DOE/EA-1406

UMTRA
Ground Water Project

Final Environmental Assessment of Ground Water Compliance at the New Rifle, Colorado, UMTRA Project Site

July 2003

Prepared by the
U.S. Department of Energy
Grand Junction Office

Work Performed Under DOE Contract No. DE–AC13–02GJ79491 for the U.S. Department of Energy

DOE/EA-1406
Rev. 0

Final Environmental Assessment of Ground Water Compliance at the New Rifle, Colorado, UMTRA Project Site

July 2003

Prepared by
U.S. Department of Energy
Grand Junction Office
Grand Junction, Colorado

Work Performed Under DOE Contract No. DE-AC13-02GJ79491

U01341

This Page Intentionally Blank

Contents

Contents (continued)

Figures

Contents (continued)

Tables

Attachment

This Page Intentionally Blank

Acronyms and Abbreviations

CFR	*Code of Federal Regulations*
cfs	cubic feet per second
COC	constituent of concern
DOE	U.S. Department of Energy
EA	Environmental Assessment
EPA	U.S. Environmental Protection Agency
ft	feet
mg/L	milligrams per liter
pCi/L	picocuries per liter
SOWP	Site Observational Work Plan
UMTRA	Uranium Mill Tailings Remedial Action (Project)
UMTRCA	Uranium Mill Tailings Radiation Control Act

This Page Intentionally Blank

Executive Summary

Pursuant to the National Environmental Policy Act (42 U.S.C. 4321 *et seq*.), the U.S. Department of Energy (DOE) Grand Junction Office has prepared this environmental assessment of ground water compliance for the New Rifle uranium mill tailings site. The site is located in western Colorado approximately 2.3 miles west of the city of Rifle, Colorado. Ground water in the surficial aquifer at the site is contaminated as a result of historical processing of uranium and vanadium ore.

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 U.S. Environmental Protection Agency has established regulations in Title 40 *Code of Federal Regulations* Part 192 for remediation of contaminated surface materials (tailings, soils, and buildings) and ground water. Surface remediation at the site was completed in 1996 in compliance with regulatory requirements.

Two distinct aquifers are present beneath the New Rifle site. The uppermost aquifer consists of unconsolidated alluvial deposits and a shallow weathered portion of Wasatch Formation that is hydraulically connected to the alluvium. The second aquifer is a semiconfined sandstone unit located deeper in the Wasatch Formation. Overlying clays and siltstones of the Wasatch Formation separate the surficial aquifer from the semiconfined Wasatch aquifer. Ground water in the surficial aquifer contains elevated levels of contaminants, but the deeper Wasatch Formation has not been affected by contamination.

On the basis of ground water use as a potable water supply in a residential setting, the human health constituents of concern (COCs) in the surficial aquifer are ammonia, arsenic, fluoride, manganese, molybdenum, nitrate, selenium, uranium, and vanadium. After an evaluation of alternatives, DOE proposes natural flushing with institutional controls and monitoring to meet the ground water cleanup standards as the compliance strategy to mitigate human health risks for all contaminants. Six of the nine constituents targeted for natural flushing are expected to attain background concentrations or maximum concentration limits established in 40 CFR 192 within 100 years. The three remaining COCs—selenium, ammonia, and vanadium—are expected to meet alternate concentration limits that are protective of human health within 100 years.

An ecological risk assessment performed for the site indicated that several constituents were of potential concern to ecological receptors, mainly in a wetland area. Ecological constituents of potential concern are ammonia, cadmium, fluoride, nitrate, sulfate, and uranium. However, due to the conservative nature of the risk assumptions, the proximity of the site to a developed and populated area, and the lack of any observed adverse ecological effects, actual risks posed by the site are probably low. DOE will monitor the wetland for ecological constituents of potential concern during the period of natural flushing to verify that the proposed action does not produce adverse ecological effects.

This environmental assessment describes the proposed compliance strategy of natural flushing combined with institutional controls and continued monitoring, and the associated environmental effects. Annual wetland assessment reports will evaluate the status of the wetland and levels for ecological COCs.

No comments were received from the public during the public comment period. A public meeting was held in Rifle, Colorado, on June 12, 2003. Minutes of this meeting are included as Attachment 1.

1.0 Introduction

The U.S. Department of Energy (DOE) is proposing a ground water compliance strategy for the surficial aquifer at the New Rifle Uranium Mill Tailings Remedial Action (UMTRA) Project site. The focus of this environmental assessment (EA) is to evaluate environmental impacts associated with the proposed compliance strategy for protection of human health and the environment.

The DOE Albuquerque Operations Office has determined that an EA is the appropriate level of National Environmental Policy Act (NEPA) documentation for the proposed action.

1.1 Background

The Uranium Mill Tailings Radiation Control Act of 1978 (UMTRCA) (42 U.S.C. 7901–7942) was enacted to control and mitigate risks to human health and the environment from residual radioactive materials from the processing of uranium ore. UMTRCA authorized DOE to perform remedial action at 24 inactive uranium-ore processing sites, including the New Rifle, Colorado, site.

U.S. Environmental Protection Agency (EPA) regulations in Title 40 *Code of Federal Regulations* Part 192, "Health and Environmental Protection Standards for Uranium and Thorium Mill Tailings," were established to implement the requirements of UMTRCA. The regulations establish procedures and standards for remediation of residual radioactive materials in land, buildings, and ground water. UMTRCA defines residual radioactive materials as "waste in the form of tailings or other material that is present as a result of processing uranium ores at any designated processing site, and other waste at a processing site which relates to such processing…" The regulations also require that selection and performance of remedial action be completed with full participation of states and with the concurrence of the U.S. Nuclear Regulatory Commission.

DOE completed the *Final Environmental Impact Statement for Remedial Actions at the Former Union Carbide Corporation Uranium Mill Sites, Rifle, Garfield County, Colorado* (Surface Environmental Impact Statement, DOE 1990) before beginning surface remediation of the land and mill tailings in 1992. The Surface Environmental Impact Statement described the affected environment, including surface water and ground water, and the effects associated with removal of tailings and debris at the New Rifle site. Surface materials contaminated with residual radioactive materials were disposed of at the Estes Gulch disposal cell approximately 9 miles north of the city of Rifle. Surface remedial action was completed in 1996.

After the source of ground water contamination (i.e., the tailings) is removed, EPA regulations require that the site be evaluated to determine if contaminant concentrations in ground water of the uppermost aquifer comply with EPA ground water standards in 40 CFR 192 Subpart B. The *Final Programmatic Environmental Impact Statement for the Uranium Mill Tailings Remedial Action Ground Water Project* (DOE 1996a) provides a general discussion of ground water contamination at the 24 former processing sites. The Programmatic Environmental Impact Statement also provides a framework for selecting site-specific ground water compliance strategies that comply with EPA regulations.

The document also requires that site-specific NEPA documentation, such as this EA, be completed as necessary to evaluate alternatives to comply with EPA regulations. The regulations outline several requirements and guidance for determining compliance with ground water standards:

- Establishing a monitoring program to determine background ground water quality.
- Identifying soluble residual radioactive materials present and determining whether the constituents exceed standards established in 40 CFR 192.
- Determining the extent of contamination as a result of residual radioactive materials.
- Identifying potential risks to human health and the environment.

Table 1. Standards for Human Health Constituents of Concern in Ground Water at the New Rifle Site

Constituent[a]	UMTRA Project[b]	Safe Drinking Water Act[c]	Risk-Based Concentration[d]
Ammonia (as ammonium)	None	None	200
Arsenic	0.05	0.05	NA
Fluoride	None	4.0	NA
Manganese	None	0.05[f]	NA
Molybdenum	0.1	None	NA
Nitrate (as N)	10.0[e]	10.0[e]	NA
Selenium	0.01	0.05	NA
Combined uranium-234 and uranium-238	30 pCi/L[g]	None	NA
Vanadium	None	None	0.33

[a]Concentrations reported in milligrams per liter (mg/L) unless otherwise noted.
[b]Maximum concentration of constituents for ground water protection, UMTRA Project Standard (40 CFR Part 192, Table 1, Subpart A).
[c]Safe Drinking Water Act maximum contaminant level (40 CFR 141.23 and 141.62).
[d]Values were derived from EPA Region III Risk-Based Concentration Table (EPA 2003); no UMTRA Project standard is available.
[e]Equivalent to 44 mg/L nitrate as NO_3.
[f]Secondary standard, not enforceable, Safe Drinking Water Act (40 CFR 143).
[g]Equivalent to 0.044 mg/L, assuming secular equilibrium of uranium-234 and uranium-238.

NA = not applicable; a standard exists pCi/L = picocuries per liter None = No standard established

To comply with these requirements, DOE completed the *Final Site Observational Work Plan for the UMTRA Project New Rifle Site* (SOWP) (DOE 1999), which includes site characterization data, monitor well locations, a site evaluation and findings, and an update of the original Baseline Risk Assessment (DOE 1996b). The Baseline Risk Assessment evaluated potential human health and ecological risks that could result from exposure to residual radioactive materials. Results of ground water characterization (DOE 1999), additional vanadium evaluation (DOE 2000a), a pilot study for removal of vanadium from ground water (DOE 2002) and a reevaluation of vanadium modeling (DOE 2003a), were used to recommend the compliance strategy for this EA. Project documents that provided guidance for the SOWP include the *UMTRA Ground Water Management Action Process* (DOE 2003b) and the *Technical Approach to Groundwater Restoration* (DOE 1993).

1.2 Site Description

The New Rifle site is located in Garfield County, Colorado, approximately 2.3 miles west of the city of Rifle (Figure 1). The site is bordered by U.S. Highway 6 to the north and by Interstate 70 and the Colorado River to the south and west.

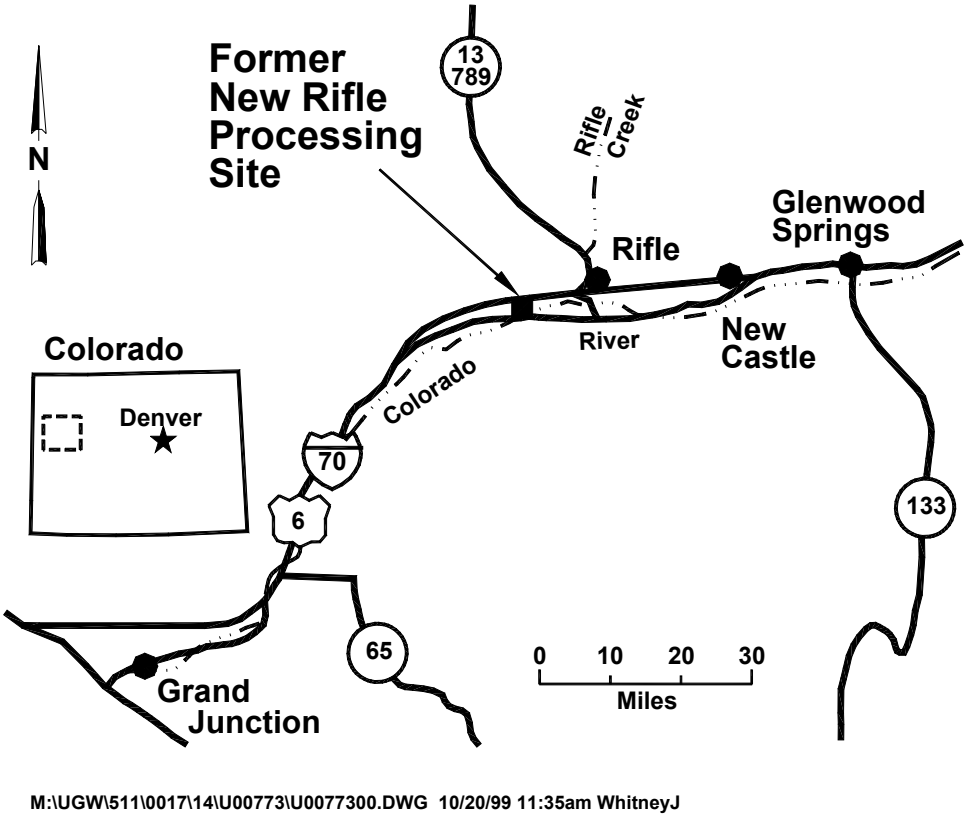


Figure 1. Location of the New Rifle Site

The former millsite is located near the northeastern edge of the Colorado Plateau physiographic province. Major features include the Roan Cliffs to the northwest, the Grand Hogback monocline to the north and northeast, and the Colorado River and Taughenbaugh Mesa along the northern flank of Battlement Mesa to the south. Topographic elevations range from approximately 5,300 feet (ft) above mean sea level at the site to 8,000 ft along the Grand Hogback to the north and to more than 10,000 ft on top of Battlement Mesa to the south. The region has an arid to semiarid climate with high evaporation, low precipitation, low humidity, and large temperature variations.

Climatological data collected from the weather station a few miles southeast of Rifle for the period 1910 through 1997, indicate the site receives an average of 11.0 inches of total precipitation per year. Rainfall occurs during the summer in high-intensity, short-duration, late afternoon thunderstorms that are conducive to runoff. Precipitation in the winter is snowfall.

Due to rapid population growth in western Colorado, the city of Rifle is experiencing increasing demand for residential and industrial lands and water supplies. The Surface Environmental Impact Statement (DOE 1990) and Section 3.1 of the SOWP provide detailed descriptions of the site.

1.3 Site History

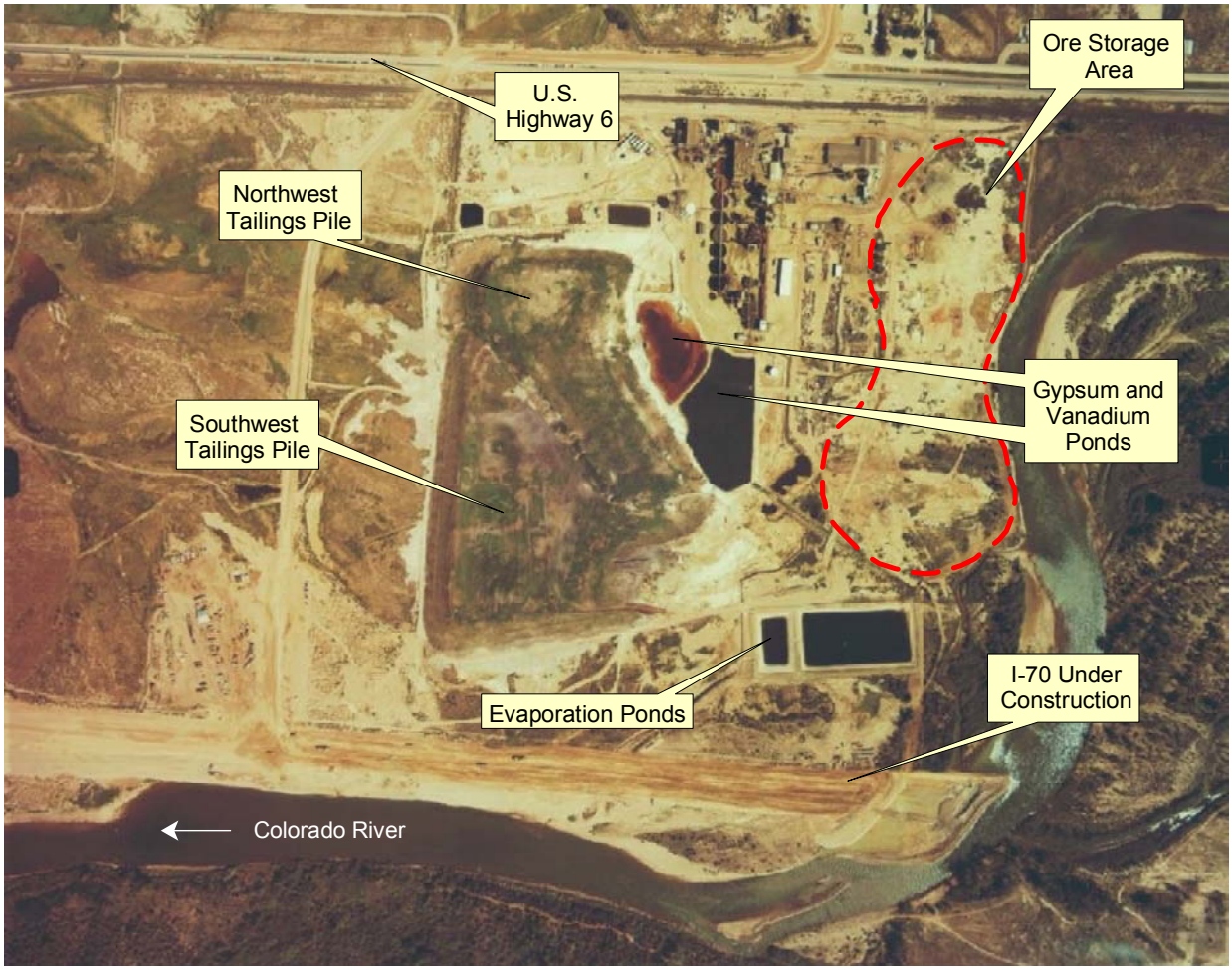
Historically, vanadium and uranium ores were processed at two different millsites located near the city of Rifle. The U.S. Vanadium Company constructed the first mill in 1924 for the production of vanadium (Merritt 1971). This plant was located approximately 0.3 mile east of the city and is referred to as the Old Rifle site. Union Carbide and Carbon Corporation purchased the assets of the U.S. Vanadium Company in 1926 and established the U.S. Vanadium Corporation as a subsidiary (Chenoweth 1982). The subsidiary operated the former Old Rifle plant intermittently until 1946, when it was modified to include the recovery of uranium as well as vanadium. Production continued until 1958, when the old plant was replaced with a new mill, located approximately 2.3 miles west of the Old Rifle site. The former location of the new mill is referred to as the New Rifle site (Figure 1).

Uranium and vanadium production at the New Rifle mill lasted from 1958 to 1984, although the U.S. Atomic Energy Commission only purchased uranium oxide through 1971. Concentrated ore was shipped to the New Rifle mill from 1958 to the early 1960s by truck and rail from upgrading plants at Green River, Utah, and Slick Rock, Colorado (Merritt 1971). Ore for the Green River concentrator came primarily from southeast Utah; ore for the Slick Rock concentrator came from numerous mines in the Uravan Mineral Belt (DOE 1982). From 1964 to 1967, the New Rifle mill also processed lignite ash produced by Union Carbide's strip mining operations near Belfield, North Dakota. From 1973 to 1984, part of the mill was used to produce vanadium; this operation, which did not produce tailings, involved processing vanadium-bearing solutions from Union Carbide's plant at Uravan, Colorado, for various vanadium products used by the steel industry.

Uranium ore with relatively low-grade vanadium was separated in a direct acid-leaching step. Higher-grade vanadium ores were initially salt roasted. The New Rifle mill processed over 2 million tons of ore and other concentrates from 1958 to 1971 to produce 5,852 tons of uranium oxide (U_3O_8) and 32,720 tons of vanadium oxide (V_2O_5) (DOE 1982).

The west central portion of the New Rifle millsite contained 33 acres of tailings in two distinct piles. The combined piles measured approximately 1,600 ft in the north-south direction and approximately 1,150 ft in the east-west direction. The northwest pile contained older tailings, and the southwest pile contained the more recent tailings. The tops of both piles were relatively flat; however, the sides were steep and had nearly 45° slopes in many places. Process mill buildings were located north and east of the piles. Former holding ponds that held processing wastes (including vanadium and gypsum) were located east of the piles. The locations of the tailings piles, evaporation ponds, ore storage area, and mill buildings as they existed in 1974 are shown in Figure 2. The tailing piles were partially stabilized by Union Carbide with the application of mulch and fertilizer. An irrigation system was installed to promote growth of native grasses that were planted. However, much of the pile did not revegetate, and wind and water eroded some of the tailings. Figure 3 shows the tailings piles in 1989, before the beginning of surface

remediation. All tailings, radiologically contaminated materials, and associated process buildings and structures were removed from the site during the surface remedial action completed in 1996.



m:\ugw\511\0017\14\u00774\u0077400.apr whitneyj 10/20/1999, 13:49 U0077400-01

Figure 2. August 1974 View of the New Rifle Millsite, Showing the Northwest and Southwest Tailings Piles, Holding Ponds, Mill Buildings, and Ore Storage Area

Figure 3. August 1989 View Looking West at the New Rifle Millsite before UMTRA Project Surface Removal of Tailings Piles

1.4 Overview of Contaminant Sources

Some ground water contamination probably resulted from rainwater and snowmelt percolating through tailings and stockpiled ore at the site. The area of potential ground water infiltration is located at the east end of the site, shown as the former ore storage area on Figure 2. The primary contaminants would have been the more water-soluble components of the ore, such as uranium, calcium, and sulfate. The source of calcium and sulfate would have been gypsum, which was associated with the ore. In addition to the uranium and vanadium, ores contained other metals such as selenium, molybdenum, and arsenic. Process chemicals, such as ammonium chloride and sulfuric acid, were an additional source of ground water contamination. Some of these chemicals remained on the sandy tailings that were transported by slurry and deposited on the west end of the site, and other solutions were sent to the gypsum and vanadium settling ponds.

2.0 Purpose and Need for Action

The purpose of the UMTRA Ground Water Project is to protect human health and the environment at abandoned ore-processing sites by complying with the final EPA ground water standards in 40 CFR 192 Subpart B. DOE proposes implementing a compliance strategy using the framework established in the Programmatic Environmental Impact Statement (DOE 1996a).

3.0 Proposed Action and Alternatives

The compliance strategy for all constituents of concern (COCs) is natural flushing with institutional controls and continued monitoring. DOE is proposing this compliance strategy to address primarily human health risks related to the surficial aquifer at the New Rifle site. Because a wetland may be affected by natural flushing, monitoring of this area is proposed to ensure that ecological risks continue to be acceptable. The proposed compliance strategy is consistent with guidance in the Programmatic Environmental Impact Statement (DOE 1996a), which provides options (compliance strategies) for complying with EPA's ground water standards and assesses general effects associated with each compliance strategy. Several alternatives were evaluated during preparation of the SOWP and are described in detail in that document. Only the proposed action and no action alternatives are presented in this EA.

Table 2 presents a summary of DOE's proposed action to address potential human health risks at the New Rifle site. Natural flushing is proposed for the uppermost aquifer because concentrations of some mill-related constituents exceed EPA standards or risk-based concentrations. Ammonia, arsenic, fluoride, manganese, molybdenum, nitrate, selenium, uranium, and vanadium are identified as the human health COCs in the surficial aquifer on the basis of ground water use as a potable water supply in a residential setting.

Sampling results from wells in the Wasatch Formation, below the surficial aquifer, show no evidence of mill-related contamination in ground water of the deeper formation. Therefore, no further activities, including monitoring, are proposed for that aquifer.

3.1 Proposed Action

DOE proposes natural flushing with institutional controls and continued monitoring to meet background, maximum concentration limits, or alternate concentration limits for nine COCs to mitigate future potential human health risks. It is predicted that natural flushing will also mitigate ecological risks.

Table 2. Summary of Proposed Action to Address Human Health Risks

Aquifer	Constituent of Concern (human health)	Compliance Strategy	Rationale
Uppermost	arsenic, fluoride, manganese, molybdenum, nitrate, uranium	Natural flushing with institutional controls/monitoring	Natural flushing of these contaminants to EPA standards or background is anticipated within 100 years.
	ammonia, selenium, vanadium	Natural flushing with alternate concentration limits/institutional controls/monitoring	No EPA numerical standard exists for ammonia or vanadium. Background concentrations of selenium exceed the 40 CFR 192 standard. Therefore, DOE proposes alternate concentration limits that are protective of human health.
Deeper Wasatch	None	None	No evidence of mill-related contamination; an overlying aquitard prevents downward migration of contaminants.

In accordance with the 40 CFR 192 Subpart B criteria for natural flushing, compliance with the EPA ground water protection standards, background levels, or alternate concentration limits must be met within 100 years by allowing natural ground water movement and geochemical processes to decrease contaminant concentrations to acceptable limits. The natural flushing strategy could be applied at a site if ground water compliance can be achieved within 100 years, if effective monitoring and institutional controls can be maintained, and if the ground water is not currently and is not projected to be a source for a public water system. As part of the natural flushing compliance strategy, an institutional controls program has been implemented for the site to administratively eliminate exposure pathways for the duration of the natural flushing period. Six of the nine constituents targeted for natural flushing are expected to attain background concentrations or maximum concentration limits within 100 years. Selenium, ammonia, and vanadium are expected to meet alternate concentration limits that are protective of human health within 100 years. Figure 4 outlines the compliance strategy selection process for natural flushing.

3.1.1 Monitoring Program

The monitoring plan is intended to confirm that natural flushing is progressing according to modeling predictions, that concentrations of constituents not modeled decrease as well, and that no contaminant spreading is taking place. Table 3 presents a summary of the proposed monitoring plan; Figure 5 shows the proposed future monitoring locations.

If the monitoring of wells at the perimeter of the contaminant plumes shows that contaminants have begun to spread beyond the current plume boundaries as predicted, or if some other changes in contaminant trends are noted, the monitoring plan may be reevaluated and adjusted at that time.

Monitor wells not required as part of the monitoring network will be decommissioned according to applicable State of Colorado regulations. Decommissioning will be accomplished under the Long-Term Surveillance and Maintenance Program.

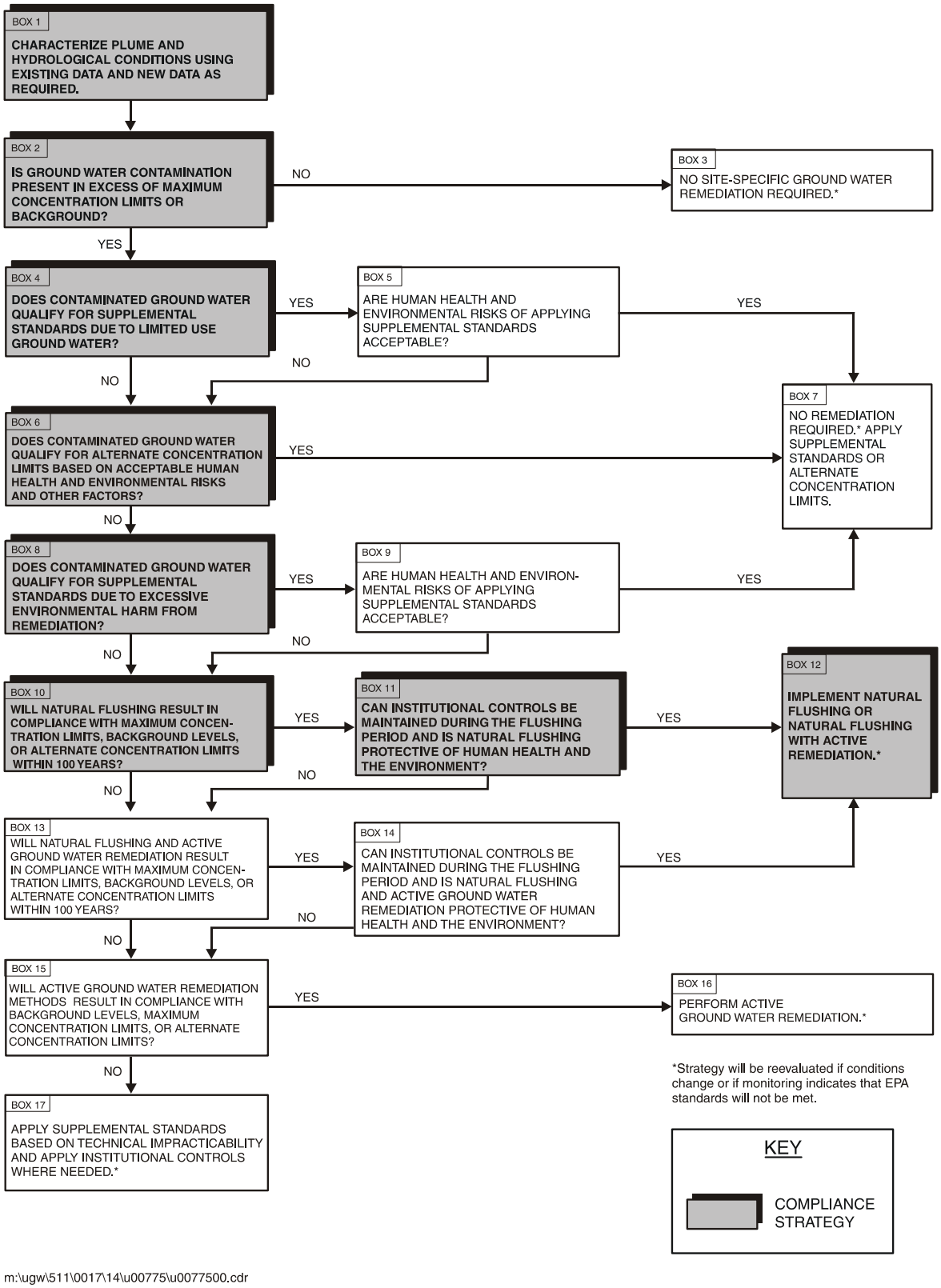


Figure 4. Ground Water Compliance Strategy for the New Rifle Site.

Table 3. Summary of Monitoring Requirements

Location	Monitoring Purpose	Analytes	Frequency[a]
0215, 0216, 0217, 0590, 0658, 0659, 0664, 0669, 0670, 0855	Monitor vanadium plume area.	vanadium, total dissolved solids	Semiannually for 5 years for wells monitoring vanadium plume. Results reevaluated at that time. Probably, monitoring will be at same frequency as other wells after that time.
0170, 0172, 0210	Monitor middle and leading edge of molybdenum, uranium, and nitrate plumes.	molybdenum, uranium, nitrate, total dissolved solids	All other wells and locations, annually for 10 years and every 5 years thereafter until 2030. Monitoring requirements will be reevaluated at that time, but are anticipated to take place at a frequency of no less than once every 10 years.
0169, 0173	Monitor background to establish appropriate standard for uranium; ensure no upgradient spread of plumes.	arsenic, vanadium, selenium, molybdenum, uranium, ammonium, nitrate, manganese, fluoride, total dissolved solids	
0195, 0201, 0215, 0216, 0217, 0590, 0635, 0658, 0659, 0664, 0669, 0670, 0855	Monitor flushing in main body of plumes.	arsenic, vanadium, selenium, molybdenum, uranium, ammonium, nitrate, manganese, fluoride, total dissolved solids	
0320, 0322, 0452, 0453, 0575	Monitor surface water to determine impact of ground water discharge to surface water and ecological receptors; 0322 is point of exposure location.	arsenic, vanadium, selenium, molybdenum, uranium, ammonium, nitrate, cadmium, sulfate, manganese, fluoride, total dissolved solids	
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, vanadium, selenium, molybdenum, uranium, ammonium, nitrate, manganese, fluoride, total dissolved solids	

[a]Monitoring for a COC will be discontinued if concentrations are below standards for 3 consecutive years.

5

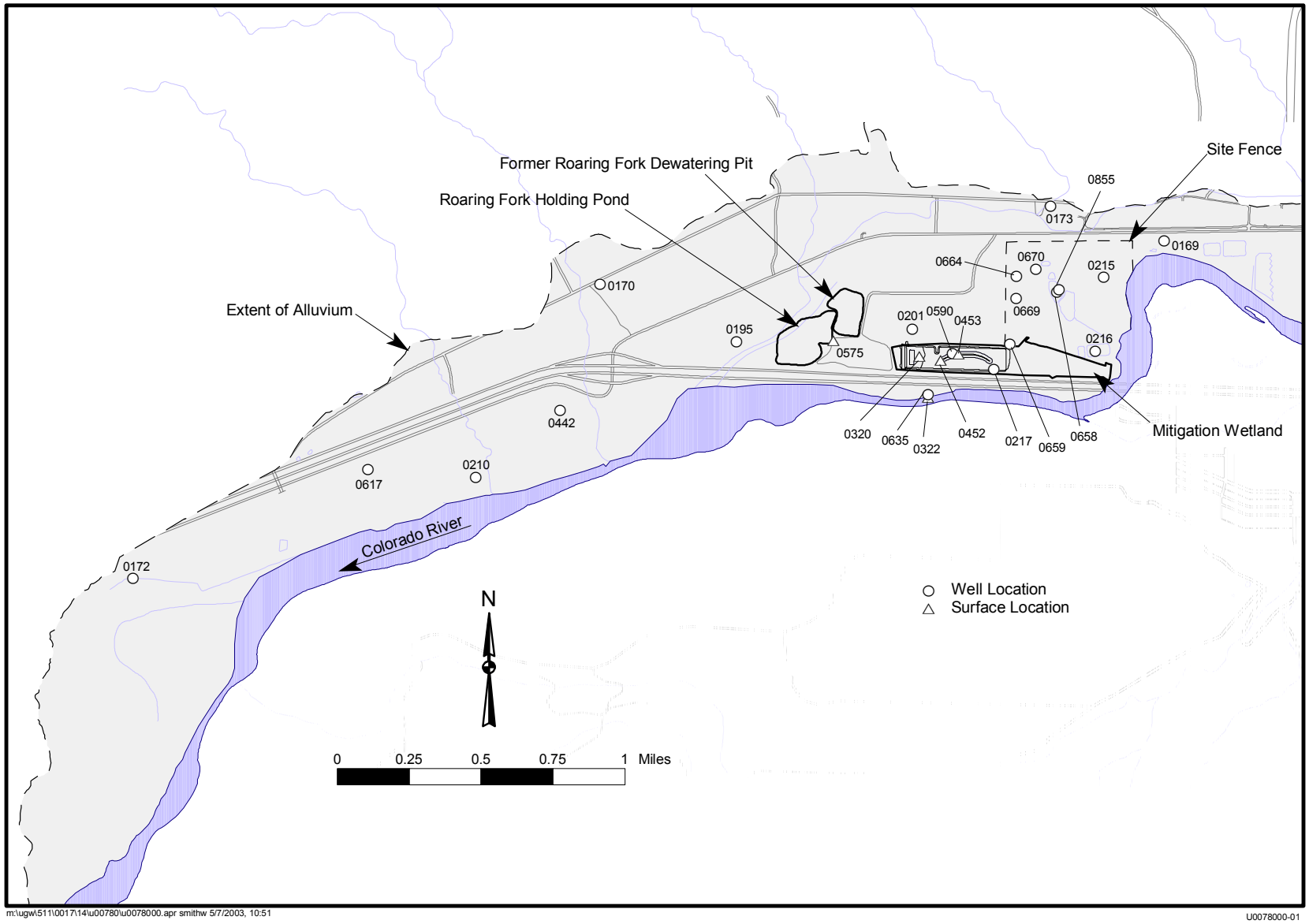


Figure 5. Proposed Monitoring Locations for the New Rifle Site

3.1.2 Alternate Concentration Limits

An alternate concentration limit of 0.05 milligram per liter (mg/L) is proposed for selenium. This is the Safe Drinking Water Act maximum contaminant level. An alternate concentration limit is warranted because background concentrations of selenium exceed the 40 CFR 192 standard and there is no complete exposure pathway for human health risk. All detected concentrations of selenium are below an EPA-accepted risk-based concentration of 0.18 mg/L and are protective of human health (EPA 2003).

Because no standard exists for ammonia, it is necessary to establish an alternate concentration limit for that constituent. Based on site-specific conditions, an alternate concentration limit of 200 mg/L (measured as NH_4) in a residential setting is proposed. Vanadium does not have an established standard, so a risk-based concentration of 0.33 mg/L for drinking water in a residential setting is proposed as the alternate concentration limit (EPA 2003).

3.1.3 Institutional Controls

An institutional controls program has been developed to prevent future use of contaminated ground water associated with the New Rifle site during the 100-year natural flushing period. The institutional controls include zone district changes (Garfield County Resolution No. 2001-73 and City of Rifle Ordinance No. 24 series of 2001) and deed restrictions. In addition, DOE provided funding for a water line extension to the current municipal system to replace the beneficial use of ground water in the area where restrictions are required. Because the water line extension will not cover the extent of the contaminated ground water plume, DOE, in cooperation with Garfield County, has provided reverse osmosis systems for users within the institutional controls boundary but beyond the reach of the waterline. The County will continue to provide reverse osmosis systems on an as-needed basis to users within this affected area who have no access to the municipal supply.

DOE defined an institutional controls boundary on the basis of the extent of uranium, the most widespread COC. The southern boundary follows the Colorado River; the northern and western boundary follows the extent of alluvium as it pinches out against Wasatch Formation outcrops. To ensure that the area is protective of human health, a small buffer zone was included. The institutional controls boundary follows quarter-quarter section lines and natural features such as the Colorado River for easy delineation (Figure 6).

The institutional controls boundary encompasses both Garfield County and city of Rifle property, requiring both governments to enact administrative institutional controls. Garfield County passed a resolution requiring residents to prove a source of potable water for developing property in county jurisdiction. Most of the land within the institutional controls boundary has been identified as a growth corridor for the city of Rifle and likely will be annexed into the city during the natural flushing period. To ensure a safe source of domestic water, the city of Rifle passed an ordinance requiring any resident within city limits to tap into the municipal water system.

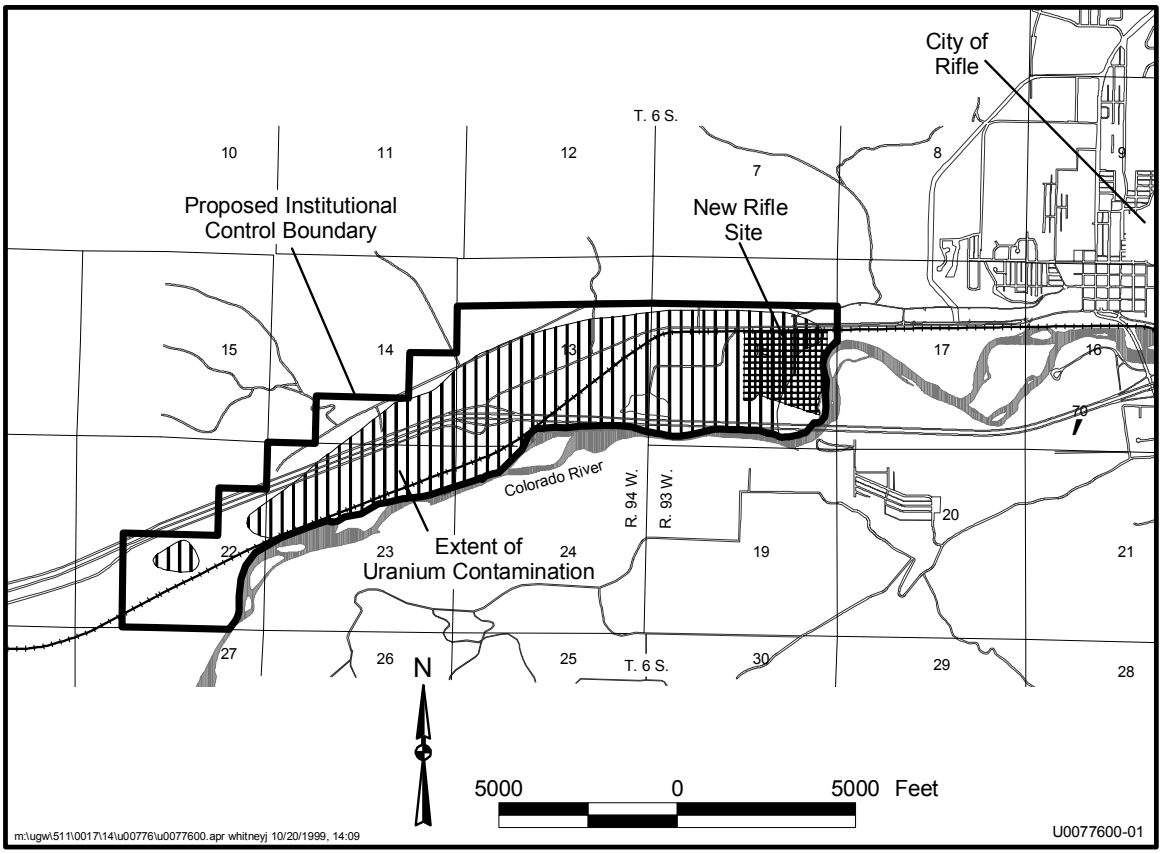


Figure 6. Proposed Area of Institutional Controls

To further enhance the enforceability of established institutional controls, the City and County are required by an agreement executed with DOE and the Colorado Department of Public Health and Environment to notify DOE and the State at least 30 days in advance of any changes to the administrative institutional controls that serve as the ground water restrictions. As another layer of protection, the aforementioned agreement serves as an intergovernmental agreement (per Colorado Statute) among the City, County, and State that designates the established institutional controls as environmental covenants to be listed and monitored by the State. The administrative institutional controls, the executed agreement, and the state statute will ensure that the institutional controls will be effective and enforceable for the 100-year natural flushing period. If contaminants flush more quickly than predicted, DOE, the State of Colorado, the City, and the County may repeal the restrictions on ground water use or may adjust the institutional controls boundary in portions of the properties where contaminant concentrations are within cleanup standards.

3.2 No Action Alternative

By law, DOE is required to evaluate a no action alternative to provide a baseline for comparing the effects of the proposed action (10 CFR 1021.321[c]). Under the no action alternative at the New Rifle site, no further site activities would be performed, including implementation of the proposed compliance strategy. DOE would take no action to bring contaminant concentrations in the surficial aquifer into compliance with EPA ground water standards.

4.0 Affected Environment and Environmental Consequences

This section discusses only the potential effects of the proposed action. DOE has determined that some resources to consider when evaluating the effects of the proposed action are not present at the site or, if present, would not be affected by the proposed action. These resources include cultural resources, socioeconomic resources, air quality, noise, visual resources, and recreational resources. Therefore, these are not discussed further. Because of the uncertainty of the effects the proposed action may have on ecological resources, primarily the wetland located on site, monitoring in this area will be continued as part of the monitoring plan. Any actions taken in the wetland are subject to a U.S. Army Corps of Engineers Section 404 permit.

4.1 Geology

The site is located near the southeastern edge of the Piceance Creek basin and along the southwestern edge of the Grand Hogback monocline that was formed in response to the adjacent White River uplift. Figure 7 presents a generalized north-south geologic cross-section of the Rifle region.

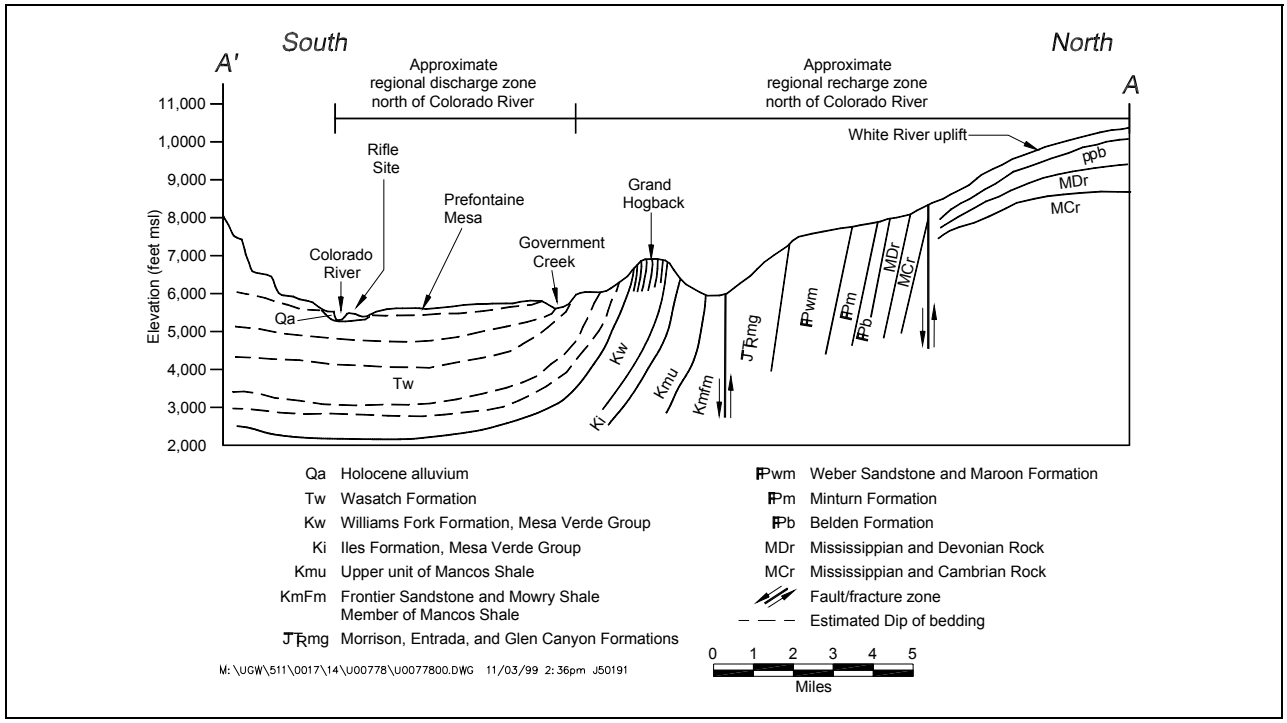


Figure 7. Regional Geologic Cross-Section of the Rifle Area

Principal geologic rock types in the site area include a diverse assemblage of unconsolidated Quaternary deposits and Tertiary-age sedimentary beds of the Wasatch Formation. The unconsolidated deposits consist mostly of alluvial silt, sand, and cobble gravels in stream channels, beneath flood plains, and in terraces along the Colorado River Valley and its major tributaries. Other sediments include fine-grained silt and sand overbank deposits, and mass-wasting deposits consisting of sheetwash, colluvium, and alluvial fan material. The

Wasatch Formation consists mostly of variegated claystone, siltstone, and fine-grained sandstone of fluvial origin. The New Rifle site is situated on a broad section of Colorado River floodplain alluvium deposited over several thousand feet of Wasatch Formation (Figure 8).

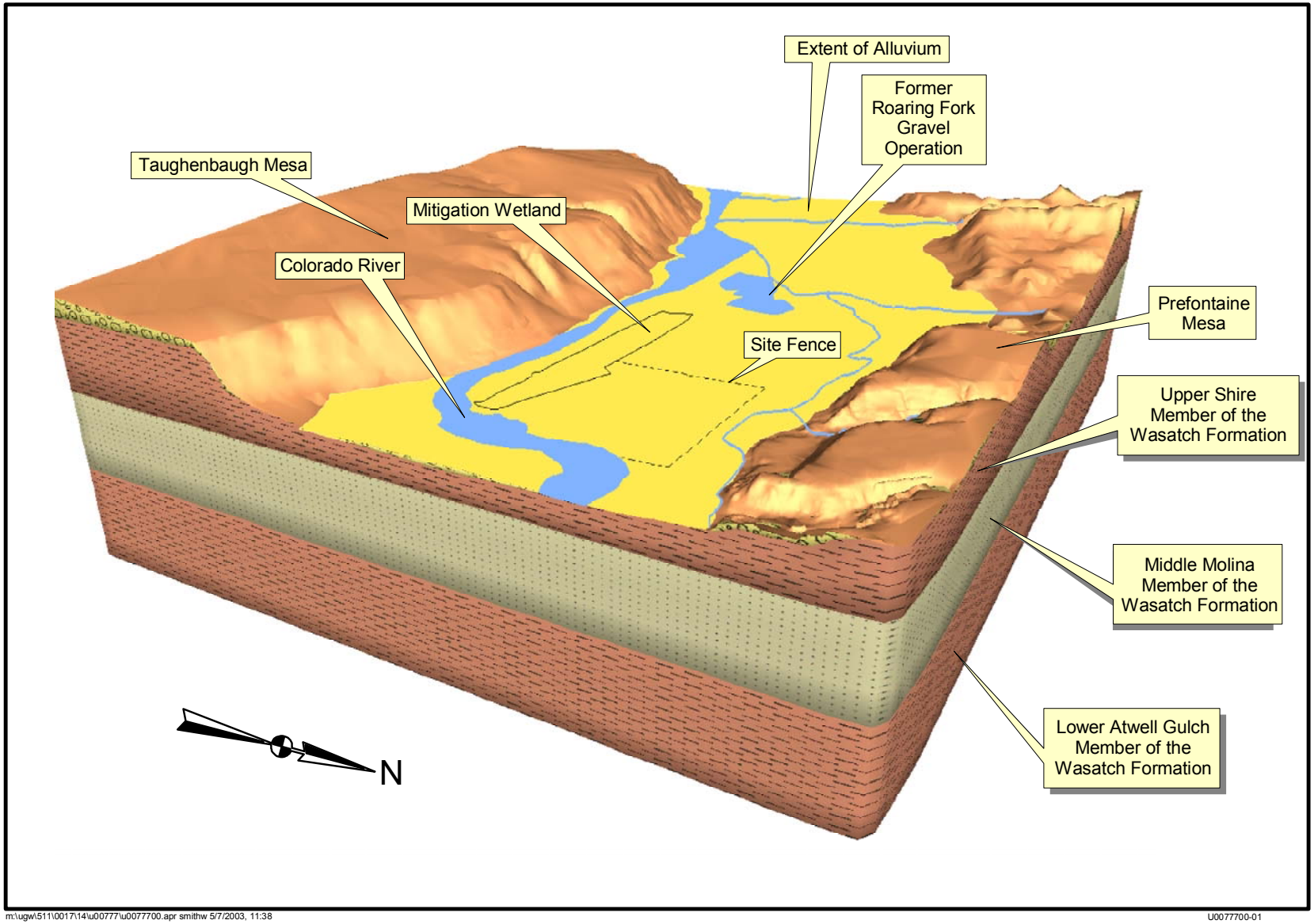
The oldest rock units in the region are present north of Rifle, between the Grand Hogback and the White River uplift, where a 6-mile section of near-vertical sedimentary beds of Paleozoic and Mesozoic age are exposed. In this area one of the largest vanadium-uranium deposits on the Colorado Plateau occurs in host rocks of the Triassic Chinle Formation, Triassic-Jurassic Glen Canyon Group (consisting of the Wingate Sandstone, Kayenta Formation, and Navajo Sandstone), and Jurassic Entrada Sandstone (Chenoweth 1982, Fischer 1960). The deposits produced approximately 47 million pounds of V_2O_5 and about 1 million pounds of U_3O_8 from the Garfield and Rifle mines from 1925 through 1977. A few miles east of the Rifle Mine several smaller vanadium-uranium deposits were mined from the Salt Wash Member of the Jurassic Morrison Formation. Sediments containing uranium, vanadium, and other metals from these mineralized Triassic-Jurassic host rocks were eroded and transported south and deposited in the Wasatch Formation prior to the later part of the Laramide deformation, when intensive folding of the Grand Hogback monocline occurred in response to the White River uplift. As a result of the uplift, the sedimentary beds of the Wasatch Formation are now at a near-vertical orientation along the face of the Grand Hogback monocline. To the southwest of the monocline the dip declines rapidly to 30 to 40 degrees just north of Rifle and then flattens to a gentle dip of 5 degrees or less in the vicinity of the site. Shallow bedrock between the Colorado River and the Grand Hogback consists of variegated shale, siltstone, and fine-grained sandstone of the Wasatch Formation.

Although the Wasatch Formation contains some resistant beds that form cliffs, most of the formation weathers easily and has formed lowland mesas, including the Webster and Prefontaine Mesas directly west to northwest of the city of Rifle.

Younger sedimentary rocks overlying the Wasatch Formation are the Eocene sandstone, oil shale, and marlstone beds of the Green River Formation, which crop out almost continuously around the southeastern margin of the Piceance Creek Basin and form the prominent Roan Cliffs. These cliffs are visible to the northwest from the city of Rifle.

The youngest geologic units include Quaternary alluvium, colluvium, landslides, debris-flow, and loess that have been mapped in and adjacent to the Colorado River valley near Rifle (Shroba et al. 1995, Stover 1993). These surficial unconsolidated units overlie several thousand feet of Tertiary-age Wasatch Formation.

Major features of the regional hydrologic system are the result of the White River uplift and the Grand Hogback located north of the site. Besides being in the regional zone of recharge, the steeply dipping Grand Hogback monocline redirects surface drainage from the steep-walled canyon and the mountain region of the White River Plateau to the broad flat valleys of the Colorado River Basin. Rifle Creek drains most of the regional hydrologic catchment north of Rifle and is used extensively as a source of surface irrigation water in the Rifle area. Other Colorado River tributaries that provide regional drainages north of Rifle include Government Creek and Elk Creek. The Colorado River to the south of the contaminated area is in the zone of regional discharge and acts as the regional ground water flow divide (Figures 7 and 8).



m:\ugw\511\0017\14\u00777\u0077700.apr smithw 5/7/2003, 11:38 U0077700-01

Figure 8. Regional Hydrostratigraphic Model and Key Features

4.2 Ground Water

4.2.1 Affected Environment

The surficial aquifer is the uppermost aquifer at the New Rifle site and consists of unconsolidated deposits of mostly silts, sands, and gravels and also includes weathered fine-grained sandstones and claystones of the upper few feet of the underlying Shire Member of the Wasatch Formation. Figure 8 shows a geologic cross-section extending north to south through the site. Underlying the surficial aquifer are indurated claystones and siltstones that are interbedded with lenticular fine-grained sandstones of the Wasatch Formation.

The lateral extent of the surficial aquifer at the New Rifle site is largely limited by the boundary of Wasatch Formation outcrops to the north and the Colorado River to the south. Alluvial deposits at the New Rifle site are approximately 20 to 30 ft thick over most of the site; depth to ground water ranges from 5 to 10 ft below ground surface. The greatest depth to water is 90 ft, which occurs approximately 1.5 miles downgradient of the site where alluvial fan material fills a local valley.

Recharge to the surficial aquifer at the site occurs mostly as infiltration of precipitation, leakage from the unnamed intermittent tributaries and Pioneer ditch north of U.S. Highway 6, and by the Colorado River, especially along the north-south reach of the river east of the site, which appears to be a ground water recharge source most of the year. During spring runoff in May and June, the Colorado River also temporarily recharges the surficial aquifer along the southeast portion of the site when high-river flows start to exceed ground water elevations in the surficial aquifer.

Several surface features at the New Rifle site interact with alluvial ground water and influence both dilution effects and contaminant migration from the site. Primary features are the Colorado River, the former Roaring Fork gravel operations, and the wetland south of the former millsite (Figures 9 and 10). Detailed descriptions of interactions between surface water and ground water are presented in Section 5.0 of the SOWP.

Alluvial ground water at the site discharges to the wetland, the former Roaring Fork gravel pits, and the Colorado River. Plant transpiration and evaporation in areas of shallow ground water depths are the only other processes by which ground water may be discharged from the surficial aquifer.

Discharge by plant evapotranspiration is considered minimal because the site is dominated by wheatgrasses, which are shallow rooted and not considered to be phreatophytes (plants that root in ground water). Discharge (evapotranspiration) by phreatophytes, mostly large greasewood and cottonwood communities located downgradient of the site, can be significant.

Fluctuations in river stage produce a significant response in water table elevations near the river. Aquifer responses appear to diminish with increasing distance from the river. During low river stage, most alluvial ground water at the site flows southwest and discharges into the Colorado River along the southern boundary of the site. As the river rises in the spring and early summer, ground water maintains the southwest flow direction through the eastern portion of the wetland.

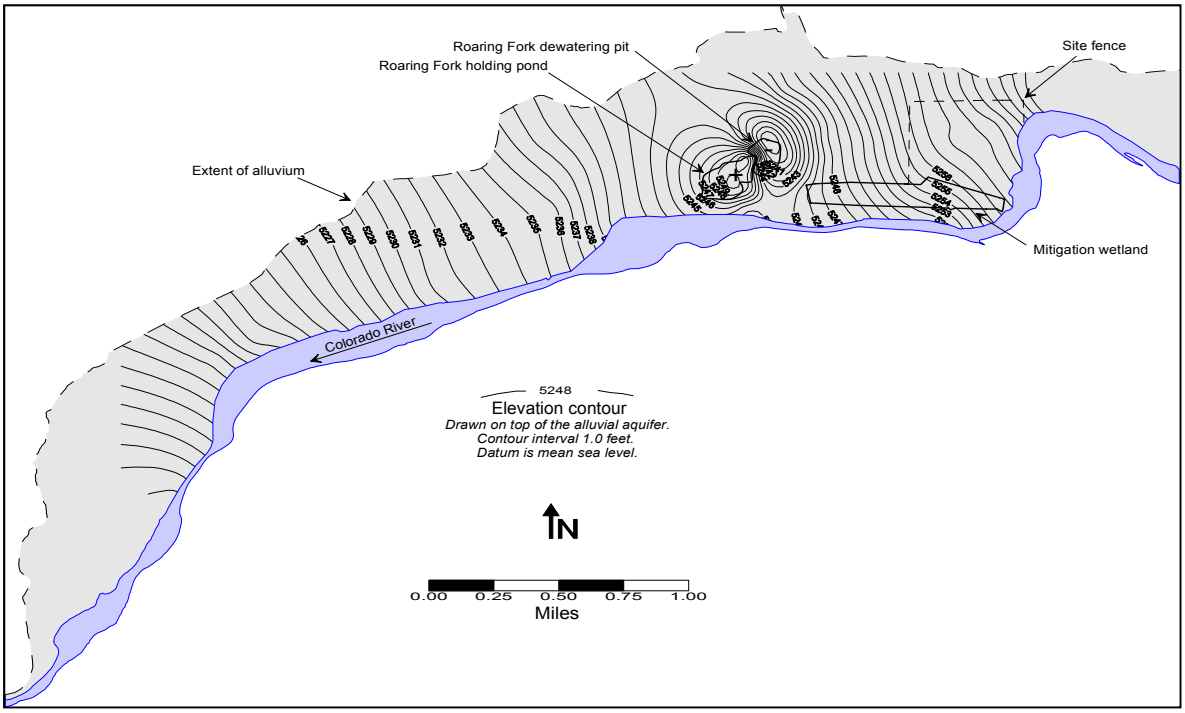


Figure 9. Alluvial Ground Water Elevations at the New Rifle Site—July 1998

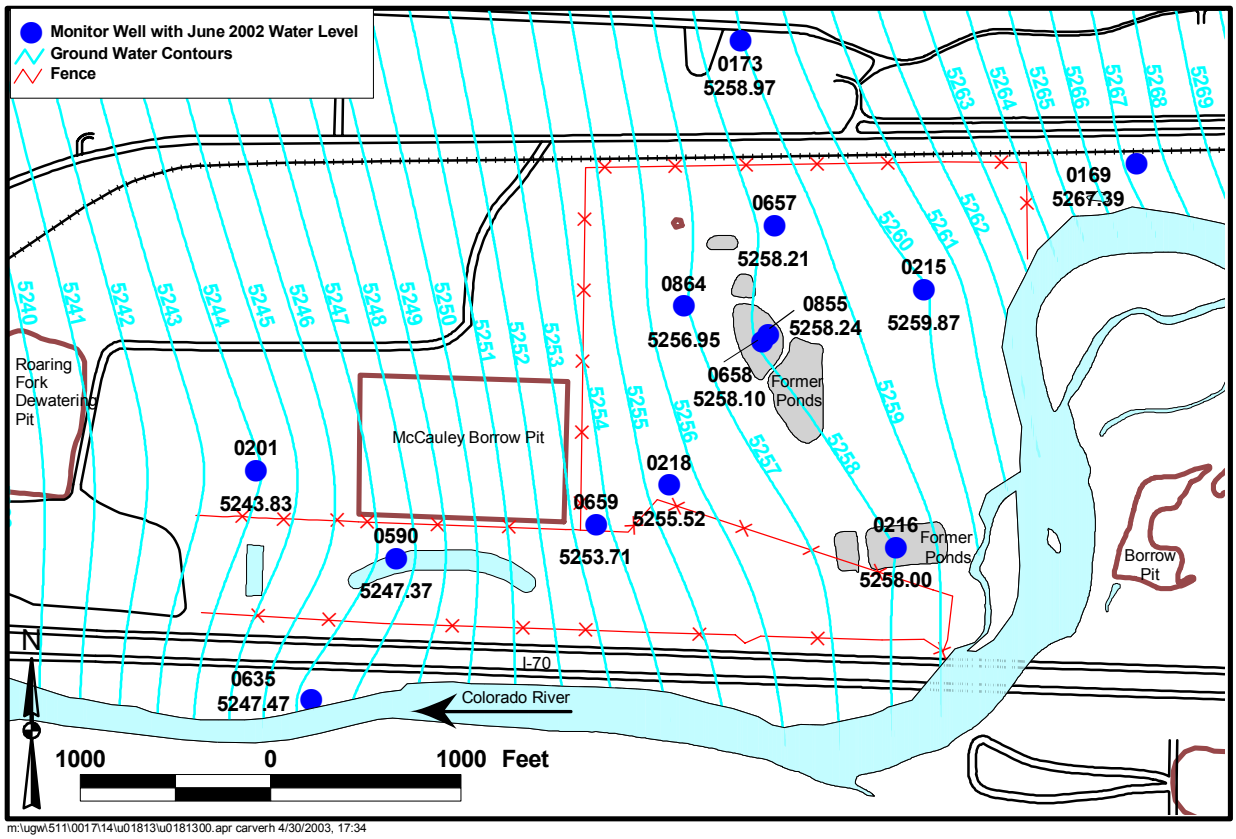


Figure 10. Alluvial Ground Water Elevations at the New Rifle Site—June 2002

During operation of the Roaring Fork gravel mine, ground water infiltrating the active mining area was diverted to the east pit where it was pumped into the west pond and held to allow the water to evaporate or infiltrate back into the surficial aquifer downgradient of the mining operation. Figure 9 shows that in 1998 dewatering had significantly altered the local natural ground water flow gradients. In effect, the dewatering pit was behaving as a large-diameter pumping well located next to a large-diameter downgradient injection well. The pumping had effectively increased hydraulic gradients east of the dewatering pit. The increase was accompanied by an increase in ground water flow velocities east of the pit and a radial warping of flow directions toward the dewatering pit. Conversely, the holding pond had created a ground water mound and a radial warping of flow directions away from the west pond. A corresponding increase in ground water flow velocities west of the holding pond resulted from the increase in the hydraulic gradient created from the mound.

Mining of gravel at the Roaring Fork gravel mine ceased in 2002. From 2002 and into 2003, the western pit was being contoured and may undergo further reclamation. During this period, water is being pumped into the eastern pit and water levels in the wetlands area are rising. This situation will continue until the western pit reclamation has been completed and water is allowed to reach equilibrium. Figure 10 shows the June 2002 ground water elevations in the former millsite area. Flow directions are perpendicular to the lines of equal elevation. The current ground water flow directions are probably similar to pre-mining conditions, and they are expected follow this trend as gravel mining reclamation proceeds to conclusion.

Extent of Contamination

Ammonia (measured as ammonium), nitrate, molybdenum, and uranium are the site-related constituents most widespread in the surficial aquifer. They tend to be mobile in ground water under a variety of geochemical conditions and, therefore, move with the most ease. Other constituents such as sulfate, cadmium, fluoride, manganese, selenium, arsenic, and vanadium are less widespread because they tend to attach or adsorb more readily to constituents in the subsurface. EPA uses the generic term “sorb” for this process of dissolved constituents being attached or incorporated into a solid material such as soil (EPA 1999).

An overall or general look at contamination is provided in Table 4. It contains mean historical concentrations of pre-remediation COCs measured during preparation of the Baseline Risk Assessment (DOE 1996b), mean concentrations after surface remediation during preparation of the SOWP in 1998 to 1999 (DOE 1999), and mean concentrations for two sample rounds in 2002. The same sets of wells or the closest matching wells were used for this long-term look at COCs. Selenium and fluoride were not always measured in the set of wells under footnote c of Table 4; therefore, analyses from other nearby wells were substituted. Overall, the levels of all COCs dropped significantly after surface remedial action and continue to decline. Vanadium and selenium were exceptions, and their unusual geochemistry is discussed in this section.

Table 4. New Rifle Chemistry Trends

COC (All units mg/L)	Historical Range [a] Aug. 1987–Aug. 1994	Median	SOWP Range[b] (1998–1999)	Mean	Most Recent Range (2002)[c]	Mean	Difference of Means, Historical to Current	Difference of Means, SOWP to Current
Ammonium	506–1,745	1,030	0.004–475	146	12–409	140	−891	−7
Arsenic	0.97–1.3	1.1	0.0001–0.304	0.0391	0.0008–.059	0.019	−1.08	−0.02
Fluoride	0.06–9.0	4.7	0.477–5.5	2.5	0.343–3.49	1.86	−2.88	−0.68
Manganese	9–13	9.9	0.34–4.55	2.1	0.647–7.59	2.98	−6.92	+0.88
Molybdenum	2.3–3.7	2.9	0.010–6.84	2.2	0.018–5.86	1.57	−1.34	−0.64
Nitrate	552–1,110	784	0.11–324	35	0.02–194	78.6	−706	+43.1
Selenium	0.005–0.2	0.06	0.001–0.782	0.09	0.0001–0.255	0.079	+0.03	−0.011
Uranium	0.24–0.37	0.29	0.010–0.395	0.11	0.17–0.314	0.093	−0.20	−0.02
Vanadium	0.59–2.8	1.3	0.001–25.3	3.17	0.0003–8.13	1.85	+0.55	−1.32

[a] Ranges and median values are from the Baseline Risk Assessment, Table 3.1.
[b] Ranges and means are from the SOWP, Table 5–8.
[c] Wells used are 0215, 0216, 0218, 0657, 0658, 0659, and 0590.
Other wells used for fluoride include 0584 (for 0659), 0587 (for 0659), 0590, 0594 (for 0658), and 0625 (for 0216).
Other wells used for selenium include 0584 (for 0659), 0587 (for 0659), 0590, 0594 (for 0658), and 0625 (for 0216).

Ground water quality data have been collected since 1985, though sampling frequency and location of wells sampled has varied. The following discussion focuses on comparing sampling results from 1998 to the present. Historical data are referenced where appropriate. Spot plots from the June 2002 sample round showing contaminant concentrations are provided. Each COC is discussed below.

Ammonia

The distribution of ammonia (as ammonium) concentrations in the surficial aquifer for the August 1998 sampling is shown in Figure 11. A plume boundary is defined by the area where concentrations exceed the 200 mg/L risk-based concentration for human health. The highest concentrations in the plume probably originated near the center of the former gypsum-vanadium evaporation pond and migrated in a southwesterly direction through the western portion of the wetland. The highest ammonia concentration of 669 mg/L is near the west end of the wetland, approximately 2,100 ft downgradient from the former source area. Elevated concentrations extend west of the wetland boundary to the Roaring Fork gravel operation, where concentrations decrease to less than 50 mg/L. Analytical results of the January 1999 sampling show a similar ammonia distribution pattern. However, mean concentrations in the plume tend to be slightly lower in 1999 than in 1998. For example, the highest concentration decreased from 669 mg/L in 1998 to 627 mg/L in 1999. Similar decreases in ammonia concentrations are evident in 1999 at most of the other locations in the plume with two notable exceptions. Concentrations in ground water sampled near the center of the former gypsum-vanadium evaporation pond increased from 283 mg/L in 1998 to 367 mg/L in 1999 but decreased to 218 mg/L by 2002 as shown in Figure 12.

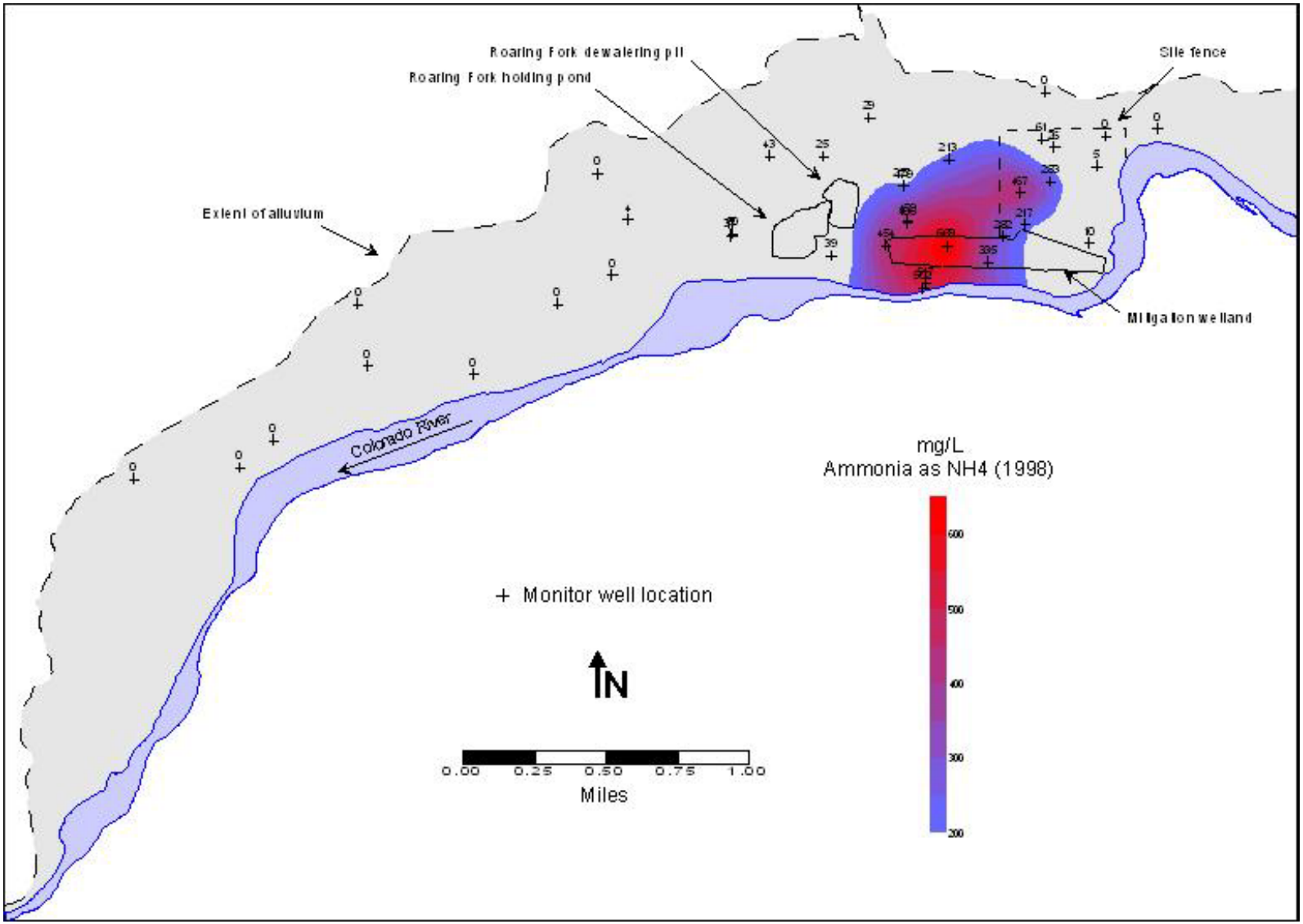


Figure 11. Ammonia Distribution in Alluvial Ground Water—New Rifle Site, 1998

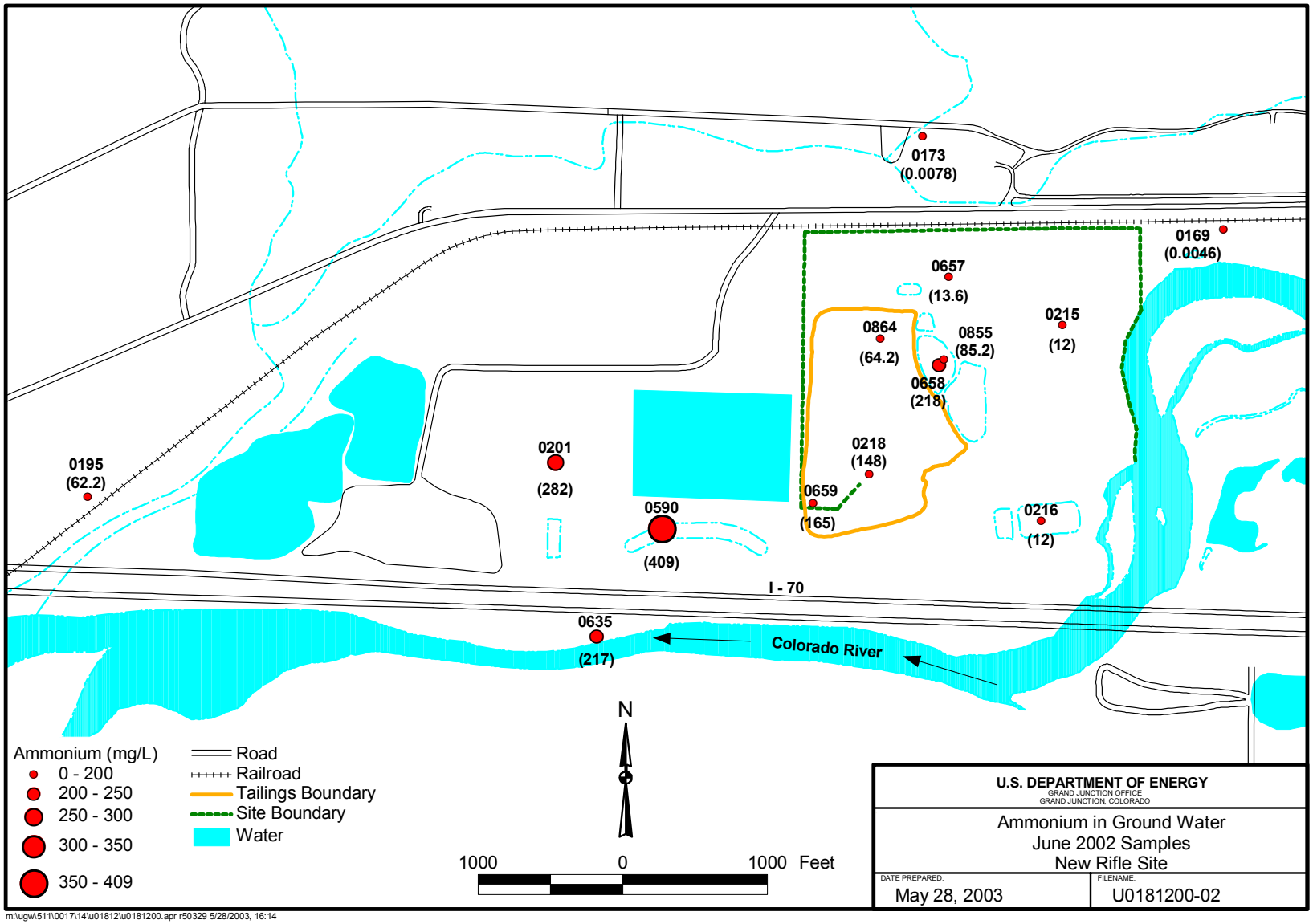


Figure 12. Ammonia Distribution in Alluvial Ground Water—New Rifle Site, 2002

This suggests that a more recent plume may have been mobilized from the area of highest concentrations when the surface remediation was in progress. Perhaps water-soluble constituents in the tailings were mobilized by construction water applied during surface remediation and by irrigation during the reseeding operation at the conclusion of surface remediation. The other increase was observed in 1999 at monitor well 0635, which is located along the river approximately 800 ft downgradient from the wetland. Ammonia concentration at this most downgradient location increased from 502 mg/L in 1998 to 550 mg/L in 1999, but decreased to 217 in 2002, suggesting that the center of the plume is naturally flushing to the river. The highest concentration of ammonia currently detected at the site is 409 mg/L at well 0590 in the wetlands area (Figure 12). Table 4 shows that in general, ammonia concentrations decreased about 77 percent after surface remedial action.

Arsenic

Arsenic concentrations in ground water at most wells are at or below the detection limit (0.001 mg/L), and only two locations had concentrations exceeding the EPA (40 CFR 192) standard used by UMTRA of 0.05 mg/L in 1999. The maximum detected concentration for the August 1998 samples was 0.30 mg/L from well 0658 near the former gypsum-vanadium evaporation pond. Arsenic concentrations in ground water from the January 1999 sampling are presented in Figure 13. By January 1999, the arsenic concentration at well 0658 had decreased to 0.08 mg/L, a value only slightly above the standard, and by December 2002 the concentration had decreased to 0.04 mg/L. Well 0855, drilled in 2000, contained 0.334 mg/L arsenic in June 2002, the highest current concentration of arsenic on site (Figure 14). Elevated arsenic concentrations do not extend beyond the boundary of the New Rifle site. The limited distributions of arsenic, selenium, and vanadium are attributable to their adsorption to the surfaces of aquifer grains (EPRI 1984). Table 4 shows that in general, arsenic concentration has decreased across the site by about 98 percent since surface remedial action.

Molybdenum

Molybdenum concentrations were distributed in the surficial aquifer as shown in Figure 15 for the August 1998 sampling. The colored areas delineate molybdenum concentrations above the EPA ground water standard of 0.1 mg/L. The highest concentrations range between 3.6 and 6.4 mg/L (well 0659) and appear beneath the former tailings area and the former gypsum-vanadium evaporation pond. The plume extends west-southwest off site as far downgradient as the Roaring Fork gravel operation. A concentration of 0.18 mg/L detected in ground water from a monitor well just west of the Roaring Fork holding pond represents the most downgradient edge of the plume in which concentrations exceed the EPA standard. The January 1999 ground water sampling results show similar concentrations and distribution patterns. By 2002, concentrations of molybdenum in well 0659 had dropped to 2.9 mg/L (Figure 16). The maximum concentration on site was 5.49 mg/L from well 0658. Table 4 shows that in general, molybdenum concentration has decreased across the site about 46 percent since surface remedial action.

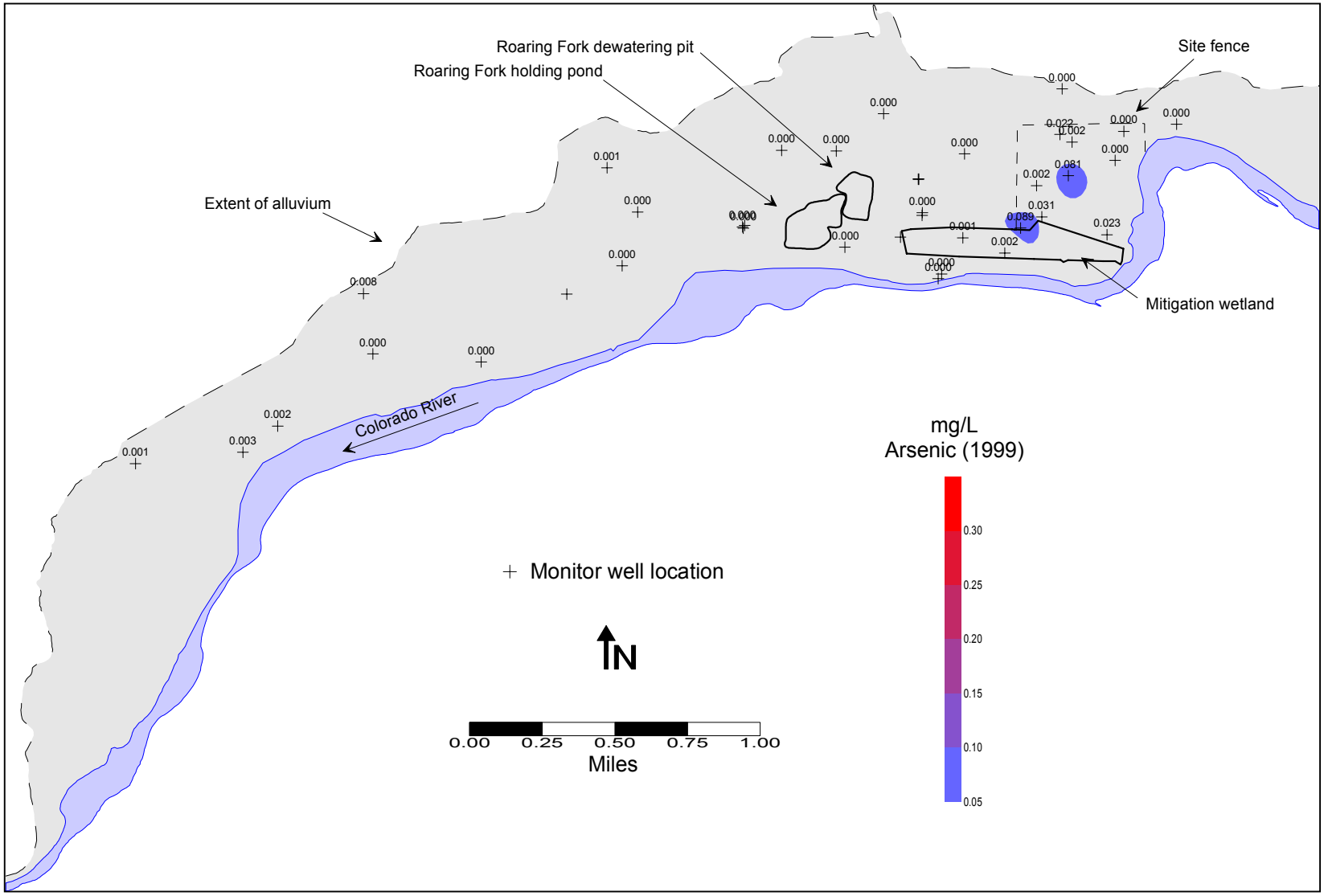


Figure 13. Arsenic Distribution in Alluvial Ground Water—New Rifle Site, 1999

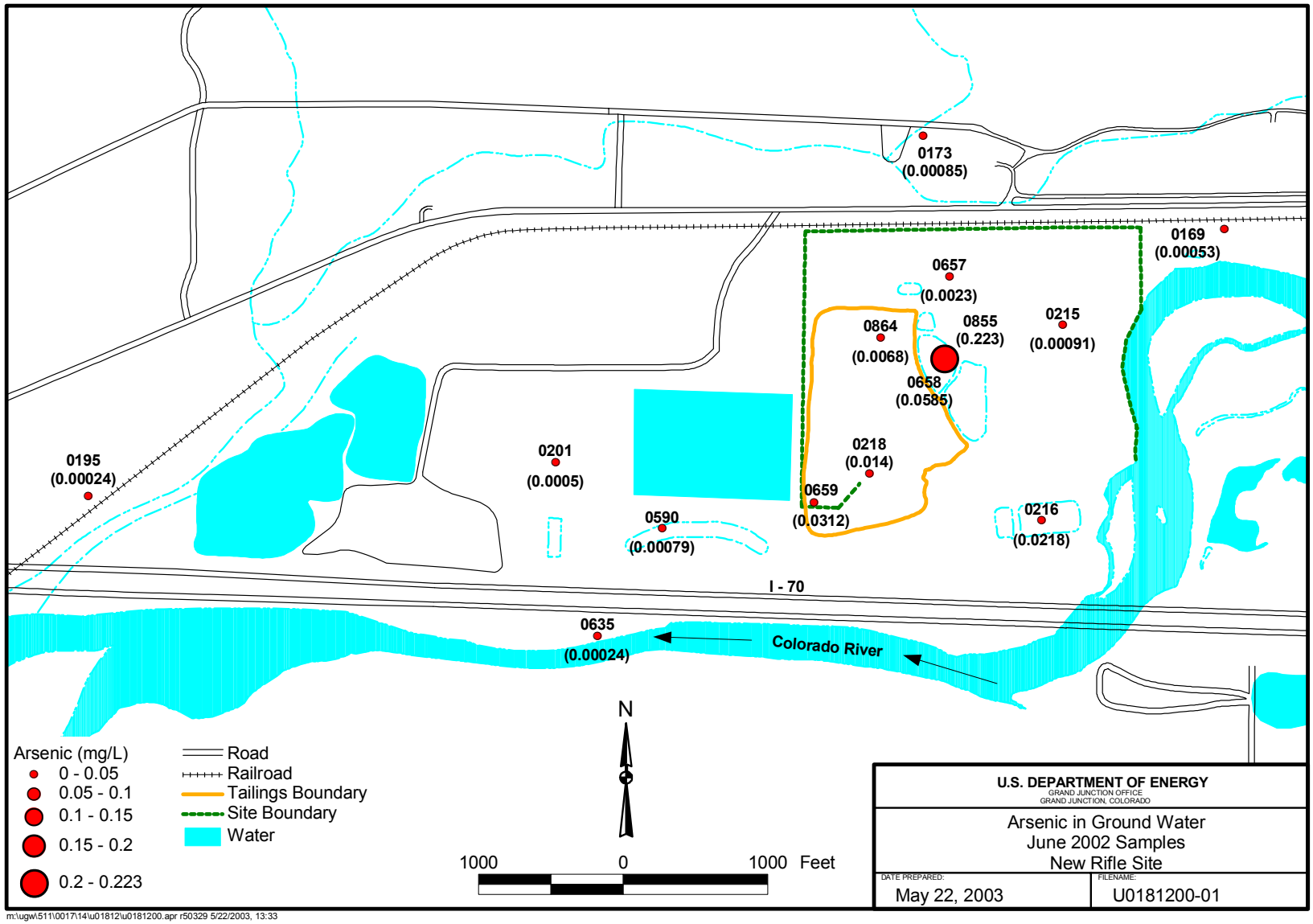


Figure 14. Arsenic Distribution in Alluvial Ground Water—New Rifle Site, 2002

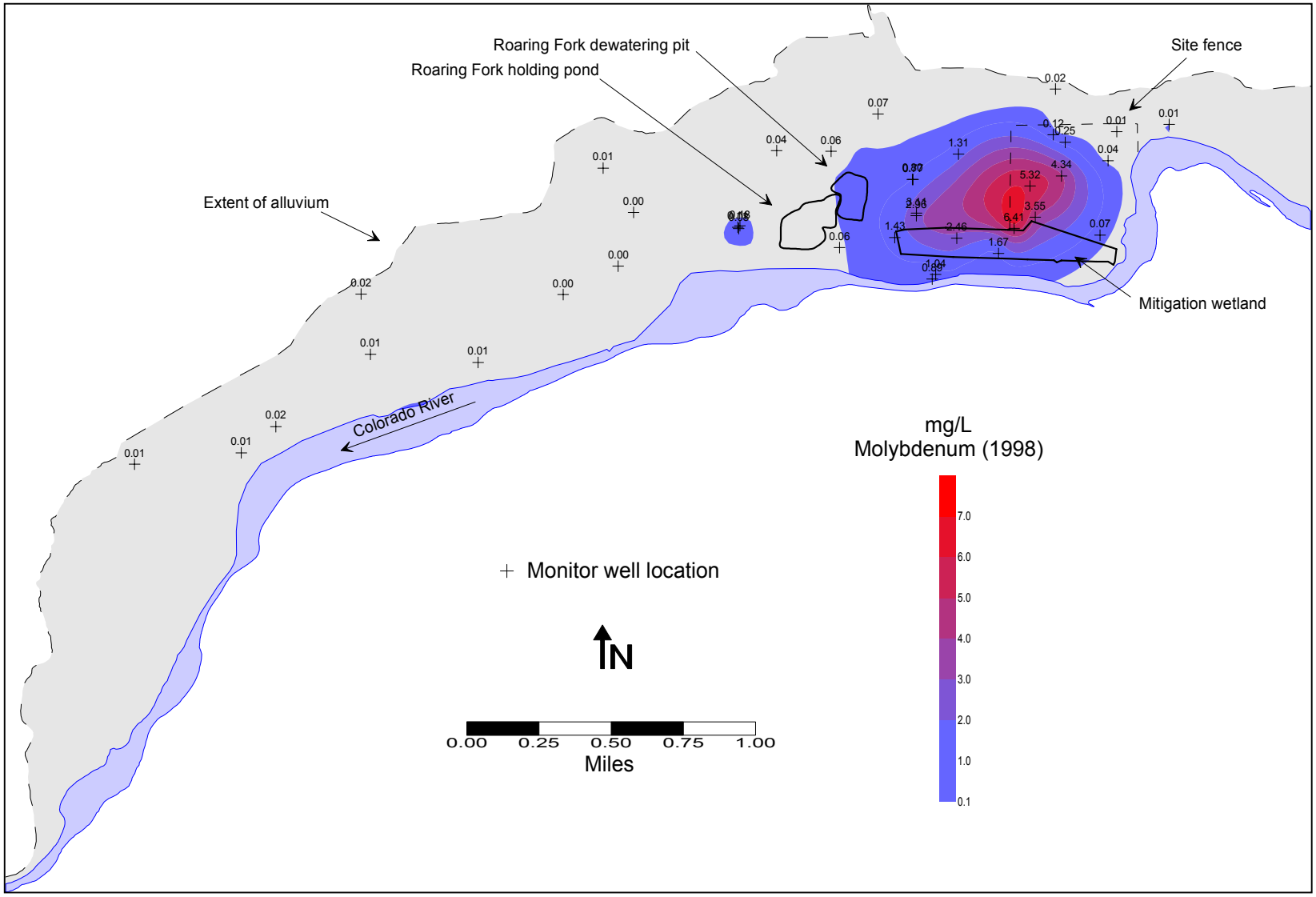
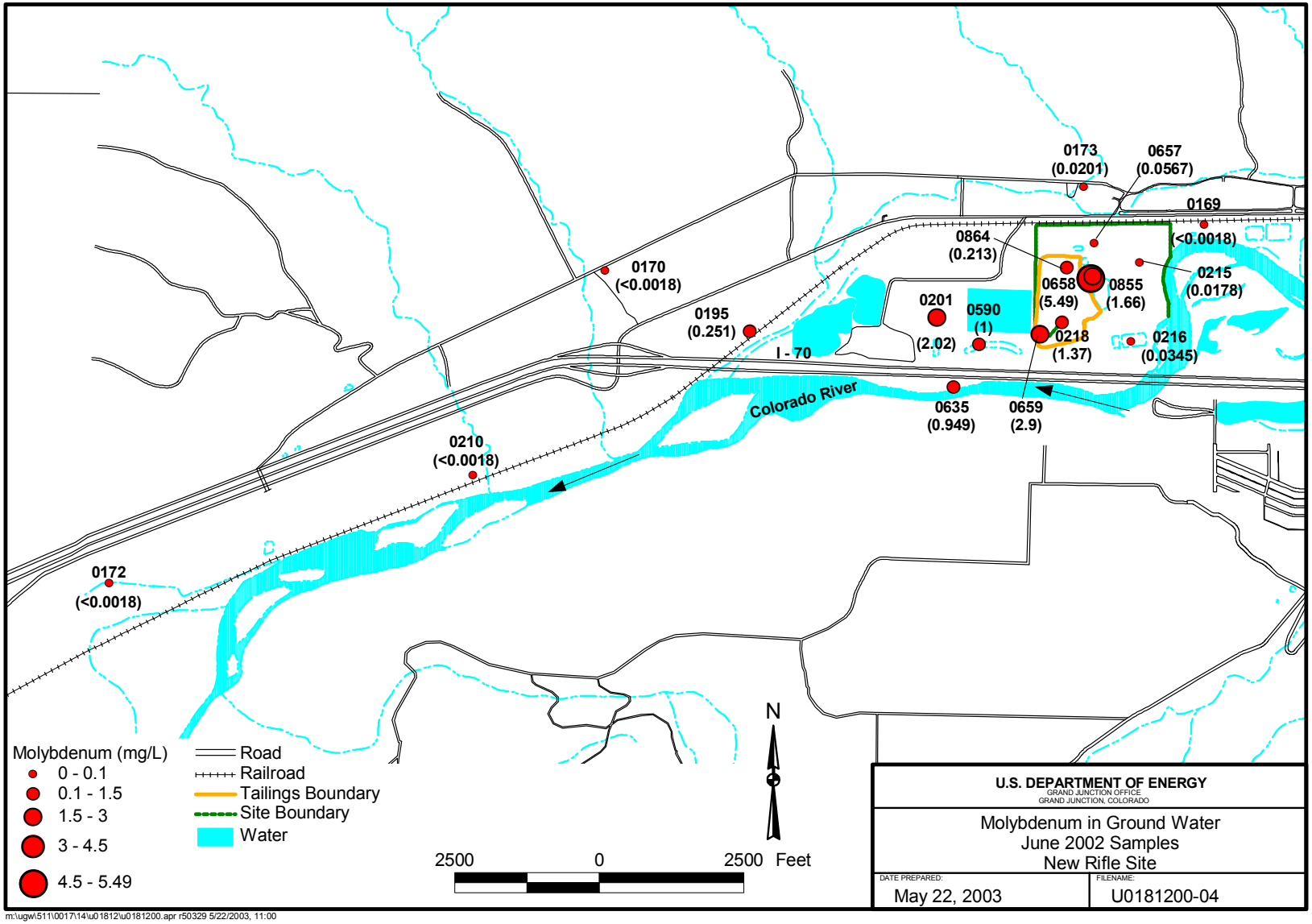


Figure 15. Molybdenum Distribution in Alluvial Ground Water—New Rifle Site, 1998



m:\ugw\511\0017\14\u01812\u0181200.apr r50329 5/22/2003, 11:00

Figure 16. Molybdenum Distribution in Alluvial Ground Water—New Rifle Site, 2002

Nitrate

Figure 17 shows the distribution of nitrate (expressed as NO_3) in the surficial aquifer for the August 1998 ground water sampling. The plume boundary in the figure is defined by the area where concentrations exceed the EPA standard of 44 mg/L (the numerical standard is 10 mg/L nitrate expressed as N, which is equivalent to 44 mg/L nitrate expressed as NO_3).

Most of the nitrate contamination has migrated off site in a west-southwest direction. The most notable feature is the delineation of two distinct plumes separated by the Roaring Fork gravel ponds. The highest nitrate concentration in the east plume was 693 mg/L in well 0635 between the Roaring Fork dewatering pond and the west end of the wetland. The highest concentration in the western plume was 377 mg/L in well 0195. Ground water flow velocities in this area of the surficial aquifer increased toward the Roaring Fork dewatering pond because of the active mining operation, especially during higher river stage, thereby enhancing the natural flushing of nitrate. Plume water actively drawn into the dewatering pond was pumped into the downgradient holding pond, at which point the water evaporated or infiltrated back into the surficial aquifer. The ground water mounding effect from the holding pond tended to increase the ground water flow velocities in a radial pattern downgradient from the holding pond, thereby reducing nitrate concentrations through dilution and dispersion. Figure 18 shows that nitrate concentrations have decreased to 273 mg/L in well 0635 and to 272 mg/L in well 0195, but increased in well 0170 from 62 mg/L in 1998 to 144 mg/L in 2002. This indicates the nitrate plume is continuing to migrate downgradient. Table 4 shows that, in general, nitrate concentrations have decreased about 90 percent since surface remedial action.

Nitrate concentration in the ground water is slightly elevated above the 44 mg/L standard in two small anomalous areas more than 2 miles downgradient of the New Rifle site (Figure 17). Concentrations measured in 1998 at those monitoring locations were 48 and 49 mg/L. The 2002 nitrate concentrations in ground water collected at the more downgradient location are higher than the historical level of 12 mg/L reported in 1991 and 1992 when the original well was first sampled. However, nitrate levels appear to be declining since the highest concentration of 75 mg/L was detected in 1995. Increased ground water flow velocities downgradient from the Roaring Fork holding pond may have contributed to the slightly elevated nitrate concentrations at that location. Also, the nitrate could originate from sources other than the former millsite, such as septic tanks, stock ponds, or fertilizer. Nitrate levels in the two downgradient wells only slightly exceed the 44 mg/L standard and appear to be limited in area.

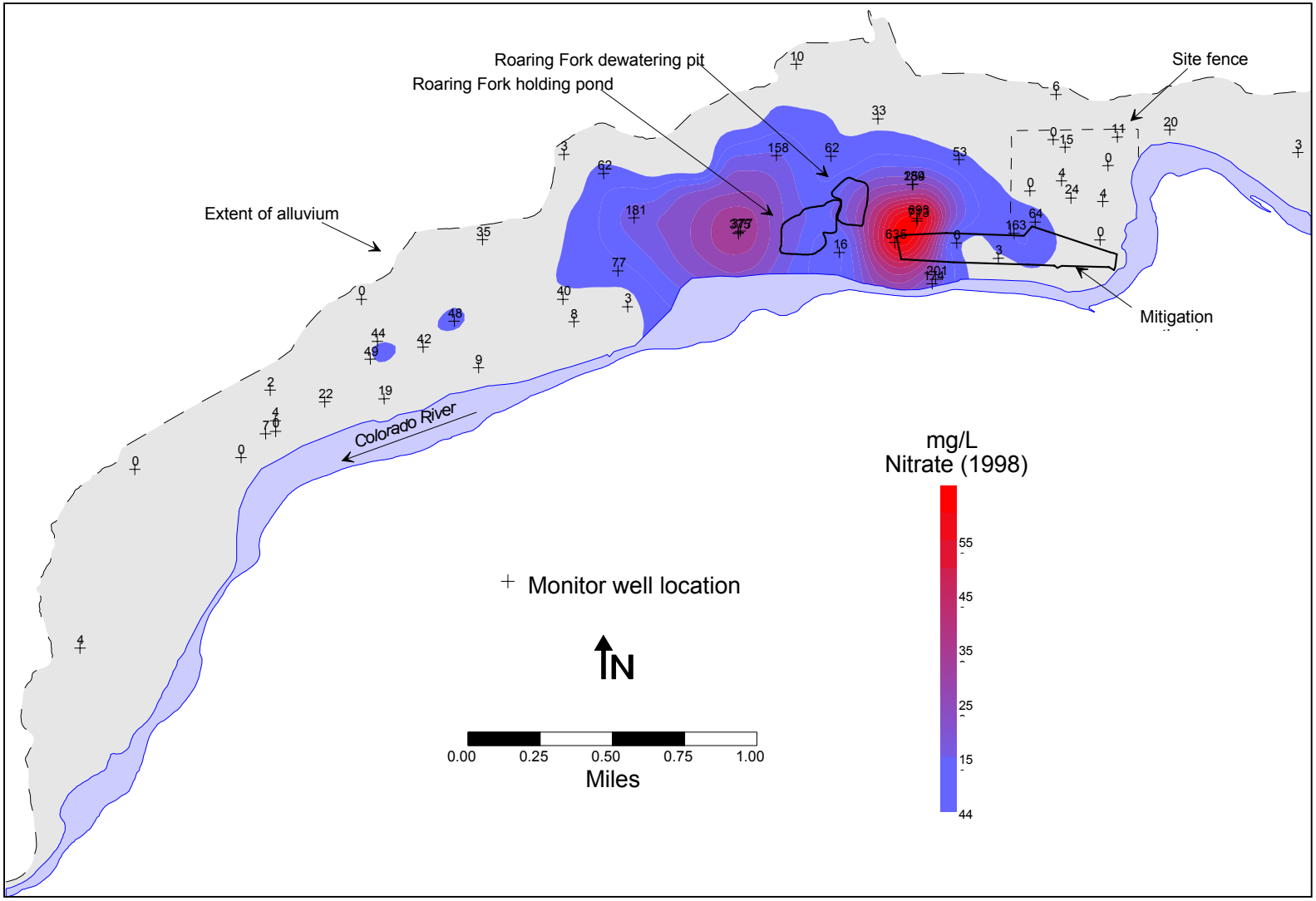


Figure 17. Nitrate Distribution in Alluvial Ground Water—New Rifle Site, 1998

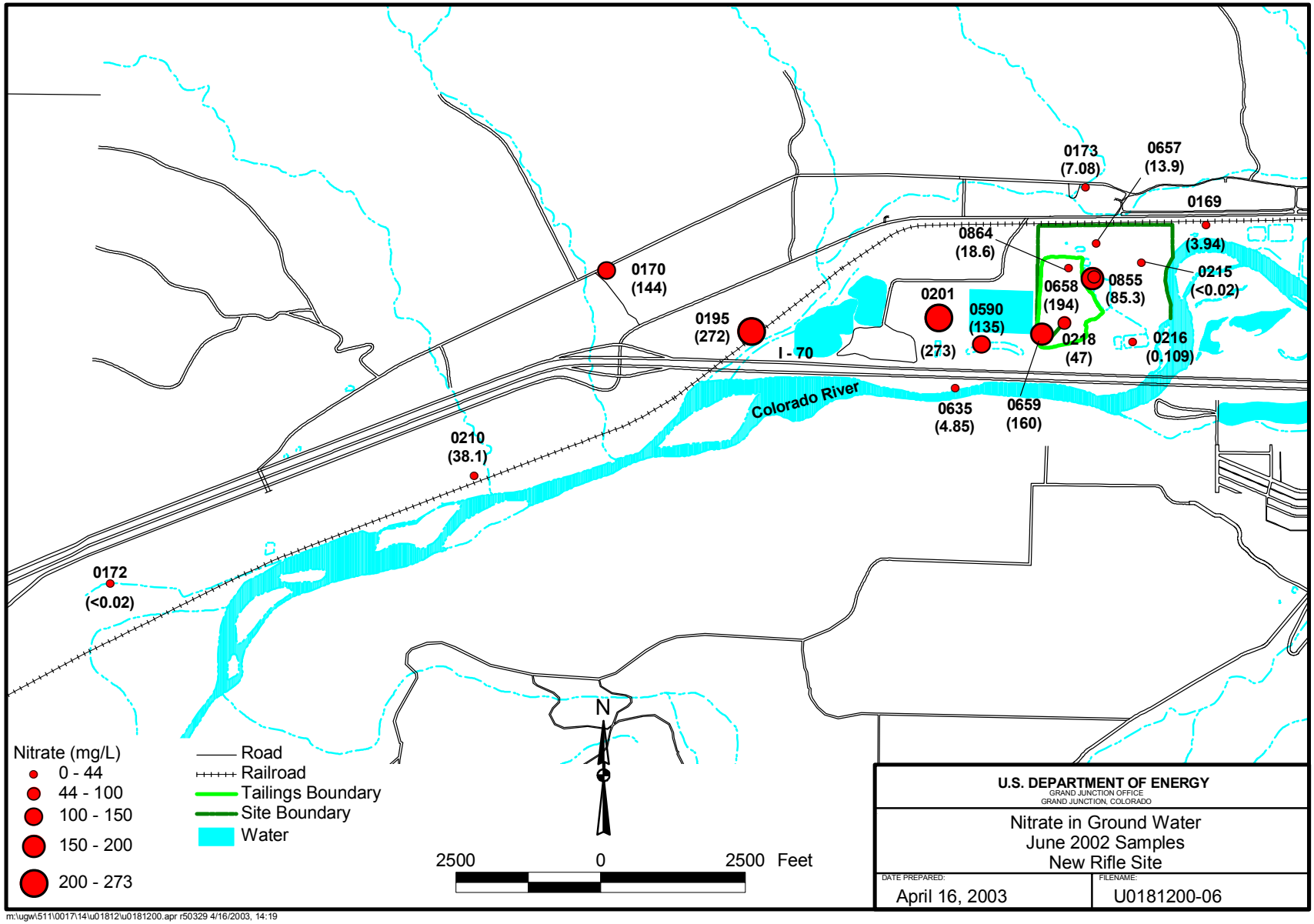


Figure 18. Nitrate Distribution in Alluvial Ground Water—New Rifle Site, 2002

Selenium

Selenium concentrations in August 1998 that exceeded the 0.05 mg/L EPA Safe Drinking Water Act standard are delineated by the colored areas in Figure 19. The area in which concentrations exceed the 40 CFR 192 standard of 0.01 mg/L is larger and includes many background locations; therefore, the area exceeding the 0.05 mg/L drinking water standard is a better indicator of the extent of site-related contamination. The distribution is similar to that of arsenic, in that elevated concentrations are generally confined to the site. Concentrations exceed the 0.05 mg/L standard at only three on-site locations. The highest 1998 concentration of 0.78 mg/L was detected in well 0658 near the center of the former gypsum-vanadium evaporation pond. The concentration in well 0658 decreased to 0.208 mg/L in 2002 (Figure 20). The concentration in recently installed well 0855 was 0.948 mg/L in June 2002, but had dropped to 0.401 mg/L in December 2002.

Selenium tends to sorb to and desorb from clays, organic debris, and ferric oxyhydroxides in a geochemical process similar to that of vanadium (EPRI 1984). It is likely that disturbing the ground water system tends to mobilize selenium, but concentrations in the aqueous phase are readily resorbed, and dissolved selenium concentration decreases in a relatively short period. This decrease is shown in Table 4. Mean selenium concentrations increased from 0.06 mg/L prior to surface remedial action to 0.09 mg/L in the 1998–1999 period after surface cleanup, and have since decreased to 0.08 mg/L in 2002. The 2002 mean value is still higher than the pre-remedial action value, but concentrations continue to decline. Elevated concentrations of selenium are confined to the former millsite.

Uranium

Figure 21 shows the uranium plume in August 1998. The colored areas on the figure define the boundary where concentrations exceed the 40 CFR 192 ground water standard of 0.044 mg/L. Uranium dispersion is similar to the nitrate dispersion with respect to contamination that has migrated a significant distance off site and the fact that the Roaring Fork gravel ponds separate two distinct plumes. The highest uranium concentration of 0.40 mg/L in well 0655 is in the east plume near the northern boundary of the former tailings area. The plume extends west-southwest slightly beyond the Roaring Fork dewatering pond. As with nitrate, the increased ground water flow velocities created by dewatering at the Roaring Fork gravel pond have enhanced the natural flushing of uranium. Similarly, radial dispersion of uranium in the west plume around the downgradient holding pond reflects the increase in ground water velocities at the time created by the ground water mound, which reduced uranium concentrations through dilution and dispersion. Uranium in well 0655 decreased to 0.13 mg/L by 2002, but higher concentrations, up to 0.31 mg/L, were detected slightly downgradient in well 0658 (Figure 22). Table 4 shows that, in general, the mean uranium concentrations across the site have decreased by about 70 percent since surface remedial action.

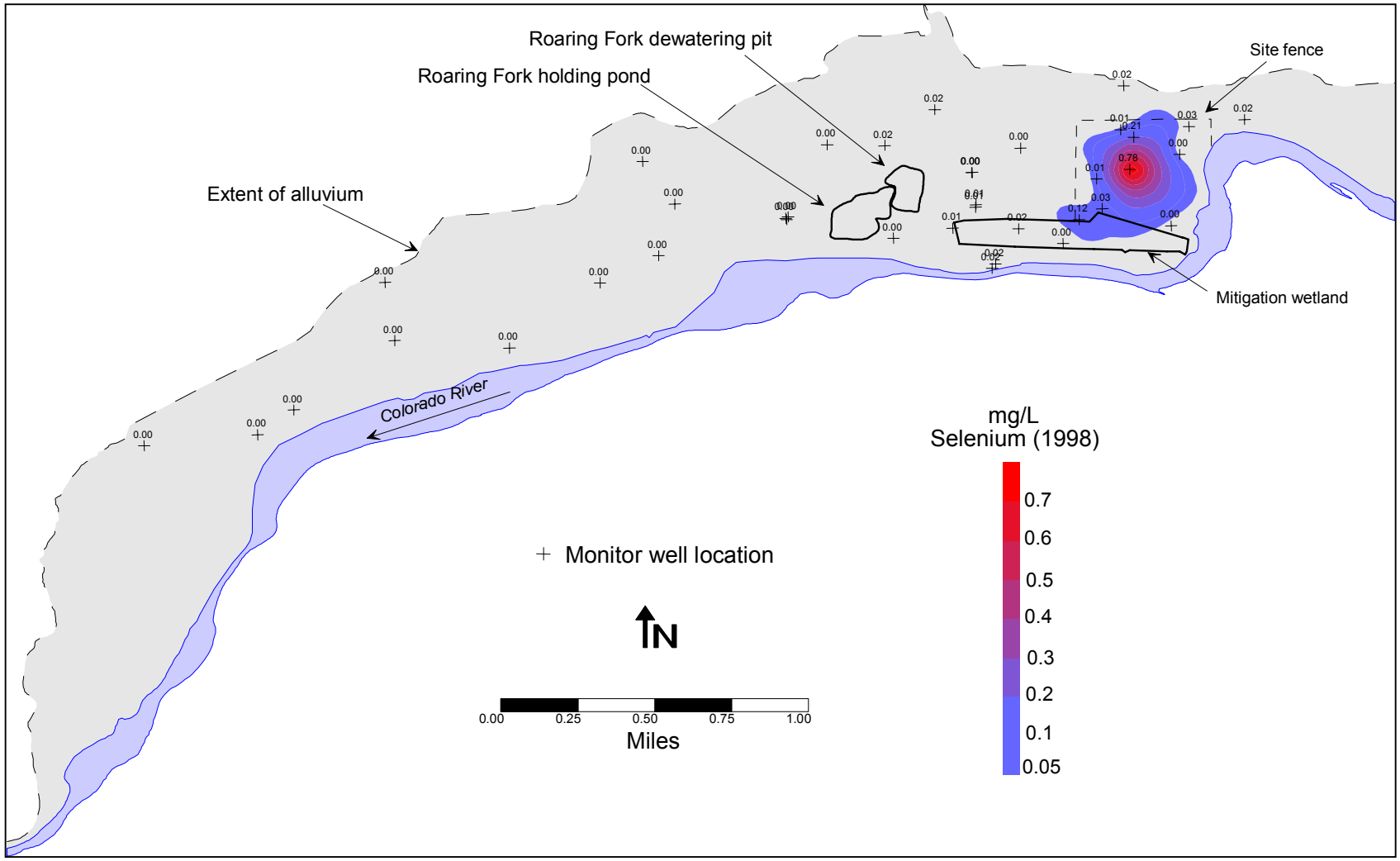


Figure 19. Selenium Distribution in Alluvial Ground Water—New Rifle Site, 1998

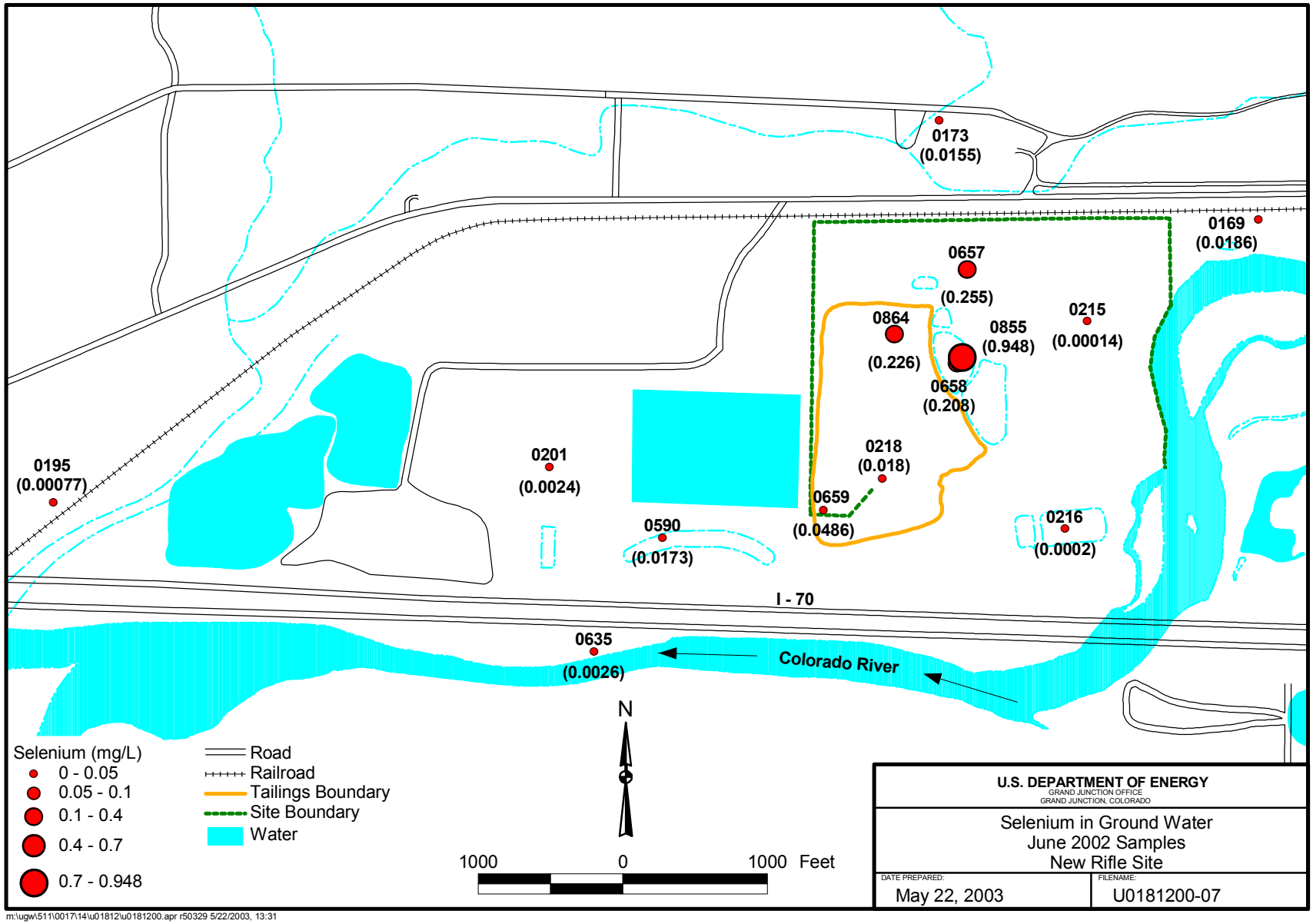


Figure 20. Selenium Distribution in Alluvial Ground Water—New Rifle Site, 2002

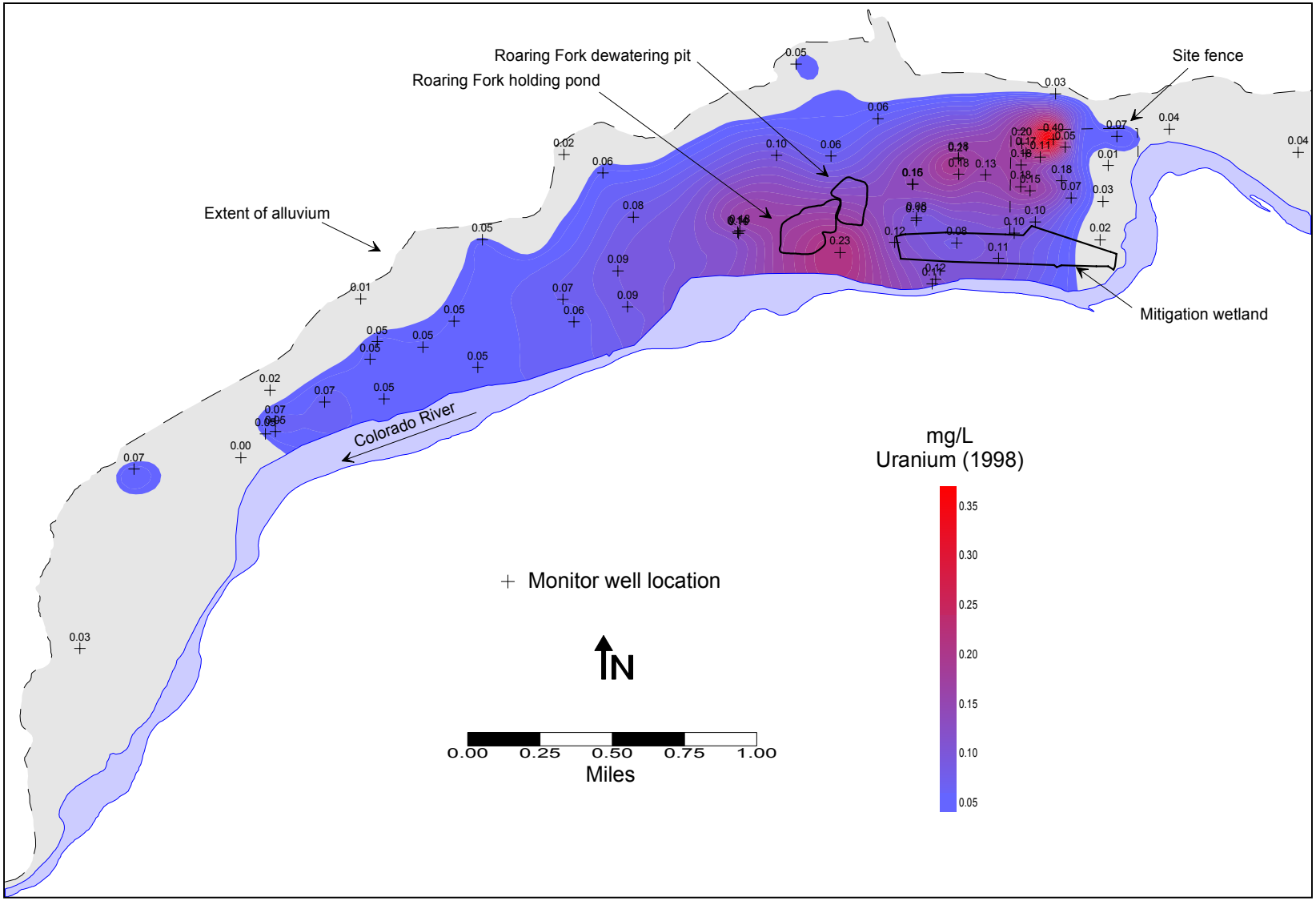


Figure 21. Uranium Distribution in Alluvial Ground Water—New Rifle Site, 1998

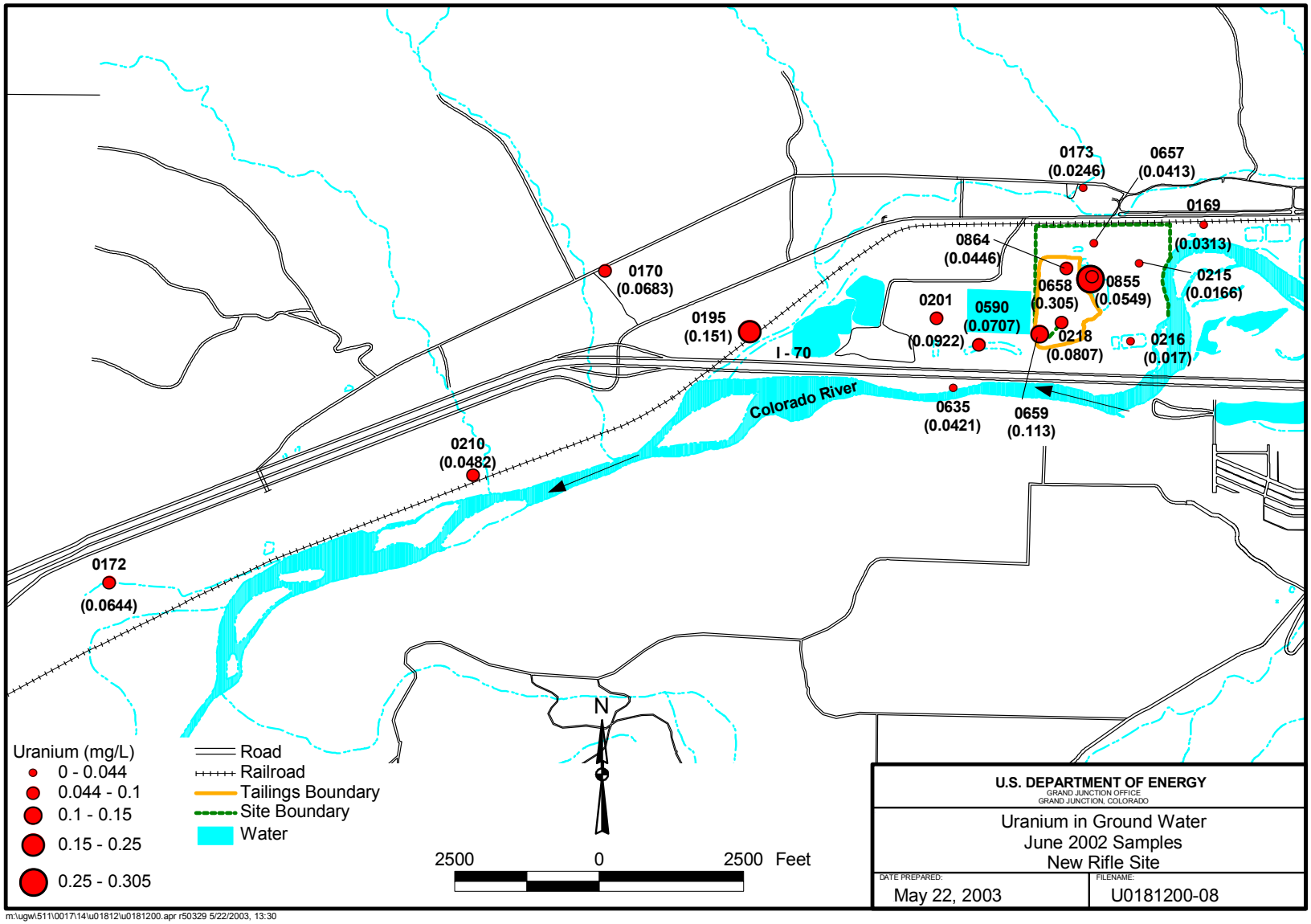


Figure 22. Uranium Distribution in Alluvial Ground Water—New Rifle Site, 2002

Vanadium

Figure 23 shows the distribution of vanadium in alluvial ground water where concentrations exceed the human health risk-based level of 0.33 mg/L for drinking water (EPA 2003). The distribution of the plume is similar to that of arsenic and selenium; the elevated concentrations are primarily confined to the site. The maximum vanadium concentration for 1998 was 25.3 mg/L from well 0658 located near the former gypsum-vanadium evaporation pond. This is also the same monitor well where the maximum arsenic and selenium concentrations were detected. Vanadium concentrations in well 0658 decreased to 8.05 mg/L by 2002 and continue to decrease. Currently, the highest concentration of vanadium in the plume area is 16.4 mg/L, in recently drilled well 0855 (Figure 24). This concentration is expected to decrease as the ground water system re-establishes equilibrium. Table 4 shows a threefold increase in vanadium concentrations in ground water after initial surface remediation but a 42 percent decrease since 1998–1999. This decreasing trend continues in the ground water system.

DOE performed additional studies and data evaluation on vanadium since the ground water site characterization work to understand its geochemical behavior (DOE 2000a, DOE 2002, 2003a). Vanadium sorbs to subsurface materials to a greater degree than most ground water contaminants (EPRI 1984). The subsurface materials that act as sorbents include iron and manganese oxides, clays, and native 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 or change in pH, may accelerate the vanadium uptake to or release from various sorbents in the alluvial material. Evidence strongly suggests that disturbing the subsurface down into the water table tends to release vanadium from sorbed sites and increases concentrations in the ground water. Studies of dissolved metals in a ground water environment suggest that the longer a metal is in contact with subsurface soils and other natural materials, the more it will tend to stay in place, a process called irreversible sorption (Brady, Brady, and Borns 1998). Therefore, the longer vanadium is undisturbed, the less likely it will be to dissolve or desorb into the ground water.

Analytical chemistry data show that, although vanadium may still be sorbed to the substrate, the amount of dissolved vanadium is decreasing at a rate that will allow it to be naturally flushed within 100 years if the ground water system is not greatly disturbed.

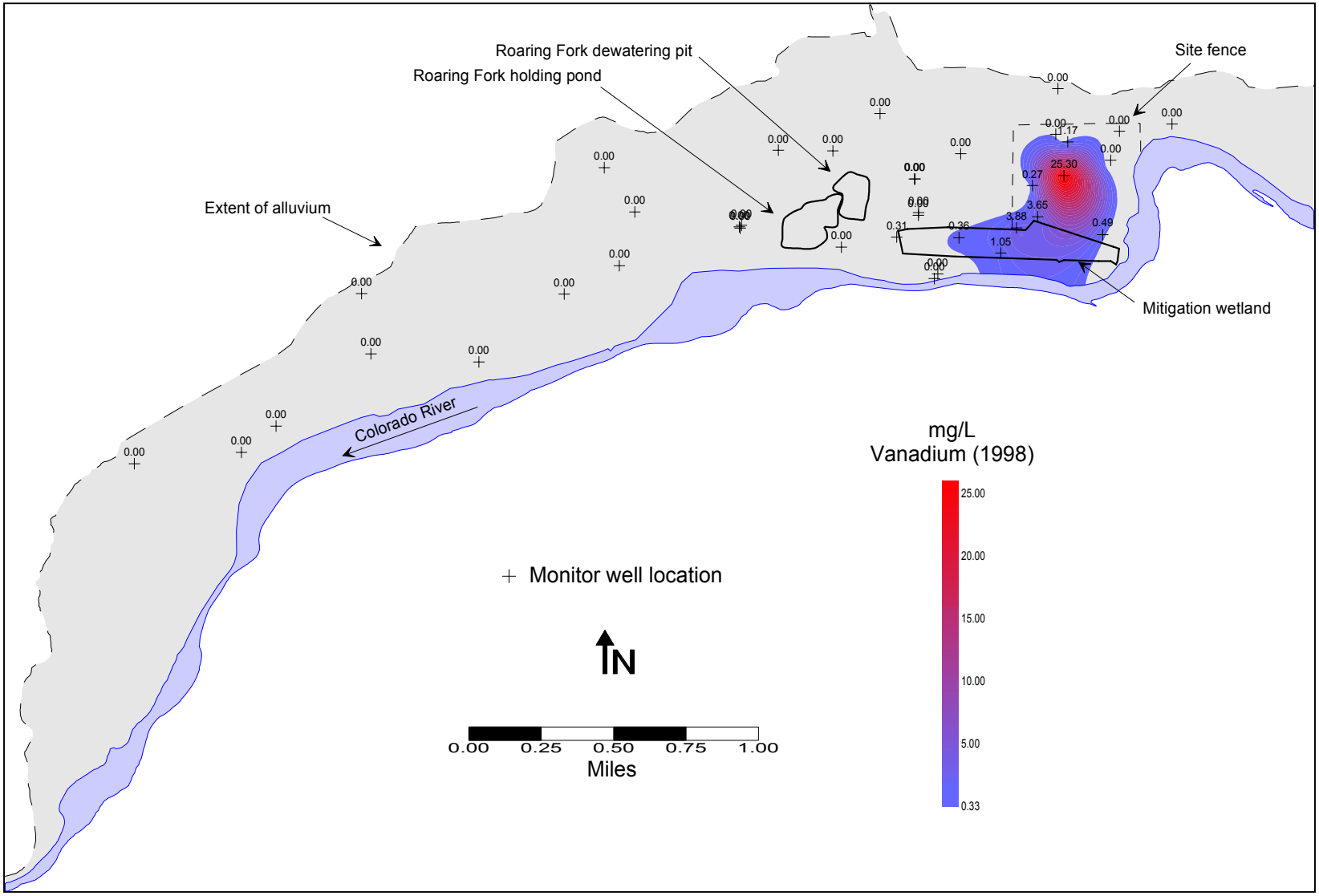


Figure 23. Vanadium Distribution in Alluvial Ground Water—New Rifle Site, 1998

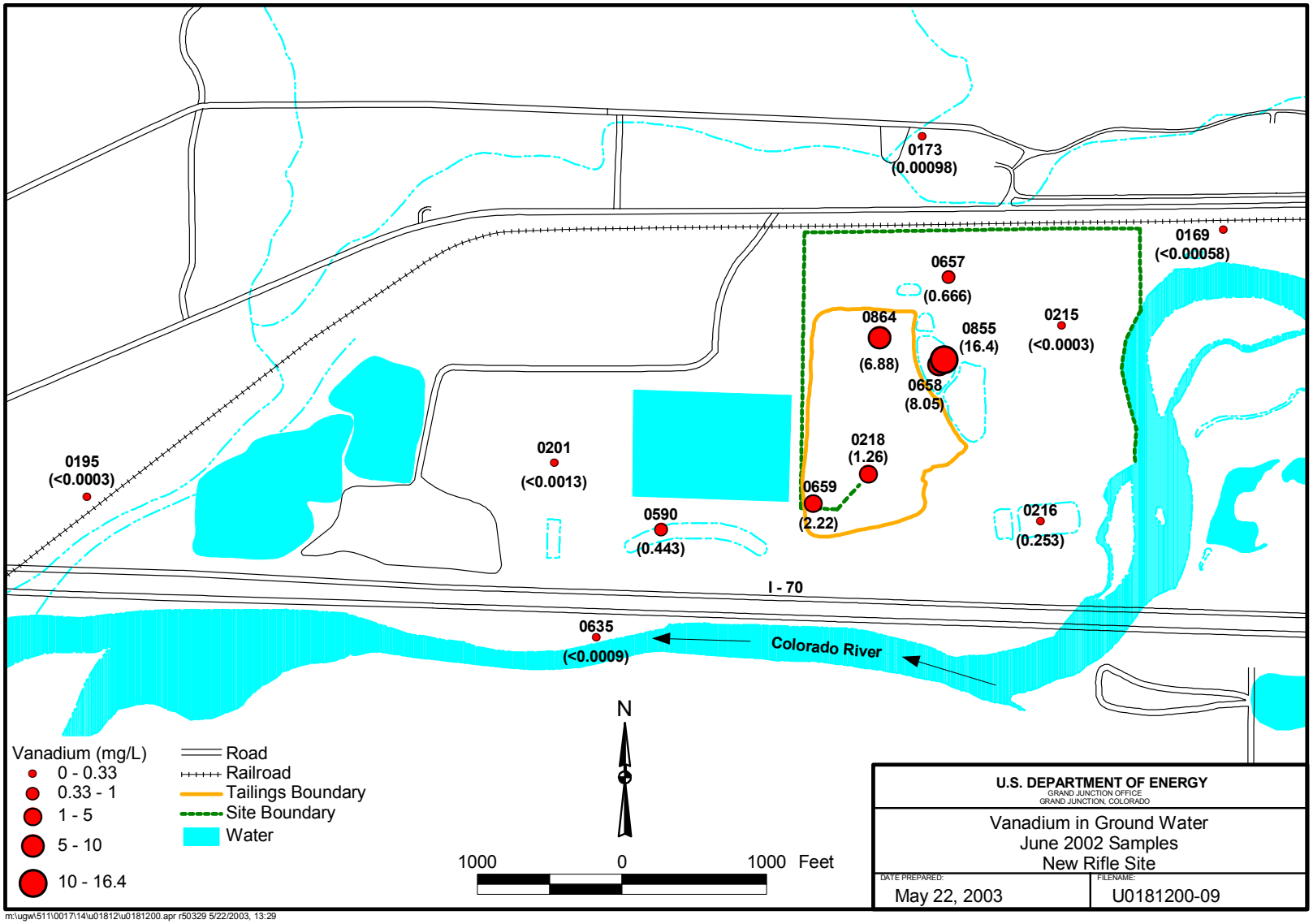


Figure 24. Vanadium Distribution in Alluvial Ground Water—New Rifle Site, 2002

Fluoride and Manganese

Fluoride and manganese were retained as COCs because they exceeded either a secondary standard or background value and are probably milling related. The Safe Drinking Water Act maximum contaminant level of 4.0 mg/L was adopted for fluoride, and for manganese 4.0 mg/L was chosen from maximum background concentrations. Figures 25 and 26 show the June 2002 values for these COCs. Fluoride concentrations exceed the 4.0 mg/L standard at two locations: well 0855 (4.22 mg/L) and well 0635 (5.87 mg/L). Concentrations in well 0855 show a decreasing trend, and those in well 0635 are variable, suggesting that the main plume may be reaching this location near the Colorado River. Manganese levels exceed 4.0 mg/L at well 0590 (7.59 mg/L) and well 0201 (4.96 mg/L). Well 0590 has been in existence since 1983 and has been sampled regularly. Concentrations of manganese decreased from a high of 20 mg/L in 1983 to 6.3 mg/L in 1995 prior to surface remedial action. Since that time, concentrations have ranged from 7.1 mg/L to 8.9 mg/L and have not shown a trend. Levels in well 0201 increased from 3.85 mg/L in August 1998, when it began to be sampled, to a maximum of 6.45 mg/L in June 2000 and have since been decreasing to the June 2002 value of 4.96 mg/L. These locations are 1,000 ft or more downgradient from the probable source area, suggesting the plume has moved to this location and continues to move in a southwest direction toward the Colorado River.

Background Ground Water Quality

Regional background water quality of the surficial aquifer in the Rifle area is naturally variable and generally poor (Wright Water Engineers 1979). A broad evaluation of the regional ground water in the Rifle area indicates that naturally occurring concentrations of several chemical constituents, including arsenic, molybdenum, selenium, and uranium, exceed 40 CFR 192 standards (DOE 1996c).

Local ground water quality beneath the site before milling operations is inferred by characterizing the water quality in areas upgradient of the site that are unaffected by process contamination but are located in the same flow system that influences the New Rifle site. Previous work has shown that alluvial water quality from the south side of the Colorado River is significantly different and of substantially higher quality than that on the north side (DOE 1996c). Ground water south of the river receives water from the recharge area that drains basalt mesas. Surface water on the north side of the Colorado River drains across larger expanses of rocks from the Green River and Wasatch Formations that contain greater concentrations of soluble minerals than the basalts on the south side of the river. Therefore, only wells located north of the river were used to characterize background water quality for the site.

Background alluvial water quality results for the May 1998, August 1998, and January 1999 sampling are summarized in Table 5-7 of the SOWP (DOE 1999). The results can be used as a basis for comparison against potential ground water contamination at the site.

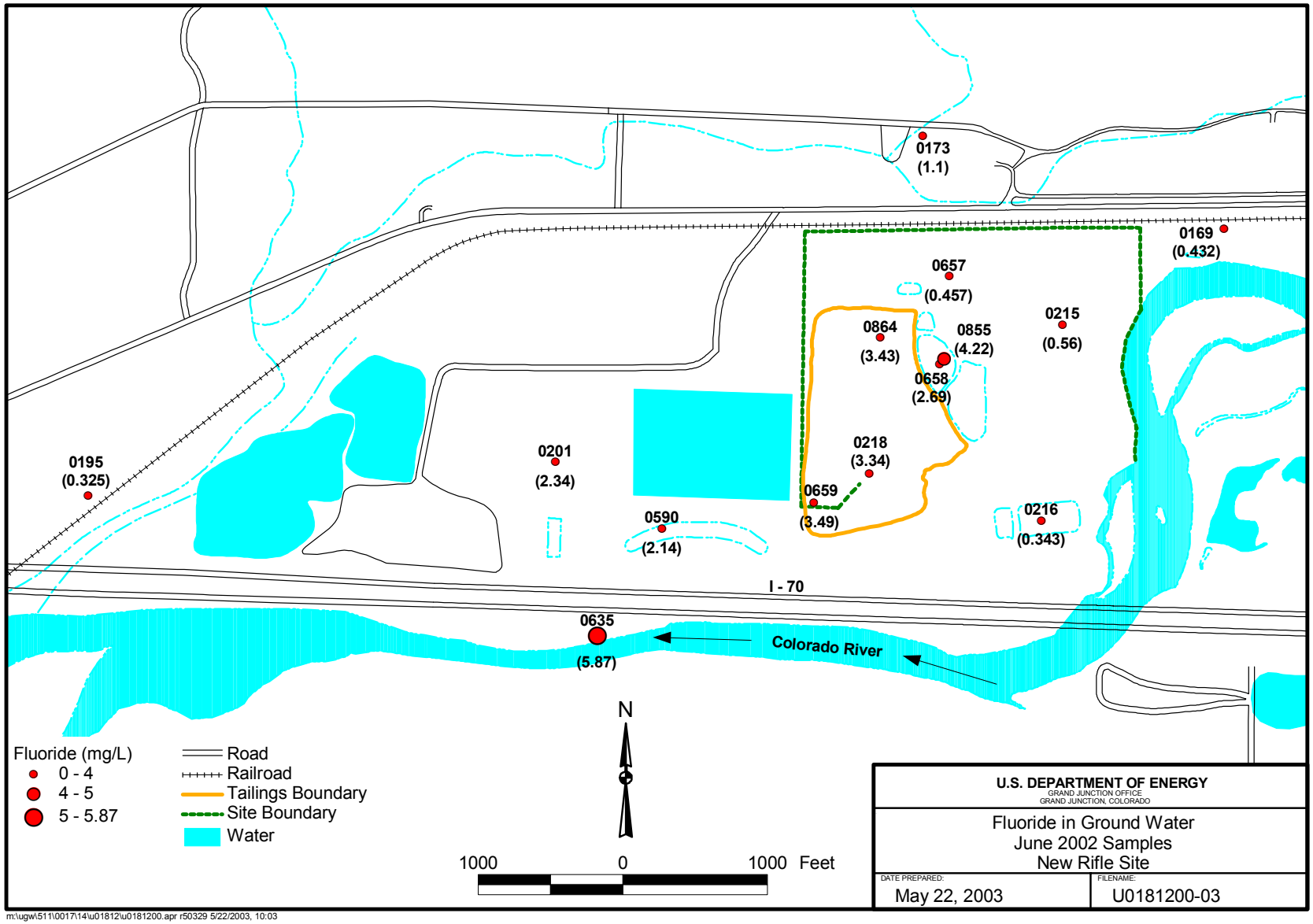


Figure 25. Fluoride Distribution in Alluvial Ground Water—New Rifle Site, 2002

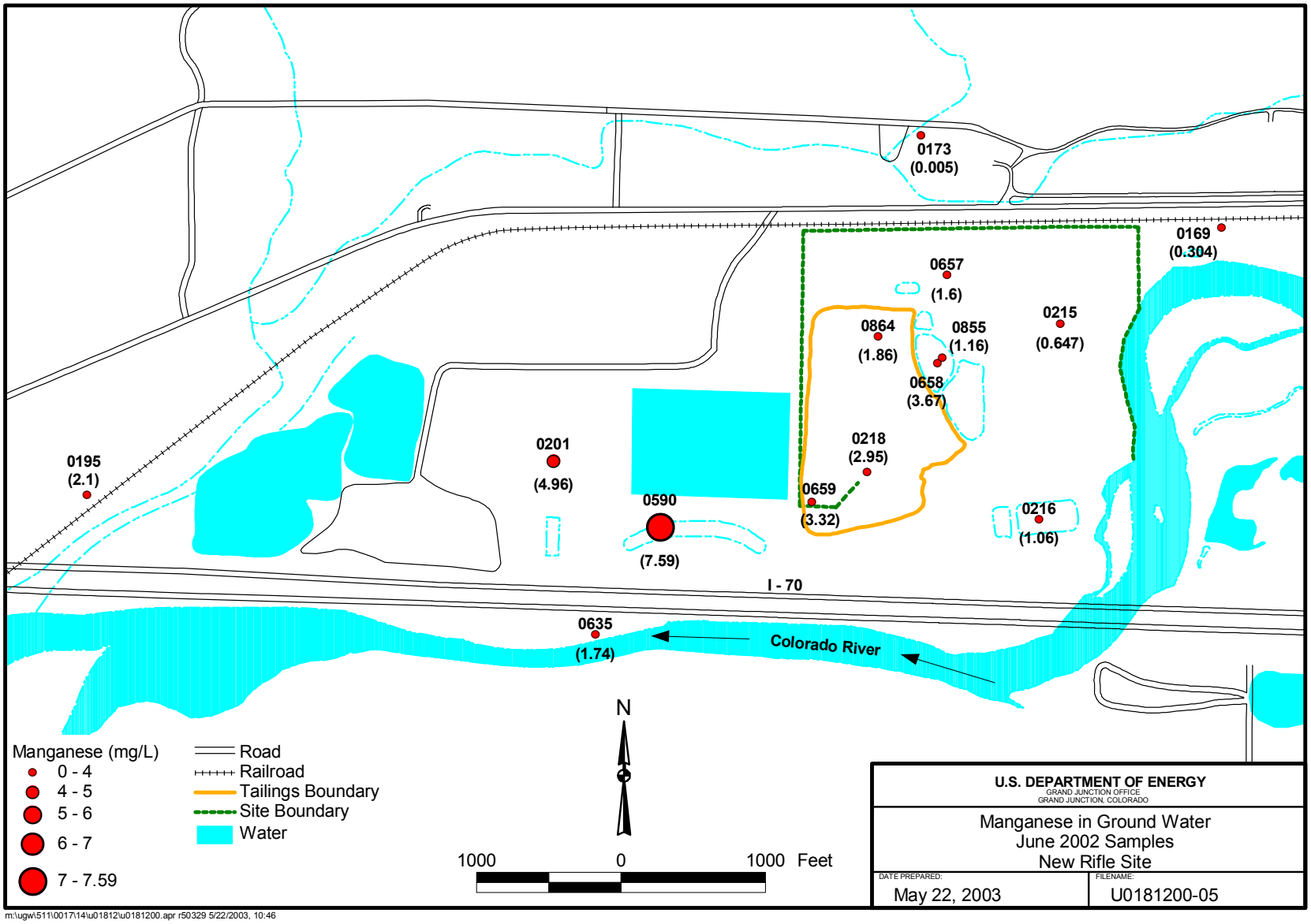


Figure 26. Manganese Distribution in Alluvial Ground Water—New Rifle Site, 2002

Sampling results confirm that alluvial ground water in the Rifle area is generally poor. Maximum detected concentrations of uranium and selenium are higher than the 40 CFR 192 standards of 0.044 and 0.01 mg/L, respectively. Sulfate values from all background samples exceed the secondary drinking water standard of 250 mg/L; manganese concentrations in some samples are higher than the secondary standard of 0.05 mg/L. Although the secondary standards are not enforceable and are not health-based levels, the fact that concentrations exceed the standards is evidence of the poor quality of the ground water. Most of the other trace elements, including arsenic, cadmium, and vanadium, were either at low concentrations or below the analytical detection limits.

Ground Water Use

Residents of Rifle obtain potable water from the municipal water system, which receives surface water from the Colorado River and Beaver Creek. Colorado River water is collected at an inlet approximately 3.5 miles upstream of the site. Beaver Creek water originates from Beaver Mountain snowmelt and precipitation across the river approximately 5 miles southwest of the city and is transported into the municipal water supply by a pipeline. Beaver Creek supplies approximately 10 percent of the city's municipal water.

The City provides potable water to some users outside the city limits, though most residents living outside the municipal boundaries obtain water from private wells or springs (DOE 1996b). Natural ground water quality in the Colorado River alluvium and weathered bedrock is poor and is considered unpalatable because of high concentrations of sulfate and other dissolved solids. Consequently, ground water from these private wells and springs generally is not used for drinking water unless treated. Ground water is used for other domestic purposes such as bathing, watering domestic livestock, and watering gardens. The nearest residential well is approximately 1.5 miles downgradient (west) of the site. That well uses a reverse osmosis system to treat the ground water to an acceptable quality. DOE monitors the effectiveness of the ground water treatment system on an annual basis.

4.2.2 Environmental Consequences

Proposed Action Alternative

Modeling results for arsenic suggest that concentrations could be within the 40 CFR 192 standard of 0.05 mg/L in 20 years of natural flushing. This estimate is consistent with observed decreases in arsenic concentrations to date (Table 4). Monitoring will take place to track the progress of natural flushing.

Molybdenum concentrations are predicted to decrease to levels below the 40 CFR 192 standard of 0.1 mg/L after about 25 years. The background concentration used for the modeling was 0.019 mg/L, and none of the background concentrations exceeded the standard.

Uranium concentrations are predicted to decrease to levels below the 0.044 mg/L standard after about 40 years. However, the calculated background concentration of 0.038 mg/L was used for ground water modeling. Levels of uranium in excess of 0.06 mg/L have been detected in one background well. Therefore, the compliance standard for uranium in site ground water may be either background or the 40 CFR 192 standard. The monitoring strategy is designed to account for variations in background concentrations that may exceed the standard.

Based on modeling results, maximum selenium concentrations are predicted to decrease to 0.05 mg/L, which is the Safe Drinking Water Act maximum contaminant level and proposed alternate concentration limit, in about 100 years. Results of January 1999 sampling indicated that background wells had concentrations of selenium up to nearly twice the 40 CFR 192 standard of 0.01 mg/L.

Nitrate concentrations are predicted to decrease to levels below the 44 mg/L standard after 10 years of natural flushing. Modeling did not take into account the positive effects that geochemical and biological reactions may have on nitrate behavior. Because natural processes such as the oxidation of ammonia to nitrate were not included in modeling, a conservative modeling approach was used to determine that nitrate concentrations will be below the standard well within the 100-year natural flushing period.

Initial vanadium modeling predictions using *A Groundwater Analysis and Network Design Tool* (GANDT) suggested that vanadium could flush within 100 years (Metzler, Marutzky, and Knowlton 1998). Other modeling using a standard modeling package called *G.W. Vistas* indicated it would require about 300 years for vanadium to flush to levels that allow unrestricted use of ground water. However, observed decreases in vanadium over the past 4 years in the vanadium plume area are not consistent with the later modeling predictions and suggest that decreases in dissolved vanadium may be more rapid than the model predicted.

Late in 2002, additional evaluation of vanadium data was performed to understand why vanadium concentrations were dropping faster than modeling had predicted. Twelve wells in the vanadium plume area (0216, 0217, 0218, 0219, 0590, 0657, 0658, 0659, 0664, 0669, 0670, and 0855) having the longest regular sampling history in the former millsite area were selected, and time-concentration graphs were generated. All but two of these plots showed decreases in vanadium. The two that showed increases are downgradient of higher concentrations and might be expected to show increases for a short period of time.

A number of these graphs were extrapolated with a regression curve generated with an analytical solution referred to as *3DADE* (Leij and Bradford 1994). This method accounts for an initial concentration, normal ground water transport of metals, and the affinity of vanadium to partition between solid and dissolved phases. This analysis suggested that dissolved vanadium at most locations will be below the risk-based level of 0.33 mg/L within 50 years and will be below this level at all locations within 100 years. Additional discussion of this approach is presented in *Data Analysis of Vanadium at the New Rifle UMTRA Project Site, Rifle, Colorado* (DOE 2003a).

Modeling was not performed for ammonia, fluoride, and manganese. However, historical trends indicate that concentrations of these constituents are decreasing and are likely to reach background levels or other applicable standards within the 100-year natural flushing time frame.

Monitoring will be conducted to ensure that concentration trends are consistent with this assumption and that acceptable levels can be reached.

There are no expected environmental consequences as a result of the proposed action alternative because there are no current or foreseeable domestic users of the untreated ground water. DOE is providing domestic water sources within the area affected by the contaminated plume. Institutional controls have been established with local governments to restrict access to the contaminated surficial aquifer. Institutional controls eliminate the domestic-use pathway and will remain in effect until such restrictions are no longer necessary. Monitoring of all COCs will continue according to the schedule in Table 3. Analytical information from this monitoring will be used to verify that concentrations are decreasing as predicted.

No Action Alternative

Under the no action alternative, ground water quality would change as the contaminant plume migrates within the aquifer. Generally, contaminant concentrations will decrease, though the centers of the plumes will shift as the plumes migrate downgradient. All contamination will eventually flush to the river, and all COCs are expected to flush within 100 years. If no action is taken, institutional controls would not be in place, and private wells could be installed in contaminated portions of the surficial aquifer for domestic purposes. No monitoring or reporting of data would take place to evaluate ground water quality.

4.3 Surface Water

4.3.1 Affected Environment

Surface water features at and near the New Rifle site include the Colorado River, the former Roaring Fork gravel ponds, the wetland, an intermittent pond (McCauley borrow pit), the Pioneer irrigation ditch, intermittent tributary streams, and the city of Rifle wastewater treatment ponds.

The Colorado River, the dominant surface water feature, forms the southern boundary of the New Rifle site and ultimately receives most of the surface drainage from the site. Precipitation falling on the site drains south directly into the river and into the wetland south of the site. The river also receives ground water discharge from the surficial aquifer along the southern portion of the site.

Daily averages of river-gauging measurements obtained for the Colorado River are available from the U.S. Geological Survey (Figure 27). The nearest flow data are collected approximately 20 miles upstream at a location near Glenwood Springs, Colorado, and approximately 25 miles downstream at a location near the town of DeBeque, Colorado. The daily average flow rate, measured over the 20-year period from 1978 through 1997, is approximately 11 percent higher at the downstream DeBeque gauging station than at the upstream Glenwood Springs gauging station (4,060 versus 3,660 cubic feet per second [cfs]). Rifle is located about halfway between these two stations; therefore, the average flow between the upstream and downstream gauging stations presented in Figure 27 is considered the best estimate of the river flow at the site. On average, the maximum flow occurs during spring runoff from the middle of May to the first of

July. Minimum flow occurs from October through March. Over the 20-year measurement period the average flow was 3,848 cfs, the maximum was 33,800 cfs, and the minimum was 938 cfs.

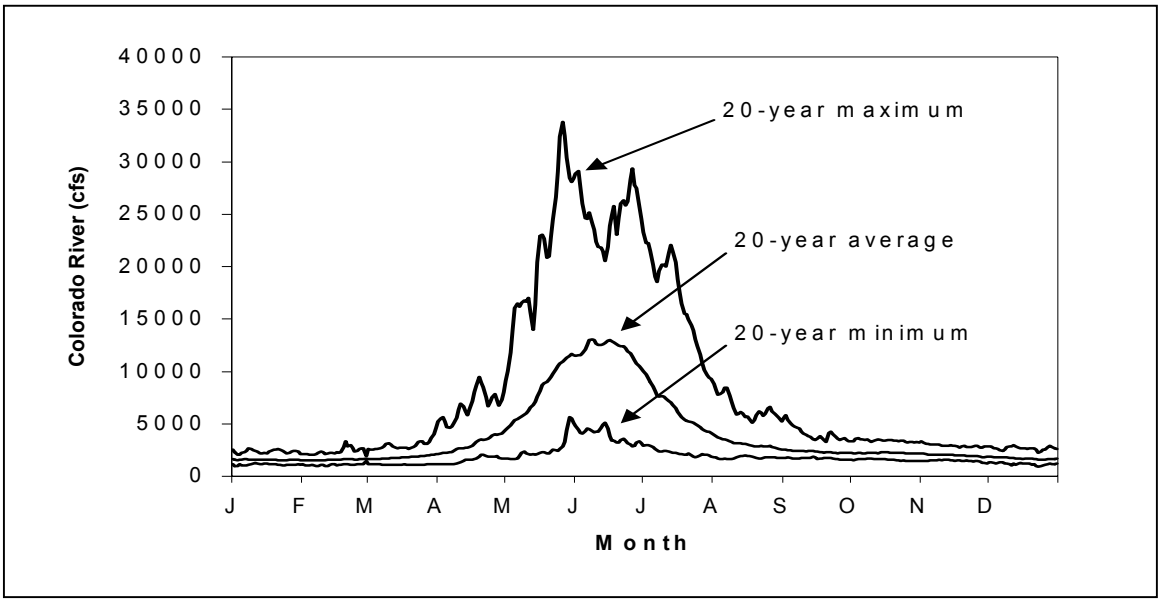


Figure 27. Estimated Seasonal Runoff for the Colorado River at the New Rifle Site

River samples were collected adjacent to and downstream of the site to determine effects on the river, if any, from site contamination. Results from on-site and downgradient samples indicate that water quality is indistinguishable from background water quality measured upriver. These results indicate that site-related contaminants have had no adverse effect on the river. Any contaminants in alluvial ground water that enter the river are quickly diluted to concentrations below detection.

The Roaring Fork gravel ponds are located approximately 0.5 mile west of the New Rifle site and consist of several large pits that have been excavated to bedrock. In the past, ground water infiltrating into the active mining area was diverted to the east pit where it is intermittently pumped into the west pit. Water pumped into the west pit has formed a perennial pond that is subject to evaporation. Operations ceased in 2002 and the site is undergoing reclamation by the lessee. Water levels are equilibrating in all ponds.

Concentrations of uranium, molybdenum, and other constituents listed in Table 5-6 of the SOWP exceed the upper limit of the range in natural background for the surface water samples collected at the Roaring Fork holding pond. Uranium, molybdenum, and nitrate concentrations exceed their respective maximum concentration limits of 0.044, 0.10, and 44 mg/L established in 40 CFR 192, suggesting that discharge from the contaminated alluvial ground water is affecting the Roaring Fork pond water.

At surface location 0575 (Figure 5), molybdenum has shown a steady increase from about 0.15 mg/L in 1991 to 0.85 mg/L in 2002. This is not unexpected, because the molybdenum plume is moving west with ground water flow, and concentrations are expected to begin

decreasing in the next few years. Nitrate at location 0573 shows a similar increasing trend, from about 179 mg/L in 1992 to a maximum concentration of 511 mg/L in 1997, followed by a decreasing trend since that time to 300 mg/L in 2002. The nitrate plume is moving faster than the molybdenum plume. Uranium concentrations were 0.44 mg/L in 1991, but started decreasing in 1996 to about 0.15 mg/L, and were 0.11 mg/L in 2002. They have been decreasing about 10 percent per year for the past 7 years. The uranium plume has traveled farther than others and continues to decrease in the Roaring Fork gravel operation area. This observed decrease demonstrates that the surficial aquifer is flushing naturally, and concentration of COCs will eventually decrease to background levels.

Background Surface Water Quality

Background surface water quality was determined by evaluating analytical results of water samples collected at selected locations upgradient and upriver from the site. Background sample locations were established at two river locations, seven wetland locations at One Mile Pond, and one active gravel-mining pond located near the Colorado River. Figure 5-19 in the SOWP shows the surface water sample locations.

Surface Water Use

Surface water near the site is used primarily for recreation, irrigation, livestock watering, and wildlife habitat. The Rifle area has been heavily irrigated for decades, and both regional and local water quality have been affected. Springs and other shallow water sources have been created by irrigation. Water quality in the irrigation sources varies, and regional contributions vary as a result of changes in annual precipitation and demand. Irrigation in the Rifle area has a significant and variable influence on local ground water flow and water quality.

4.3.2 Environmental Consequences

Proposed Action Alternative

As contaminated ground water flows to the southwest, the surface waters most likely to be affected by the proposed action are the Colorado River to the south, the wetland area to the west, and the former gravel pit operation to the west. However, the proposed action is not expected to adversely affect surface water quality. Contaminant concentrations should continue to decrease over time by natural flushing. The only uncertainties are related to the wetland area and gravel pit operations west of the site. The wetland area underwent additional reconstruction in 1999, and the gravel pit operation ceased in 2002 and is currently undergoing reclamation by the lessee. Monitoring will be conducted during the natural flushing period to determine if contaminant concentrations alter water quality enough to affect plants and wildlife that may use water in these areas. Plant species currently growing in the wetland have established themselves despite the presence of contaminants in the water. Additional pole planting of willow and cottonwood plants in the wetland area was conducted in spring 2003. Contaminant concentrations, particularly ammonia, in the gravel pit area are not as high as in the wetland area and are not expected to harm plant species. It is expected that plant species, west to southwest of the former millsite, will diversify through time as contaminant concentrations continue to decrease.

No Action Alternative

Surface waters, primarily the Colorado River, would not be adversely affected under the no action alternative. As is the case with the proposed action alternative, concentrations of ground water contaminants that flow into the river or other surface waters will decrease over time, and monitoring has shown that the volume of water flowing in the river naturally dilutes concentrations that reach the river. However, there would be no monitoring, and it would not be possible to track the progress of natural flushing.

4.4 Floodplain/Wetlands

4.4.1 Affected Environment

Contaminated ground water is within the 100-year floodplain. Both light industrial and ranching activities have historically occurred in this area.

A wetland was constructed during surface remedial action (Section 404 Permit No. 190110228 issued by the U.S. Army Corps of Engineers) to replace natural wetlands lost during milling and remedial action activities. The wetland, which consists of about 34 acres along the southern edge of the site north of Interstate 70 and the Colorado River, is designed to intersect the water table in the surficial aquifer during the high-water period of May and June. Evaporation during high river stage causes ground water discharge from the wetland, although this discharge is not likely to measurably alter ground water flow directions in the surficial aquifer. During other periods of the year, the wetland acts as a ground water discharge area through the process of plant transpiration. This discharge is also likely to be insignificant.

Vegetation mapping conducted in October 1998 as part of the requirements for the 404 Permit indicates visibly drier conditions at the west end of the wetland. The driest conditions were observed at the northwest end where the ground surface was raised by fill material during the original construction, creating a drier habitat than that specified in the original design. Kochia, an upland weed, has interspersed with a few desirable wetland plants and various other upland weeds and has become dominant in this area. Tamarisk continues to establish itself and has been sprayed and pulled at least once.

Because former dewatering at the Roaring Fork gravel pond lowered the water table, and also because the ground surface at the northwest end of the wetland was topographically higher than the elevation specified in the design, plant species called for in the 404 permit could not become established. Consequently, DOE excavated the west end of the wetland in May 1999 to restore approximately 20 acres of habitat. The excavation lowered the ground surface elevation approximately 2 ft over the western half and created a small permanent pond and an intermittent pond. The intermittent pond buffered effects to the wetland plants that resulted from changes in the ground water elevation when the Roaring Fork gravel operation ceased pumping, thus allowing natural ground water gradients to recover. Details of the reconstruction design are included in the *2000 Section 404 Monitoring Report, New Rifle Wetland* (DOE 2000b).

4.4.2 Environmental Consequences

Proposed Action Alternative

Water quality results from samples collected at the eastern end of the wetland are within the range of natural background concentrations in the reference wetland samples collected upgradient at One Mile Pond. Because contamination movement is to the southwest, the proposed action is unlikely to affect the east end of the wetland.

No surface water was present at the west end when the wetland was sampled in February 1998 and January 1999. Ground water in wells near the wetland has elevated concentrations of several COCs, particularly ammonia and nitrate. A study conducted in 1999 (BRI 1999) indicates that high ammonia levels may limit the types of vegetation that can grow on the wetland. Aquatic life also may be affected. However, as natural flushing progresses, plant species should diversify, and the wetland should become a more viable habitat. Cessation of gravel mining in 2002 and reclamation of the western pond/pit required pumping of water from this pit into the eastern pit. As the eastern pit filled, water levels increased in the adjoining wetland area in the spring of 2003. The effect this may have on flushing is unknown, but reclamation activities will cease in the summer of 2003, and the eastern pit will be allowed to adjust to its natural water level. This also will allow ground water in the wetland area to stabilize in the summer of 2003 and should allow natural flushing to proceed as normal.

No Action Alternative

Effects to the wetland under the no action alternative would be similar to effects from the proposed action with one exception. Under the no action alternative no monitoring would be conducted, and no corrective action would be taken if it were determined that natural flushing was adversely affecting the west end of the wetland.

4.5 Land Use

4.5.1 Affected Environment

The population of Rifle is approximately 6,000. The city contains businesses, industrial areas, and residential neighborhoods. A land-use map for the New Rifle site and surrounding areas is presented in Figure 28. The site is located just west of and outside the Rifle city limits and is under the jurisdiction of Garfield County, which currently zones the site and surrounding area for agricultural/industrial use.

Several light industrial facilities or commercial operations, accessible from U.S. Highway 6, are present within 0.25 mile north of the site and include a machine shop, an insulation supply business, and a salvage yard. A bulk oil and gasoline supplier is located at 69 County Road 24 to the northeast.

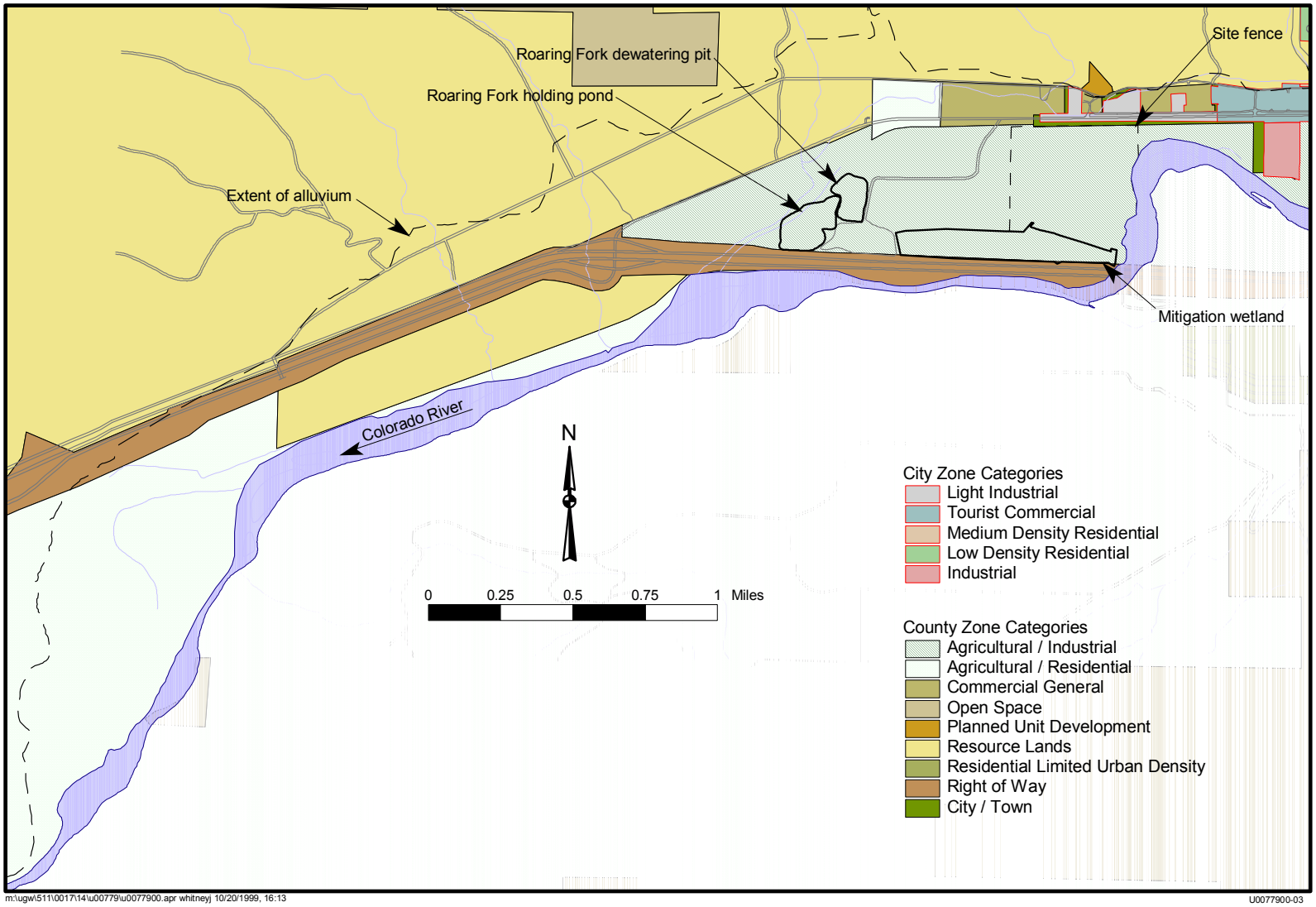


Figure 28. Land Use at the New Rifle Site and Surrounding Areas

Several sand and gravel mining operations are located along the Colorado River west and east of the site. Roaring Fork Aggregate extracted gravel until 2002 from property leased from UMETCO approximately 0.50 mile west of the site. The city of Rifle operates a series of wastewater sewage lagoons just east of the site.

No residences are adjacent to the site. The nearest residence is approximately 0.25 mile north (upgradient) of the site fence across U.S. Highway 6. Several parcels of private land used for industry and agriculture are located southwest of the site within the area of ground water contamination.

The city of Rifle's future comprehensive growth plan identifies zoning for the land within the New Rifle site boundaries as "Commercial/Service Cluster." This designation would allow for development of a western park, county fairgrounds, year-round recreation, educational facilities, agricultural facilities, a park trail to the visitor center and downtown, and possibly a wetland/recreation/wildlife enhancement use in the future if the city annexes the property. The site is currently owned by the State of Colorado. Plans to transfer the land to the City of Rifle are in progress.

4.5.2 Environmental Consequences

Proposed Action Alternative

The proposed action would not alter existing land use. Although city, county, and state restrictions would prohibit the installation of untreated wells for domestic purposes, adequate water supply for future residential or industrial development is available by treating contaminated ground water or by the extension to the existing municipal water line.

No Action Alternative

Institutional controls would not be implemented under the no action alternative. However, due to the level of public and local government knowledge concerning ground water contamination, the effects of the no action alternative would be similar to those of the proposed action. Because the quality of alluvial ground water in the area is naturally poor, untreated water is generally not used for drinking.

4.6 Human Health

4.6.1 Affected Environment

Contaminated ground water associated with the New Rifle site does not currently pose a health risk to humans because untreated water is not used as drinking water. COCs for human health are based on ingestion of contaminated alluvial ground water in a residential setting.

4.6.2 Environmental Consequences

Proposed Action Alternative

Under the proposed action alternative, human exposure to contaminated ground water would be restricted until contaminants in the surficial aquifer have flushed to acceptable levels. Institutional controls in the form of zone district changes have been implemented to prevent improper use of contaminated ground water. Deed restrictions will be implemented at the site upon transferal of land from the State of Colorado to the city of Rifle.

No Action Alternative

Potential risks to human health would be increased under the no action alternative. Because no formal administrative controls would exist to prevent use of contaminated ground water for drinking water, domestic wells could be installed in the area. The Baseline Risk Assessment update in the SOWP (DOE 1999) found that the greatest risks associated with ingestion of ground water at the New Rifle site would be from molybdenum and vanadium. In addition, arsenic, fluoride, manganese, nitrate, selenium, and uranium would remain above acceptable levels and could result in risks to human health.

4.7 Ecological Resources

A comprehensive discussion of ecological risks at the New Rifle site is provided in Section 6.2 of the SOWP (DOE 1999). The following information is drawn from that document. The ecological constituents of potential concern are ammonia, cadmium, fluoride, nitrate, sulfate, and uranium.

4.7.1 Wildlife

4.7.1.1 Affected Environment

A terrestrial wildlife survey conducted as part of the Baseline Risk Assessment (DOE 1996b) identified several species of birds and mammals at the site. Evidence of cottontail rabbits, mule deer, and muskrat were found at the site. Wildlife surveys were not conducted at the wetland. However, wildlife expected to inhabit this area was determined from pertinent literature and from observing wildlife species that inhabited the former New Rifle ditch wetland. Amphibians and reptiles may include the Woodhouse toad, northern leopard frog, racer snake, corn snake, bull snake, and western terrestrial garter snake. Fifty-one species of breeding birds may occur at or near the wetland (Table 5). Small mammals such as voles and mice and larger mammals such as rabbits, hares, raccoons, and mule deer are also expected to occasionally use the wetland.

Table 5. Bird Species That May Use the Wetland at the New Rifle Site

Pied-billed greb	Killdeer	American robin
Great blue heron	Common snipe	European starling
Black-crowned night heron	Spotted sandpiper	Yellow warbler
Canada goose	Common nighthawk	Common yellowthroat
Mallard	Belted kingfisher	Yellow-breasted chat
Gadwall	Western kingbird	Green-tailed towhee
Pintail	Say's phoebe	Rufus-sided towhee
Green-winged teal	Willow flycatcher	Savannah sparrow
Blue-winged teal	Olive-sided flycatcher	Chipping sparrow
Cinnamon teal	Barn swallow	Song sparrow
American widgeon	Cliff swallow	Yellow-headed blackbird
Common merganser	Black-billed magpie	Red-winged blackbird
Northern harrier	Common crow	Northern oriole
American kestrel	Dipper	Brewer's blackbird
Virginia rail	Bewick's wren	Black-headed grosbeak
Sora	Northern mockingbird	American goldfinch
American coot	Gray catbird	Lesser goldfinch

4.7.1.2 Environmental Consequences

Proposed Action Alternative

Most surface disturbance of the site ended in 1996 with the conclusion of surface remediation, and little previously existing wildlife habitat has been re-established. Nearby U.S. Highway 6 and Interstate 70 are sources of noise at the site. Over the long term, population abundance in this area and distribution and density of wildlife species would not be noticeably affected.

The wetland at the site is not currently a significant habitat. The 1998 update to the ecological risk assessment presented in Section 6.2.2 of the SOWP (DOE 1999) indicated that adverse effects are not expected for waterfowl that may use the wetland, though data may be inadequate to evaluate all contaminants fully. No adverse ecological affects have been observed to date, and the proposed action is expected to improve existing conditions. Samples collected in the Colorado River indicate that the site has no negative effect on river water quality. Therefore, there would be no negative effects for the razorback sucker or other ecological receptors in the river as a result of the proposed action.

No Action Alternative

Wildlife species at the New Rifle site would not be affected by the no action alternative. Contaminant concentrations in surface water are expected to continue to decrease to acceptable levels through time.

4.7.2 Vegetation

4.7.2.1 Affected Environment

Current and possible future plant ecology at the New Rifle site was investigated to evaluate ecological risks associated with site-related contaminated ground water and also to determine the relative importance of on-site evapotranspiration as a component of the site water balance.

A field study of the millsite area identified seven vegetation types (Table 6). Three are upland plant communities; the other four are wetland plant communities. The tall wheatgrass type covers most of the New Rifle site and is composed of mostly tall wheatgrass, kochia, and cheatgrass. The cattail/shrub wetland type is on the east end of the wetland, where the dominant plant species are tamarisk, cattails, and willows. This is the wettest area of the wetland, and plant species are more diverse than anywhere else on the site. The foxtail/alkaligrass type covers a large portion of the wetland. These are the two wetland species that were seeded, and they occur together in this area. The foxtail meadow is a small, wet area that is totally dominated by creeping foxtail. The kochia type is a weedy area on the northwest end of the wetland, which is too dry for wetland plants to thrive. Kochia and other weeds dominate the resulting vegetation. The alkaligrass type is an area on the west end of the wetland that was seeded at a later date than the rest of the wetland and is dominated by Fults alkaligrass (*Puccinellia distans*).

In the absence of disturbance, future upland plant communities at the site should trend toward a shrub land dominated by either greasewood (*Sarcobatus vermiculatus*) or rabbitbrush (*Chrysothamnus viscidiflorus*). The future vegetation of the east half of the wetland is a cattail/shrub wetland, including tamarisk and willows. A wet meadow area on the east end of the wetland is dominated by creeping foxtail and Fults alkaligrass. The western half of the wetland was reconstructed in May 1999. The future vegetation of the west end of the wetland is designed to eventually become a combination of shrub wetland, wet meadow, and emergent wetland dominated by bulrushes.

No adverse effects to vegetation at the New Rifle site have been observed to date. The risks that contaminants pose to vegetation at the site pertain more to plant species planned for reconstruction at the west end of the wetland. Results of a 1999 plant uptake study (BRI 1999) indicate that high levels of ammonium will probably limit the types of vegetation that can initially thrive in the wetland. However, as natural flushing continues to decrease contaminant concentrations, the wetland will support a greater variety of plant species. Thus, site-related contaminants probably represent more of a short-term hindrance to wetland reconstruction than a threat to existing plant populations.

Table 6. Vegetation Types at the New Rifle Site

Taxonomic Name	Common Name	Tall Wheat Grass	Cattail/ Shrub	Foxtail/ Alkali-grass	Foxtail Meadow	Kochia	Alkali-grass	Upland
Agropyron elongatum	Tall wheatgrass	4		+		1		3
Alopecuris arundinaceus	Creeping foxtail			3	5	2	1	2
Artemesia tridentata	Sagebrush							+
Bromus inermis	Smooth brome	+		+				+
Bromus tectorum	Cheatgrass	2		+		1		
Centaurea repens	Russian knapweed							+
Convulvulus arvensis	Field bindweed							+
Deschampsia cespitosa	Tufted hairgrass		+					
Descurania pinnata	Tansy mustard	1				+	+	1
Hordeum jubatum	Foxtail barley		1					1
Kochia scoparia	Kochia	2		1	1	3	1	2
Lepidium montanum	Western pepperweed	1						
Lepidium perfoliatum	Clasping pepperweed			+		+		
Melilotus officionale	Yellow sweet clover			+				+
Muhlenbergia asperifolia	Alkali muhly		1		+			
Oenothera sp.	Evening primrose							+
Opuntia polycantha	Prickly pear cactus							+
Oryzopsis hymenoides	Indian ricegrass							1
Populus fremontii	Fremont's cottonwood		1	+				
Puccinellia distans	Fults alkaligrass		+	3	+	2	5	
Salix exigua	Sandbar willow		1					
Salix lasiandra	Whiplash willow		+					
Salix planifolia	Planeleaf willow		+					
Salsola kali	Russian thistle	+						1
Scirpus americanus	Olneys three-square		1					
Sporobolis airoides	Alkali sacaton		+					
Tamarix ramosissima	Salt cedar/tamarisk		4	1			1	
Tragapogon dubius	Western salsify	+				+		+
Trifolium sp.	Clover			+				
Typha latifolia	Cattail		2					
Ulmus pumila	Chinese elm		+					

COVER CLASSES: (+) <1%, (1) 1-5%, (2) 5-25%, (3) 25-50%, (4) 50-75%, (5) 75-100%

4.7.2.2 Environmental Consequences

Proposed Action Alternative

Natural flushing is not expected to affect vegetation currently growing on the site. Further reconstruction activities at the wetland would be designed to accommodate the effects of natural flushing, that is, the initial revegetation would consist of species that are more tolerant of ground water contaminants, especially ammonium. Cottonwood and willow pole plantings in the spring of 2003 should tolerate current ammonia levels. As contaminant concentrations decrease through time, other species less tolerant of contaminants can be introduced into the wetland.

No Action Alternative

Existing plant species at the New Rifle site would not be affected by the no action alternative. Contaminant concentrations in ground water and surface water are expected to continue to decrease through time. Although elevated vanadium concentrations would continue throughout most of the natural flushing period, vanadium is not an ecological COC and is not expected to adversely affect vegetation.

4.8 Environmental Justice Considerations

4.8.1 Affected Environment

Executive Order 12898, *Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations*, states that federal programs and actions shall not disproportionately affect minority or low-income populations.

4.8.2 Environmental Consequences

Proposed Action Alternative

The proposed action would have no adverse effects to ground water, surface water, land or water use, ecological resources, threatened and endangered species, floodplains, air quality, visual resources, transportation, historical and cultural resources, socioeconomics, or wetlands. The natural flushing strategy with institutional controls and continued monitoring would be protective of human health and the environment for its contaminants. The institutional controls boundary is the same for all COCs and therefore affords protection for human. Because the proposed action would have no adverse effects to the human population, no disproportionately high or adverse effects to minority or low-income populations would occur.

No Action Alternative

Potential risks to human health would be increased under the no action alternative. Because no formal administrative controls would exist to prevent use of contaminated ground water for drinking water, domestic wells could be installed in the area. However, the increased risk would be to the general population consuming contaminated ground water. The no action alternative would not disproportionately affect minority or low-income populations.

4.9 Cumulative Effects Assessment

The Council on Environmental Quality defines “cumulative impact” as the “impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency or person undertakes such other actions” (40 CFR 1508.7).

The objective of the proposed action is to protect human health and the environment from ground water contamination resulting from the historical processing of uranium and vanadium ore. There are no past, present, or reasonably foreseeable future actions in the area of influence

that could potentially result in impacts to resource issues addressed in Section 4.0 for the proposed action and the no action alternatives. Consequently, no cumulative issues are present.

5.0 Persons or Agencies Consulted

Wendy Naugle	Colorado Department of Public Health and Environment Division of Hazardous Materials Denver
Jeff Deckler	Colorado Department of Public Health and Environment Division of Hazardous Materials Denver
Mary Brown	Colorado Department of Public Health and Environment Legislative Liaison Denver
Paul Oliver	Colorado Department of Public Health and Environment Grand Junction, Colorado
Steve Pope	Colorado Department of Natural Resources Division of Water Resources Glenwood Springs, Colorado
Pat Hopkins	Planner, city of Rifle Rifle, Colorado
Selby Myers	Manager, city of Rifle Rifle, Colorado
Lee Leavenworth	Attorney for the city of Rifle Glenwood Springs, Colorado
James Neu	Attorney for the city of Rifle Glenwood Springs, Colorado
Ed Green	Administrator, Garfield County Glenwood Springs, Colorado
Mark Bean	Planner, Garfield County Glenwood Springs, Colorado
Tim Sarmo	Colorado Department of Local Affairs Office of Field Services Grand Junction, Colorado

Steve Colby	Colorado Department of Local Affairs Denver, Colorado
Jim Evans	Associated Government of Northwest Colorado Rifle, Colorado
Davis Farrar	Western Slope Consulting (consultant for the City of Rifle) Carbondale, Colorado
Russell George	State Representative Colorado House of Representatives Rifle office: Stuver and George, Rifle, Colorado
Patty Schrader	U.S. Fish and Wildlife Service Grand Junction, Colorado
Rick Krueger	U.S. Fish and Wildlife Service Grand Junction, Colorado.

In addition to these contacts, DOE also participated in the following meetings:

- March 10, 1999—meeting with landowners whose properties would be affected by the proposed institutional controls.
- May 22, 1999—public workshop at the Rifle City Hall to discuss the proposed action at the New Rifle site.
- June 8, 1999—meeting with State Representative Russell George and City and State government organizations to discuss the institutional controls program for the New Rifle site.
- January 26, 2001—meeting at Rifle City Hall to discuss institutional controls.
- July 10, 2001—meeting at Rifle City Hall to discuss the cooperative agreement draft document.
- September 24, 2001—meeting at Garfield County Courthouse to discuss cooperative agreement and institutional controls.
- September 28, 2001—meeting at the Garfield County Courthouse to witness enactment of county resolution and signing of cooperative agreement.
- March 6, 2003—meeting at Rifle City Hall with city of Rifle officials and Garfield County officials to discuss natural flushing compliance strategy for vanadium.
- June 12, 2003—public meeting held at the Rifle City Hall to discuss the *Environmental Assessment of Ground Water Compliance at the New Rifle, Colorado, UMTRA Project Site*.

6.0 References

Bitterroot Restoration, Incorporated (BRI), 1999. *Report to MACTEC-ERS: Phytotoxic Evaluation of Ammoniacal-N Contaminated Groundwater,* Corvallis, Montana, June 15.

Brady, P.V., M. V. Brady, and D. J. Borns, 1998. *Natural Attenuation, CERCLA, RBCA's, and the Future of Environmental Remediation*. Lewis Publishers, New York, New York.

Chenoweth, W.L., 1982. "*The Vanadium-Uranium Deposits of the East Rifle Creek Area, Garfield County, Colorado, Southeastern Piceance Basin, Western Colorado*," W.R. Averett, ed., Grand Junction Geological Society, pp 79–81.

Electric Power Research Institute (EPRI), 1984. *Chemical Attenuation Rates, Coefficients, and Constants in Leachate Migration*, EPRI EA-3356, Volume 1, prepared by Battelle Pacific Northwest Laboratories, Richland, Washington, February.

Fisher, R.P., 1960. *Vanadium-Uranium Deposits of the Rifle Creek Area, Garfield County, Colorado,* U.S. Geological Survey Bulletin 1101, U.S. Government Printing Office, Washington, D.C.

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.

Metzler, D., S. Marutzky, and D. Knowlton, 1998. Implementing the Natural Flushing Strategy: A Case History, in *Uranium Mining and Hydrology II,* Proceedings of the International Conference and Workshop, Freiberg, Germany. Published by GeoCongress, Freiberg Technische Universitat.

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

Shroba, R.S., G.M. Fairer, and M.W. Green, 1995. "Preliminary Geologic Map of the Rifle Quadrangle, Garfield County, Colorado," open-file report 95-52, U.S. Department of the Interior, U.S. Geological Survey, Denver.

Stover, B.K., 1993. *Debris-Flow Origin of High-Level Sloping Surfaces on the Northern Flanks of Battlement Mesa, and Surficial Geology of Parts of the North Mamm Peak, Rifle and Rulison Quadrangles, Garfield County, Colorado,* Bulletin 50, Colorado Geological Survey, Division of Minerals and Geology, Department of Natural Resources, Denver.

U.S. Department of Energy (DOE), 1982. *Summary History of Domestic Uranium Procurement Under U.S. Atomic Energy Commission Contracts,* Final Report, GJBX-220(82), prepared for the U.S. Department of Energy, Assistant Secretary for Nuclear Energy, Grand Junction Area Office, Grand Junction, Colorado.

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.

———, 1993. *Technical Approach to Groundwater Restoration,* Final, DOE/AL/62350-20F, prepared by the U.S. Department of Energy, UMTRA Project Office, Albuquerque Operations Office, Albuquerque, New Mexico, November.

———, 1996a. *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.

———, 1996b. *Baseline Risk Assessment of Ground Water Contamination at the Uranium Mill Tailings Sites Near Rifle, Colorado,* DOE/AL/62350-179, Rev. 2, U.S. Department of Energy, Albuquerque, New Mexico, February.

———, 1996c. *UMTRA Ground Water Project Supplemental Water Sampling and Analysis Plan for All UMTRA Sites,* U.S. Department of Energy, UMTRA Project Office, Albuquerque, New Mexico.

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

———, 2000a. *Draft Work Plan for Vanadium Pilot Study, New Rifle UMTRA Site, Rifle, Colorado*, GWRFL 10.6.4, U.S. Department of Energy Grand Junction Office, Grand Junction, Colorado, July.

———, 2000b. *2000 Section 404 Monitoring Report, New Rifle Wetland,* GJO-2000-170-TAR, MAC-GWRFL 11.10.3, U.S. Department of Energy Grand Junction Office, Grand Junction, Colorado, September.

———, 2000c. *Management Plan for Field-Generated Investigation Derived Waste*, MAC-GWADM-21.1.1, Revision 1, U.S. Department of Energy Grand Junction Office, Grand Junction, Colorado, June.

———, 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-GWRL-10.6.5-1, U.S. Department of Energy Grand Junction Office, Grand Junction, Colorado, April.

———, 2003a. *Data Analysis of Vanadium at the New Rifle UMTRA Project Site, Rifle, Colorado*, U.S. Department of Energy, Grand Junction Office, Grand Junction, Colorado, unpublished report, March.

U.S. Department of Energy, 2003b. *UMTRA Ground Water Project Management Action Process (MAP) Document,* GJO-2002-391-TAC, GWADM 1.1, Rev. 5, U.S. Department of Energy Grand Junction Office, Grand Junction, Colorado, May.

U.S. Environmental Protection Agency (EPA), 1999. *Use of Monitored Natural Attenuation at Superfund, RCRA Correction Action, and Underground Storage Tank Sites*, Office of Solid Waste and Emergency Response 9200.4-17P, April 1999.

———, 2003. "Risk-Based Concentration Table," U.S. EPA Region III, Superfund Technical Support Section, memorandum from Jennifer Hubbard, toxicologist, updated April 2003. The table is available on the Internet at **http://www.epa.gov/reg3hwmd/risk/**.

Wright Water Engineers, 1979. *Garfield County Water Resources,* prepared for the County Commissioners of Garfield County.

Attachment 1

Minutes of the Public Meeting in Rifle, Colorado

Minutes of the Public Meeting held at the City Hall in Rifle, Colorado, June 12, 2003, to discuss the Environmental Assessment of Ground Water Compliance at the New Rifle, Colorado, UMTRA Project Site

Presentation

The Rifle, Colorado, public meeting to support the *Environmental Assessment of Ground Water Compliance at the New Rifle, Colorado, UMTRA Project Site* was conducted at the Rifle City Hall, beginning at 7:00 pm. The session was videotaped by the local PBS affiliate, Channel 13.

In attendance were members of the Rifle City government including the City Manager, Garfield County government including County Commissions, two members of the Colorado Department of Public Health and Environment (CDPHE), and a Nuclear Regulatory Representative on travel from Rockville, Maryland. A head count showed 18 people were present.

Don Metzler presented and discussed slides in support of the compliance strategy of passive remediation by natural flushing of the nine contaminants of concern (COC), ammonia, arsenic, fluoride, manganese, molybdenum, nitrate, selenium, uranium, and vanadium. This strategy will also have institutional controls in the form of a zone overlay by the county and a city ordinance to prevent anyone from drinking the contaminated water. The quitclaim deed eventually transferring the former millsite from the State (CDPHE) to the City of Rifle will also have institutional control language. Mr. Metzler assured the local citizens that DOE or some federal agency will be monitoring the area for the next 100 years, or however long the ground water system requires to flush to acceptable concentrations for the COCs. Regular reports on its progress will be forwarded to the local government. DOE will also be available if something does not work with this compliance strategy.

Mr. Metzler also commended the Rifle and DeBeque high school students for helping with pole planting of the wetlands in April. This was an effort by DOE to help enhance the habitat in the newly established wetland. From observation of the wetland area earlier in the day, the planting looks to be most promising, as many of the pole plants are sprouting leaves.

Several questions were asked from the audience.

Q. Randy Russell - (Garfield County Planner). What is the level that we will not be able to dig beyond – 7 ft. – 8 ft. due to the V contamination?
A. Metzler – Yes, this is something we discussed at the last meeting, but only applies to the millsite proper where V contamination occurs.
Naugle – This will be put into the deed when the former millsite is transferred from the State to the City.
Q. R. Russell – I'm not assuming a deed, but will we need to put a zone overlay on the IC area?
A. Metzler/Jeff Deckler – showing the IC boundary and zone overlay. The deed restrictions will be sufficient for the V contaminated area.

Q. R. Russell/ John Martin – What will these restrictions consist of?
A. J. Deckler – These usually consist of not disturbing the surface without permission, and will have language about not disturbing the V area. All requests will be handled on a case-by-case basis.
Q. R. Russell/ J. Martin – What is the harm of disturbing the ground water with the V? It just causes a spike in the V in the ground water.
A. Metzler – Yes, it will not harm anyone because no one is drinking the water, but it will cause the natural flushing to take longer and we do not want to extend this period.
Q. R. Russell – But couldn't this preclude us from building a large structure that would require a foundation into the bedrock?
A. Metzler – We don't think this will be a serious problem. Let's consider a worse case scenario. Suppose the County or City needs to build grandstands and needs footings into the bedrock and wants to build it in the center of the V plume (showing map on screen). Then, DOE would probably ask you to move the foundation away from the worst part of the plume. I don't see us being any more restrictive than this.
Q. Ed Green – Where is the 400 ft by 400 ft area of the V study where most of the V is located? Is this where the V plume is shown here? How long will it take before disturbing the V plume will not release more V into the ground water from the substrate?
A. Dayvault/Metzler – We don't have a good answer for this. Certainly, the longer the system is undisturbed, the more tightly the metal (V) is attached to the clays, oxides, etc.
A. Metzler – The V plume is approximately where that study area is located.
Q. Joe Clugston – How may reverse osmosis units are now working?
A. Metzler – only one. I just found out last week that the other unit that was supplied to the cement operation was shut off. The Rail Road owns the property and found out that water was being treated, so they abandoned the well on the property. No one ask us about this, but it's their property and they can do what they want.
Q. Metzler – Are there any further questions? If not, I will take this meeting and the responses here tonight to mean that DOE is moving in the right direction and will finalized the EA next month.
Q. R. Russell – Is the surface water in the Roar Fork Gravel operation as contaminated as the ground water?
A. Metzler/Peterson – not quite as bad. Some surface recharge is occurring in that area that helps dilute the ground water. Metzler added that DOE may request that people not swim or fish in that water for the next few years until levels of contamination drop. This is something that will be discussed with CDPHE.

Mr. Metzler asked if there were any other questions. None were asked. He indicated that the public comment period for the EA would extend until June 30. After that time the EA would be finalized and a Finding of No Significant Impact would be generated and submitted to the DOE National Environmental Planning Act (NEPA) officer. The required NEPA phase would be completed. He thanked everyone for attending. The meeting ended about 8:00 pm.

No written comments were received from the audience.

A June 14 article about the public meeting appeared in the *Daily Sentinel* Newspaper with the title "Zoning Will Control Exposures to Tainted Groundwater Near Rifle."