expires: 09/02/2001.

Brenda K. Mack
Notary Public

BRENDA K. MACK NOTARY PUBLIC STATE OF COLORADO

STATE OF COLORADO)
) SS
COUNTY OF GARFIELD)

The foregoing instrument was acknowledged before me this 26 day of June, 2000, by Don Charbon-au, , and Ted Monger, acting in their capacity of Trustees on behalf of Rocky Mountain Baptist Church of Rifle, Colorado.

Witness my hand and official seal

My commission expires: 09/02/2001

Brenda K. Mack
Notary Public

BRENDA K. MACK NOTARY PUBLIC STATE OF COLORADO

STATE OF COLORADO)
) SS.
COUNTY OF GARFIELD)

The foregoing instrunent was acknowledged before me this 30th day of June, 2000, by Wayne Pollard, acting in his capacity as Trustee on benalf of Rocky Mountain Baptist Church of Rifle, Colorado

Witness my hand and official seal.
My commission expires: 02-20-02

Notary Public

866575 07/21/2006 10:02A 81198 P301 M RLSDORF
1 of 4 R 20.00 D 0.00 GARFIELD COUNTY CO

CONSENT TO AMENDMENT

The Board of County Commissioners of Garfield County, Colorado, consents to the foregoing Amendment this 17 day of July, 2000.

BOARD OF COUNTY COMMISSIONERS OF
GARFIELD COUNTY, COLORADO

By: _____
Chairman

WITNESS my hand and the seal for the County of Garfield.

ATTEST:

Mildred Alsdorf
Mildred Alsdorf
County Clerk

Part A4—Environmental Covenant between Colorado Department of Public Health and Environment and Umetco Minerals

This property is subject to an Environmental Covenant held by the Colorado Department of Public Health and Environment pursuant to section 25-15-321, C.R.S.

ENVIRONMENTAL COVENANT

Umetco Minerals grants an Environmental Covenant ("Covenant") this _____ day of _____, _____ to the Hazardous Materials and Waste Management Division of the Colorado Department of Public Health and the Environment ("the Department") pursuant to § 25-15-321 of the Colorado Hazardous Waste Act, § 25-15-101, *et seq.* The Department's address is 4300 Cherry Creek Drive South, Denver, Colorado 80246-1530.

WHEREAS, Umetco Minerals is the owner of certain property commonly referred to as Umetco Minerals, located at [ADDRESS], more particularly described in Attachment A, attached hereto and incorporated herein by reference as though fully set forth (hereinafter referred to as "the Property"); and

WHEREAS, pursuant to the Site Observational Workplan for the Rifle, Colorado UMTRA Project Site, dated _____, the Property is the subject of remedial action pursuant to the Uranium Mill Tailings Radiation Control Act, P.L. 95-604 ("UMTRCA") and UMTRCA regulations, 40 C.F.R.§ 192 Subpart B, and;

WHEREAS, the purpose of this Covenant is to ensure protection of human health and the environment by minimizing potential exposure to residual radioactive materials and contaminated groundwater through restrictions on penetration of the ground surface, and to minimize agricultural exposures by prohibiting the use of groundwater for stock watering, and

WHEREAS, Umetco Minerals desires to subject the Property to certain covenants and restrictions as provided in Article 15 of Title 25, Colorado Revised Statutes, which covenants and restrictions shall burden the Property and bind Umetco Minerals and all parties having any right, title or interest in the Property, or any part thereof, their heirs, successors and assigns, and any persons using the land, as described herein, for the benefit of the Department and the U.S. Department of Energy.

NOW, THEREFORE, Umetco Minerals hereby grants this Environmental Covenant to the Department, with the U.S. Department of Energy as a third party beneficiary, and declares that the Property as described in Attachment A shall hereinafter be bound by, held, sold, and conveyed subject to the following requirements set forth in paragraphs 1 through 10 below, which shall run with the Property in perpetuity and be binding on Umetco Minerals and all parties having any right, title or interest in the Property, or any part thereof, their heirs, successors and assigns, and any persons using the land, as described herein. As used in this Environmental Covenant, the term OWNER means the record owner of the Property and, if any, any other person or entity otherwise legally authorized to make decisions regarding the transfer of the Property or placement of encumbrances on the Property, other than by the exercise of eminent domain.

1) Use restrictions

A. No wells or drilling or pumping whatsoever shall be permitted or allowed in the alluvial aquifer or the Wasatch formation underlying the Property. The only exception to the foregoing is for monitoring and remedial wells installed by the Department of Energy, in connection with the on-going, approved remedial activities at the Property.

B. No stock watering utilizing the alluvial aquifer or the Wasatch formation, including use of the former Roaring Fork Gravel Pit, shall be allowed. Appropriate measures such as fencing shall be used as necessary to restrict access of cattle or other stock to the former Roaring Fork Gravel Pit.

C. No activities that will in any way damage any monitoring or remedial wells installed by the Department of Energy, or interfere with the maintenance, operation, or monitoring of said wells is allowed.

D. OWNER shall grant access to the Department and the U.S. Department of energy to perform any and all activities required to monitor or implement the remedy for the New Rifle Mill Site.

2) Modifications This Covenant runs with the land and is perpetual, unless modified or terminated pursuant to this paragraph. [OWNER] may request that the Department approve a modification or termination of the Covenant. The request shall contain information showing that the proposed modification or termination shall, if implemented, ensure protection of human health and the environment. The Department shall review any submitted information, and may request additional information. If the Department determines that the proposal to modify or terminate the Covenant will ensure protection of human health and the environment, it shall approve the proposal. No modification or termination of this Covenant shall be effective unless the Department has approved such modification or termination in writing. Information to support a request for modification or termination may include one or more of the following:

a) a proposal to perform additional remedial work;
b) new information regarding the risks posed by the residual contamination;
c) information demonstrating that residual contamination has diminished;
d) information demonstrating that the proposed modification would not adversely impact the remedy and is protective of human health and the environment; and
e) other appropriate supporting information.

3) Conveyances [OWNER] shall notify the Department at least fifteen (15) days in advance of any proposed grant, transfer or conveyance of any interest in any or all of the Property.

4) Notice to Lessees [OWNER] agrees to incorporate either in full or by reference the restrictions of this Covenant in any leases, licenses, or other instruments granting a right to use the Property.

5) Notification for proposed construction and land use [OWNER] shall notify the Department simultaneously when submitting any application to a local government for a building permit or change in land use.

6) Inspections The Department shall have the right of entry to the Property at reasonable times with prior notice for the purpose of determining compliance with the terms of this Covenant. Nothing in this Covenant shall impair any other authority the Department may otherwise have to enter and inspect the Property.

7) No Liability The Department does not acquire any liability under State law by virtue of accepting this Covenant, nor does any other named beneficiary of this Covenant acquire any liability under State law by virtue of being such a beneficiary.

8) Enforcement The Department may enforce the terms of this Covenant pursuant to §25-15-322. C.R.S. Umetco Minerals and the U.S. Department of energy may file suit in district court to enjoin actual or threatened violations of this Covenant.

9) Owner's Compliance Certification OWNER shall execute and return a certification form provided by the Department, on an annual basis, detailing OWNER's compliance, and any lack of compliance, with the terms of this Covenant.

10) Notices Any document or communication required under this Covenant shall be sent or directed to:

Jeffrey Deckler
Hazardous Materials and Waste Management Division
Colorado Department of Public Health and the Environment
4300 Cherry Creek Drive South
Denver, Colorado 80246-1530

Richard Bush
U.S. Department of Energy
Grand Junction Office
2597 B3/4 Road
Grand Junction, CO 81503

Umetco has caused this instrument to be executed this ____ day of _____, _____.

Umetco

By:_____

Title:_____

STATE OF _____)
) ss:
COUNTY OF_____)

The foregoing instrument was acknowledged before me this ___day of _____, _____ by _____ on behalf of Umetco Minerals

_____
Notary Public

_____
Address

_____

My commission expires:_____

Accepted by the Colorado Department of Public Health and Environment this ____ day of _____, _____.

By:_____

Title:_____

STATE OF _____)
) ss:
COUNTY OF_____)

The foregoing instrument was acknowledged before me this ___day of _____, _____ by _____ on behalf of the Colorado Department of Public Health and Environment.

_____
Notary Public

_____
Address

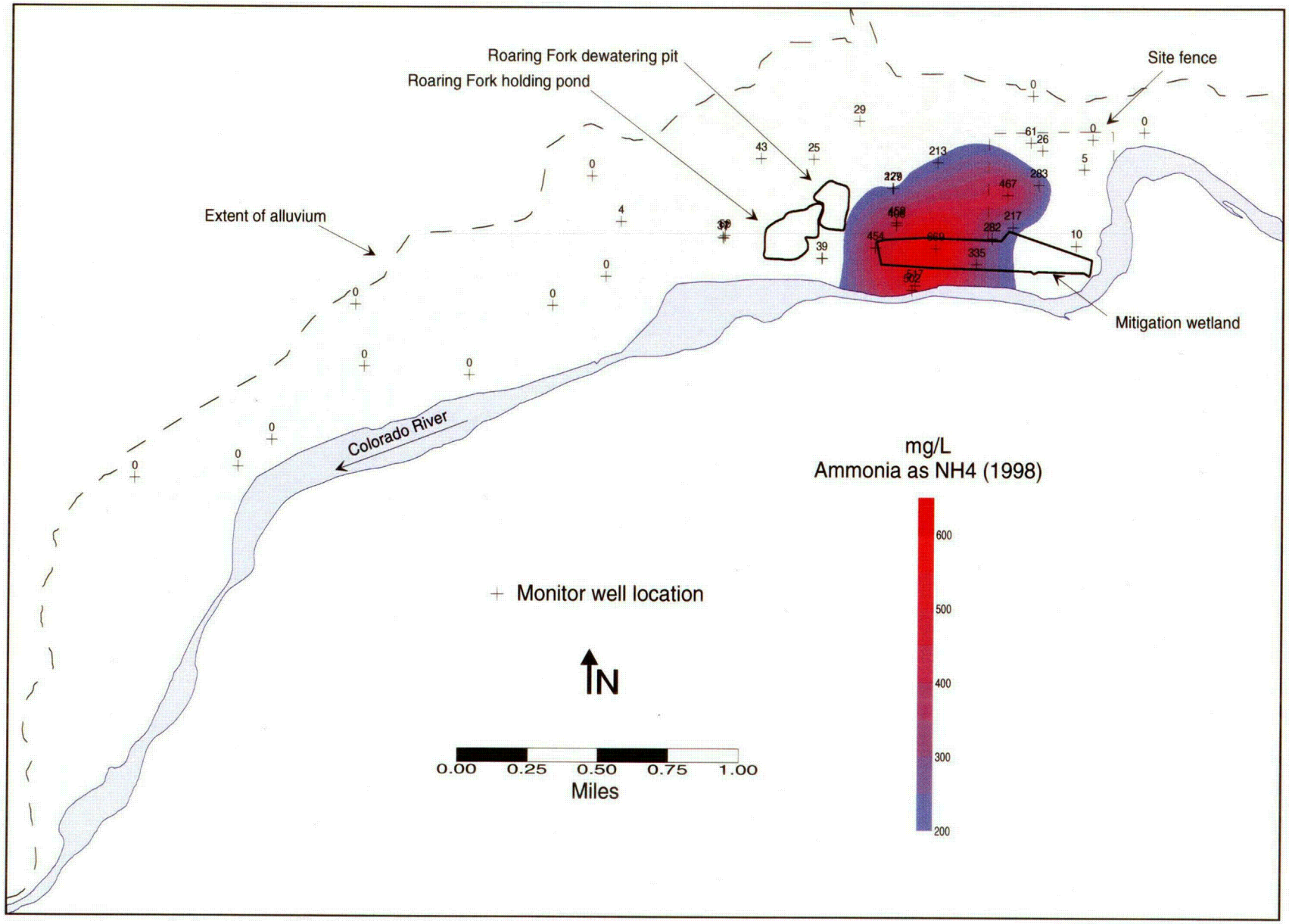
_____

My commission expires:_____

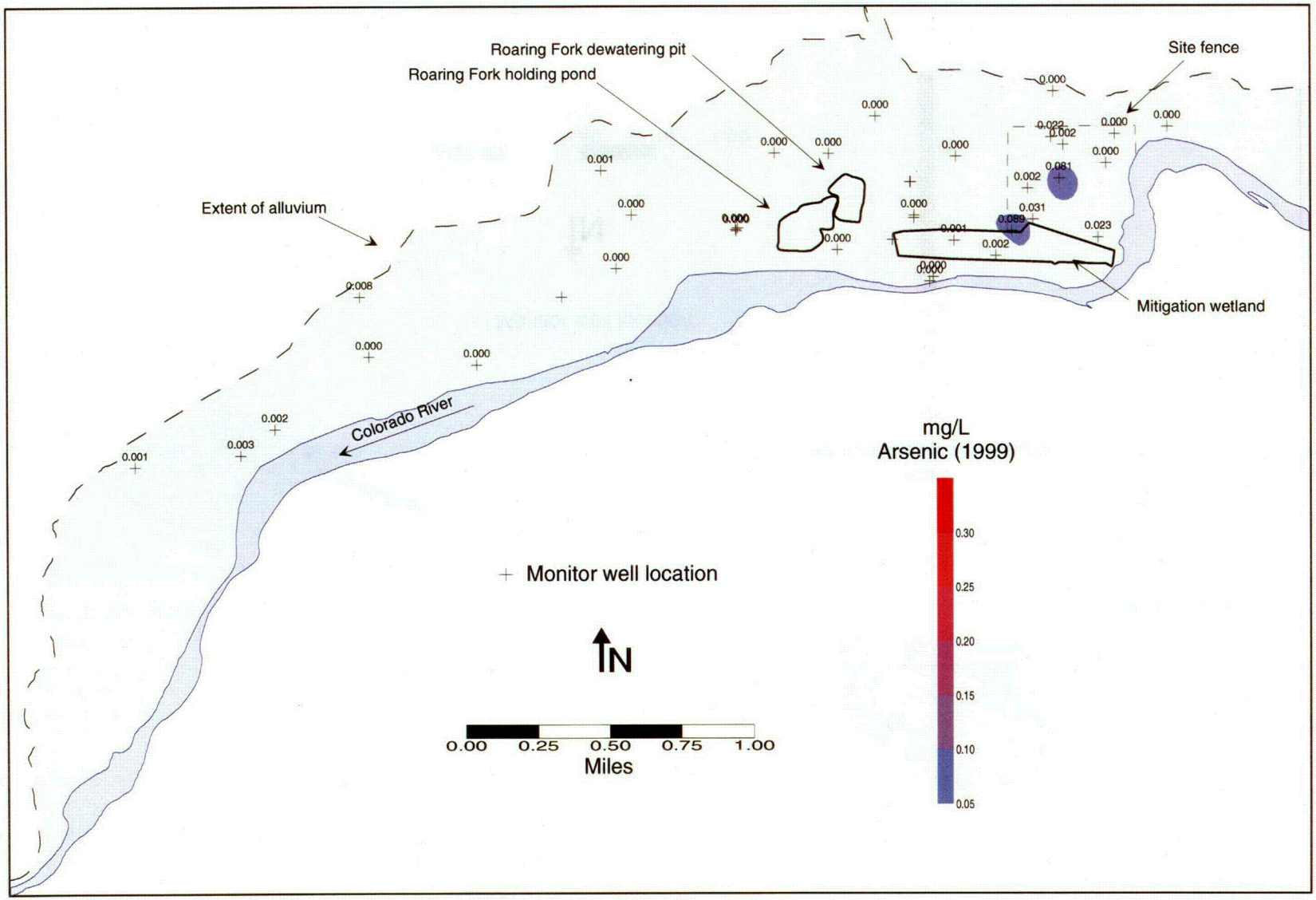
End of current text

Appendix B

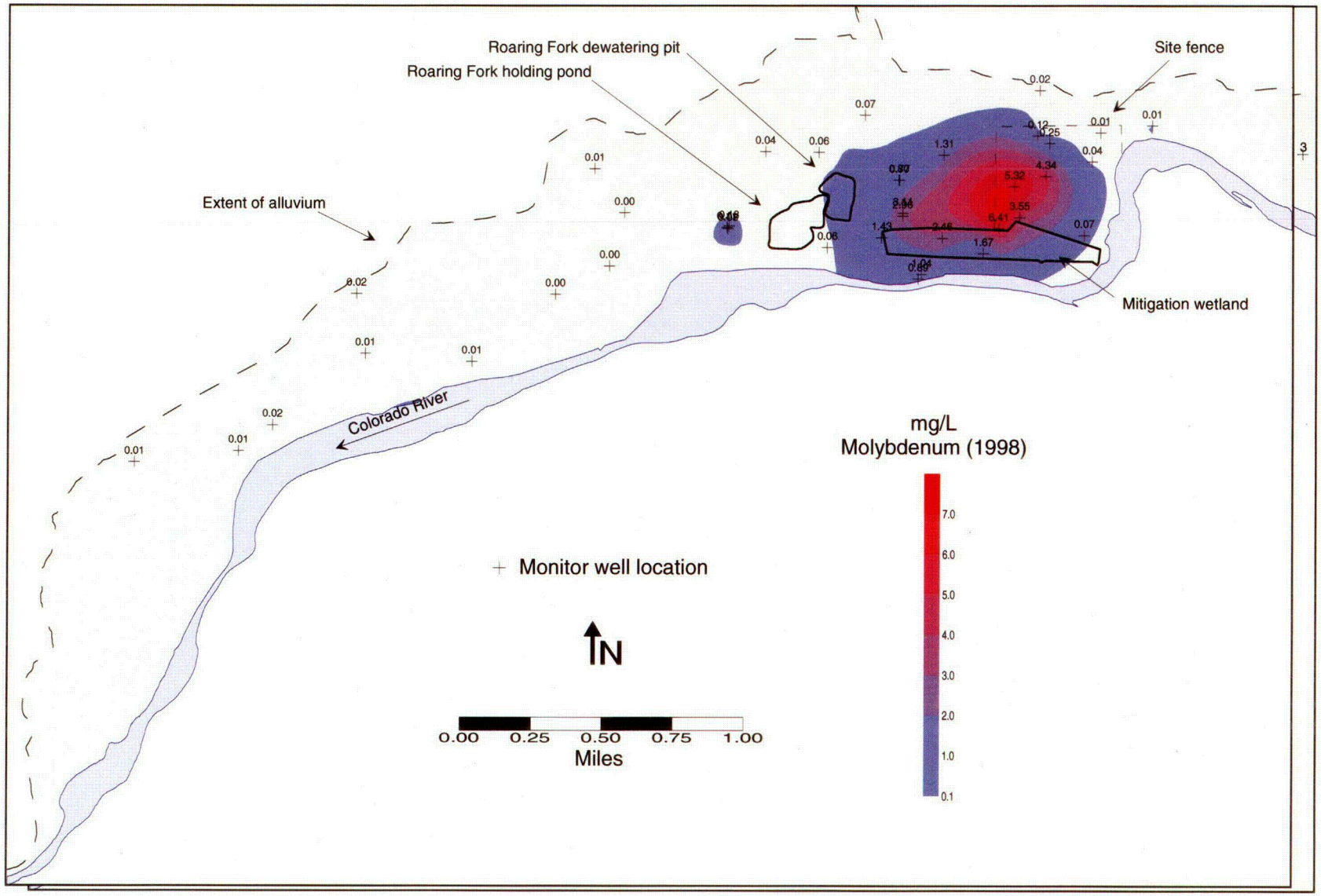
Plume Maps, Spot Plots, and Time-Concentrations Graphs for COCs at the New Rifle, Colorado, Site


Roaring Fork dewatering pit
Roaring Fork holding pond
Site fence
Extent of alluvium
Colorado River
Mitigation wetland
mg/L
Ammonia as NH4 (1998)
600
500
400
300
200
Monitor well location
N
0.00
0.25
0.50
0.75
1.00
Miles

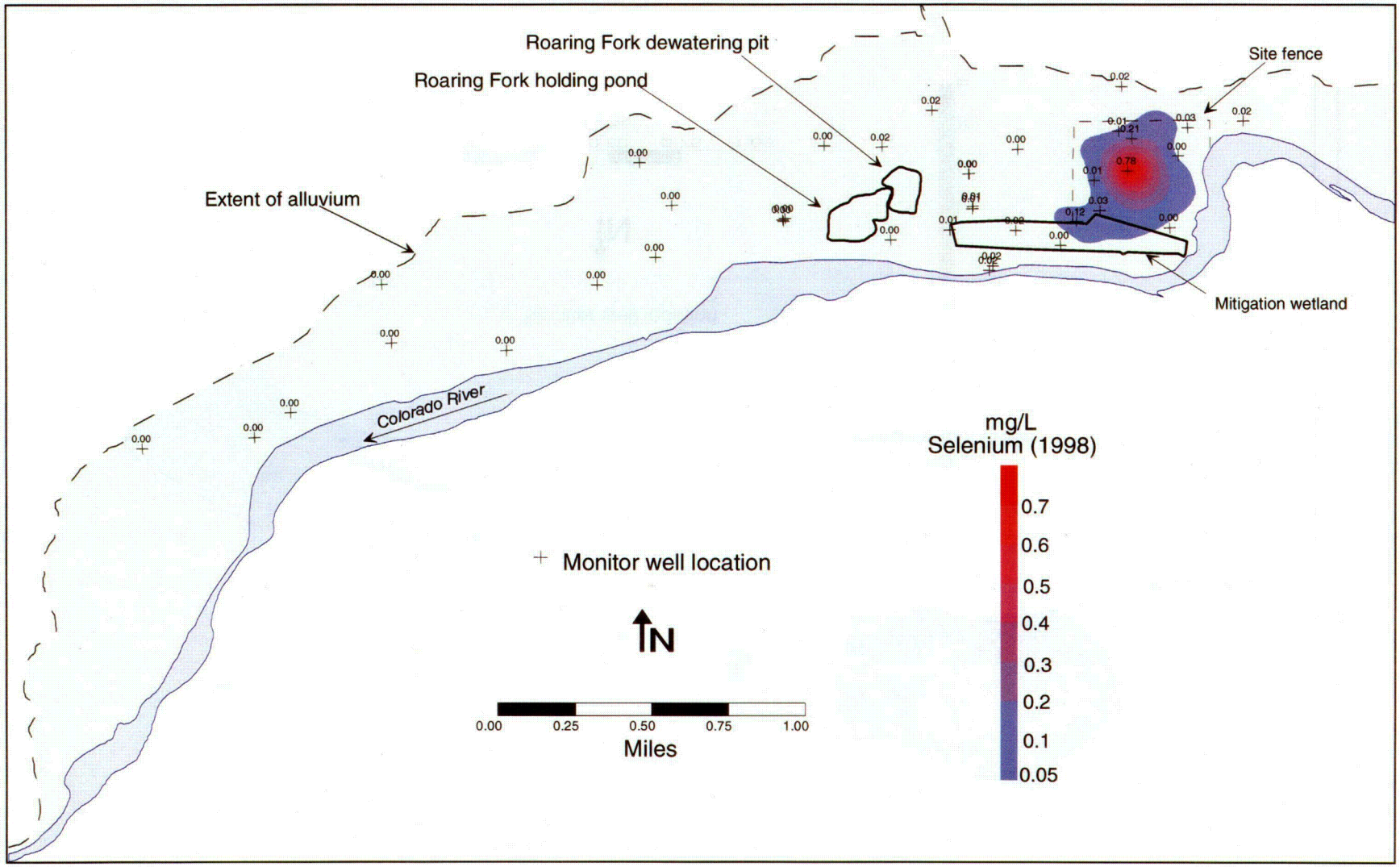
C03

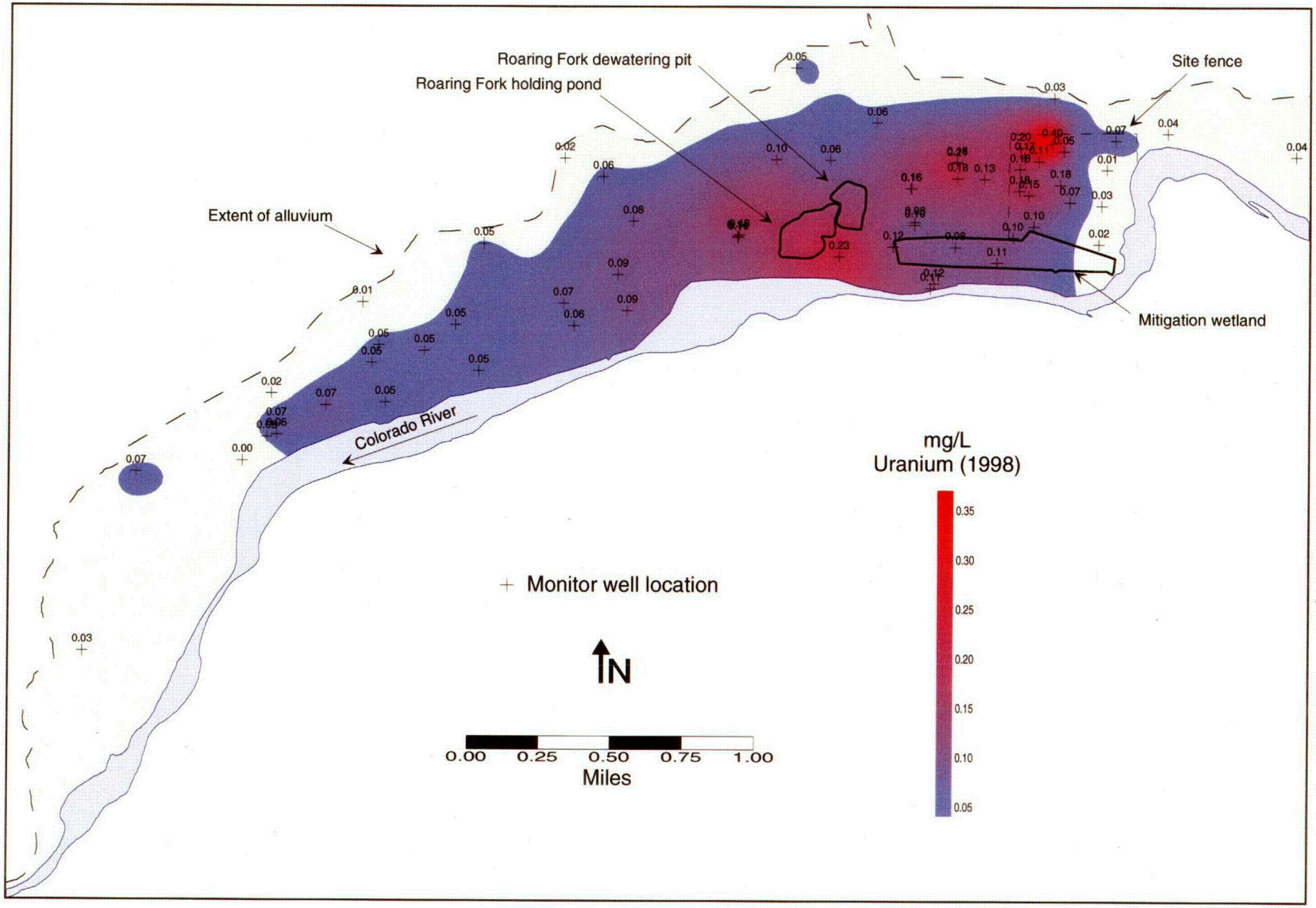

Roaring Fork dewatering pit
Roaring Fork holding pond
Site fence
Extent of alluvium
Colorado River
Mitigation wetland
Monitor well location
N
0.00 0.25 0.50 0.75 1.00
Miles
mg/L
Arsenic (1999)
0.30
0.25
0.20
0.15
0.10
0.05

C04

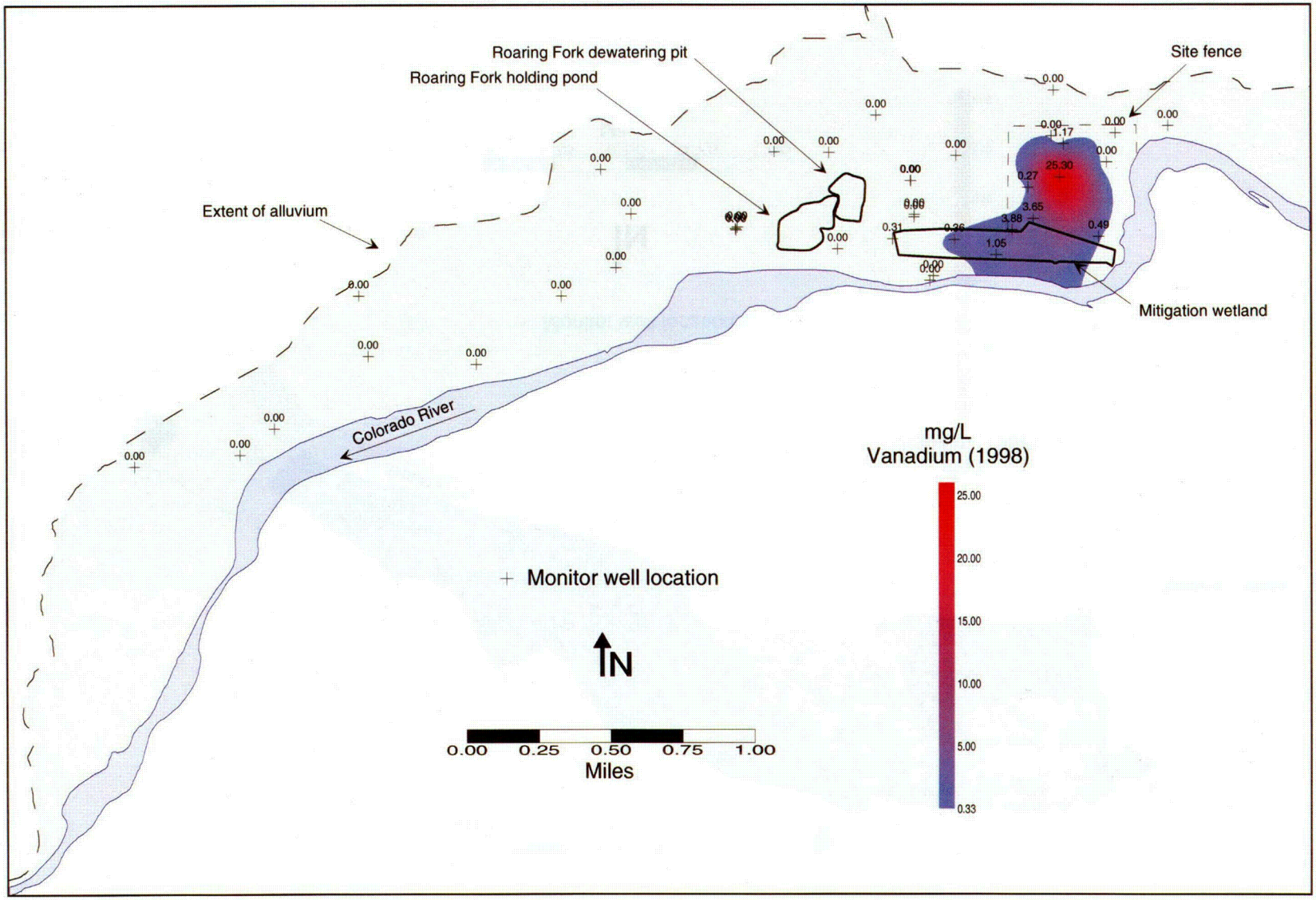

Roaring Fork dewatering pit
Roaring Fork holding pond
Site fence
Extent of alluvium
Mitigation wetland
Colorado River
mg/L
Molybdenum (1998)
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.1
Monitor well location
N
0.00 0.25 0.50 0.75 1.00
Miles

C05

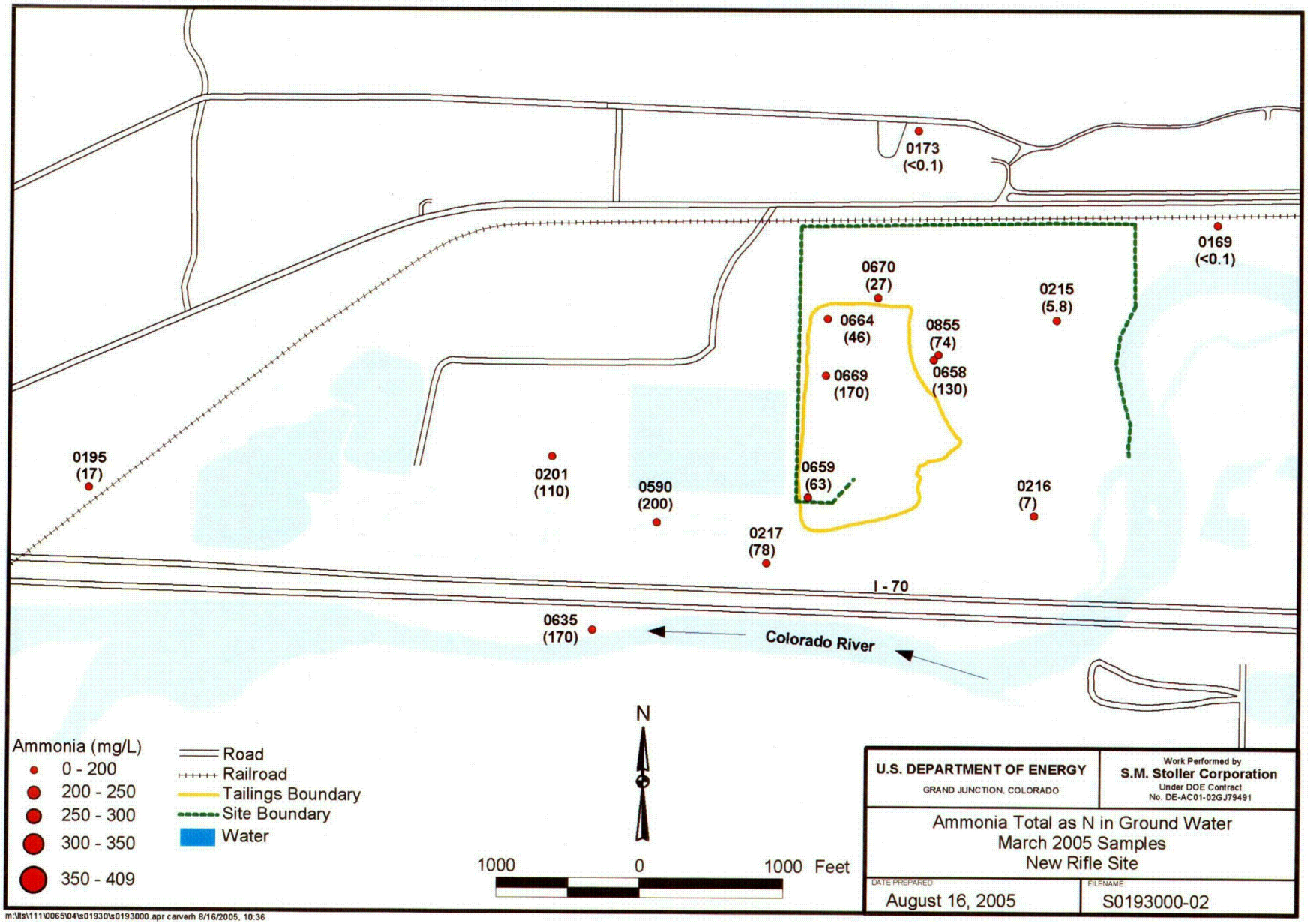

Roaring Fork dewatering pit
Roaring Fork holding pond
Site fence
Extent of alluvium
Mitigation wetland
Colorado River
Monitor well location
N
0.00
0.25
0.50
0.75
1.00
Miles
mg/L
Selenium (1998)
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.05


Roaring Fork dewatering pit
Roaring Fork holding pond
Site fence
Extent of alluvium
Colorado River
Mitigation wetland
mg/L
Uranium (1998)
0.35
0.30
0.25
0.20
0.15
0.10
0.05
Monitor well location
N
0.00 0.25 0.50 0.75 1.00
Miles

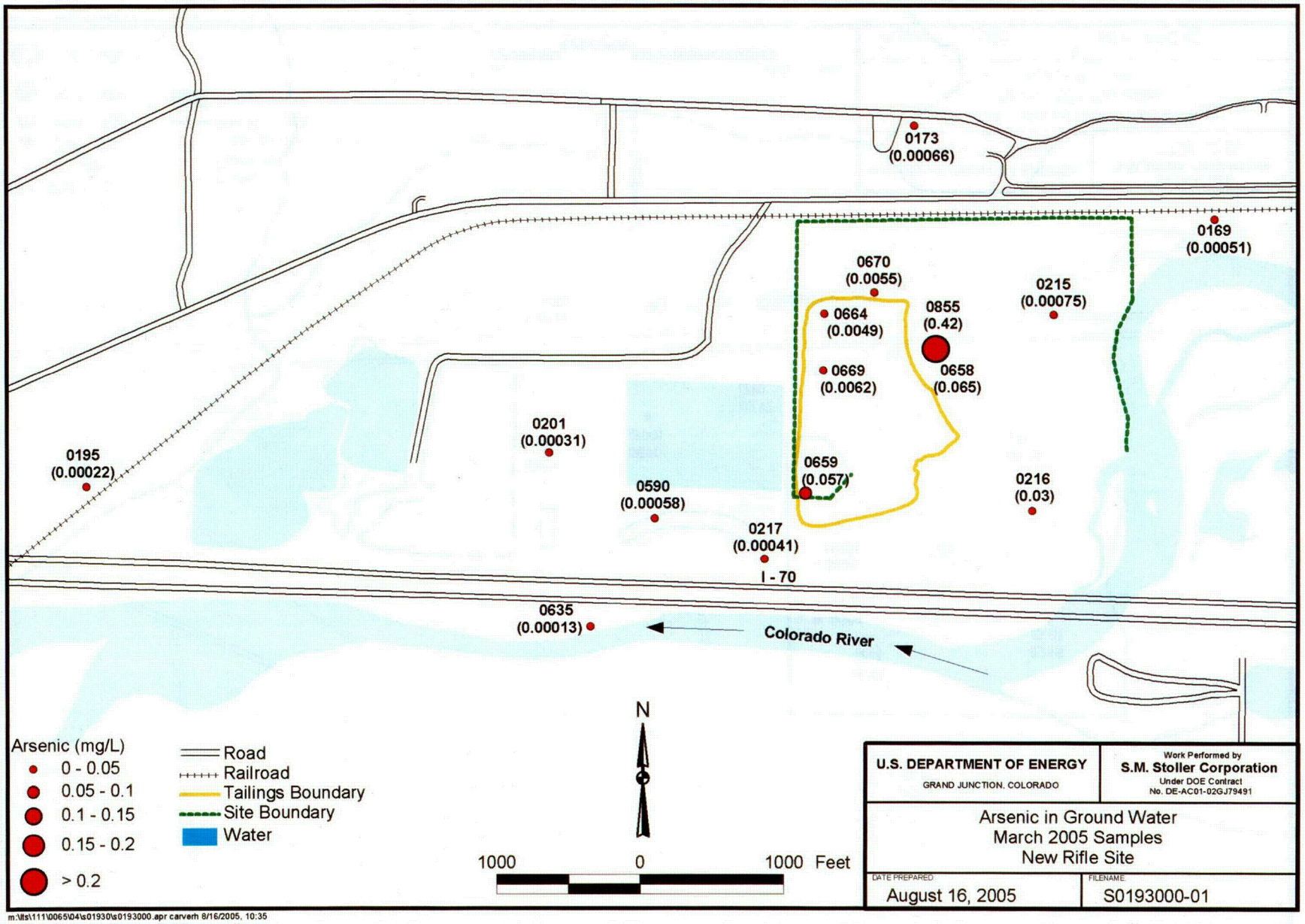
C07


Roaring Fork dewatering pit
Roaring Fork holding pond
Site fence
Extent of alluvium
Colorado River
Mitigation wetland
Monitor well location
N
0.00 0.25 0.50 0.75 1.00
Miles
mg/L
Vanadium (1998)
25.00
20.00
15.00
10.00
5.00
0.33
0.00
1.17
25.30
0.27
3.65
3.88
0.31
0.26
0.49
1.05

C08


0173
(<0.1)
0169
(<0.1)
0670
(27)
0215
(5.8)
0664
(46)
0855
(74)
0669
(170)
0658
(130)
0195
(17)
0201
(110)
0590
(200)
0659
(63)
0216
(7)
0217
(78)
I - 70
0635
(170)
Colorado River
N
Ammonia (mg/L)
0 - 200
200 - 250
250 - 300
300 - 350
350 - 409
Road
Railroad
Tailings Boundary
Site Boundary
Water
1000
0
1000 Feet
U.S. DEPARTMENT OF ENERGY
GRAND JUNCTION, COLORADO
Work Performed by
S.M. Stoller Corporation
Under DOE Contract
No. DE-AC01-02GJ79491
Ammonia Total as N in Ground Water
March 2005 Samples
New Rifle Site
DATE PREPARED
August 16, 2005
FILENAME
S0193000-02
m:\lts\111\0065\04\s01930\s0193000.apr carverh 8/16/2005, 10:36

C09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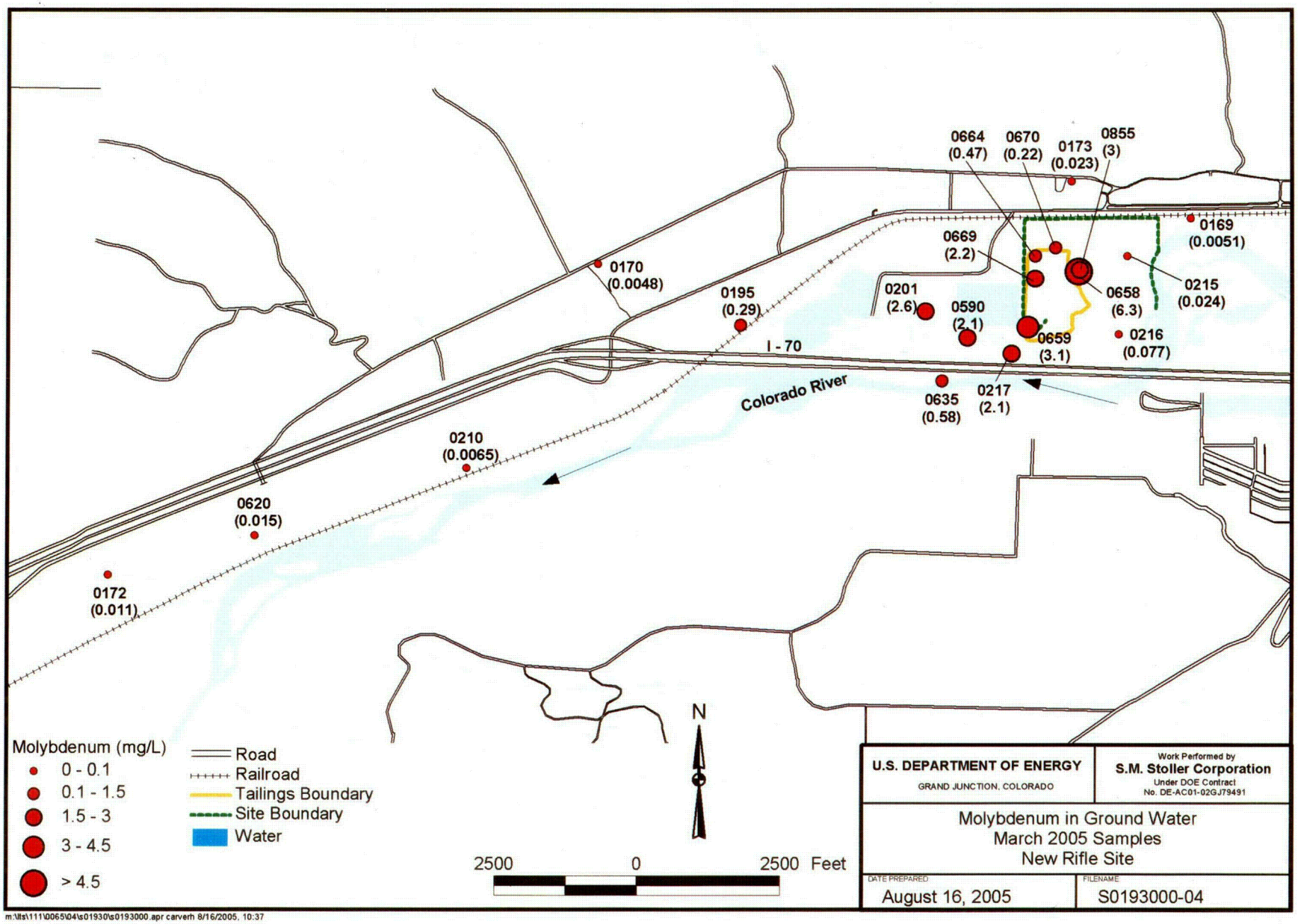
0169
(0.00051)
0670
(0.0055)
0215
(0.00075)
0664
(0.0049)
0855
(0.42)
0669
(0.0062)
0658
(0.065)
0201
(0.00031)
0195
(0.00022)
0659
(0.057)
0216
(0.03)
0590
(0.00058)
0217
(0.00041)
I - 70
0635
(0.00013)
Colorado River
N
Arsenic (mg/L)
0 - 0.05
0.05 - 0.1
0.1 - 0.15
0.15 - 0.2
> 0.2
Road
Railroad
Tailings Boundary
Site Boundary
Water
1000
0
1000 Feet
U.S. DEPARTMENT OF ENERGY
GRAND JUNCTION, COLORADO
Work Performed by
S.M. Stoller Corporation
Under DOE Contract
No. DE-AC01-02GJ79491
Arsenic in Ground Water
March 2005 Samples
New Rifle Site
DATE PREPARED:
August 16, 2005
FILENAME:
S0193000-01
m:\lts\111\0065\04\s01930\s0193000.apr carverh 8/16/2005, 10:35

C10


0664
(0.47)
0670
(0.22)
0173
(0.023)
0855
(3)
0169
(0.0051)
0669
(2.2)
0170
(0.0048)
0195
(0.29)
0201
(2.6)
0590
(2.1)
0658
(6.3)
0215
(0.024)
0659
(3.1)
0216
(0.077)
I - 70
Colorado River
0635
(0.58)
0217
(2.1)
0210
(0.0065)
0620
(0.015)
0172
(0.011)
N
Molybdenum (mg/L)
0 - 0.1
0.1 - 1.5
1.5 - 3
3 - 4.5
> 4.5
Road
Railroad
Tailings Boundary
Site Boundary
Water
2500
0
2500 Feet
U.S. DEPARTMENT OF ENERGY
GRAND JUNCTION, COLORADO
Work Performed by
S.M. Stoller Corporation
Under DOE Contract
No. DE-AC01-02GJ79491
Molybdenum in Ground Water
March 2005 Samples
New Rifle Site
DATE PREPARED
August 16, 2005
FILENAME
S0193000-04
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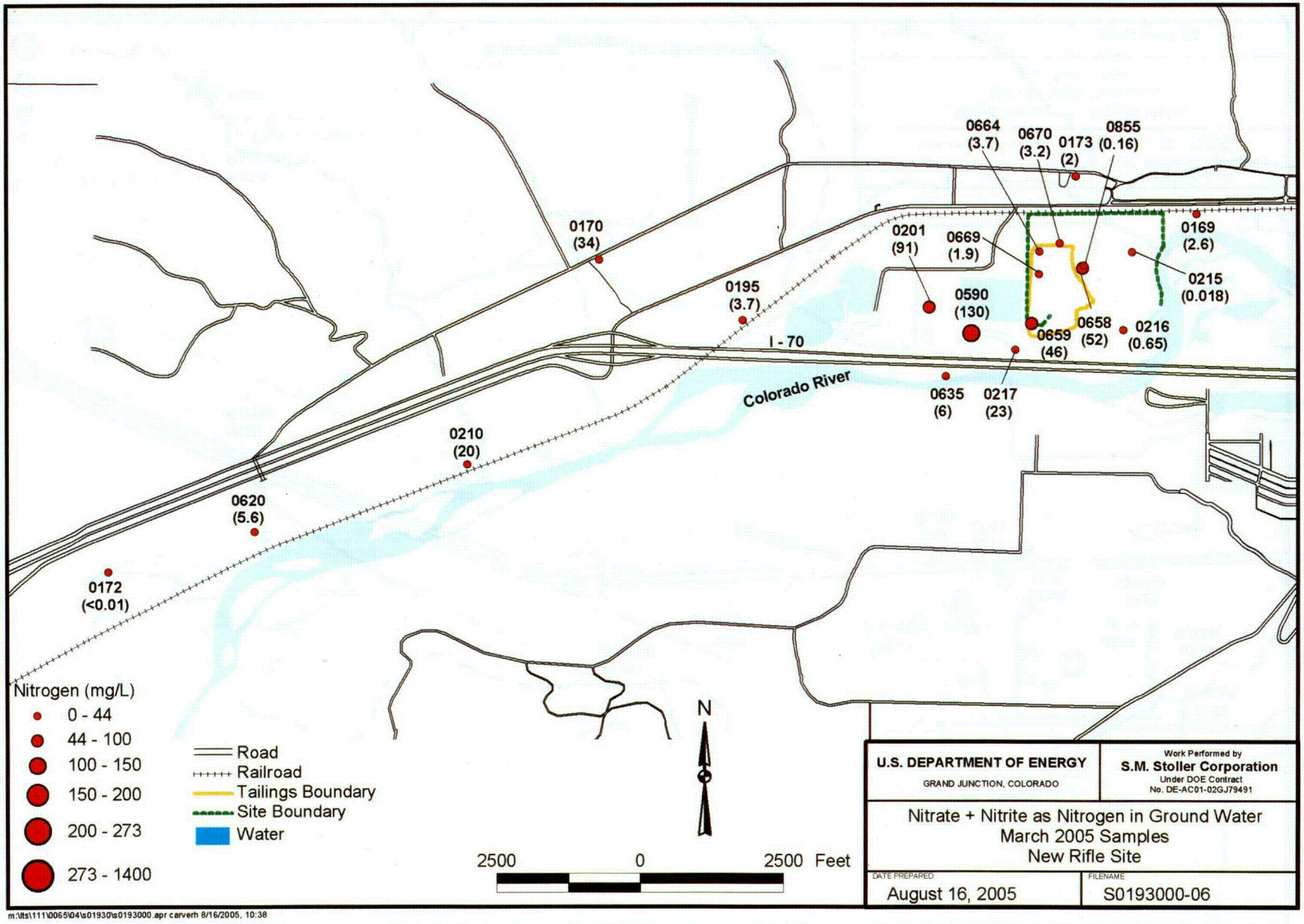
C11


0664 (3.7)
0670 (3.2)
0173 (2)
0855 (0.16)
0169 (2.6)
0201 (91)
0669 (1.9)
0215 (0.018)
0170 (34)
0195 (3.7)
0590 (130)
0658 (52)
0216 (0.65)
0659 (46)
I - 70
Colorado River
0635 (6)
0217 (23)
0210 (20)
0620 (5.6)
0172 (<0.01)
Nitrogen (mg/L)
0 - 44
44 - 100
100 - 150
150 - 200
200 - 273
273 - 1400
Road
Railroad
Tailings Boundary
Site Boundary
Water
N
2500 0 2500 Feet
U.S. DEPARTMENT OF ENERGY
GRAND JUNCTION, COLORADO
Work Performed by
S.M. Stoller Corporation
Under DOE Contract
No. DE-AC01-02GJ79491
Nitrate + Nitrite as Nitrogen in Ground Water
March 2005 Samples
New Rifle Site
DATE PREPARED
August 16, 2005
FILENAME
S0193000-06
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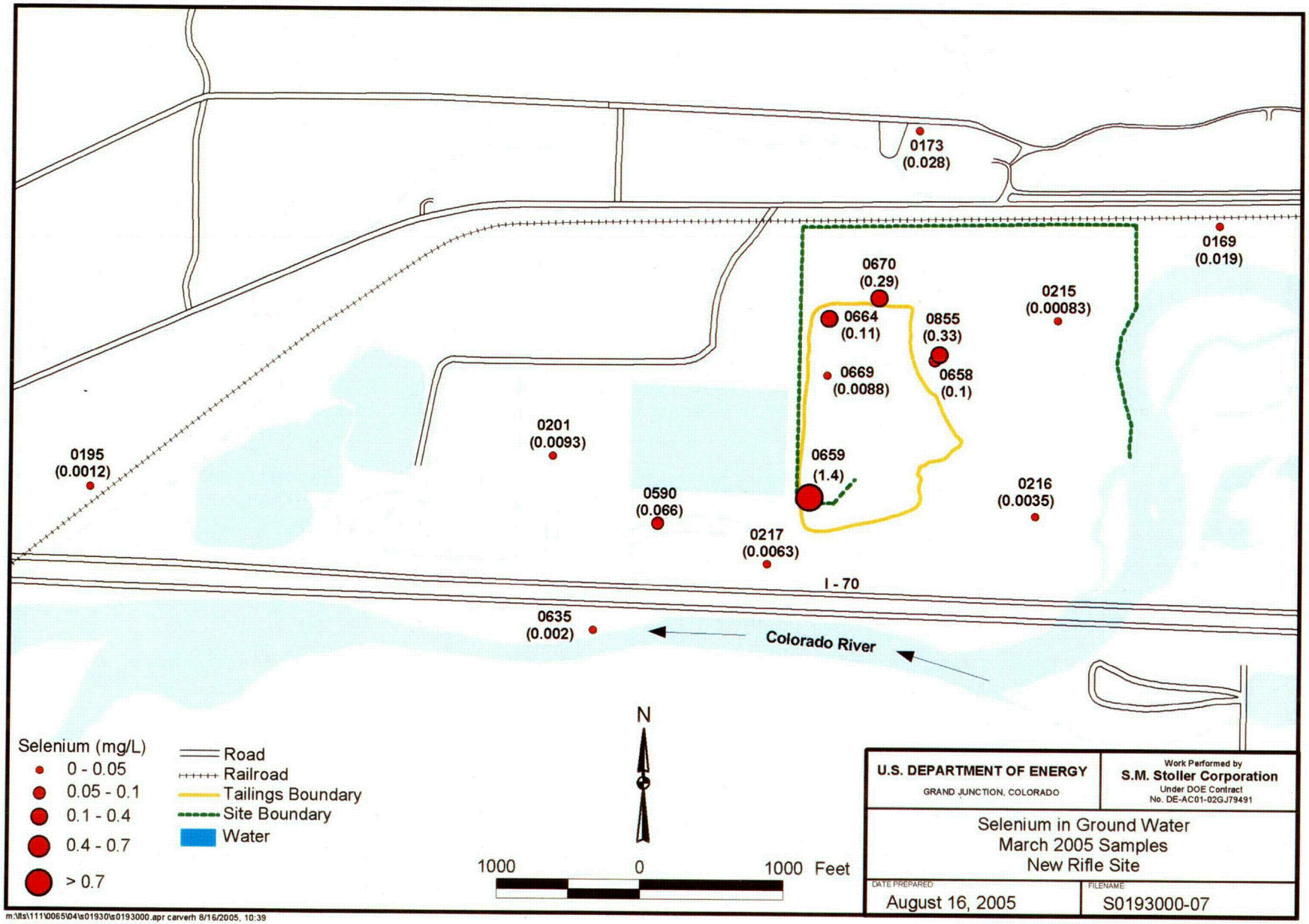
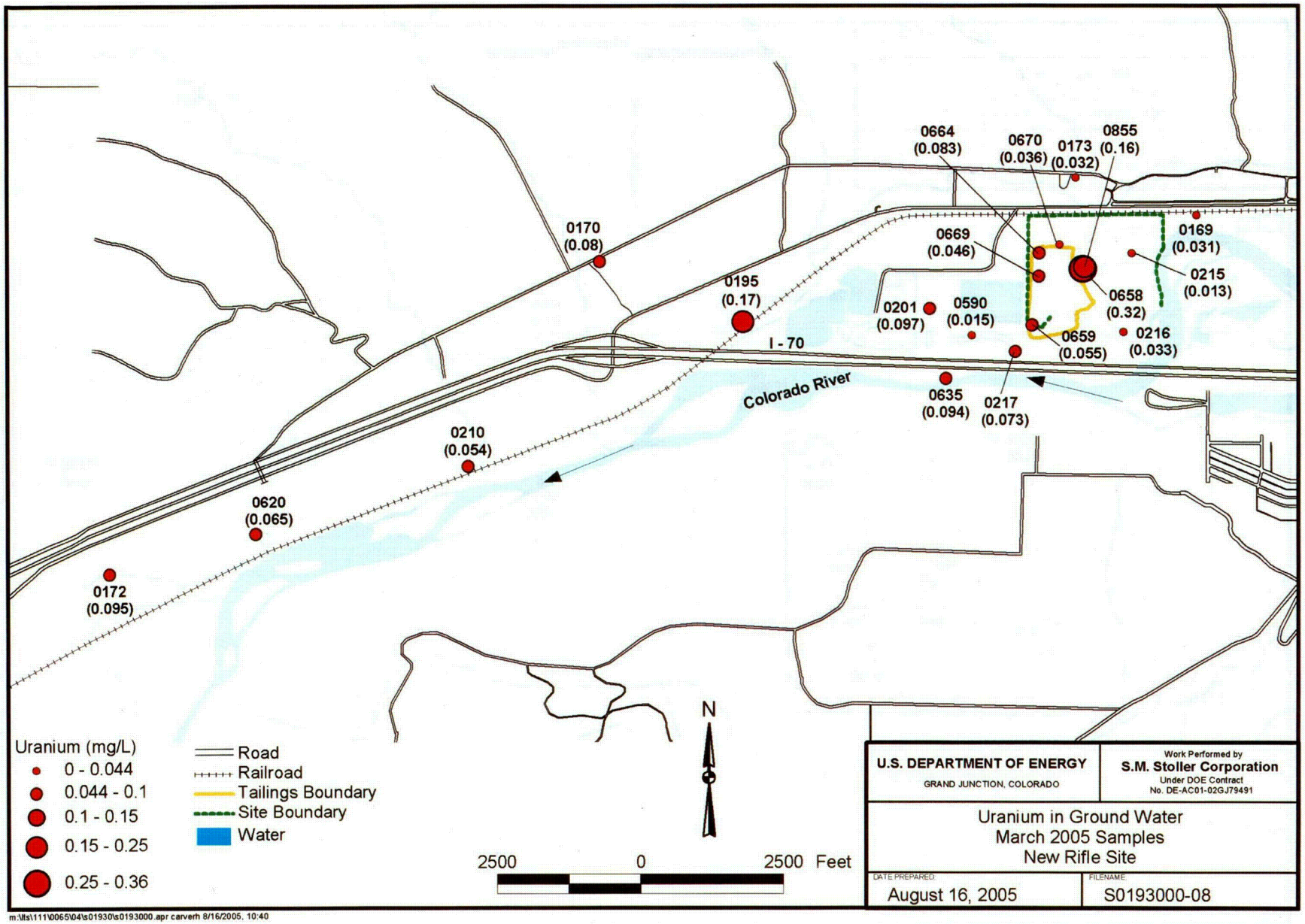
C12


0173
(0.028)
0169
(0.019)
0670
(0.29)
0664
(0.11)
0855
(0.33)
0215
(0.00083)
0669
(0.0088)
0658
(0.1)
0201
(0.0093)
0195
(0.0012)
0659
(1.4)
0590
(0.066)
0216
(0.0035)
0217
(0.0063)
I - 70
0635
(0.002)
Colorado River
N
Selenium (mg/L)
0 - 0.05
0.05 - 0.1
0.1 - 0.4
0.4 - 0.7
> 0.7
Road
Railroad
Tailings Boundary
Site Boundary
Water
1000
0
1000 Feet
U.S. DEPARTMENT OF ENERGY
GRAND JUNCTION, COLORADO
Work Performed by
S.M. Stoller Corporation
Under DOE Contract
No. DE-AC01-02GJ79491
Selenium in Ground Water
March 2005 Samples
New Rifle Site
DATE PREPARED
August 16, 2005
FILENAME
S0193000-07
m:\lts\111\0065\04\s01930\s0193000.apr carverh 8/16/2005, 10:39

C13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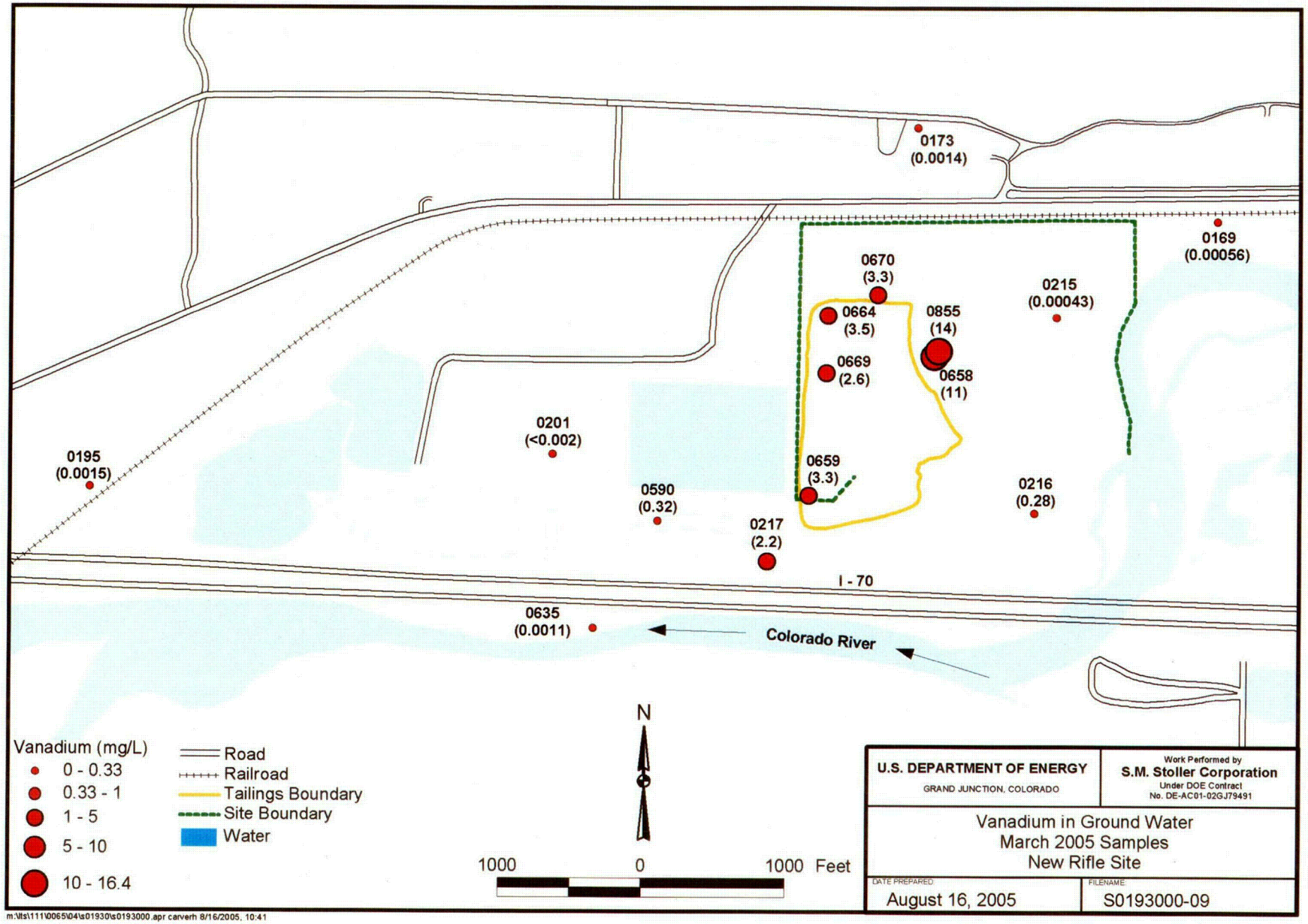
(0.083)
0670
(0.036)
0173
(0.032)
0855
(0.16)
0170
(0.08)
0669
(0.046)
0169
(0.031)
0215
(0.013)
0195
(0.17)
0658
(0.32)
0201
(0.097)
0590
(0.015)
I - 70
0659
(0.055)
0216
(0.033)
Colorado River
0635
(0.094)
0217
(0.073)
0210
(0.054)
0620
(0.065)
0172
(0.095)
N
Uranium (mg/L)
0 - 0.044
0.044 - 0.1
0.1 - 0.15
0.15 - 0.25
0.25 - 0.36
Road
Railroad
Tailings Boundary
Site Boundary
Water
2500 0 2500 Feet
U.S. DEPARTMENT OF ENERGY
GRAND JUNCTION, COLORADO
Work Performed by
S.M. Stoller Corporation
Under DOE Contract
No. DE-AC01-02GJ79491
Uranium in Ground Water
March 2005 Samples
New Rifle Site
DATE PREPARED:
August 16, 2005
FILENAME:
S0193000-08
m:\lts\111\0065\04\s01930\s0193000.apr carverh 8/16/2005, 10:40

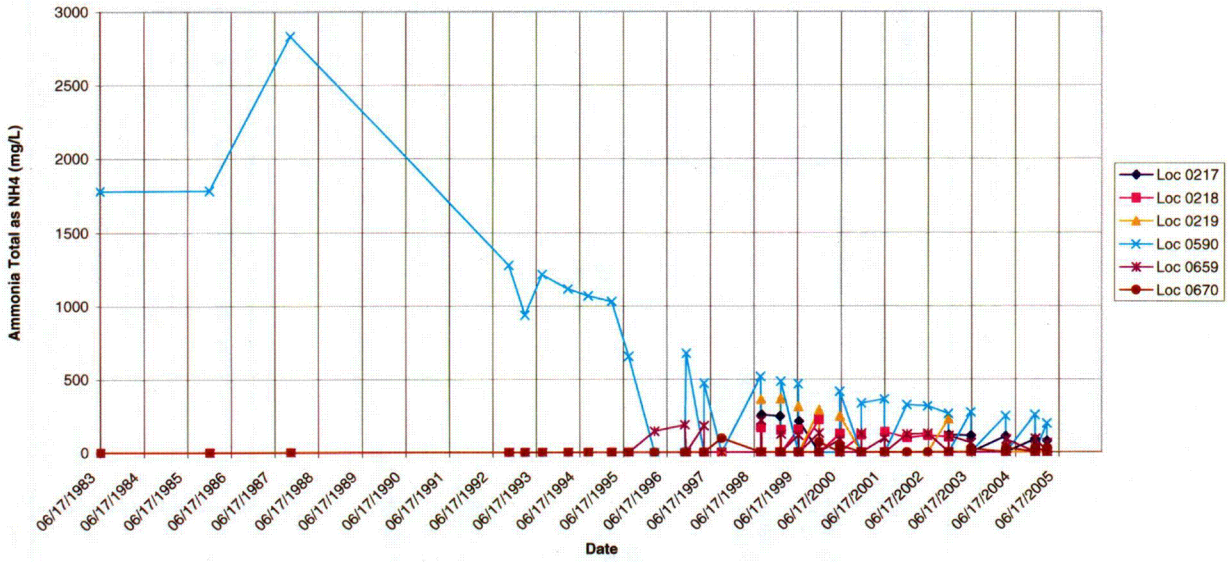
C14


0173
(0.0014)
0169
(0.00056)
0670
(3.3)
0215
(0.00043)
0664
(3.5)
0855
(14)
0669
(2.6)
0658
(11)
0201
(<0.002)
0195
(0.0015)
0659
(3.3)
0590
(0.32)
0216
(0.28)
0217
(2.2)
I - 70
0635
(0.0011)
Colorado River
N
Vanadium (mg/L)
0 - 0.33
0.33 - 1
1 - 5
5 - 10
10 - 16.4
Road
Railroad
Tailings Boundary
Site Boundary
Water
1000
0
1000 Feet
U.S. DEPARTMENT OF ENERGY
GRAND JUNCTION, COLORADO
Work Performed by
S.M. Stoller Corporation
Under DOE Contract
No. DE-AC01-02GJ79491
Vanadium in Ground Water
March 2005 Samples
New Rifle Site
DATE PREPARED:
August 16, 2005
FILENAME:
S0193000-09
m:\lts\111\0065\04\s01930\s0193000.apr carverh 8/16/2005, 10:41

C15

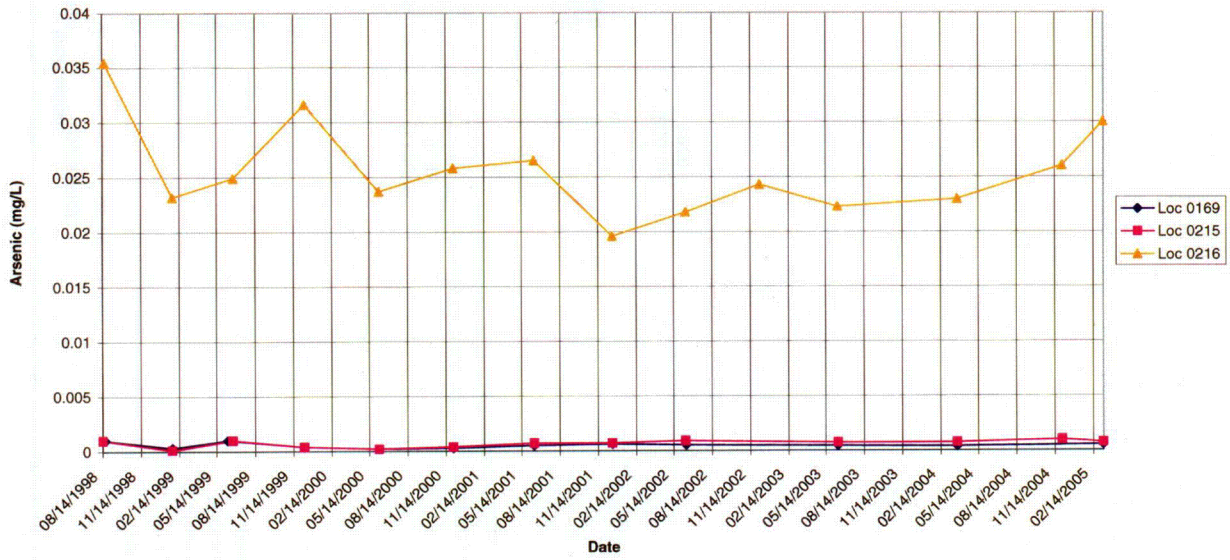
Rifle New Processing Site (RFN01)

Ammonia Total as NH4 Concentration



Rifle New Processing Site (RFN01)

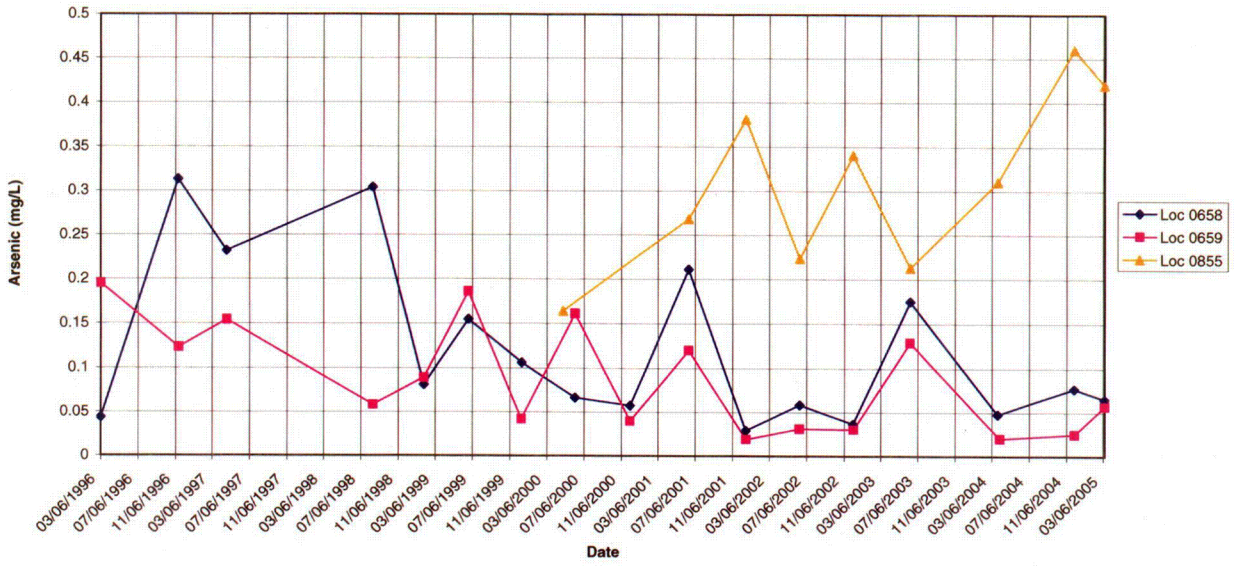
Arsenic Concentration



C16

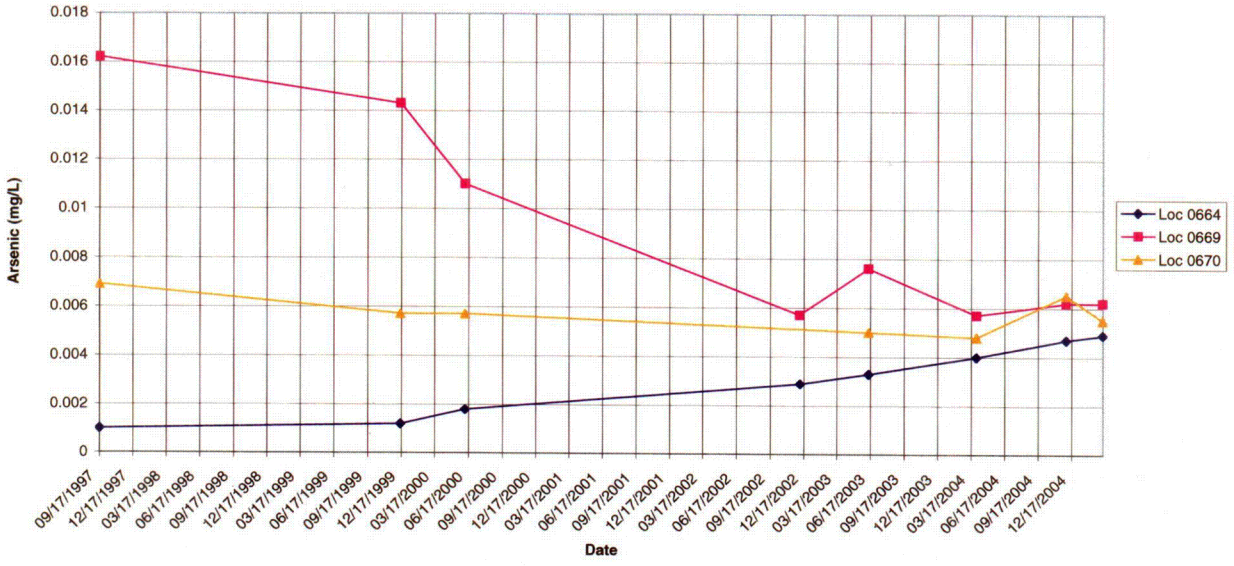
Rifle New Processing Site (RFN01)

Arsenic Concentration



Rifle New Processing Site (RFN01)

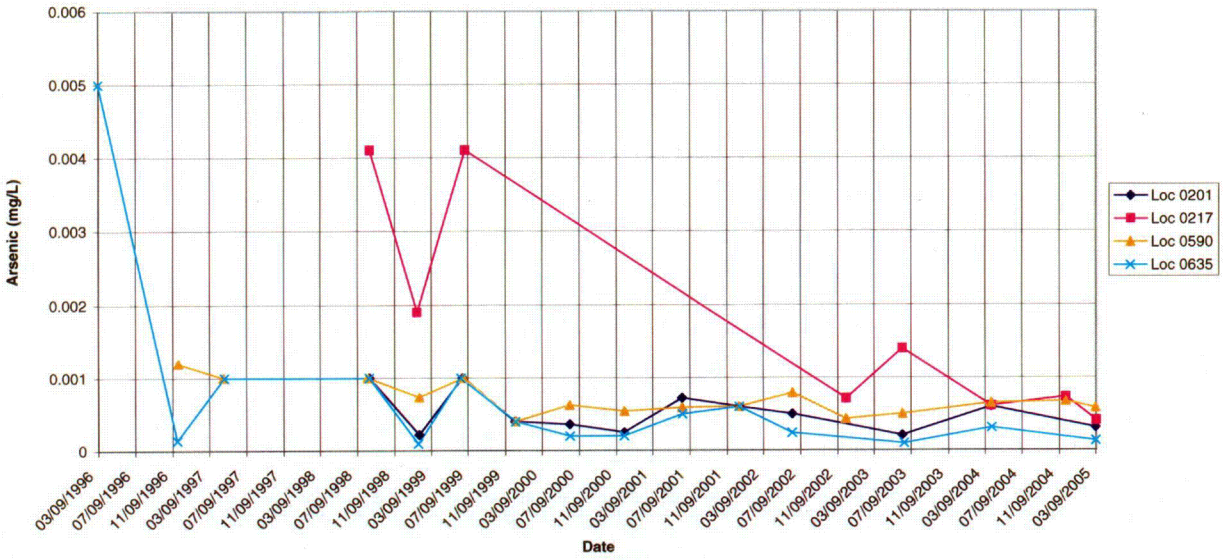
Arsenic Concentration



C17

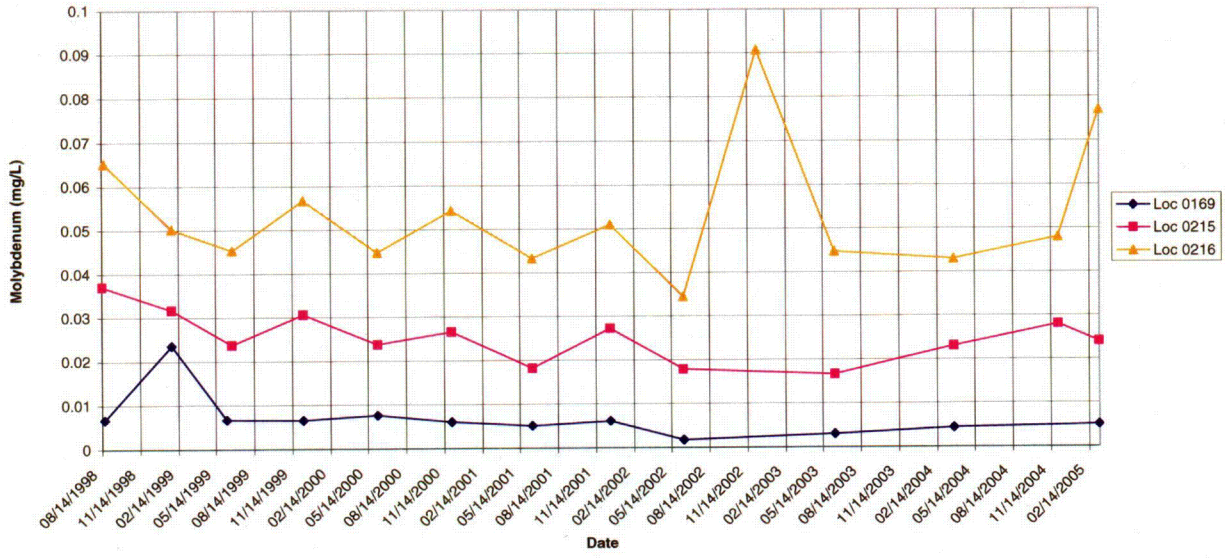
Rifle New Processing Site (RFN01)

Arsenic Concentration



Rifle New Processing Site (RFN01)

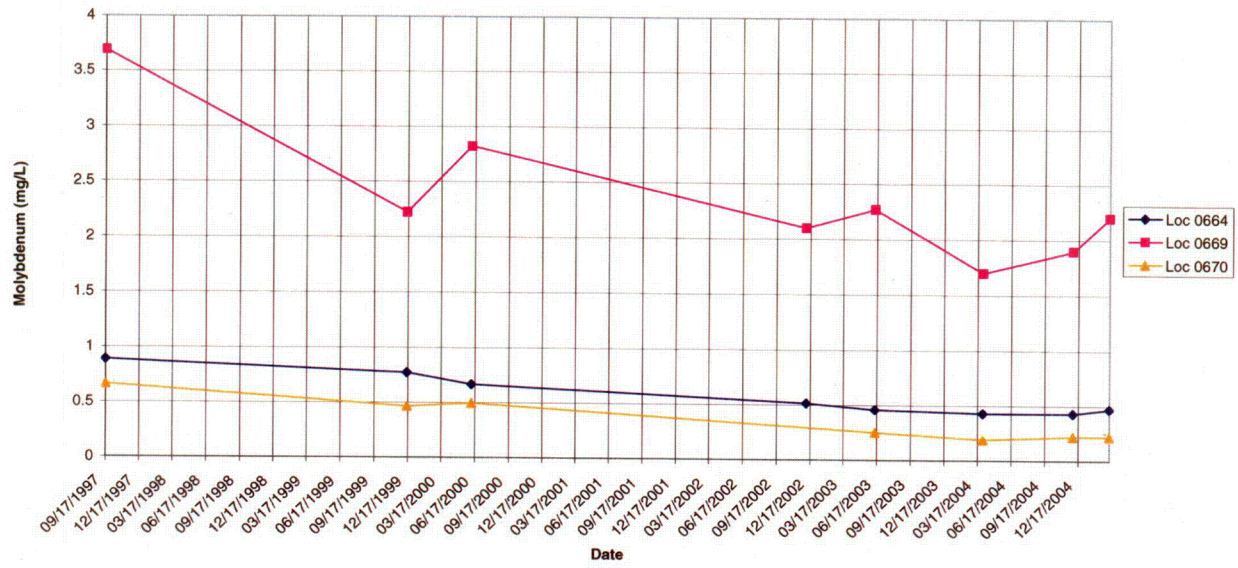
Molybdenum Concentration



C18

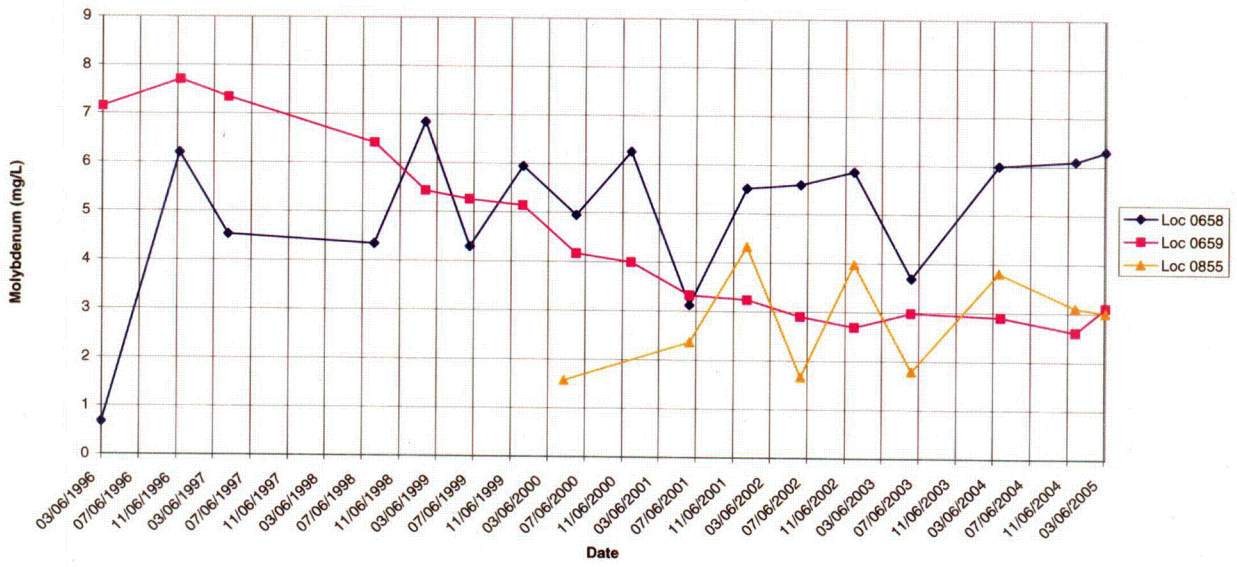
Rifle New Processing Site (RFN01)

Molybdenum Concentration



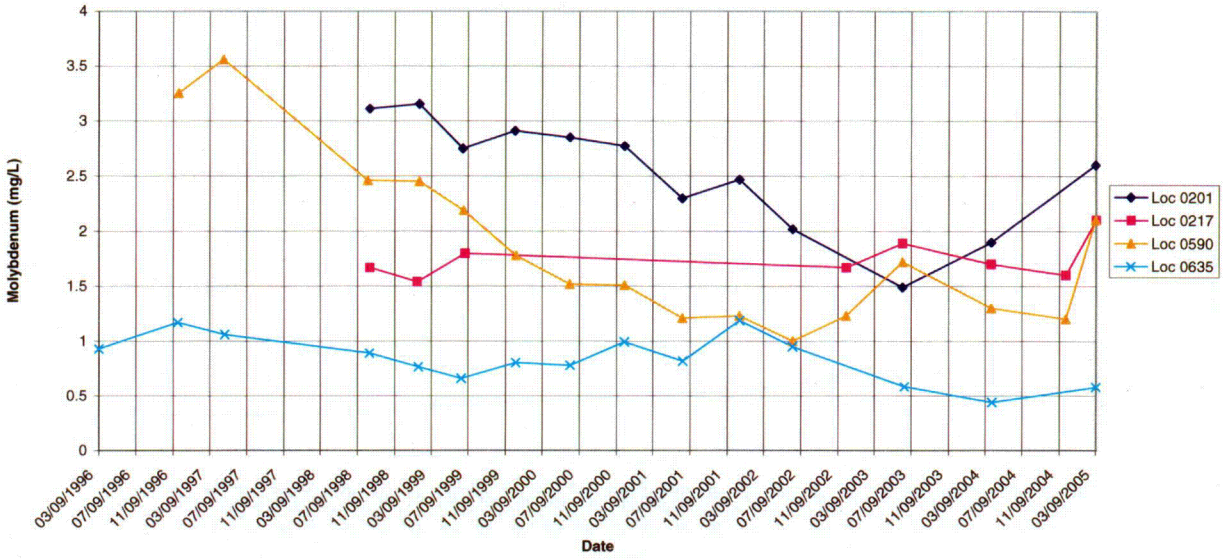
Rifle New Processing Site (RFN01)

Molybdenum Concentration



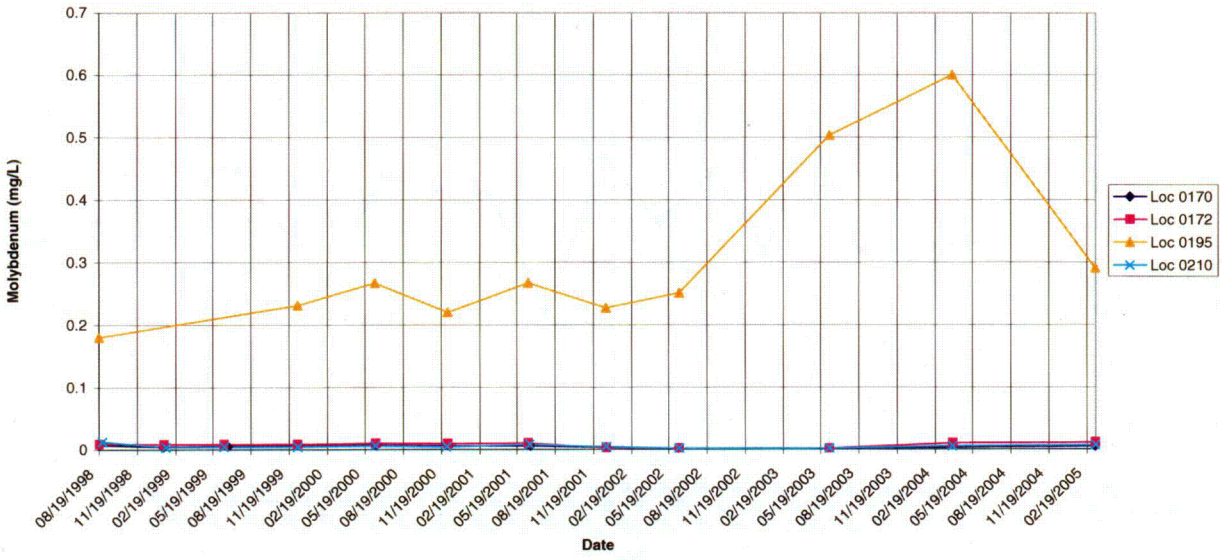
Rifle New Processing Site (RFN01)

Molybdenum Concentration



Rifle New Processing Site (RFN01)

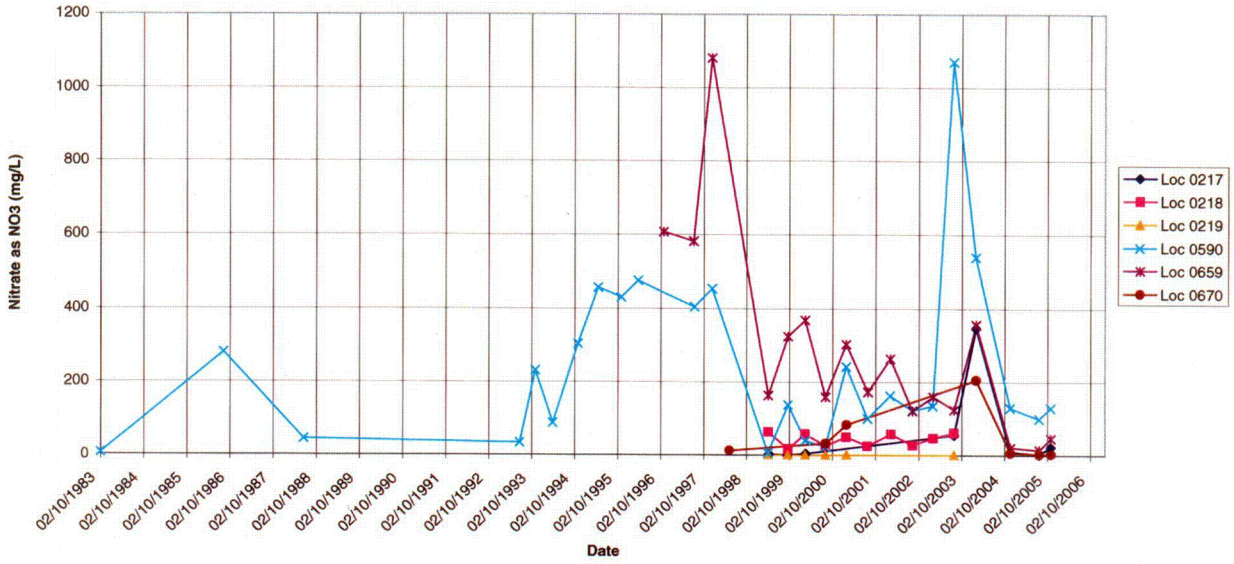
Molybdenum Concentration



C20

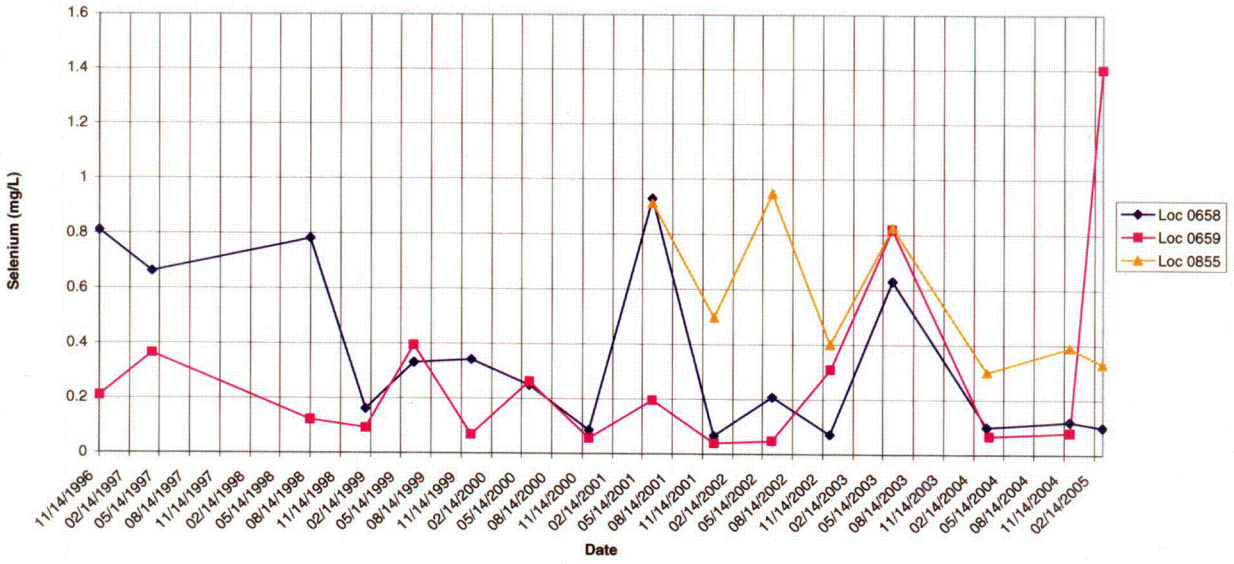
Rifle New Processing Site (RFN01)

Nitrate as N



Rifle New Processing Site (RFN01)

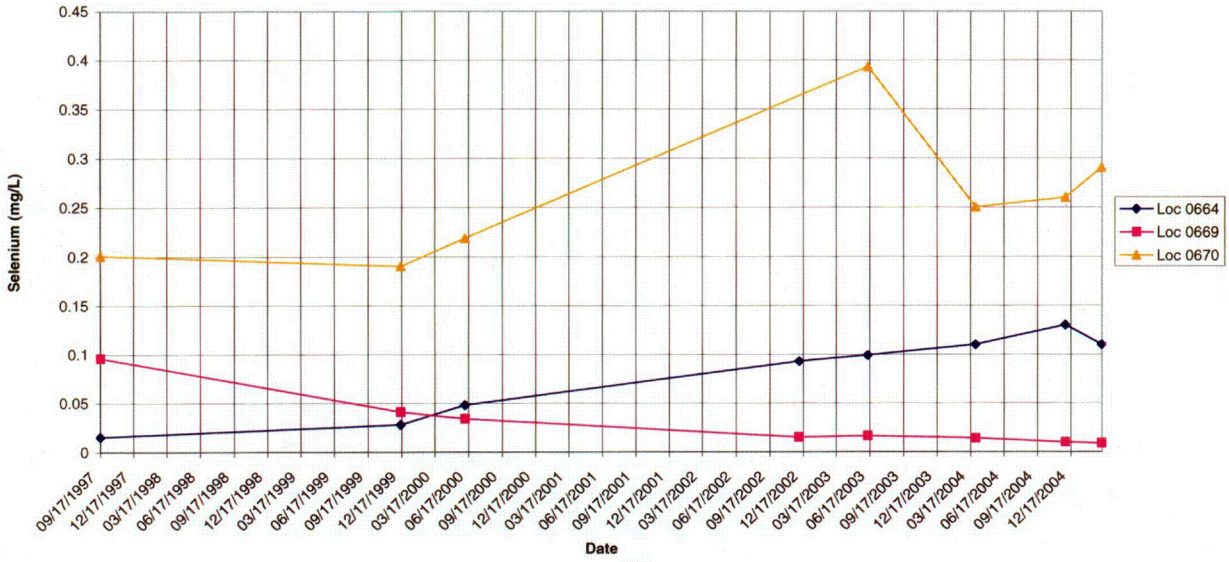
Selenium Concentration



C21

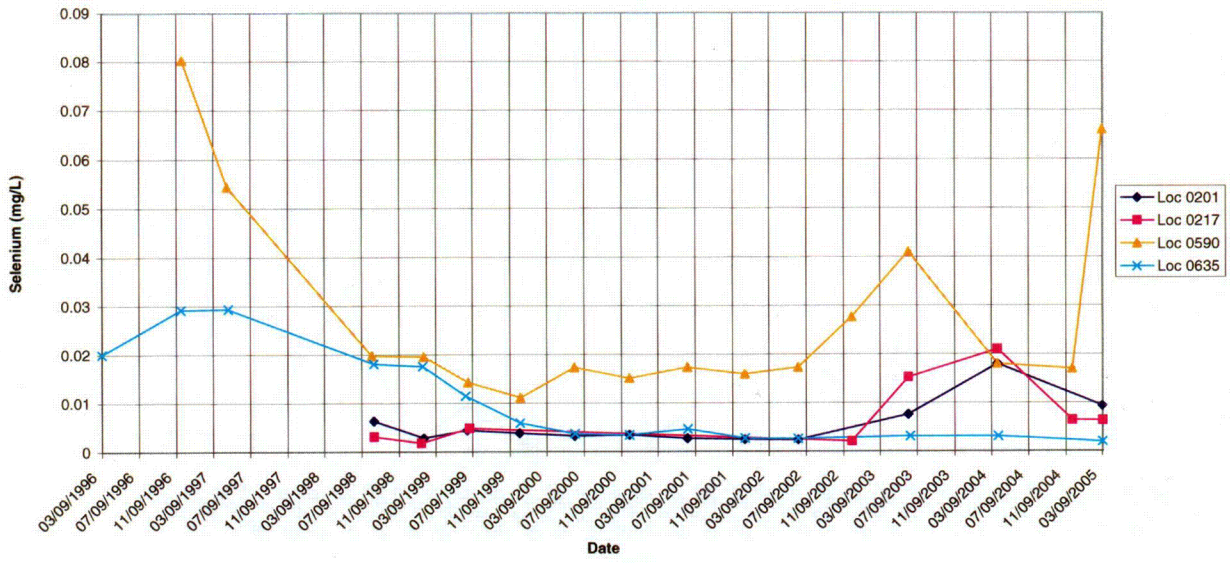
Rifle New Processing Site (RFN01)

Selenium Concentration



Rifle New Processing Site (RFN01)

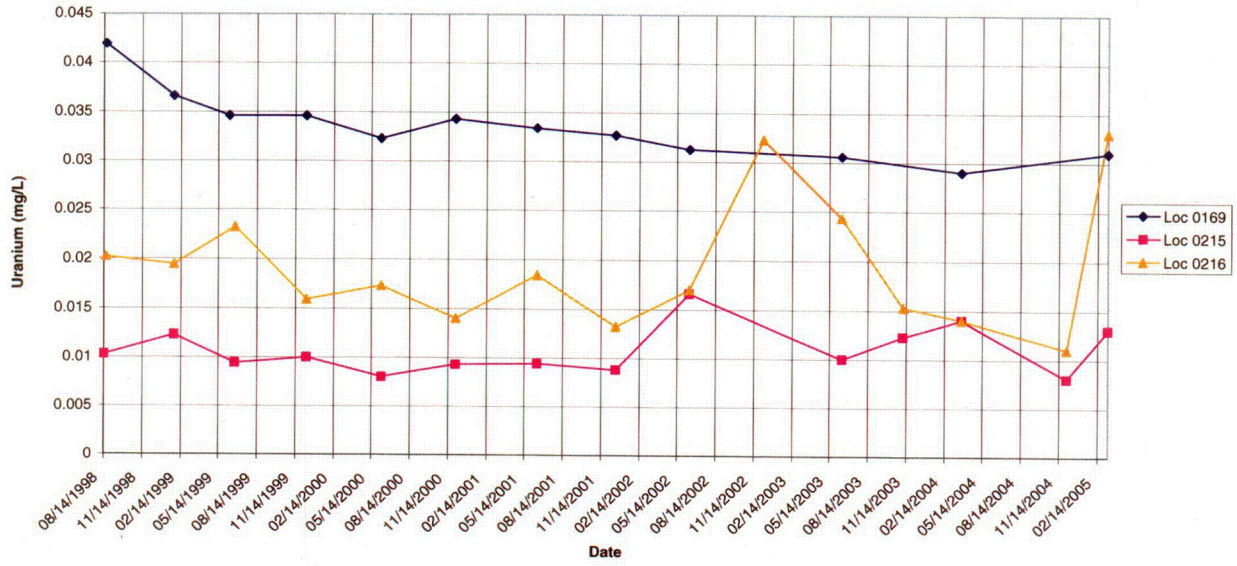
Selenium Concentration



C22

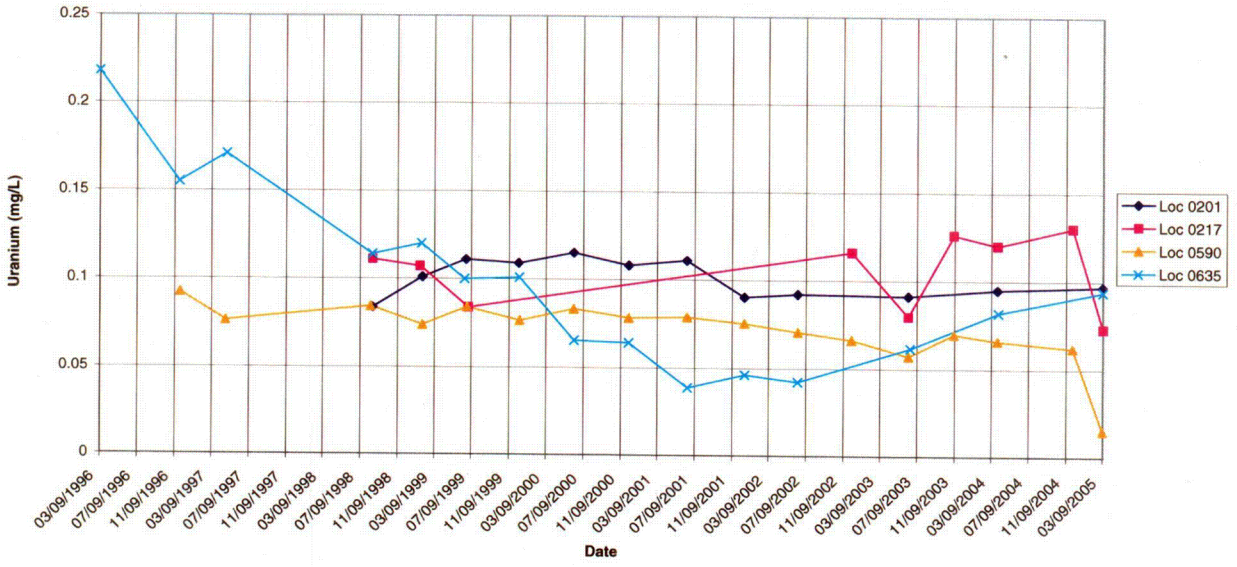
Rifle New Processing Site (RFN01)

Uranium Concentration



Rifle New Processing Site (RFN01)

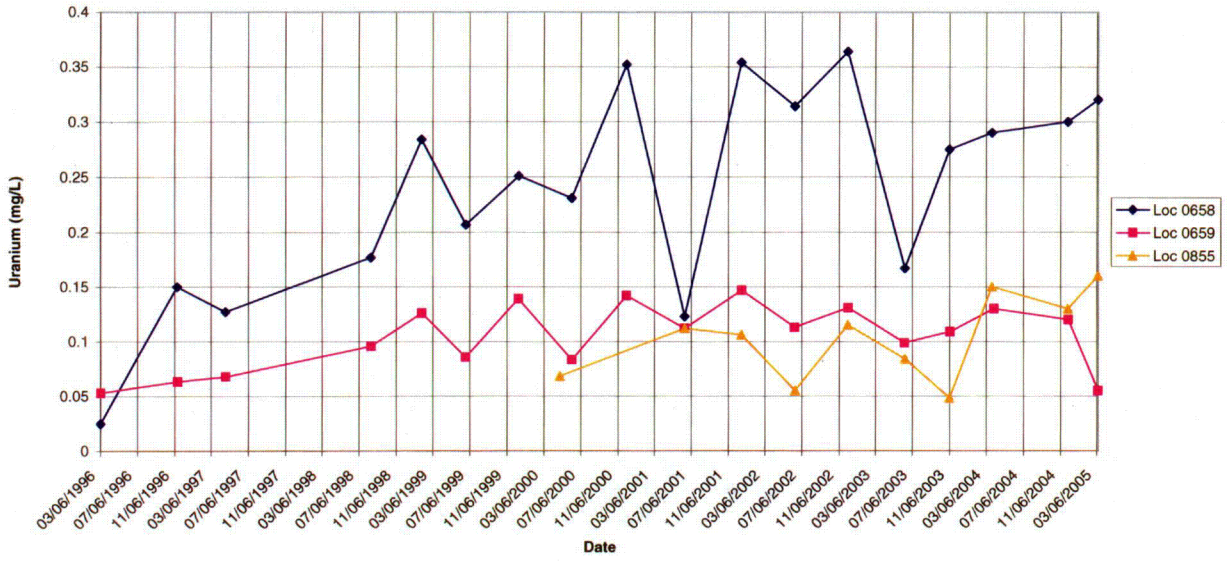
Uranium Concentration



C23

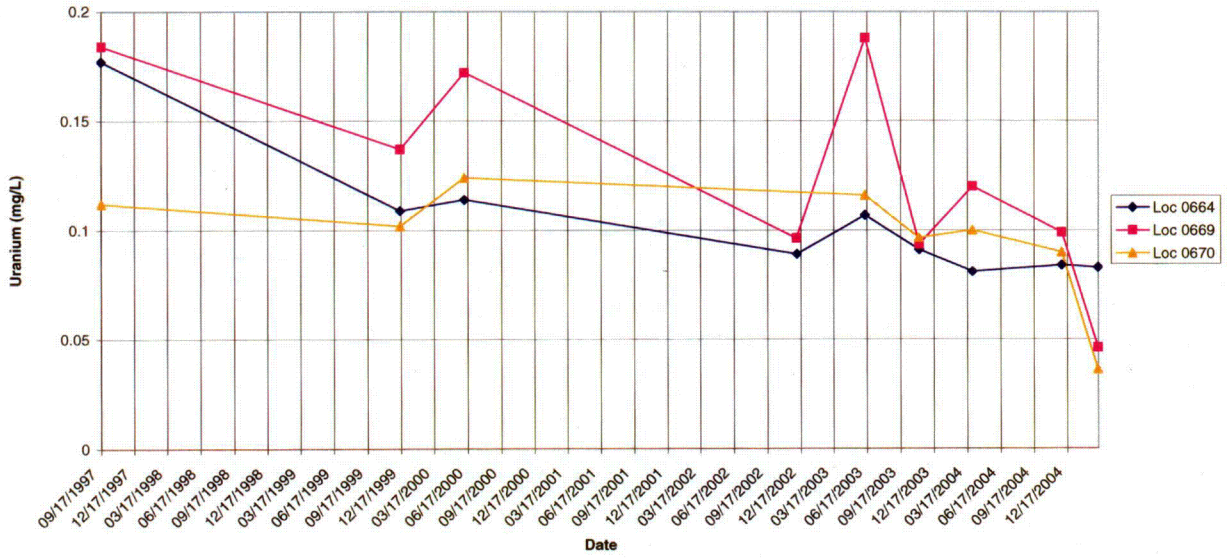
Rifle New Processing Site (RFN01)

Uranium Concentration



Rifle New Processing Site (RFN01)

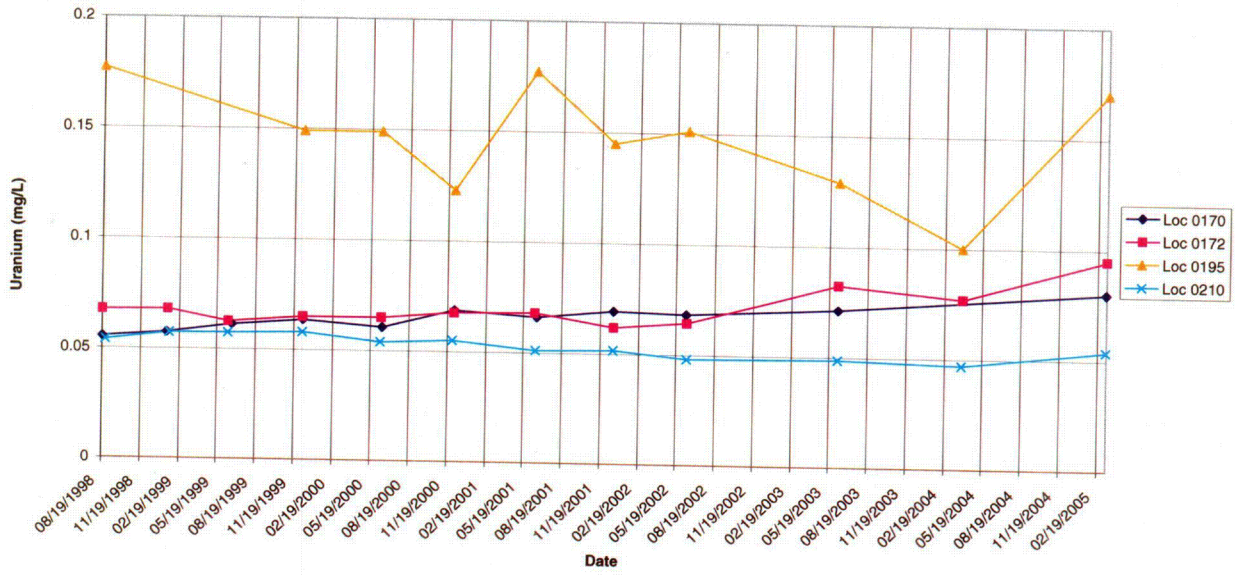
Uranium Concentration



C24

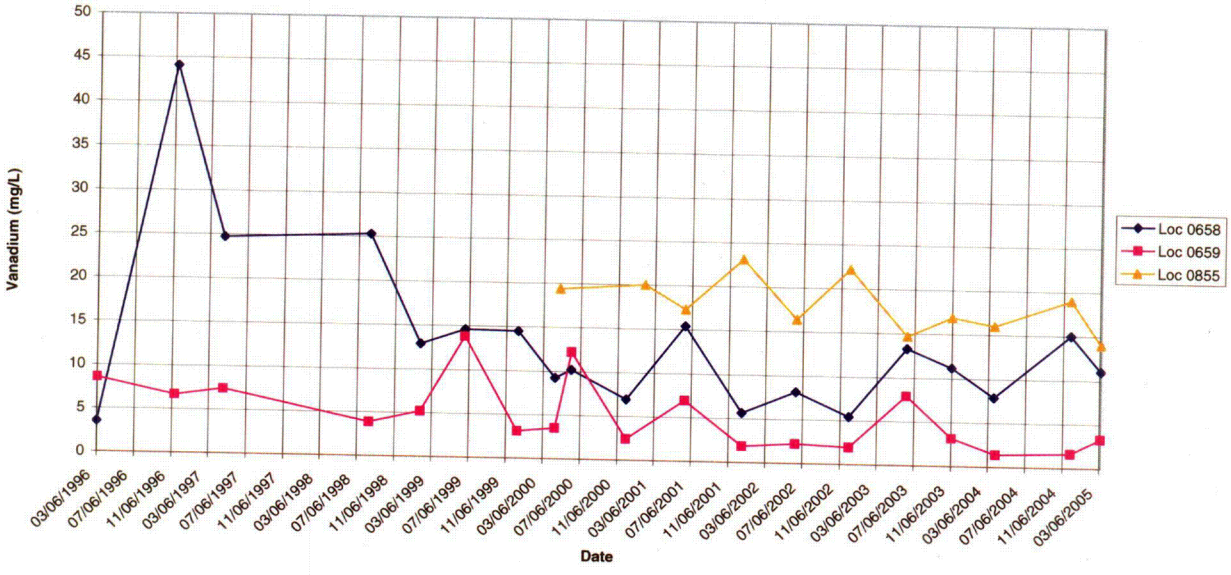
Rifle New Processing Site (RFN01)

Uranium Concentration



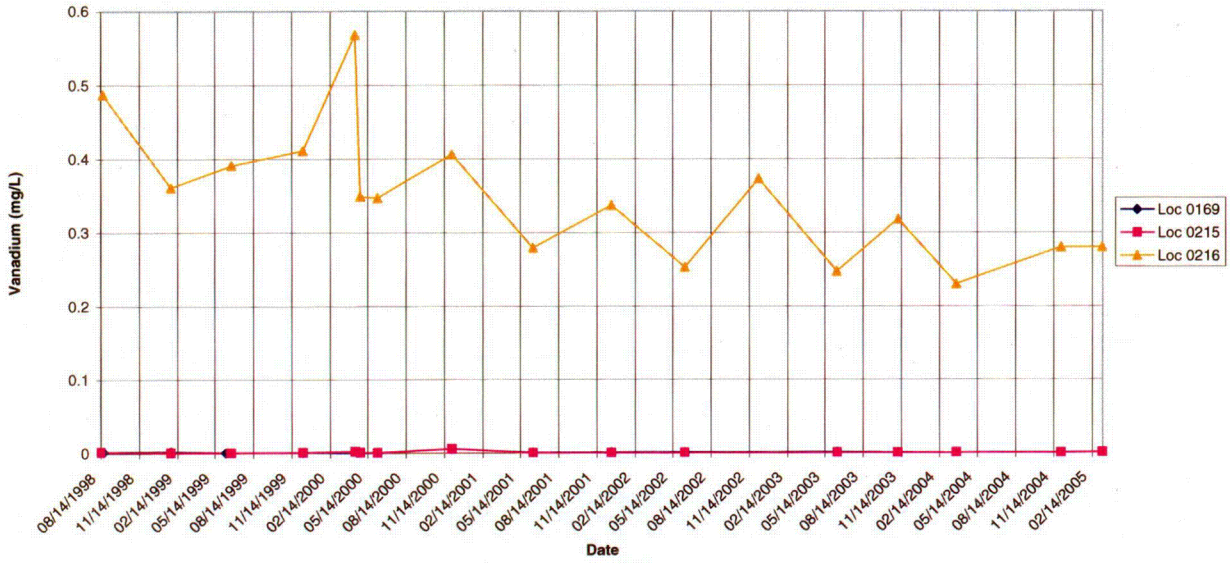
Rifle New Processing Site (RFN01)

Vanadium Concentration



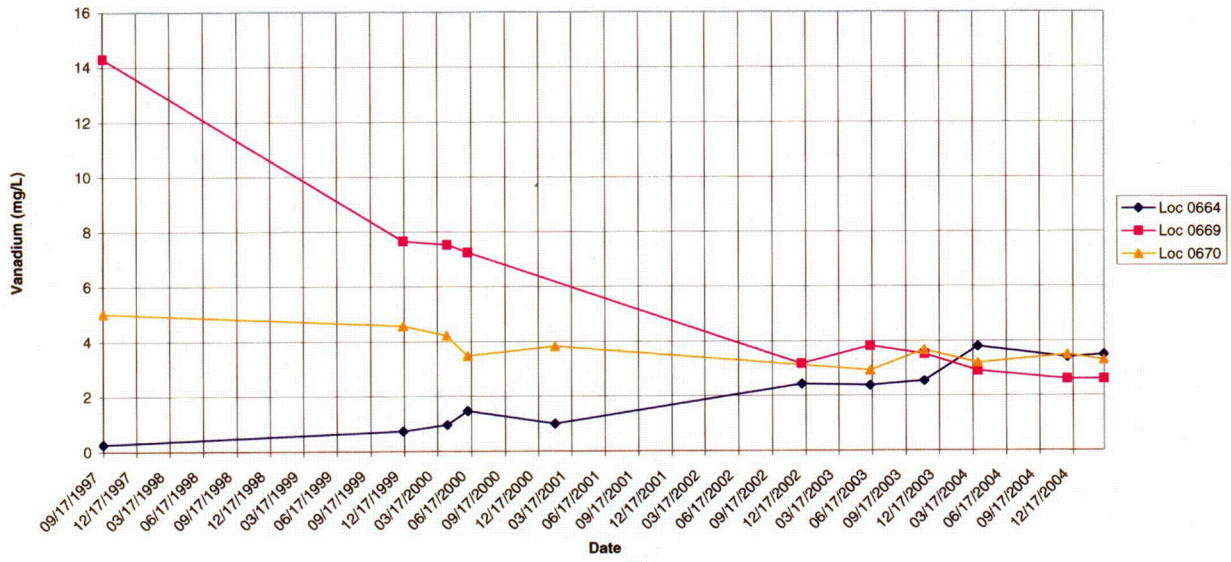
Rifle New Processing Site (RFN01)

Vanadium Concentration

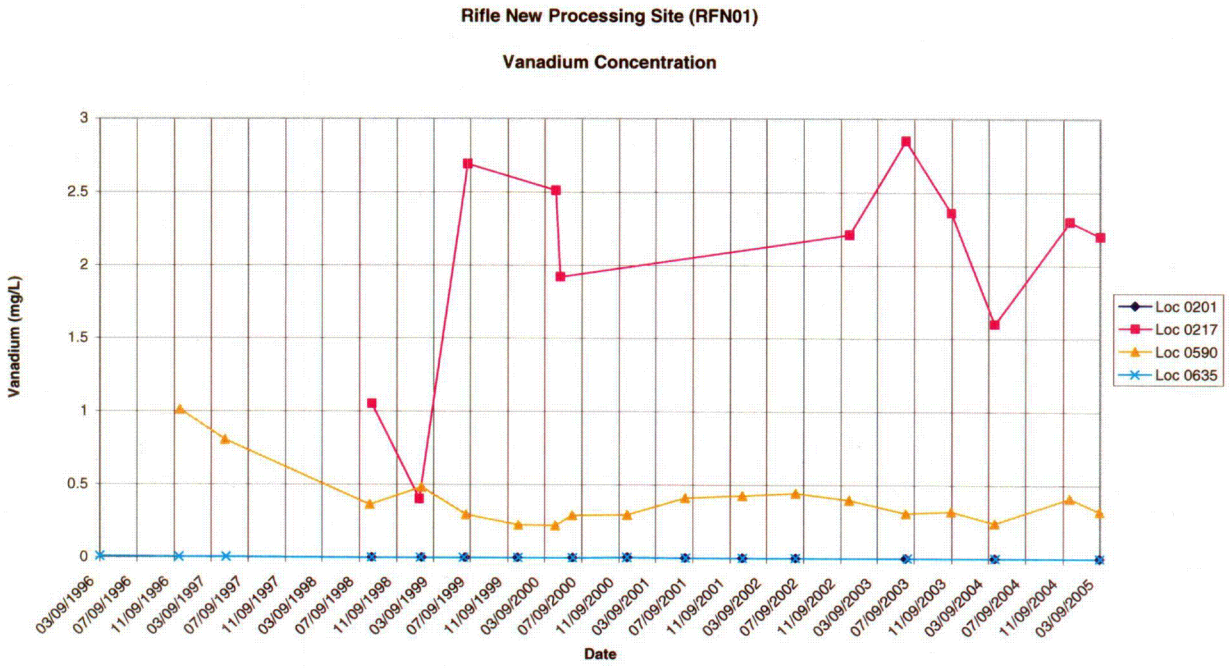


Rifle New Processing Site (RFN01)

Vanadium Concentration



C26


Rifle New Processing Site (RFN01)
Vanadium Concentration
Vanadium (mg/L)
3
2.5
2
1.5
1
0.5
0
03/09/1996
07/09/1996
11/09/1996
03/09/1997
07/09/1997
11/09/1997
03/09/1998
07/09/1998
11/09/1998
03/09/1999
07/09/1999
11/09/1999
03/09/2000
07/09/2000
11/09/2000
03/09/2001
07/09/2001
11/09/2001
03/09/2002
07/09/2002
11/09/2002
03/09/2003
07/09/2003
11/09/2003
03/09/2004
07/09/2004
11/09/2004
03/09/2005
Date
Loc 0201
Loc 0217
Loc 0590
Loc 0635

End of current text

Appendix C

Data Analysis of Vanadium at the New Rifle, Colorado, Uranium Mill Tailings Site

Contents

Figures

Tables

Attachment

Plates

End of current text

Executive Summary

The U.S. Department of Energy (DOE) conducted studies from 1997 to 1999 at the New Rifle Uranium Mill Tailings Remedial Action (UMTRA) Project site to understand the types, distributions, interactions, and movement of contaminants in ground water and to evaluate the risks posed to human health and the environment from these contaminants. A site conceptual model incorporating this information was used to propose a future course of action (i.e., compliance strategy) for the site. Based on results of these studies, a compliance strategy for all of the contaminants of concern (COC), except vanadium, was proposed in the Site Observational Work Plan (SOWP) (DOE 1999). This strategy was natural flushing of ground water to meet maximum concentration limits, alternate concentration limits, or background concentrations. Institutional controls and monitoring were to be implemented to ensure protectiveness of the compliance strategy until cleanup goals were met. Additional studies regarding vanadium, including distribution, behavior, and removal from the ground water were recommended and have been ongoing until recently (DOE 2000 and DOE 2002).

Initial modeling of ground water flow and vanadium transport, conducted in 1998 and using established methods for measuring vanadium mobility, showed that about 300 years would be required to decrease dissolved vanadium levels to a risk-based screening level of 0.33 milligrams per liter (mg/L) (EPA 2003). Actual data obtained from monitor wells during the 4 years since that modeling was completed indicate that the concentration of vanadium in ground water is decreasing faster than the modeling predicted. Recent evaluation of the initial model indicates that geochemical processes controlling vanadium in ground water at the site are more complex than originally assumed and could vary significantly over small distances, making it difficult to produce an accurate sitewide model for vanadium fate and transport. Consequently, an analytical solution describing localized vanadium transport has been applied to individual sets of time-concentration data to better match the more rapid decrease in observed vanadium concentrations and to develop a more realistic predictive tool. This analysis indicates that vanadium concentrations in ground water are likely to decrease to levels below the risk-based screening level of 0.33 mg/L in less than 100 years.

The apparent reason for the discrepancy between the earlier model and observed vanadium concentrations stems from the behavior of vanadium in this ground water setting. Vanadium attaches itself or sorbs to various materials in the subsurface, more so than most ground-water contaminants. These materials that act as sorbents include iron and manganese hydroxides, clays, and organic materials; all are commonly found in alluvial sediments at the New Rifle site. Therefore, vanadium tends to be easily sorbed but slowly released from these locations into the ground water. Changes in ground water chemistry, such as the addition or loss of oxygen, may accelerate the vanadium uptake to or release from the alluvial materials. The resulting sorption and desorption processes are controlling the natural flushing of vanadium observed today. The ground water system at New Rifle, in the area of the vanadium plume, is apparently more variable than characterization data suggested; therefore, it is more difficult to predict how these sorption-desorption processes will influence vanadium movement. Evidence strongly suggests that disturbing the subsurface tends to release vanadium from sorbed sites and increases concentrations in the ground water; consequently, further disturbance should be minimized. Studies indicate that the risk to human health and environmental for allowing vanadium to slowly flush from the New Rifle site is low, especially with institutional controls to prevent access to the contamination.

This information, when considered with other vanadium studies at the site, was used to select a compliance strategy for vanadium of natural flushing that is the same for all contaminants at New Rifle. Institutional controls and monitoring will continue for all contaminants at the New Rifle site until cleanup objectives are met. This strategy will be discussed in the Ground Water Compliance Action Plan and the Environmental Assessment for the New Rifle UMTRA Project site.

1.0 Background Information

Contaminated soil and sediment were removed from the New Rifle site during the UMTRA Project from 1992 to 1996 (DOE 1999). After the surface program concluded, contamination remaining in the ground water was characterized and evaluated. The purpose of this characterization was to select a compliance strategy for ground water contamination based selection processes shown in the Programmatic Environmental Impact Statement (PEIS) DOE 1996). This process was followed for all contaminants except vanadium, which required additional study. This data analysis discusses these results.

After information was collected from the site, the first attempt at quantifying the migration of vanadium and other contaminants in ground water was made in the Site Observational Work Plan (SOWP) that was prepared for on the basis of conditions observed in the late 1990s (DOE 2000). Studies of vanadium chemistry during that time revealed that numerous geochemical processes, including sorption on aquifer solids and chemical precipitation, might influence levels of dissolved vanadium in ground water. Although these processes can vary greatly in both space and time at a given site, the conceptual model developed for the New Rifle site assumed that the result of all of these processes could be described through the use of contaminant sorption theory based on a linear soil-water distribution coefficient, which is often denoted by the term K_d. In 1998, in accordance with the conceptual model for vanadium, a numerical model of ground water flow and an associated transport model, using both deterministic and probabilistic methods, was developed for the site using this distribution coefficient theory.

One of the purposes of modeling ground water flow and transport at the site was to assess the potential for vanadium to naturally flush. Chemical transport principles dictate that, as the K_d for a ground water constituent increases, the mobility of that constituent is reduced, and its potential to flush naturally decreases. In such a case, the constituent shows a preference to attach to solid particles that the aquifer comprises, and its transport in ground water is said to be "retarded." The corresponding decrease in transport rate compared to a constituent that does not attach to aquifer solids is described using a dimensionless retardation factor R, which is calculated using the K_d for the chemical, the dry bulk density of aquifer materials, and porosity of the aquifer. The larger the K_d value, the greater the retardation and the value of R.

With an emphasis on soil-water distribution coefficients, attempts were made during preparation of the SOWP to derive reasonable estimates of K_d for vanadium in the alluvial aquifer at the New Rifle site. Laboratory estimates of vanadium K_d based on samples of alluvial aquifer material ranged from 3.1 to 58.8 milliliters per gram (mL/g). A standard correction factor was applied to the fraction of smaller size (< 2 millimeter) particles in the samples of aquifer material that act as locations for sorption of ground water contaminants more than the coarse fraction. The resulting K_d values were lower and ranged from 1.2 to 10.5 mL/g. However, even these revised estimates of the soil-water distribution coefficient suggested that vanadium transport in ground water would be heavily retarded. Assuming an aquifer porosity of 25% and an aquifer material density of 1.5 g/ml, the range of revised K_ds resulted in computed retardation factors of about 8 to 64. This in turn meant that vanadium could be migrating downgradient and toward the Colorado River anywhere from 8 to 64 times slower than a non-retarded constituent, thereby diminishing the potential for natural flushing of vanadium within a reasonable time frame.

With the concerns over the apparent low potential for vanadium flushing from the site, DOE recommended that additional study be conducted to better understand the lateral and vertical extent of vanadium in ground water and soil before a remediation strategy could be selected for vanadium. In October 1999, a series of backhoe trenches were dug and soil samples were collected every 2 feet to a depth of 10 feet. (DOE 2000). Analytical results showed that vanadium was most concentrated in the deepest intervals. In the spring of 2000, 20 boreholes were drilled and sampled. Soil and ground water grab samples were collected from the top of the water table, from just above bedrock, and from a point halfway in between. Soil samples were also collected above the water table. In addition, four sets of three nested wells were constructed near the edges of the vanadium plume, and samples were collected from the same depths as the borehole samples. Results suggested that vanadium in the soil was most concentrated near well cluster 855, 856, and 867 and that the maximum vanadium concentration in ground water was in the middle part of the saturated zone located about 400 feet downgradient of the area of maximum soil contamination.

DOE then decided to evaluate the effectiveness of removing vanadium from the ground water and established a pilot plant for this purpose in the center of the plume. A pump and treat system using zero valent iron to remove vanadium and other metals operated from January until November of 2001 and treated nearly 3,000,000 gallons of water. This resulted in removal of approximately 99 kilograms (kg) of vanadium from the ground water in the plume area (DOE 2002).

In the past 3 years since modeling was completed, and in the past year since the pilot study was conducted, vanadium concentrations in most wells at the site were decreasing faster than the model predicted. In 2002, the model was reevaluated using several probabilistic modeling techniques. Probabilistic simulations were conducted with the ground water transport model for the site to determine if conditioning of model results on observed vanadium concentrations collected during the past few years would produce parameter ranges leading to a decrease in the time needed for natural flushing of vanadium. Most of this evaluation was accomplished using the model previously developed for the site as part of the SOWP (DOE 1999). This model was constructed using the ground water flow simulator MODFLOW (McDonald and Harbaugh 1988; Harbaugh and McDonald 1996) and the transport code MT3DMS (Zheng 1999) with the Ground Water Vistas (ESI 1998) graphical user interface.

A probabilistic model is distinguished from a deterministic model in the sense that the latter consists of a single set of parameter inputs, rather than numerous combinations of parameters in the probabilistic realm. The parameter set in the deterministic model is developed through the process of model calibration, wherein the model user manually adjusts input parameter values until a single, reasonable combination of values provide model results that compare favorably with observed conditions within a specified criterion. The calibrated deterministic model is then used to provide a best estimate of future vanadium concentrations. In contrast, the probabilistic approach does not produce a best estimate, but rather a suite of simulation results that are expected to span the expected future behavior of vanadium.

The probabilistic modeling consisted of making multiple runs with the original SOWP model, with each run based on input parameters that were randomly sampled from prescribed probability density functions (PDF) for each parameter. This approach, which is generally referred to as Monte Carlo simulation, made it possible to examine hundreds of different parameter sets to better match observed trends in vanadium concentration.

The most significant finding from the recent probabilistic modeling (discussed in Attachment A) was that no better fits to observed natural flushing data could be derived than had been predicted previously using the same SOWP model. The model is not capable of predicting what actual data are showing. This conclusion was drawn despite the fact that additional probabilistic runs took into account distribution coefficients that would cause less sorption than was simulated in the SOWP model. Therefore, it was unlikely that reasonable distribution coefficients could be used to fully explain the decrease in dissolved vanadium levels observed at site monitor wells during the past several years. Attachment A provides a more detailed discussion of the steps taken with the probabilistic modeling and the applied logic that led to these findings.

Given the uncertainties regarding vanadium fate at the site, DOE concluded that tools other than the existing model should be used to evaluate the observed decreases in vanadium with time. A simpler analytical solution was employed to evaluate current time-concentration curves and to predict future vanadium concentrations (see Section 1.3, Alternative Deterministic Simulations," this report).

1.1 General Behavior of Vanadium

The behavior of vanadium in sediments and ground water is not well understood. Vanadium may be removed from water by sorption onto clays, amorphous iron, manganese hydroxides, or organic matter in the soil or sediment. EPA (1999) defines sorption as any variety of processes by which an aqueous phase partitions to a solid, such as by precipitation of a three-dimensional solid molecular coating on the surface of a solid, adsorption onto the surface of a solid, adsorption into the structure of a solid, or partitioning into organic matter. This general usage is helpful because it is usually not known how the contaminant is associated with the solid. This varied chemical behavior is true of vanadium, which has oxidation states of +3, +4, and +5 for most environments of normal, near-surface pH ranges and oxidation potentials (Rai and Zachara 1986). These oxidation states affect the mobilization or sorption of vanadium. A decrease in pH could lead to the dissolution of carbonates and iron or manganese hydroxides along with any metals sorbed onto them because of competition with the more strongly adsorbed hydrogen ion (Hounslow 1995). Mobilization of vanadium might also be caused by changes in dissolved oxygen, which can be produced by the addition of organic matter (Bloomfield and Kelso 1973). These or other processes could be acting on vanadium-hosted soils and sediments at the New Rifle site. Drilling and excavation may have introduced oxygen from the atmosphere to the ground water, thus increasing desorption of vanadium from the sediments and concomitantly increasing concentrations of vanadium in ground water.

Vanadium contamination in ground water was identified in the eastern portion of the New Rifle site during the 1980s. Most of this contamination appeared to be associated with the gypsum and vanadium ponds located immediately east of the former tailings pile at the site (DOE 1999). The observed vanadium concentrations in the 1980s steadily and gradually decreased over time. Increased vanadium concentrations at the New Rifle site first appeared in 1992 when surface cleanup began; concentrations declined following completion of these activities in 1996. Plots of vanadium concentration over time at several monitor wells (ones that have a long monitoring history) show high concentration spikes during the early to mid 1990s, indicating a distinct correlation with the cleanup activities. The best example of this is shown in Figure 1 for well 0590, which has a long monitoring history. Well 0590 is located farthest from the center of the of the vanadium plume; the graph shows an increase in the concentration of vanadium during

surface remedial action from about 1994 to 1996. Well 0658 (Figure 2) is near the center of the vanadium plume and shows vanadium mobilization during remedial action around 1996 and again in 2001 when new wells were being installed in this area. At most monitor wells that have existed since the 1980s, post cleanup vanadium concentrations have returned to, or are below, levels that were observed prior to the cleanup period.

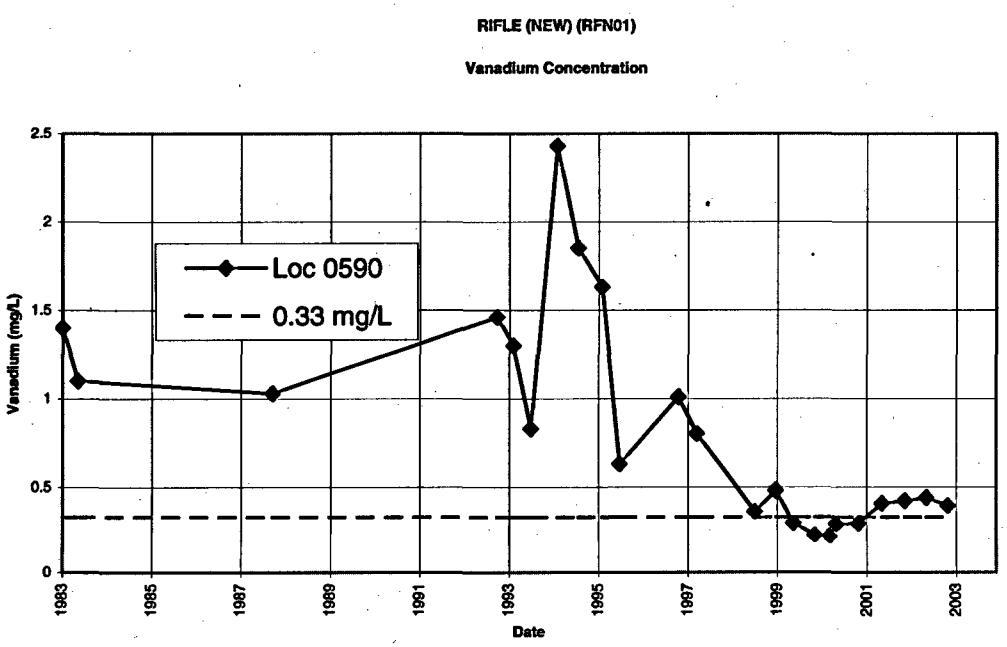


Figure 1. Vanadium Concentration Through Time for Monitor Well 0590

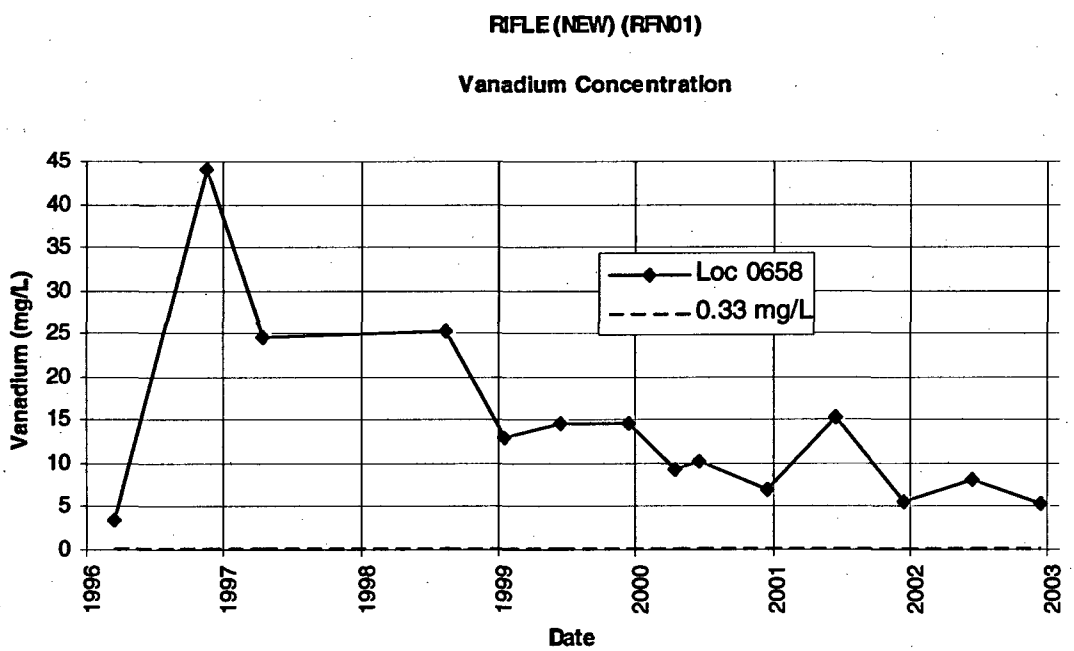


Figure 2. Vanadium Concentration Through Time for Monitor Well 0658

Regardless of the relationship between pre-cleanup and post cleanup vanadium levels at monitor wells, declines in dissolved vanadium concentration have been observed in recent years at nearly all wells now used to monitor site contamination in the vanadium plume area (see Plates 1a and 1b). This observation indicates a general trend toward natural flushing of vanadium. Such flushing is occurring now, during the period following the surface remediation program, and was probably occurring prior to surface remediation.

1.2 Vanadium as a Risk

The current site-related contamination does not pose any unacceptable risk to human health or the environment. The only exposure pathway that presents a potential risk is ingestion of ground water. The vanadium ground water plume is mainly confined to the site and the wetland area, and there are no uses of ground water in those areas. Institutional controls will prevent ground water use for at least 100 years while contaminants flush. Although concentrations of some constituents, including vanadium, are somewhat elevated in the wetland area surface water, these levels do not present unacceptable risk to ecological receptors, or livestock. As contaminated ground water slowly discharges to the Colorado River, it is rapidly mixed with river water and diluted by a factor of about 30,000 times. It has no detectable effect on surface water quality. Thus, no unacceptable risks to human health and the environment are expected as contaminants flush. For additional information, see Section 6 in the SOWP (DOE 1999), *Summary of Human Health and Ecological Risk.*

1.3 Alternative Deterministic Simulations

Despite the fact that the probabilistic modeling was inconclusive as to whether vanadium is naturally flushing at a faster rate than previously indicated, the fact that most monitor wells show a gradual decrease in dissolved vanadium suggested that further analysis of vanadium fate and transport was warranted. To carry out additional analyses, several deterministic modeling runs were made with the site model using various model conditions and parameters that led to improved simulation of vanadium flushing at selected wells during the past 5 to 6 years. The approach allowed model conditioning (i.e., model calibration) to be based on individual wells rather than several wells together and also allowed the use of initial conditions and flow and transport parameters different from those used in either the SOWP model or the probabilistic analyses in this study.

Part of the rationale behind conducting alternative deterministic simulations was that the SOWP modeling did not account for the spatial variability in geochemical conditions at the site that control observed levels of dissolved vanadium. Additional rationale was based on the assumption that the initial vanadium concentrations adopted in the SOWP model were representative of observed concentrations at monitor wells where they were measured but not necessarily representative of actual concentrations between monitor points. This latter reasoning was tantamount to saying that the interpolation techniques employed to develop initial concentrations in the SOWP model provided smoothed estimates of concentration between observed concentrations, when in fact the actual concentrations in these locales, though not known, were different from the smoothed estimated values. The combination of these rationales suggested that the behavior of dissolved vanadium at one well is independent of vanadium fate at all other monitor wells. Such a conclusion was warranted by the fact that the probabilistic modeling

performed earlier revealed no combinations of parameters for the entire model that provided better fits to observed concentrations at all wells.

Ultimately, it was found that the observed gradual decline in vanadium concentration at each monitor well was best matched by allowing the initial vanadium distribution to be focused on the area surrounding the well and not distributed in space in the manner that previous models had adopted. In addition, various combinations of initial spatial distribution of vanadium and vanadium K_d could be applied to specific areas while still providing accurate simulations of observed concentrations. Application of these techniques to numerous wells using the existing site flow model led to three major conclusions:

- Geochemical conditions that control vanadium dissolution and transport in the alluvial aquifer are very heterogeneous, and vary strongly over distances of a few hundred feet or less. Such spatial heterogeneity appears to be partly the result of surface remediation conducted during the early to mid-1990s, during which time natural background geochemistry was disturbed.

- The spatially variable geochemical conditions make it extremely difficult to accurately model how dissolved vanadium throughout the New Rifle site will behave in coming years, particularly since the numerous factors governing the distribution of vanadium between dissolved and solid phases can only be modeled using relatively simple soil-water distribution coefficients. This conclusion is likely to be true even if concerted efforts were made to further characterize the site over spatial scales of tens of feet.

- Because the numerical model did not work, simple models applied in the area of specific wells were tried.

In accordance with the third bullet, simple models were developed for several of the monitor wells onsite for which dissolved vanadium concentrations had been declining during the past several years. These simple models were developed using an analytical solution (as opposed to a numerical model) included in a package of solutions referred to as 3DADE (Leij and Bradford 1994), as provided and supported by the U.S. Salinity Laboratory of the U.S. Department of Agriculture. The specific solution used at each well allows for an initial vanadium concentration uniformly distributed over a block of finite dimensions, advective and dispersive transport along a uniform ground water flow path, and control of vanadium partitioning between the dissolved and solid phases in accordance with a soil-water distribution coefficient (K_d).

All of the simple model evaluations were made by adjusting the K_d value and the size of the block containing the uniform initial concentration of vanadium. In each case, the monitor well being analyzed was assumed to lie at the center of the initial concentration block. By running multiple simulations with varying initial concentration blocks and K_ds, it was possible to identify a range of natural flushing estimates that all correlated well with observed vanadium concentrations at the monitor well. If the range of these estimates all fell within a 100-year time frame, it was reasonable to conclude that decreases of dissolved vanadium to levels below the 0.33 mg/L risk-based screening level over the entire site was possible within 100 years, and that natural flushing was a viable alternative. As shown in Table 1, the projected cleanup dates all fall within the 100-year time frame.

Table 1. 3DADE Simulations and Estimated Year of Vanadium Cleanup

Well	Initial Concentration Block Dimensions – Width × Length × Height (feet)	Initial Concentration C_0 (mg/L)	Soil-Water Distribution Coefficient K_d (mL/g)	Retardation Factor R (dimensionless)	Projected Year of Cleanup[a]
0216	100 x 100 x 30	0.55	11.5	70. 0	2002
0216	100 x 100 x 30	0.50	13.2	80.0	2001
0216	100 x 100 x 30	0.47	14.8	90.0	2001
0216	100 x 300 x 30	0.55	2.7	17.0	2002
0216	100 x 300 x 30	0.50	3.2	20.0	2002
0216	100 x 300 x 30	0.47	3.5	22.0	2002
0218	100 x 100 x 30	3.5	4.8	30.0	2009
0218	100 x 100 x 30	3.2	6.5	40.0	2012
0218	100 x 300 x 30	3.5	1.5	10.0	2006
0219	100 x 100 x 30	0.268	4.8	30.0	1998
0219	100 x 100 x 30	0.24	7.3	45.0	1998
0219	100 x 300 x 30	0.24	1.5	10.0	1998
0590	100 x 100 x 30	0.90	8.2	50.0	2002
0590	100 x 300 x 30	0.80	2.3	15.0	2001
0657	100 x 100 x 30	1.31	19.8	120.0	2015
0657	100 x 300 x 30	1.31	4.8	30.0	2010
0658	100 x 100 x 30	35.0	5.7	35.0	2035
0658	100 x 100 x 30	35.0	4.8	30.0	2029
0658	100 x 300 x 30	35.0	1.8	12.0	2018
0659	100 x 100 x 30	10.0	6.5	40.0	2023
0659	100 x 300 x 30	10.0	2.5	16.0	2016
0669	100 x 100 x 30	14.5	7.3	45.0	2032
0669	100 x 300 x 30	14.5	1.8	12.0	2014
0670	100 x 100 x 30	5.2	14.8	90.0	2040
0670	100 x 300 x 30	5.2	3.2	20.0	2017

[a]Year at which simulated vanadium concentration decreases to risk-based screening level of 0.33 mg/L.

Figures 3 through 6 graphically show the decreasing trends of vanadium for several representative wells from Table 1, both in the form of observed information and plots for two predicted curves using the simple analytical model. The vanadium concentrations predicted by the flow and transport model used in the SOWP are also included for comparison. In each of these illustrated cases, the time needed for dissolved vanadium concentration to drop below the risk-based concentration as predicted by the simple analytical model is much shorter than the corresponding time predicted by the SOWP model. Well 0659 shows three spikes for vanadium concentrations that correspond to three June sampling events, when the river stage was high. This might suggest that vanadium is mobilized when water levels are high at this location.

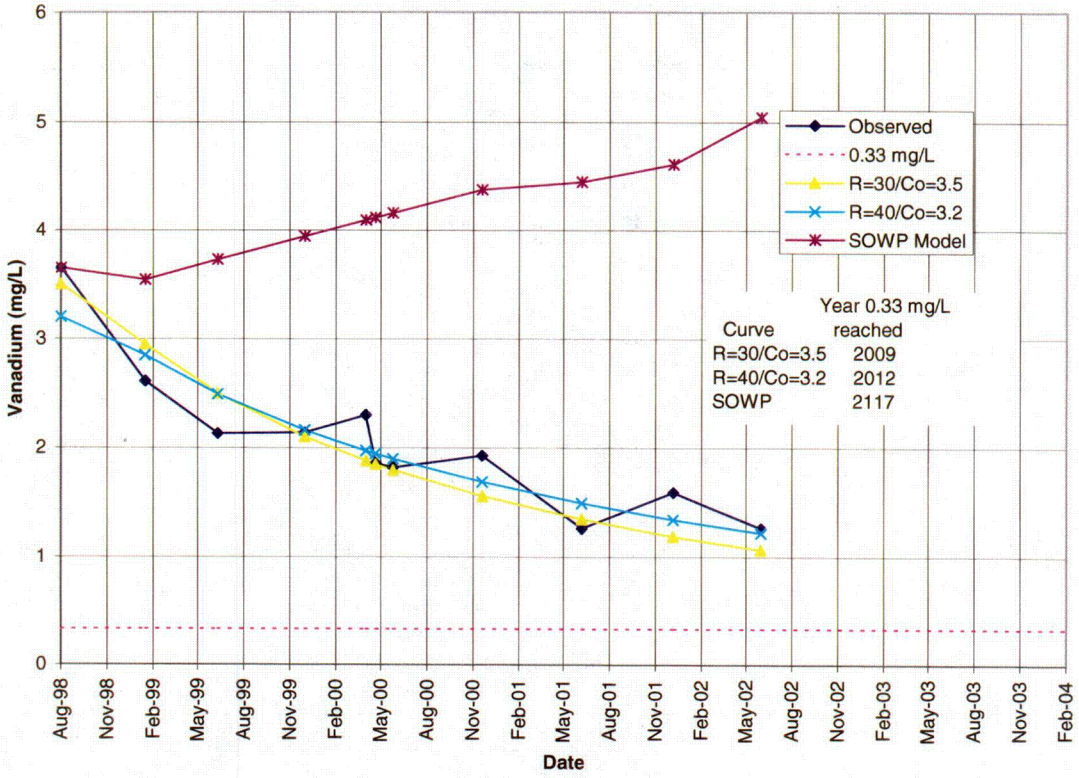


Figure 3. Vanadium Concentrations, 3DADE Evaluations, and Original Modeling Curve for Well 0218

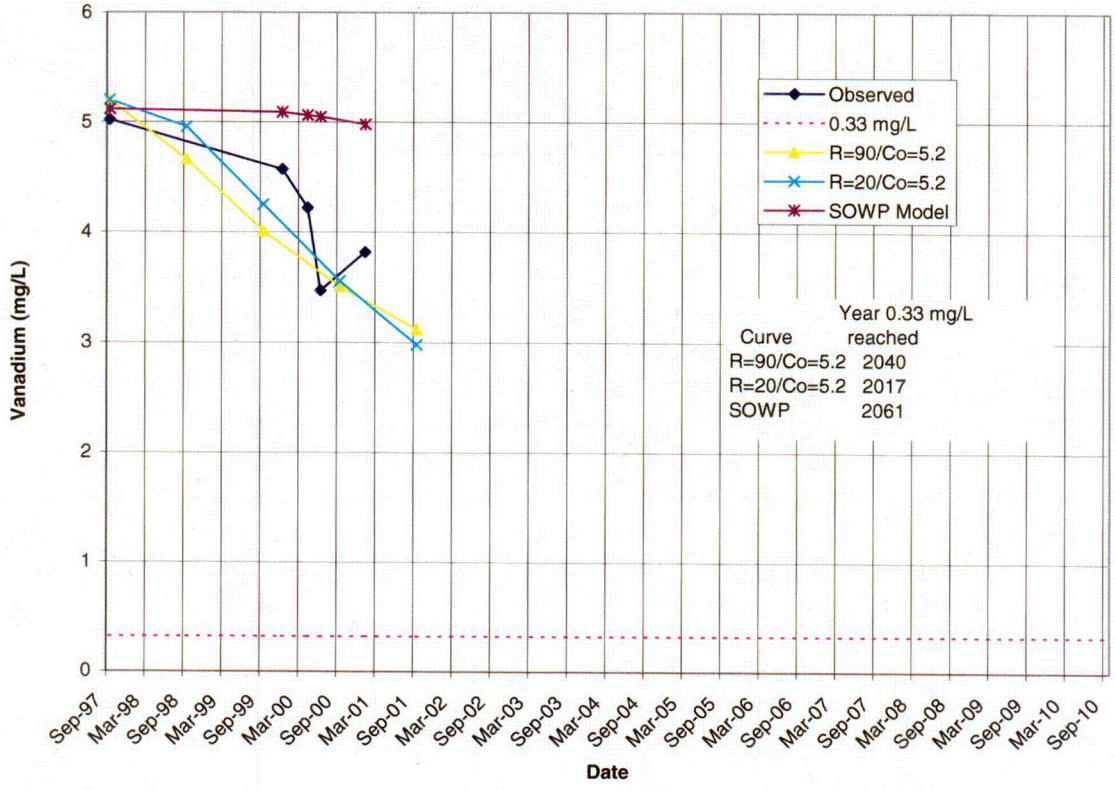


Figure 4. Vanadium Concentrations, 3DADE Evaluations, and Original Modeling Curve for Well 0670

C28

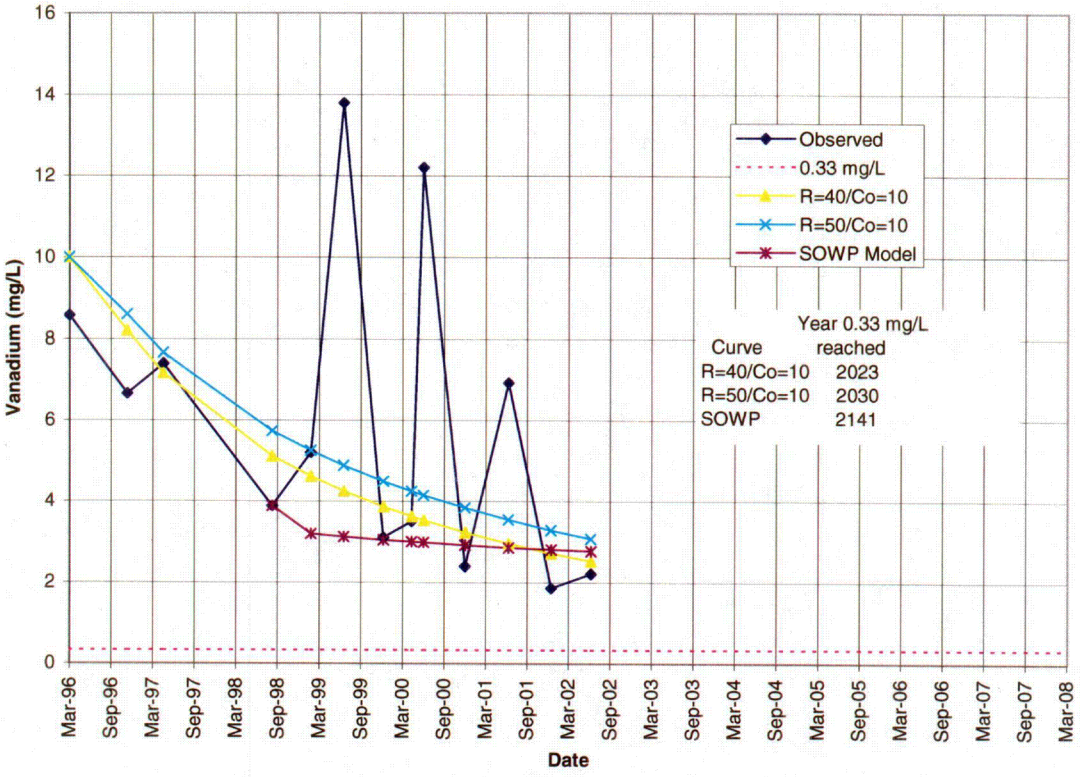


Figure 5. Vanadium Concentrations, 3DADE Evaluations, and Original Modeling Curve for Well 0659

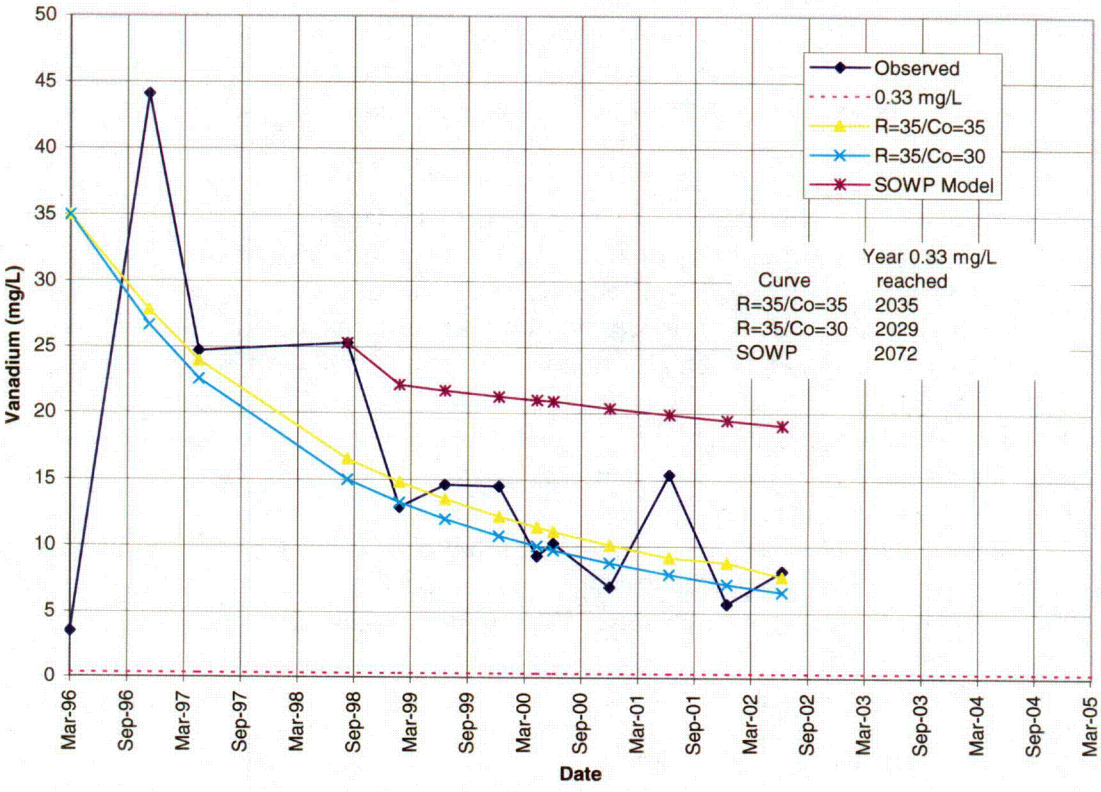


Figure 6. Vanadium Concentrations, 3DADE Evaluations, and Original Modeling Curve for Well 0658

C29

1.4 Uncertainty

The observations made regarding spatial variability of geochemical conditions at the New Rifle site along with the difficulties encountered in providing an accurate vanadium transport model for the entire site highlight the large degree of uncertainty associated with the assessment of vanadium fate. The SOWP model made the best available use of site data at the time it was prepared in 2000. And though this model properly emphasized the generally retarded movement of vanadium in comparison to more mobile constituents like uranium and selenium, it was apparently unable to account for the uncertain geochemical conditions that have existed for the past several years in the vicinity of and downgradient of the gypsum and vanadium ponds.

In addition to the uncertainty associated with the SOWP model, the simple models used in this study to represent vanadium flushing at selected wells are also uncertain. Though these simple models match recent vanadium data relatively well and project quicker cleanup times than predicted by the SOWP model, the fact remains that the exact year at which complete flushing to the risk-based screening level will be achieved cannot be predicted with complete confidence. Actual cleanup time could be somewhat longer than the 35 to 40 years that is indicated by the simple models, or possibly less. Continued monitoring of dissolved vanadium, and maintaining undisturbed conditions at the site are the key components to refining the estimated time of cleanup.

1.5 Moving Vanadium Contaminated Soils

The alternative to remove the most contaminated portion of the vanadium-contaminated soil area is not considered prudent for the following four reasons.

1. Recent time-concentration data strongly suggest that vanadium levels will diminish to acceptable risk-based concentrations in less than 100 years. This is a change from previous estimates.

2. Time-concentration plots (Figures 1 and 2) show that vanadium can be mobilized or desorbed into ground water by any of several poorly understood means. The graphs for well 0590, which is removed from the center of the vanadium plume, well 0658, which is near the apparent center of the vanadium plume, demonstrate the increase in vanadium concentration when either remedial action has occurred or other disturbances, such as drilling of wells, has occurred. Active excavation of the vanadium plume would likely remobilize vanadium in the area of the plume. For this reason, it is suggested that, since vanadium is sorbing at a faster rate than was originally estimated, the ground water system should not be disturbed and should be allowed to continue this steady decrease in concentration naturally. The area containing the highest vanadium concentrations was excavated in most places to the water table and clean fill was replaced in the excavation. It is unlikely that future construction activities in the vanadium plume area would require excavation below the water table; accordingly, disturbance of the aquifer materials is unlikely. The water table in the main area of the vanadium plume varies spacially and seasonally from about 7 to 18 feet below the ground surface. Ground water is shallower near the Colorado River.

3. Vanadium is residual radioactive material (RRM) according to the first part of the definition in the Uranium Mill Tailings Radiation Control Act of 1978. Title 1, Section 101, states that RRM is "(A) waste in the form of tailings resulting from the processing of ores from the extraction of uranium and *other valuable constituents of the ores*." The materials removed during surface cleanup at the New Rifle site were disposed of in a U.S. Nuclear Regulatory Commission (NRC)-approved disposal cell. Removal of any additional material from the New Rifle site would require written permission from NRC and would similarly require disposal in an NRC-approved facility.

4. Extensive soil characterization was conducted as part of the vanadium pilot study for the New Rifle site. Soil samples were collected on an approximately 400- ft by 400- ft grid. Four samples were collected from each location—one each from the unsaturated zone, upper saturated zone, middle saturated zone, and the saturated zone just above bedrock. The less-than-2 mm fraction of the samples was leached with a 5 percent nitric acid solution. Results of these analyses showed a range of vanadium concentrations from approximately 3 milligrams per kilogram (mg/kg) to 6,200 mg/kg. All but three concentrations were less than 1,000 mg/kg. Only 38 percent of the aquifer material is represented by the less-than-2 mm fraction (DOE 1999); the rest of the alluvial materials are generally much larger than this and probably contain little if any leachable vanadium, as the leachable vanadium is preferentially sorbed on clay-sized particles. Available vanadium in the bulk aquifer is therefore on the order of 1 to 2,400 mg/kg (with all numbers adjusted to the 38 percent value), and samples from all but three locations at less than 380 mg/kg (EPA 2001). EPA's vanadium soil screening levels for protection of ground water range from 300 mg/kg (no attenuation in ground water) to 6,000 mg/kg (a 20-fold attenuation factor). The upper end of this range is reportedly more realistic (EPA 2001). Concentrations of vanadium in New Rifle alluvial material are well below the upper end of EPA's screening range; most areas are below the lower end of the range. Because EPA's default soil screening levels represent conservative estimates, it is unlikely that the soils remaining at the New Rifle site represent a significant source of long-term ground water contamination.

   The fact that vanadium concentrations in ground water are currently higher than should be expected from this analysis would suggest the Rifle geochemical system is not in equilibrium, a criterion assumed for the EPA study. From historical information, original milling-related concentrations of vanadium in solution may have been much higher than the current concentrations and contributed more vanadium to the substrate. Merritt (1971) discusses standard practices for vanadium beneficiation. Unused portions of the solute from the milling process could still contain 2 to 3 grams of vanadium per liter. Concentrations of vanadium at this level may have been sent to the former vanadium pond at Rifle for disposal. It is unknown how long and at what concentrations vanadium was sent to the evaporation pond, but sorbed concentrations in sediments beneath this former pond were probably higher in the past than current sampling suggests. The remedial action disturbance during the mid-1990s may have mobilized sorbed vanadium, leaving dissolved concentrations potentially out of equilibrium with corresponding soil concentrations. This equilibrium state, if not already present, should be obtained everywhere at New Rifle in the future if no further intrusions into the system occur.

   According to the Performance Report for the Pilot Study (DOE 2002), 99 kg of vanadium was removed from ground water during pumping of the nearly 3,000,000 gallons of

water. This report also concludes that about 31,766 kg of vanadium is sorbed onto soil matrices and about 271 kg is dissolved in the ground water. However, the mean concentration sorbed in the upper third of the saturated subpile soil (where it is most concentrated) is 553 mg/kg. If the upper end of EPA's soil screening levels for vanadium applied at the New Rifle site, it suggests that vanadium concentrations in soils are acceptable and should not result in ground water concentrations of greater than 0.33 mg/L; therefore, removal of only the dissolved vanadium would be needed to remediate the ground water to this level. This would indicate that the pilot study removed in excess of 30 percent of dissolved vanadium from ground water. This is probably an overestimate of the percentage of vanadium removed, and in all likelihood there is continued desorption of vanadium from soils in some areas. However, the mass of vanadium removed probably does represent a significant amount of the mass that was in solution at the time and most likely will have a positive impact on the ability of the system to naturally flush.

2.0 Compliance Strategy

The proposed compliance strategy for vanadium and all other contaminants at New Rifle is natural flushing in conjunction with institutional controls and monitoring. The natural flushing strategy is discussed in the Programmatic Environment Impact Statement (DOE 1996). Natural flushing allows the natural ground water movement and geochemical processes to decrease contaminant concentrations. These chemical processes include:

- Dissolution – the process of dissolving minerals from the aquifer matrix
- Precipitation – the separation of chemical constituents from ground water to form new minerals on the aquifer matrix
- Adsorption – the adhesion of chemical constituents from the aquifer matrix
- Desorption – the removal of a chemical constituent from the aquifer matrix by the reverse of adsorption
- Ion Exchange – the replacement of adsorbed chemical constituents by constituents in the ground water, and
- Biological – the process of transforming chemical compounds into different chemical compounds by bacteria or other biological agents

Of these processes, adsorption and desorption are most likely the controlling factors for vanadium movement at the New Rifle site. If this assumption is true for vanadium, the best course of action is to not disturb the ground water system and continue to observe the decrease in vanadium concentration.

3.0 Institutional Controls, Monitoring Plan, Performance Measures

Currently, zone overlays have been adopted by the City of Rifle and Garfield County for the site that will prevent anyone from accessing contaminated water. Interpretation of the most recent time-concentration information suggests that vanadium from most locations will flush to levels below 0.33 mg/L in less than 100 years. Deed restrictions were imposed when the property was transferred from the State of Colorado to the City of Rifle to prevent access to ground water and disturbance of vanadium-contaminated soils. Restrictions were also imposed on downgradient properties within the contamination plume. Drinking water for these properties must either be treated prior to use or obtained from the Rifle community water supply system. DOE has provided funding for a water line in the area to furnish future users with municipal water. Copies of the institutional control documentation are presented in Appendix A of the Ground Water Compliance Action Plan.

Monitoring of the vanadium plume area has been expanded to include two sample rounds per year and the inclusion of the five additional wells: 0217, 0219, 0664, 0669, and 0670. Wells 0215, 0216, 0218, 0590, 0657, 0658, 0659, 0855, and 0856 are already being monitored in this area, resulting in 14 wells in the plume area that will be monitored two times per year. Monitoring will be conducted when water levels are at approximately the same levels to allow better correlation of data for the two annual events. This monitoring program will continue for 5 years and results will be reevaluated at this time.

As vanadium is monitored semiannually during the next 5 years, it will be important to establish measures to evaluate the performance of the natural flushing alternative. These performance measures are currently being developed and will probably consist of time-concentration graphs of a contaminant that were predicted by some modeling technique with actual sampling data superimposed on the graph.

4.0 Summary

- Most of the vanadium-contaminated soils were removed during surface remedial action; therefore, the principal mass of vanadium is gone.
- Vanadium concentrations in soils at the site do not pose a threat to human health and the environment. Vanadium in the ground water could be harmful to humans only if they used it as their only source of drinking water.
- Vanadium entering the Colorado River is diluted by a factor of about 30,000 times and does not present a threat to ecological receptors such as aquatic life and livestock.
- Vanadium is apparently mobilized when the ground water system is disturbed. This was observed during and immediately after surface remedial action and during subsequent well installations in the vanadium plume area. Vanadium attenuation will work best if the ground water system is not disturbed in the future. Vanadium should not be removed as disturbing the saturated zone would probably result in increased concentrations in the ground water.

- Previous modeling indicated that vanadium would require about 300 years to naturally flush from the alluvial aquifer.
- Data collected in the 4 years since modeling was completed indicate that dissolved vanadium is decreasing in ground water more quickly than suggested by the model.
- Analysis of modeling and investigations of vanadium geochemistry indicates that the system is complex and that transport-modeling parameters do not adequately portray the sorption/desorption qualities for vanadium.
- Extrapolation of time-concentration curves for vanadium at 12 wells in the plume area, where data have been collected most consistently, suggests that vanadium concentrations at most sampling locations will decrease to a risk-based level of 0.33 mg/L within 50 to 60 years and all will attenuate in less than 100 years.
- The proposed compliance strategy for vanadium is natural flushing (meaning attenuation by sorption) with institutional controls and continued monitoring.
- Institutional controls in the form of a zone overlay and deed restriction will prevent access to ground water.

5.0 References

Bloomfield, C., and W.I. Kelso, 1973. "The Mobilization and Fixation of Molybdenum, Vanadium, and Uranium by Decomposing Plant Matter," *J. Soil Sci.*, V. 24, pp. 368-379.

Environmental Simulations, Inc. (ESI), 1998. *Guide to Using Ground water Vistas, Version 2.* 291 p.

Harbaugh, A.W., and M.G. McDonald, 1996. *Programmer's Documentation for MODFLOW-96, An Update to the U.S. Geological Survey Modular Finite-Difference Ground-Water Flow Model,* U.S. Geological Survey Open-File Report 96-486, 220 p.

Hounslow, A.W., 1995. *Water Quality Data,* Lewis Publishers, New York, 397 p.

Leij, F.J., and S.A. Bradford, 1994. *3DADE: A Computer Program for Evaluating Three-Dimensional Equilibrium Solute Transport in Porous Media,* Research Report No. 134, U.S. Salinity Laboratory, U.S. Department of Agriculture.

McDonald, M.G., and A.W. Harbaugh, 1988. *A Modular Three-Dimensional Finite-Difference Ground Water Flow Model,* U.S. Geological Survey, Techniques of Water-Resources Investigations, Book 6, Chap. A1, 586 p.

Merritt, R.C., 1971. *The Extractive Metallurgy of Uranium,* Colorado School of Mines Research Institute. 576 p.

Rai, D., and J. M. Zachara, 1986. *Chemical Attenuation Rate, Coefficients, and Constants in Leachate Migration Volume I: Critical Review,* EA-3356, V. I, Battelle Pacific Northwest Laboratory, Richland, Washington, prepared for Electric Power Research Institute, Palo Alto, California.

U.S. Department of Energy (DOE), 1992. *Remedial Action Plan and Site Design for Stabilization of the Inactive Uranium Mill Tailings Sites at Rifle, Colorado,* Appendix B, prepared for the U.S. Department of Energy, Albuquerque Area Operations Office, Albuquerque, New Mexico, February.

———, 1996. *Final Programmatic Environmental Impact Statement for the Uranium Mill Tailings Remedial Action Ground Water Project,* DOE.EIS-0198, prepared for the U.S. Department of Energy Grand Junction Projects Office, Grand Junction, Colorado, October.

———, 1999. *Site Observational Work Plan for the UMTRA Project New Rifle Site,* GJO-99-112-TAR, Rev. 1, prepared for the U.S. Department of Energy Grand Junction Office, Grand Junction, Colorado, November.

———, 2000. *Draft Work Plan for Vanadium Pilot Study New Rifle UMTRA Site, Rifle Colorado,* GWRFL10.6.4, prepared for the U.S. Department of Energy Grand Junction Office, Grand Junction, Colorado, July.

———, 2002. *Performance Report on the Operations of the Pilot Plant for the Treatment of Vanadium in Ground Water New Rifle UMTRA Site, Rifle, Colorado,* prepared for the U.S. Department of Energy, Grand Junction Office, Grand Junction, Colorado, April.

———, 2001. *Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites, Peer Review Draft,* OWSER 9355.4-24, March.

Zheng, C. and P.P. Wang, 1999. *MT3DMS: A Modular Three-Dimensional Multispecies Model for Simulation of Advection, Dispersion and Chemical Reactions of Contaminants,* in *Ground water Systems*; Documentation and User's Guide, Contract Report SERDP-99-1, U.S. Army Engineer Research and Development Center, Vicksburg, Mississippi.

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Attachment 1

Evaluation of Modeling in View of Recent Time/Concentration Data

Probabilistic Simulations

Uncertain Parameters

Stochastic simulations with the New Rifle ground water flow and transport model were accomplished using a conventional Monte Carlo simulation module built into GW Vistas. Initially, several different model parameters were treated as uncertain in the analysis. However, the simulations ultimately used to assess the potential for natural flushing were limited to three: aquifer hydraulic conductivity, aquifer dispersivity, and the vanadium soil-water distribution coefficient, which is denoted by K_d. These parameters were observed to have the most significant effect on dissolved vanadium concentrations over time.

Initial Concentrations

The stochastic simulations made use of an initial vanadium distribution drawn from observed vanadium concentrations during a sampling event that occurred between October 26 and November 4 of 1987. At the time, vanadium concentrations were monitored at 17 alluvial monitoring wells, which appeared to provide a realistic representation of the vanadium distribution. The well numbers, coordinates, and vanadium concentrations (mg/L) from this sampling event are shown in Table 1. The data in Table 1 were imported into the program Surfer, and were subsequently used in a kriging module to determine a starting concentration value for each active cell in the New Rifle transport model.

Use of the 1987 vanadium concentrations as initial conditions in the model differed from the approach taken with the modeling performed for the SOWP (DOE 2000), wherein vanadium concentrations measured in the summer of 1998 were applied as initial conditions. The rationale for employing initial conditions from an earlier year stemmed from the effects that surface remediation apparently continued to have on dissolved vanadium concentrations in the mid- to late- 1990s, but had since declined in the 2000s. This observation suggested that vanadium concentrations during the last few years had largely returned to pre-remediation levels, and that the fate of vanadium today was now governed solely by the processes that previously affected the site in the late 1980s. Accordingly, it was believed that forward predictions with the model using 1987 concentrations as starting conditions would provide reasonable fits to observed vanadium levels during the last few years.

Conditioning Times and Locations

Conditioning of stochastic model results was accomplished using vanadium concentrations that have been measured in recent years. The conditioning exercise made use of differences between observed and simulated vanadium concentrations, which are referred to as model residuals. The criterion used to assess the overall fit of a model run to observed concentrations was the root mean squared error (RMSE) (Anderson and Woessner 1992), which is defined as the square root of the sum of all squared residuals. In effect, the conditioning exercise comprised a method for attempting to calibrate the model, as only the simulations that resulted in the lowest residuals (i.e., the lowest RMSE values) were examined to discern representative values for flow and transport model parameters.

Table 1: Initial Vanadium Concentrations

Well Location	X coordinate	Y coordinate	Concentration (mg/L)
0581	1346316.	623212.6	0.35
0585	1348610.8	625132.8	0.03
0588	1347475.3	623701.7	0.7
0589	1344251.04	623257.37	0.05
0590	1345383.69	623244.7	1.03
0591	1348693.	624928.1	0.03
0592	1348684.1	624921.8	0.03
0594	1347389.9	624261.4	1.78
0595	1346365.5	623163.7	0.22
0599	1344572.79	624314.81	0.05
0600	1345807.2	622993.3	0.29
0603	1341394.73	623420.95	0.03
0609	1343083.9	624827.2	0.04
0610	1346191.5	625242.5	0.84
0615	1346756.2	625071.4	9.86
0616	1346603.1	622918.3	0.19
0618	1343239.48	623073.25	0.06

The selection of a threshold RMSE value as a conditioning criterion was subjective. Following guidance provided in Knowlton and Peterson (1998), initial values for the threshold RMSE were set at values that were of the same general magnitude as the model calibration targets (i.e., measured concentrations during recent years). As discussed later, difficulties were encountered in producing simulations that meet threshold criteria of these magnitudes.

Three sampling events, each with five monitoring locations within the area of vanadium contamination, were used for the model conditioning. Table 2 shows the well locations, conditioning times, and measured vanadium concentrations that were applied. During some of the stochastic simulations, all sampling times and wells were used in the conditioning, whereas other stochastic analyses were conditioned on just one or two sampling events and fewer wells.

Table 2: Locations, Times, and Measured Vanadium Concentrations (mg/L) Used for Model Conditioning

Well Location	June 2000	November/ December 2000	June 2002
0218			1.26
0590	0.289	0.294	0.443
0657	0.896	0.945	0.666
0658	10.2	6.94	8.09
0659	12.2	2.4	2.22

Uncertain Parameter Distributions

Characteristics of the probability density function (PDF) used for each of the three parameters treated as uncertain in the probabilistic simulations (aquifer hydraulic conductivity, aquifer

dispersivity, vanadium soil-water distribution coefficient [K_d]) are presented in Table 3. As this table shows, uniform distributions were assigned to each parameter. The choice of the PDF type was somewhat arbitrary; that is, no statistical tests were performed to determine if the assumed distribution conformed with measured or literature estimates of distributions for each parameter. Nevertheless, the use of a uniform distribution was believed to be sufficient for identifying parameter combinations, if any, that would improve the fit between modeled and observed vanadium concentrations.

During each Monte Carlo analysis with the site model, constant values were assigned to all flow and transport parameters that were not considered uncertain. The constant values were identical to those employed in the SOWP model.

Table 3: Distribution Characteristics of Uncertain Parameters in the Probabilistic Simulations

Parameter	Minimum Value	Maximum Value	Distribution Type
Hydraulic Conductivity (ft/day)	94.0	174.0	Uniform
Dispersivity (ft)	50.0	150.0	Uniform
Distribution Coefficient (mL/g)	2.0	7.8	Uniform

Probabilistic Results

Several probabilistic analyses were performed, each varying with respect to the sampling times and monitor wells used for conditioning of the predicted vanadium concentrations. During each analysis, three hundred (300) realizations of parameter combinations were generated, which in turn resulted in 300 sets of modeling results. This number of simulations was believed to be sufficient for analyzing the effects of all possible parameter combinations on computed vanadium concentrations. Though no statistical tests were performed to demonstrate that this was accomplished, visual inspection of the parameter values generated in each model realization did appear to support this goal. To help demonstrate this point, Figures 1 and 2 show plots of realization number versus hydraulic conductivity and soil-water distribution coefficient, respectively. These plots provide a subjective indication of how well the simulated parameter values represent their respective theoretical distributions.

Four probabilistic analyses that were conducted are listed in Table 4 along with the assumed RMSE criterion and resulting minimum and maximum RMSE values for each analysis. An obvious conclusion drawn from the table is that none of the Monte Carlo analyses was capable of producing a simulation with an RMSE value less than the respective RMSE criterion. This result strongly suggested that the behavior of dissolved vanadium in ground water at the site varies considerably in time and space, and, as a consequence, it is very difficult to produce a flow and transport model that can perform reasonably in matching observed vanadium concentrations at monitor wells.

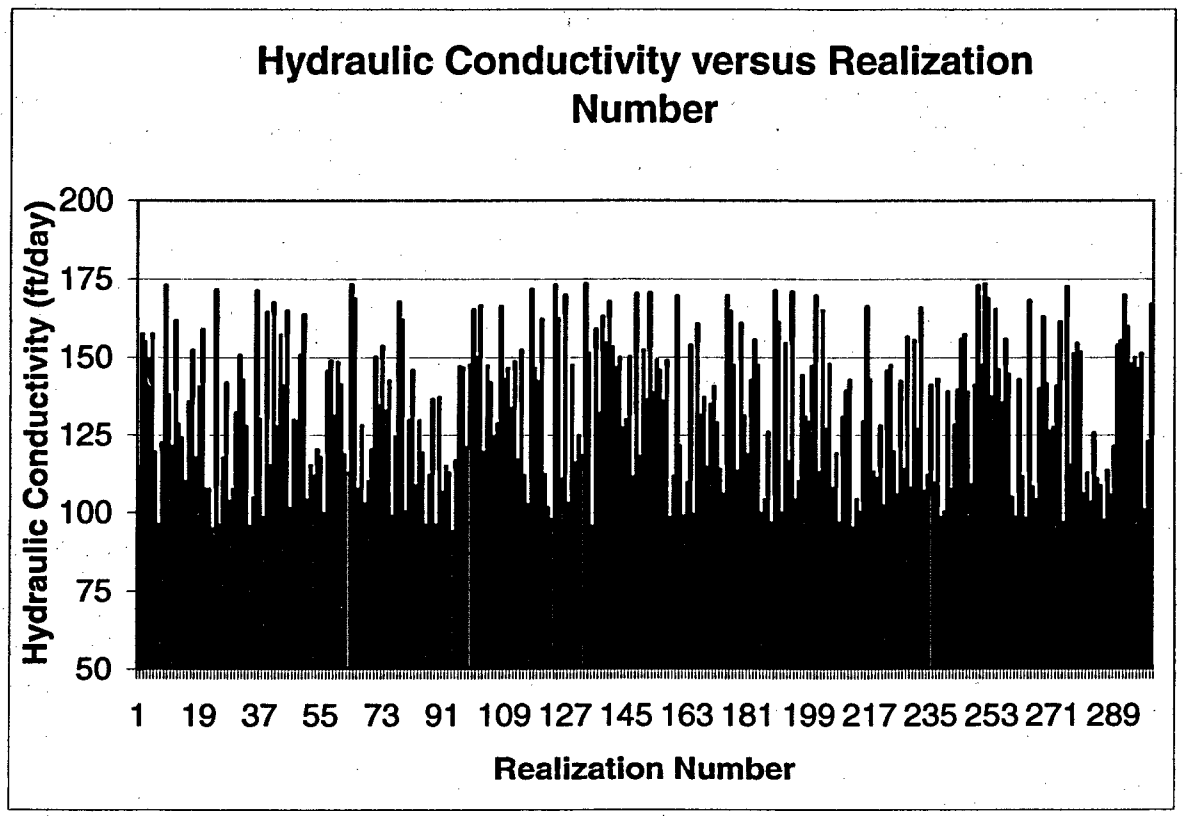

Figure 1. Generated Hydraulic Conductivity versus Realization Number

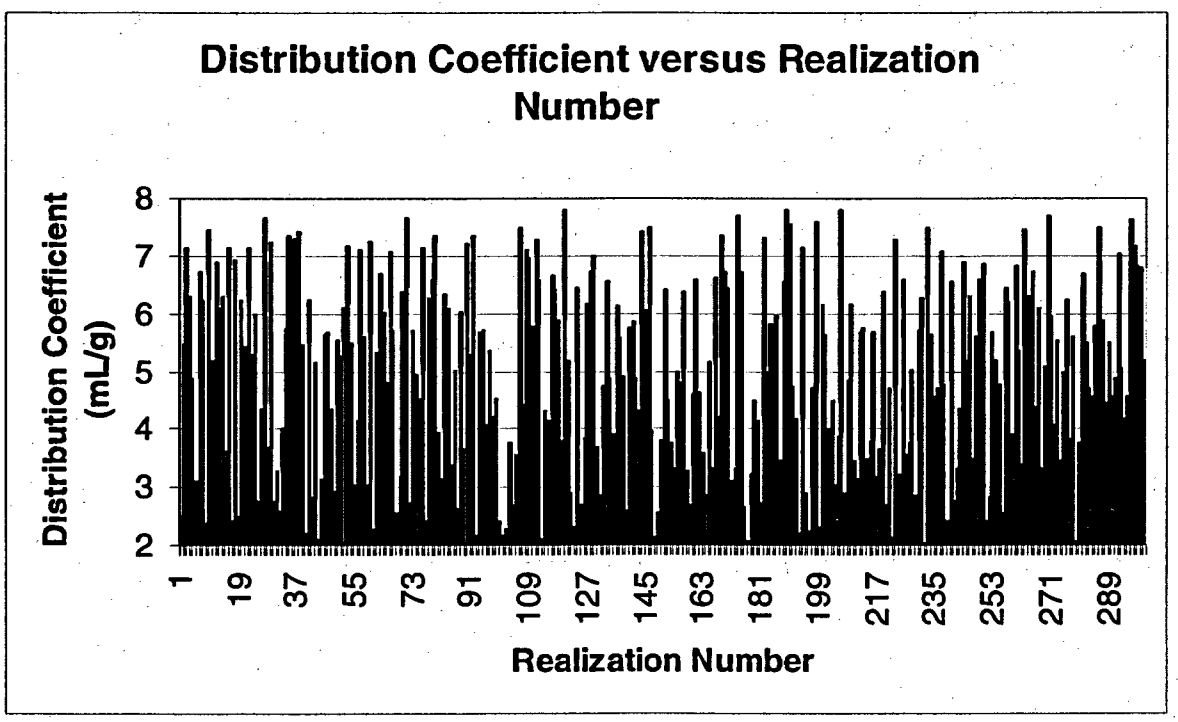

Figure 2. Generated Distribution Coefficient versus Realization Number

Table 4. Conditioning Results from Monte Carlo Analyses

Monte Carlo Analysis	Conditioning Times	Conditioning Locations	RMSE Criterion (mg/L)	RMSE Minimum (mg/L)	RMSE Maximum (mg/L)
1	June 2000 N/D 2000 June 2002	All Wells	3.60	4.42	4.73
2	June 2000 June 2002	All Wells	4.03	5.02	5.32
3	June 2002	All Wells	1.15	2.82	3.24
4	June 2000 N/D 2000 June 2002	Well 0590	0.342	0.531	0.851

Inspection of Table 4 also reveals that the range of RMSE values resulting from each Monte Carlo analysis is very narrow. This observation suggests that, despite the relatively wide range in possible values of uncertain parameters that can be utilized in the model (See Table 3), no particular parameter value or combination of values exists that allows the model to perform significantly better than other realizations in matching observed vanadium concentrations. To examine this latter issue further, analyses were performed on the probabilistic modeling results with the intent of identifying explicit trends in parameter values that are most representative of site conditions. These additional analyses are discussed in the following section.

It should be noted that several simulation scenarios other than those listed in Table 4 were performed during this study. Though the results of those additional analyses are similar to those mentioned above, they are excluded from this report in the interest of brevity.

Potential Relationships Between RMSE and Uncertain Parameter Values

Regression analyses were conducted to determine if any correlation existed between the values of uncertain parameters used in each Monte Carlo simulation and the corresponding RMSE for that simulation. Results from one of the regression analyses is shown in Figure 3, which contains a scatter plot of RMSE (mg/L vanadium) and associated hydraulic conductivity for Monte Carlo Analysis 1 in Table 4. Also listed are the coefficient of determination (R^2) and the equation describing the least squares fit between RMSE (y) and hydraulic conductivity (x). An obvious conclusion taken from Figure 3 is that there is no apparent relationship between RMSE and hydraulic conductivity. The scatter plot does indicate that RMSEs tend to be slightly smaller when lower hydraulic conductivities are used, but the low R^2 value associated with the regression do not suggest that such a relationship is strong.

The results of a similar regression analysis are illustrated in Figure 4, which comprises a scatter plot of RMSE and the vanadium distribution coefficient (K_d) for Monte Carlo Analysis 1. Again, there appears to be no distinct correlation between RMSE and the model parameter being investigated, in this case vanadium K_d. However, unlike the potential relationship between RMSE and aquifer hydraulic conductivity, RMSE values show no distinct trends toward increasing or decreasing with increases in K_d. Thus, it is impossible to discern whether model performance improves with lower K_d values, an observation that would be expected if natural flushing were to be more rapid than has been previously observed or predicted.

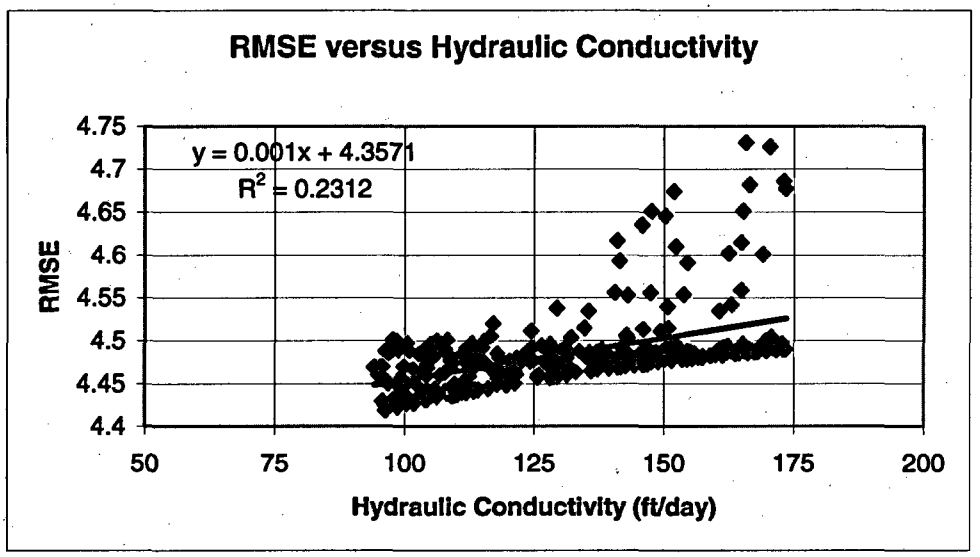

Figure 3. RMSE (mg/L) Versus Hydraulic Conductivity in Monte Carlo Analysis 1

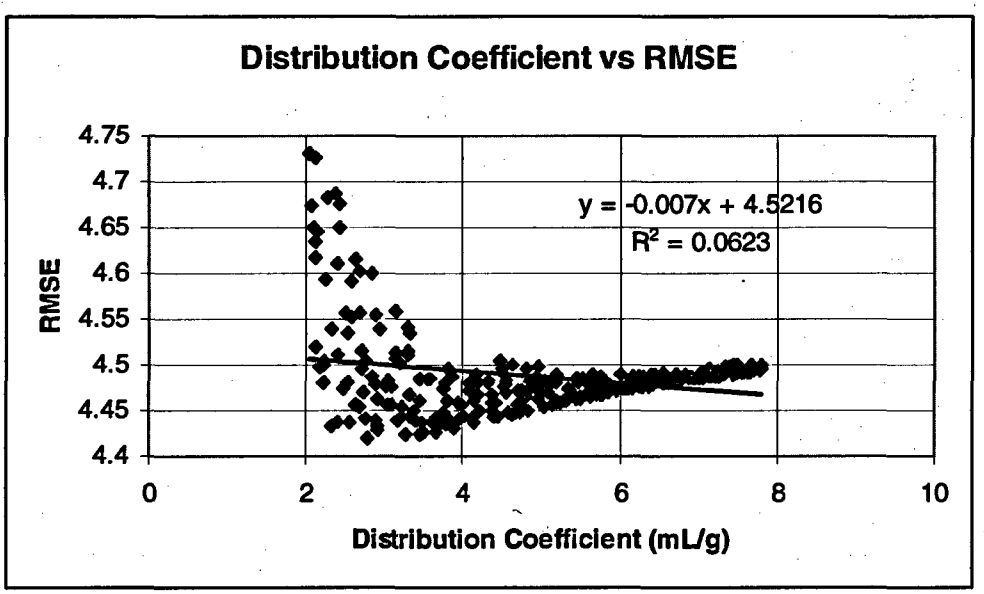

Figure 4. RMSE (mg/L) Versus Vanadium Distribution Coefficient for Monte Carlo Analysis 1

Because the limited RMSE ranges produced the model makes it difficult to pick a meaningful RMSE criterion for assessing model uncertainty, additional analyses were arbitrarily conducted on the 50 model runs from Monte Carlo Analysis 1 with the smallest RMSE values. The intent of these additional assessments was to ascertain whether distinct correlations exist between RMSE and uncertain parameter values with the simulations that perform best in matching observed vanadium concentrations that could not be discerned from analyzing all simulations simultaneously.

Figure 5 shows the results of a regression analysis between RMSE of the 50 best performing simulations and associated aquifer hydraulic conductivities from Monte Carlo Analysis 1. An

analogous evaluation of the vanadium distribution coefficient is provided in Figure 6. Though the scatter plot in each of these figures shows a tendency for RMSE values (i.e., better model fit)

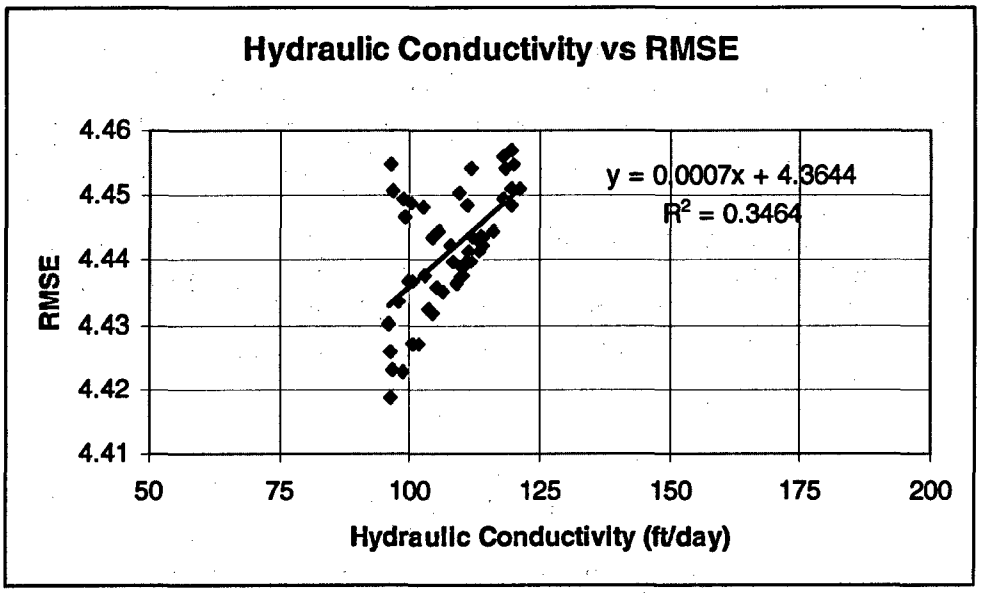

Figure 5. RMSE(mg/L) Versus Hydraulic Conductivity for the 50 Model Runs with the Lowest RMSE values, Monte Carlo Analysis 1

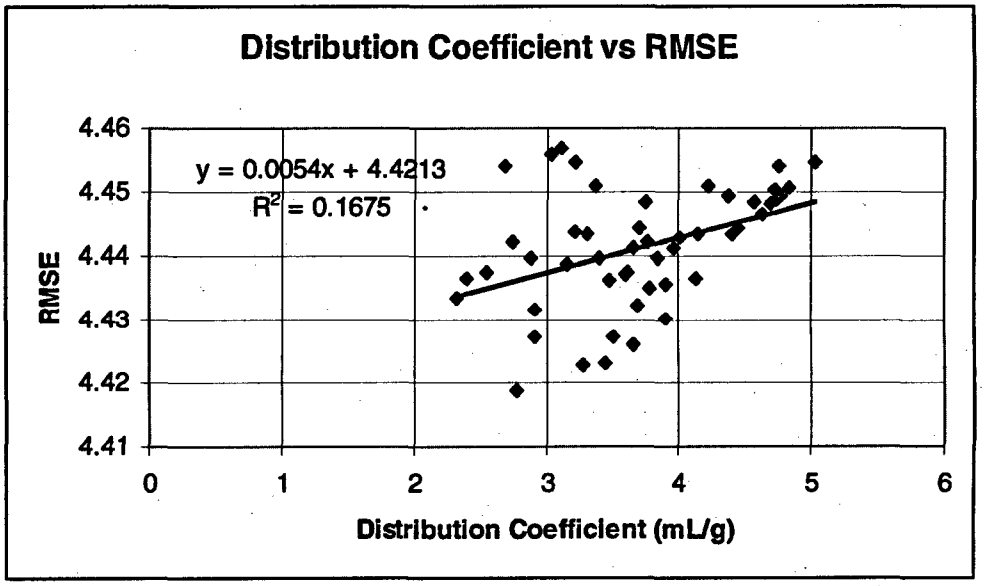

Figure 6. RMSE(mg/L) Versus Vanadium Distribution Coefficient for the 50 Model Runs with the Lowest RMSE values, Monte Carlo Analysis 1

to occur with decreasing values of hydraulic conductivity and K_d, neither analysis indicates that such tendencies translate into strong correlations. This observation again suggests there is little evidence to indicate that, in general, dissolved vanadium is attenuating faster from the New Rifle Site than had previously been predicted in the SOWP (DOE 2000).

To provide some quantitative evidence as to whether the distribution of the 50 smallest RMSEs in Monte Carlo Analysis 1 was significantly different from the distribution of the remaining 250 realizations, two statistical tests were performed. Both tests made use of the t-statistic with a level of significance of 1% for each test.

The first test assumed that the standard deviations of the 50 smallest RMSEs and the remaining 250 RMSEs were unknown but equal. The second test assumed that the standard deviations were unknown and not necessarily equal. Both tests indicated that there was no difference in the mean RMSE values calculated for each set of simulations. This finding indicated that the results of attempts to find correlations between uncertain model parameters was no more significant in the case of the 50 simulations with the lowest RMSEs than it was in the analysis based on all simulations. That is, there was no reason to believe that analysis of a limited number of simulations that perform better in matching observed vanadium concentrations would provide evidence of accelerated natural flushing.

References

Anderson, M.P., and W.W. Woessner, 1992. *Applied Ground water Modeling, Simulation of Flow and Advective Transport*, 381 p.

Knowlton, R.G., and D.M. Peterson, 1998. *Analysis of Natural Attenuation as a Possible Ground water Remedial Alternative at the DOE UMTRA New Rifle Site at Rifle, CO*, September.

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