Department of Energy
Office of Legacy Management

April 13, 2006

Gary Janosko, Chief
U.S. Nuclear Regulatory Commission
Fuel Cycle Facilities Branch
Mail Stop T-8A33
Washington, DC 20555-0001

Subject: Ground Water Compliance Action Plan for the Green River, Utah, Site

Dear Mr. Janosko:

Enclosed for your review and comment are four copies of the Preliminary Final *Ground Water Compliance Action Plan* [GCAP] *for the Green River, Utah, (UMTRCA Title I) Disposal Site*. This document incorporates U.S. Department of Energy responses to comments by the State of Utah on the Draft GCAP. Copies of this document were submitted to the Utah Division of Radiation Control for final review and comment on September 8, 2005, and comments have not been received as of this date.

Upon final approval, the GCAP will serve as the concurrence document for compliance with ground water cleanup standards in Subpart B of 40 CFR 192 for the Green River processing site. Because residual radioactive material is stabilized in an on-site disposal cell, the compliance strategy will also be applicable to Subpart A of 40 CFR 192, which prescribes initial disposal cell performance monitoring. The site Environmental Assessment will be finalized to incorporate the approved compliance strategy, and the site Long-Term Surveillance and Maintenance Plan will be revised and submitted to the Commission for concurrence prior to implementation of the strategy.

Please return your comments to me. If you have any questions, please call me at (970) 248-6073.

Sincerely,

Richard P. Bush
Site Manager

Enclosure

cc w/o enclosure:
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File: GRN 402.02 (D. Roberts)

Bush/GRN GCAP.doc

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DOE-LM/GJ950-2005

Preliminary Final

Ground Water Compliance Action Plan for the Green River, Utah, (UMTRCA Title I) Disposal Site

September 2005

U.S. Department of Energy

Office of Legacy Management

Work Performed Under DOE Contract No. DE-AC01-02GJ79491
for the U.S. Department of Energy Office of Legacy Management.
Approved for public release; distribution is unlimited.

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Preliminary Final

Ground Water Compliance Action Plan for the Green River, Utah, (UMTRCA Title I) Disposal Site

September 2005

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

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1.0 Introduction

This Ground Water Compliance Action Plan (GCAP) presents the compliance strategy for ground water cleanup at the Green River, Utah, former uranium processing site (Figure 1) as mandated by the Uranium Mill Tailings Radiation Control Act (UMTRCA). The compliance strategy is based on U.S. Department of Energy (DOE) evaluation of information included in the Site Observational Work Plan (SOWP) (DOE 2002) and ground water quality data to date. This GCAP serves as a stand-alone modification to the Remedial Action Plan (RAP) (DOE 1991) and Modification No. 2 to the RAP (DOE 1998a) to address ground water restoration and compliance with the U.S. Environmental Protection Agency (EPA) ground water protection standards for the UMTRCA Title I processing sites (EPA 1995). The GCAP will be the U.S. Nuclear Regulatory Commission (NRC) concurrence document for compliance with ground water cleanup standards in Subpart B of 40 CFR 192 for the Green River processing site. Because residual radioactive material is stabilized in a disposal cell onsite, the compliance strategy will also be applicable to Subpart A of 40 CFR 192, which prescribes initial disposal cell performance monitoring. The Long-Term Surveillance Plan (LTSP) for the Green River site (DOE 1998b) will be revised to reflect the compliance strategy and monitoring plan for the entire site, and will be submitted to NRC for concurrence prior to implementation of the strategy.

National Environmental Policy Act (NEPA) issues and environmental concerns are addressed in the Environmental Assessment (EA), which will be made available to public officials and stakeholders for their review and comment.

This preliminary final version of the GCAP updates the draft version (June 2003) by addressing comments from the State of Utah Division of Radiation Control received in a letter dated October 7, 2003, and including an appendix containing the application for alternate concentration limits (ACLs). Upon resolution of all issues, the GCAP will be finalized and submitted for regulatory concurrence with the compliance strategy. At that time, the LTSP will be revised accordingly and will be the document of record for implementation of long-term surveillance activities for the entire site.

Section 2.0 of this document provides a summary assessment of environmental data relevant for development of the ground water compliance strategy (see the SOWP for site characterization details—DOE 2002). Section 3.0 discusses development of the ground water compliance strategy and Section 4.0 addresses implementation of the compliance strategy. The application for ACLs for the Green River site, as required by EPA and NRC guidance, is included as Appendix A to this report, and is summarized in Section 3.0.

2.0 Assessment of Environmental Data

2.1 Hydrogeology

Ground water in the vicinity of the Green River site occurs in the Browns Wash alluvium of Quaternary age and in sandstone units of the Cretaceous Cedar Mountain Formation. Hydrogeologic data relevant to selection of a ground water compliance strategy are summarized in this section; additional data are available in Modification No. 2 to the RAP (DOE 1998a) and the SOWP (DOE 2002).

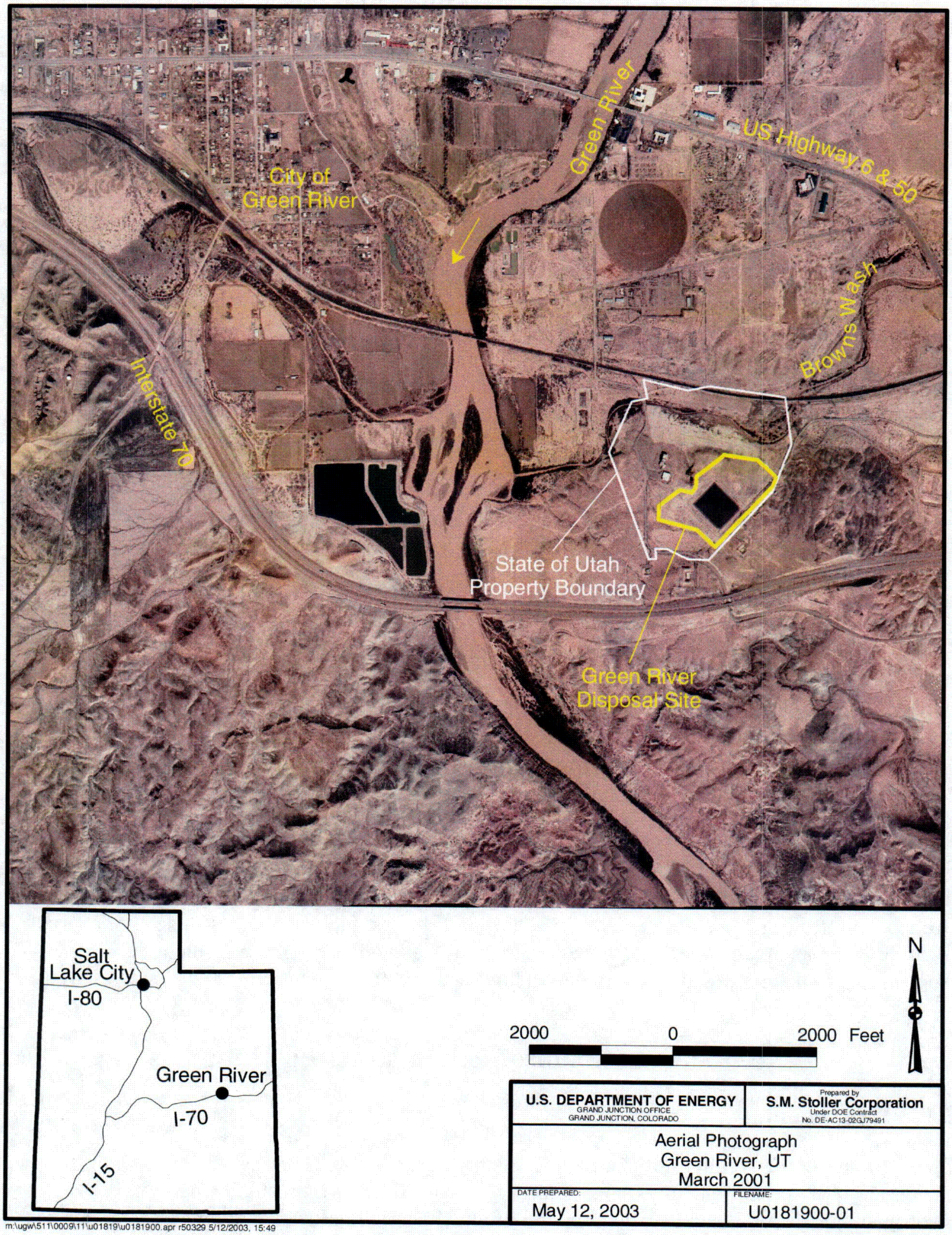

Figure 1. Aerial Photograph of the Green River Area—March 2001

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2.1.1 Browns Wash Alluvium

Browns Wash is an ephemeral stream that is normally dry and flows only during local precipitation events. Ground water occurs in the alluvial system under unconfined conditions and is limited by the lateral extent of the alluvium. Depth to ground water varies from 8 to 17 feet below land surface with limited saturated thickness ranging from 0 to 3 feet. Ground water flow in the alluvium follows the path of Browns Wash toward the Green River. The Browns Wash alluvium grades westward into alluvial deposits of the Green River. Ground water in the Browns Wash alluvium is classified as limited use on the basis of low yield (DOE 2002).

The Browns Wash alluvial system is recharged by infiltration of precipitation and surface water flow from Browns Wash (when flowing). Some recharge is also possible from water-bearing units in the underlying Cedar Mountain Formation as a result of the upward hydraulic gradient from these units. Alluvial ground water discharge is predominantly through evapotranspiration, along with a minor amount of ground water discharge to the Green River. Discharge to the bedrock appears to be unlikely because of the low permeability of the underlying competent bedrock units and their upward hydraulic gradients.

Small pools of water are often present following storm events at the location where the upper unit of the Cedar Mountain Formation crops out in Browns Wash (approximately 1,300 feet upstream of the confluence with the Green River). The pools occur in scour holes that form as runoff crosses the bedrock. These pools, though temporary and depleted by evaporation, may linger as the saturated banks and upstream alluvium dewater after a runoff event. Though not verified, the pools could also be recharged from seepage from the Cedar Mountain Formation.

2.1.2 Cedar Mountain Formation

The middle sandstone unit of the Cedar Mountain Formation is the uppermost bedrock aquifer beneath and adjacent to the site, and contains ground water under confined to semi-confined conditions. An upper complexly interbedded unit overlies the middle sandstone and acts predominantly as an aquitard. The middle sandstone unit ranges in thickness from 15 to 40 feet and ground water is encountered at approximately 80 feet below land surface adjacent to the disposal cell. The middle sandstone does not appear to be laterally continuous in the vicinity of the site. The saturated portion of the middle sandstone unit is more predominant north and east of the disposal cell, and restricted to the south and west. The basal sandstone unit is approximately 160 feet below land surface and contains ground water under confined conditions. There is a significant upward vertical hydraulic gradient from this unit.

Interpretation of the local ground water flow component in the middle sandstone unit is complicated primarily by both the structural and stratigraphic characteristics of the bedrock units. Uncertainties surrounding the complex hydrogeology and ground water flow directions in units of the Cedar Mountain Formation in the vicinity of the Green River site are discussed in Section 5.1 of the SOWP (DOE 2002).

Recharge to the middle sandstone unit of the Cedar Mountain Formation is from precipitation where this unit crops out, and from vertical contributions of ground water along the flow path.

Discharge from the middle sandstone unit probably flows into the Green River alluvium and possibly Browns Wash alluvium; however, the flow path between the disposal cell and the discharge areas may be circuitous due to stratigraphic and structural discontinuities. This interpretation is supported by the following evidence: (1) hydraulic head measurements in the middle sandstone unit of the Cedar Mountain Formation show that the unit is unsaturated or absent south and west of the disposal cell, and that saturation increases to the north and east; (2) a northward ground water flow direction towards Browns Wash is inferred for the middle sandstone unit (DOE 2002); (3) there is an upward hydraulic gradient component in the sandstone aquifers of the Cedar Mountain Formation, which is indicative of a ground water discharge area; and (4) the inferred horizontal flow direction follows the north to northwest dip of the middle sandstone unit while upwelling of ground water probably occurs along vertical fractures and joints whose orientation is predominantly northwest.

Water levels of the middle sandstone unit aquifer have been measured in several monitor wells since completion of surface remediation in 1989. Water levels in wells adjacent to the disposal cell generally increased for about 3 years, declined for the next 11 years, and then began increasing again in late 2004 (Figure B–1 in Appendix B). Initial transient drainage from the disposal cell may have caused a temporary increase in water levels in the early 1990's, followed by decreasing levels as drainage slowed. Some of the decrease, to levels below initial measurements, may also be attributable to drought conditions that persisted in the area for several years. Precipitation in the region has returned to normal or above normal amounts, and current water levels are about the same as the initial measurements.

Ground water from the middle sandstone unit is not being used and is not considered to be a significant source of water in the area. The underlying confined basal sandstone unit, separated from the middle sandstone unit by an impermeable sequence of claystones and shales, is a more likely source of ground water in the site vicinity, though specific uses from this unit are not known. The major source of usable water in the area is surface water from the Green River and ground water from the Green River floodplain alluvium.

2.2 Ground Water Quality

Background water quality in both the Browns Wash alluvium and middle sandstone unit of the Cedar Mountain Formation is not well understood. Water quality in the alluvium appears to have naturally high dissolved solids content, though quality is quite variable (DOE 2002). Uncertainty regarding ground water flow direction in the middle sandstone unit of the Cedar Mountain Formation likewise leads to questionable interpretation of background water quality. Monitor well 0817 in the middle sandstone unit is interpreted to be a background location; contaminant concentrations in this well are below their respective EPA maximum concentration limits (MCLs) (40 CFR 192). Ground water in the basal sandstone unit has not been affected by site-related contaminants because of the hydrogeologic isolation and upward vertical hydraulic gradient of this unit. Therefore, the basal sandstone unit will not be discussed further.

Despite the uncertainty regarding background conditions, ground water in the Browns Wash alluvium and the middle sandstone unit of the Cedar Mountain Formation beneath the Green River site appears to have been contaminated by former uranium processing activities. Constituents elevated above standards or relevant benchmarks in the Browns Wash alluvium include ammonia, manganese, nitrate, selenium, sodium, sulfate, and uranium (DOE 2002). With the exception of ammonia and manganese, these constituents are elevated above a standard or risk-based concentration (human health) in the middle sandstone unit of the Cedar Mountain Formation. Arsenic is also elevated in the Cedar Mountain Formation.

Table 1 shows the maximum concentrations of various contaminants in ground water of the Cedar Mountain Formation and Browns Wash alluvium through June 2005, as compared to relevant human health and aquatic benchmarks. Also included for comparison are maximum concentrations from the Green River at the mouth of Browns Wash.

Table 1. Maximum Concentrations of Contaminants and Appropriate Benchmarks

Constituent	Human Health Benchmark (mg/L)	Aquatic Benchmark (mg/L)	Maximum in Cedar Mountain Formation[a] (mg/L)	Maximum in Browns Wash Alluvium (mg/L)	Maximum in Green River at Browns Wash Confluence (mg/L)
Ammonia (total as NH_4)	30 (total as NH_3) 32 (total as NH_4)[b]	<6 (total as N) <7.7 (total as NH_4)[c]	1.1	51.0	0.0378
Arsenic	0.05[d] (MCL)	0.150[c]	0.191	0.025	0.00096
Manganese	1.7[e]	0.08[f]	0.87	3.15	0.0068
Nitrate (as N)	10[d] (MCL)	na	426	642	0.21
Selenium	0.01[d] (MCL)	0.005[c]	0.849	0.549	0.00079
Sodium	120[g]	na	5,000	13,000	70.5
Sulfate	500[h]	na	8,620	37,000	185
Uranium	0.044[d,i] (MCL)	0.0026—0.455[j]	0.229	3.11	0.0029

Key: MCL = maximum concentration limit; mg/L = milligrams per liter; na = not applicable
[a]Maximum from all members of Cedar Mountain Formation; middle sandstone was generally highest
[b]EPA lifetime health advisory (EPA 2002a)
[c]National Recommended Water Quality Criteria (EPA 2002b)
[d]EPA ground water maximum concentration limit (EPA 1995, 40 CFR 192)
[e]Risk based concentration calculated from data in EPA IRIS database
[f]EPA Ecotox Threshold (EPA 1996)
[g]Nonenforceable EPA benchmark value (EPA 2002c)
[h]EPA health-based advisory for acute effects (EPA 2002d)
[i]Assumes secular equilibrium of uranium isotopes
[j]Suter and Tsao 1996

Concentrations of contaminants detected in the middle sandstone unit of the Cedar Mountain Formation have been somewhat sporadic over the period of time that monitoring has taken place. Time concentration plots for arsenic, nitrate, selenium, and uranium in eight monitor wells adjacent to the disposal cell are provided in Appendix B.

Arsenic concentrations are exceeding the MCL of 0.05 milligrams per liter (mg/L) in only one well (0813). Concentrations have increased over time in this well, but have apparently stabilized over the last 10 years to a level approximately three times the MCL (Figure B–2).

As shown on Figure B–3, the nitrate MCL (10 mg/L) is exceeded in five of the wells (0171, 0173, 0176, 0179, and 0181). Nitrate has significantly increased in one well (0173) but has remained nearly constant at a concentration between 300 and 350 mg/L for the last couple of years.

Selenium concentrations exceed the MCL of 0.01 mg/L in the same five wells that have elevated nitrate concentrations. Four of the wells (0171, 0173, 0176, and 0179) have demonstrated an increase in selenium concentrations, though at substantially different values (Figure B–4).

Two wells have uranium concentrations in excess of the MCL (0.044 mg/L) as indicated on Figure B–5. A steady increase in uranium concentrations is apparent in well 0171, reaching a maximum of 0.10 mg/L in June 2005. Concentrations have fluctuated at an elevated rate in well 0179; the average concentration is approximately 0.18 mg/L, which is four times the MCL.

All of the wells have sodium and sulfate concentrations substantially above the human health benchmarks indicated in Table 1 (MCLs have not been established for these constituents). Sodium concentrations have increased in two wells (0173 and 0181), and have remained steady or decreased in the other wells. Sulfate concentrations have increase substantially in well 0173 and to a lesser degree in well 0171, but have remained steady or decreased in the other wells. Ammonia and manganese concentrations have never exceeded the human health benchmarks indicated in Table 1.

No obvious correlations have been found between contaminant concentrations and well locations, sampling methods, precipitation rates, or any other single process, and no conclusions have been reached to explain the variations from well to well. The observed ground water concentrations are most likely a manifestation of a number of factors in this complex subsurface system.

3.0 Ground Water Compliance Strategy

The ground water compliance strategy for the Green River processing site (Subpart B of 40 CFR 192) is based on the compliance strategy selection framework (Figure 2) following the steps presented in the Programmatic Environmental Impact Statement (PEIS) (DOE 1996). DOE's goal is to implement a cost-effective ground water compliance strategy at the Green River site that is protective of human health and the environment and returns contaminated ground water to its maximum beneficial use. Because the disposal cell is located at the Green River processing site, both Subparts A (disposal site) and B (ground water cleanup) of 40 CFR 192 will be addressed by the ground water compliance strategy.

Two distinct hydrostratigraphic units in the vicinity of the site that have been impacted by uranium processing activities—the Browns Wash alluvium and bedrock of the Cedar Mountain Formation. After evaluating existing site information and following the decision framework in the PEIS, the compliance strategy is no further remediation with the application of supplemental standards based on limited yield (sustained continuous flow of less than 150 gallons per day) for ground water in the Browns Wash alluvium, and no further remediation and application of alternate concentration limits (ACL) for constituents with concentrations that exceed EPA MCLs for ground water in the middle sandstone unit of the Cedar Mountain Formation. The compliance strategy will be implemented in conjunction with ground water and surface water monitoring to observe the effectiveness of the strategy, and institutional controls to provide adequate restriction of nearby land use and ground water withdrawals. Updated risk assessments demonstrate that the compliance strategy will be protective of human health and the environment (DOE 2002).

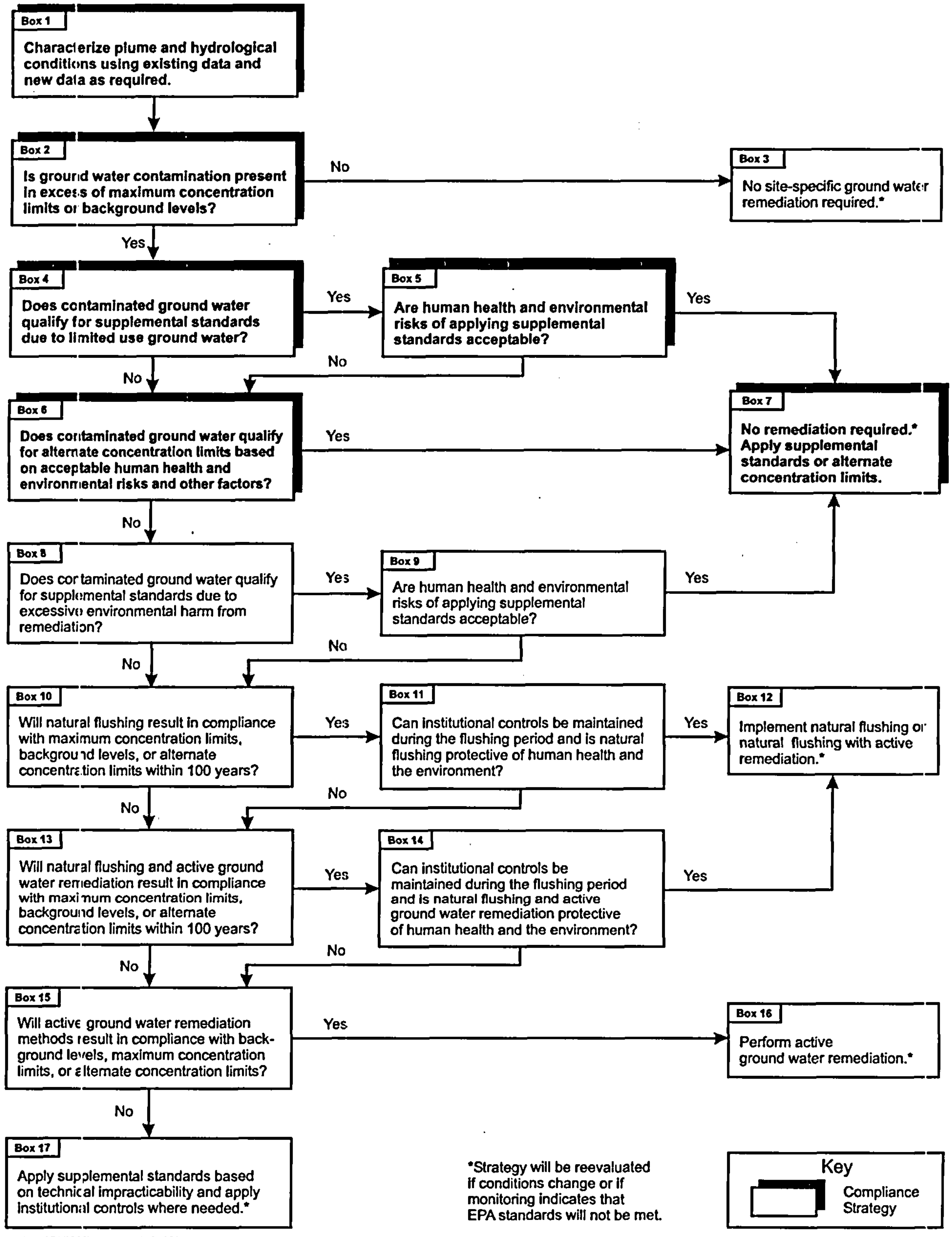

Figure 2. Compliance Strategy Decision Framework

3.1 Browns Wash Alluvium

The compliance strategy for ground water in the Browns Wash alluvium is no further remediation with application of supplemental standards. This compliance strategy is based on the decision framework in Figure 2 and is explained in Table 2, and fulfills requirements for Subpart B of 40 CFR 192.

Table 2. Compliance Strategy Selection Process for Ground Water in the Browns Wash Alluvium

Box from Figure 2	Action or Question	Result or Decision
1	Characterize plume and hydrological conditions.	See conceptual site model presented in Section 5.0 and contaminant screening presented in Section 6.0 of the SOWP. Move to Box 2.
2	Is ground water contamination present in excess of maximum concentration limits or background levels?	Ammonia, manganese, nitrate, selenium, sodium, sulfate, and uranium exceed the MCLs or appropriate benchmarks at one or more monitoring points. Move to Box 4.
4	Does contaminated ground water qualify for supplemental standards due to limited use ground water?	Yes. Ground water in the Browns Wash alluvium qualifies for limited use because it is not capable of a sustained yield of 150 gallons per day. Move to Box 5.
5	Are human health and environmental risks of applying supplemental standards acceptable?	Yes. The quantity of ground water available would not result in unacceptable exposures. Ground water currently does not discharge to the surface in quantities sufficient to produce unacceptable environmental risks. Move to Box 7.
7	*Compliance strategy*	*No remediation required. Apply supplemental standards.*

Ground water in Browns Wash alluvium qualifies for supplemental standards based on limited yield (less than 150 gallons per day) as demonstrated by observations of ground water availability in the alluvial system during field investigations (DOE 2002) and sampling events. Currently, it appears that the ground water levels in the Browns Wash alluvium are below the elevation of the wash itself. However, surface water monitoring to be performed in conjunction with ACLs for the Cedar Mountain Formation (see below) would also detect any contaminants from possible future discharges from Browns Wash alluvium, should water levels rise. This monitoring will satisfy the State of Utah concern that a supplemental standards strategy must address surface water conditions.

3.2 Cedar Mountain Formation

The compliance strategy for ground water in the middle sandstone unit of the Cedar Mountain Formation is no further remediation with application of ACLs. The compliance strategy is based on the decision framework in Figure 2 and is explained in Table 3, and fulfills requirements for both Subpart A and Subpart B of 40 CFR 192. Implementation of this strategy is presented in this document and will be included in the revised LTSP that is the licensing document for the disposal site (Subpart A of 40 CFR 192).

Ground water in the middle sandstone unit of the Cedar Mountain Formation qualifies for ACLs based on existing conditions at the processing/disposal site (DOE 2002). The application for ACLs for the Green River site, as required by EPA and NRC guidance, is included as Appendix A to this report, and is summarized in this Section.

Table 3. Compliance Strategy Selection Process for Ground Water in the Cedar Mountain Formation

Box from Figure 2	Action or Question	Result or Decision
1	Characterize plume and hydrological conditions.	See conceptual site model presented in Section 5.0 and contaminant screening presented in Section 6.0 of the SOWP. Move to Box 2.
2	Is ground water contamination present in excess of maximum concentration limits or background levels?	Arsenic, nitrate, selenium, and uranium exceed the MCLs at one or more monitoring points. Move to Box 4.
4	Does contaminated ground water qualify for supplemental standards due to limited use ground water?	Ground water in the Cedar Mountain Formation is not classified as limited use. Move to Box 6.
6	Does contaminated ground water qualify for alternate concentration limits based on acceptable human health and environmental risks and other factors?	Yes. (1) A disposal cell is located above the contaminated area of the aquifer, (2) the State of Utah owns the surrounding land, (3) ICs can be implemented that would prevent use of contaminated water, and (4) outside the IC boundary at the point of exposure, ground water would be suitable for unrestricted use. Move to Box 7.
7	Compliance strategy	No remediation required. Apply alternate concentration limits.

At the Green River site, a disposal cell was built at the same location where processing of uranium ores took place. Minor seepage during long-term disposal has probably resulted in somewhat elevated concentrations of mill-related constituents in the uppermost aquifer (middle sandstone unit of the Cedar Mountain Formation) below the disposal cell, though tailings did not contain appreciable moisture when disposed. Therefore, transient drainage should be minimal and probably confined to the immediate vicinity of the disposal cell. Although it is not clear if the contaminants detected in the Cedar Mountain Formation are a result of disposal cell seepage or if they pre-date cell construction, the fact that a cell exists at the site makes the use of ACLs as ground water standards reasonable. EPA specifically retained the ACL provision in its final ground water rule (40 CFR 192) "...because it is clearly needed, if for no other reason than to deal with the possibilities of unavoidable minor projected seepage over the extremely long-term design life (1,000 years) of the disposal required..." (60 FR 2857). The ACL policy was developed for use at sites where concentration levels less stringent that MCLs would still be protective of human health and the environment.

Ground water flow direction in the middle sandstone unit of the Cedar Mountain Formation is temporally variable, and consequently, somewhat ambiguous. The ground water flow velocity in the middle sandstone unit is apparently very low. Contamination is confined to the immediate vicinity of the cell and is not widespread. The middle sandstone unit is not laterally continuous, especially to the south and west, and is not a significant source of ground water. Water used for domestic purposes in the Green River area is predominantly surface water obtained from the Green River. The low ground water flow velocity in the middle sandstone unit impedes the natural flushing of existing contamination from the ground water system. Because of the limited extent of this unit and associated contamination, and the fact that use of water from this unit is unlikely, active remediation provides little, if any, benefit or risk reduction. Establishment of ACLs with no remediation, therefore, appears to be the most reasonable compliance strategy for the middle sandstone unit of the Cedar Mountain Formation. ACLs may be applied if the constituents will not pose a substantial present or potential hazard to human health and the environment as long as the ACLs are not exceeded. The factors specified in 40 CFR 192.02(c)(3)(ii)(B) have been considered for the Green River site and are included in Appendix A.

Constituents of potential concern (COPC) that require ACLs because concentrations exceed their respective EPA ground water standards (EPA 1995, 40 CFR 192) are arsenic, nitrate, selenium, and uranium. Sodium and sulfate were also identified as COPCs in the SOWP because of elevated concentrations (DOE 2002); however, these constituents do not have MCLs or aquatic benchmarks and will not be monitored. Manganese concentrations, though they exceed aquatic benchmarks, are below human-health risk-based concentrations; therefore, manganese is not considered to be a COPC for the Cedar Mountain Formation ground water.

Based on a comparison of detected concentrations of analytes in ground water with risk-based concentrations, arsenic is the constituent that makes up greater than 95 percent of the potential risks associated with ground water use. Nitrate, selenium, and uranium make up most of the remaining risk. Because these four constituents are the only ones of concern at the Green River Site for which EPA has ground water standards, they are identified as the contaminants for long-term monitoring at the site.

In determining an appropriate method to establish numerical values for ACLs at the Green River site, the methodology used for other uranium mining and CERCLA sites was reviewed. A case study provided in EPA guidance on ground water remedial actions (EPA 1988) first considered the potential effect of ground water discharge on surface water (the point of exposure—POE). In that study of a former municipal landfill, a dilution factor of 40,000, even under low flow conditions, led to the conclusion that ground water discharge would have no impact at the POE. The ACL proposed was simply ten times the ground water concentrations observed at that time. In several other studies with surface water POEs, dilution factors were used to calculate the maximum permissible concentrations in ground water that would still be protective of discharge to surface water (Umetco 2003; EPA 1990 & 1998). For most sites, it appears that one site-wide ACL was established for each constituent and that the ACL applied to all POC wells (EPA 1998). However, for one uranium milling site, compliance was determined by comparing the average concentration of POC wells against the ACL. At some sites, individual ACLs were established for each constituent at each well, resulting in over 100 ACLs for a given site (EPA RODS database).

At the Green River site, it is not clear if ground water actually discharges to the surface to any significant degree. However, if it does, the point of exposure could be the Green River but, because the middle sandstone unit of the Cedar Mountain Formation appears to pinch out west of the site, the most likely point of exposure would be Browns Wash. Because Browns Wash is only likely to contain water following a significant precipitation event, it is assumed that any ground water discharging to the wash would be diluted. The Green River would also dilute any potential ground water discharge. Average monthly discharge rates for the Green River range from 2,300 to 18,000 cubic feet per second (cfs) in the vicinity of the Green River site (USGS monitoring data), while ground water discharge from the middle sandstone unit is estimated without empirical data at much less than 100 gallons per minute (0.2 cfs), resulting in a greater than 10,000-fold dilution at the lowest flow rate in the river. This means that to meet the benchmarks contained in Table 1, concentrations of constituents in ground water could be hundreds to thousands of times higher than those currently observed.

Because DOE's ACL guidance indicates that ACLs should be established at levels that are as low as reasonably achievable (ALARA), DOE did not base the ACLs on maximum assumed dilution rates. Rather, ACLs were set at two orders of magnitude (100 times) the respective MCLs and are expected to be achievable based on observed site conditions (see Appendix A). As discussed in Section 2.2, solute concentrations have fluctuated inexplicably at some of the monitor wells adjacent to the disposal cell. Depending on site conditions, some further variability may be expected. The ACLs will accommodate potential future increases, and should be more than protective at the POEs given the assumed dilution rates of the Green River.

For simplicity and ease in implementation and in accordance with EPA guidance (EPA 1992), site-wide ACLs will be applied to the yearly average concentration in a group of POC wells. Table 4 presents the ACLs along with maximum analytical results through June 2005. The observed and averaged results are from the four POC wells identified in the LTSP (0171, 0172, 0173, and 0813). Analytical results for all the wells adjacent to the disposal cell are discussed in Section 2.2 and shown as time-concentration plots in Appendix B.

Table 4. Alternate Concentration Limits and Maximum Concentrations for the Green River Site

Constituent	MCL (mg/L)	ACL (mg/L)	Maximum Concentration Observed to Date in POC Wells[a] (mg/L)	Maximum Averaged Concentration in POC Wells[a] (mg/L)
Arsenic	0.05	5.0	0.191	0.057[b]
Nitrate (as N)	10	1,000	427	180[c]
Selenium	0.01	1.0	0.32	0.18[d]
Uranium	0.044	4.4	0.100	0.032[e]

Key: ACL = alternate concentration limit; MCL = maximum concentration limit (EPA); mg/L = milligrams per liter; POC = point of compliance
[a]Point of compliance wells 0171, 1072, 0173, and 0813 stipulated in the LTSP.
[b]Average of samples collected during a 1995 sampling event.
[c]Average of samples collected during a 2003 sampling event.
[d]Average of samples collected during a 2003 sampling event.
[e]Average of samples collected during a 1990 sampling event.

The methodology used for deriving ACLs in this GCAP differs from that originally proposed in the SOWP. The ACLs proposed in the SOWP were somewhat arbitrary and considered achievable at the time. Since that time it was recognized that higher ACLs would avoid needlessly triggering the corrective action process and would not increase the risk to human health and the environment. The current approach—using established standards and applying a multiplier (100) to account for geochemical attenuation and dilution—was developed to account for the widely variable concentrations observed at some POC wells.

3.3 Human Health and Environmental Risk

The human health risk assessment update in the SOWP concluded that there is no unacceptable risk from site-related contaminants in ground water with the application of supplemental standards for the Browns Wash alluvial aquifer and ACLs for the middle sandstone unit aquifer of the Cedar Mountain Formation (DOE 2002). The updated ecological risk assessment determined that there is little potential for site-related constituents to affect surface water or sediments and, consequently, ecological receptors. As noted previously, dilution of any contamination potentially discharging to the surface is likely. In addition, any potential exposure of wildlife to contamination is expected to be infrequent and not result in any unacceptable risks.

4.0 Compliance Strategy Implementation

The compliance strategy for Subparts A and B of 40 CFR 192 for the Green River site will be implemented in conjunction with ground water and surface water monitoring and institutional controls.

4.1 Monitoring Program

Ground water and surface water will be monitored at select locations annually to observe the effectiveness of the compliance strategy and ensure long-term protection of human health and the environment (Figure 3). A summary of the monitoring requirements is presented in Table 5.

Table 5. Summary of Monitoring Requirements for the Green River Site

Location	Monitoring Purpose[a]	Analytes	Frequency
Ground Water			
0171, 0173, 0174, 0175, 0176, 0181[b], 0813	Point of compliance monitor wells adjacent to the disposal cell and completed in the middle sandstone unit of the Cedar Mountain Formation; ensure ACLs are not exceeded.	As, N, Se, U	Annual for 5 years; reevaluate monitoring requirements at that time.
0179	Best management practice monitor well near the disposal cell in the middle sandstone unit of the Cedar Mountain Formation; apparent upgradient well.	As, N, Se, U	Same as above.
0188, 0189, 0192	Best management practice monitor wells completed in Browns Wash allumvium; potential discharge of ground water from middle sandstone unit of Cedar Mountain Formation into the Browns Wash alluvium.	As, N, Se, U	Same as above.
0194	Best management practice monitor well in the Browns Wash alluvium; monitor for leading edge of contamination.	As, N, Se, U	Same as above.
0179, 0180, 0182, 0183, 0184, 0185, 0582, 0588, 0813, 0817	Best management practice monitor wells to confirm persistence of the upward hydraulic gradient from the basal and middle sandstone units of the Cedar Mountain Formation.	Water level only unless gradient reverses.	Continuous monitoring with automated data loggers for 5 years; reevaluate monitoring requirements at that time.
Surface Water			
0846, 0847	Potential point of exposure; monitor for degradation of water quality resulting from ground water discharge to Browns Wash or Green River.	As, N, Se, U	Annual for 5 years; reevaluate monitoring requirements at that time.

[a]Monitoring program addresses both Subparts A and B of 40 CFR 192.
[b]Monitor well 0181 was installed as an offset replacement well for monitor well 0172 due to unsatisfactory completion characteristics and questionable sampling results.

The ground water monitoring network for the ACL compliance strategy for the middle sandstone unit of the Cedar Mountain Formation consists of seven POC wells along the northwest and northeast edges of the disposal cell (0171, 0173, 0174, 0175, 0176, 0181, and 0813). The POC wells will monitor potential discharge of contaminants from the disposal cell into the middle sandstone unit of the Cedar Mountain Formation. Should the annual average of POC well samples exceed an ACL, quarterly sampling will be initiated for the POC wells. Should two consecutive quarterly averages exceed an ACL, data will be evaluated to assess the need for additional monitoring and/or modifying institutional controls.

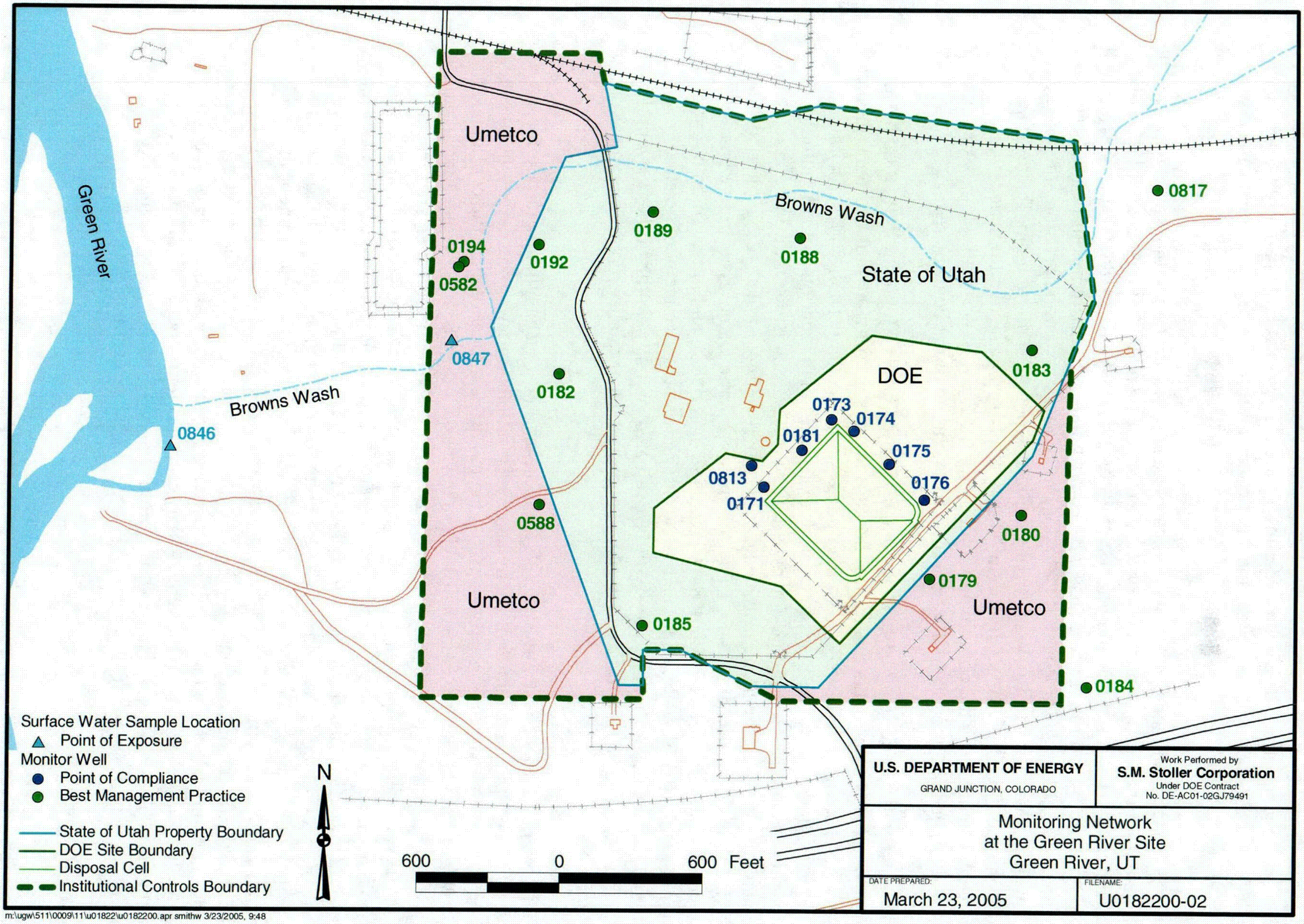

Figure 3. Proposed Monitoring Network and Institutional Controls Boundary at the Green River Site

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Another well on the southeast side of the disposal cell (0179), also completed in the middle sandstone unit, will be monitored as a best management practice because of elevated selenium and uranium concentrations in ground water in this area. This location apparently is upgradient of the disposal cell, and the cause of the elevated concentrations has not been determined. A result exceeding an ACL will not trigger corrective action.

Because the conceptual model of the site indicates that contaminated ground water in the middle sandstone unit of the Cedar Mountain Formation from the disposal cell area could potentially discharge into the Browns Wash alluvial system, three alluvial wells (0188, 0189, and 0192) will be monitored for the same constituents as the Cedar Mountain Formation aquifer as a best management practice to provide an indication of migration of contaminants along this pathway. Also, a well just west of Browns Wash (0194) will track potential migration of the residual uranium plume in the Browns Wash alluvium (also as a best management practice). Supplemental standards is the compliance strategy for the Browns Wash alluvium, so sample results will not be compared to ACLs and corrective action will not be triggered.

Ground water in the underlying basal sandstone unit of the Cedar Mountain Formation has not been contaminated by site-related activities because there is a strong upward hydraulic gradient and it is hydrogeologically isolated from the middle sandstone unit (DOE 2002). As long as this upward hydraulic gradient continues to exist, as expected, contamination from the middle sandstone unit is unlikely to migrate downward into the basal sandstone unit. In order to verify the upward hydraulic gradient and provide a better understanding of the hydrogeology of the Cedar Mountain Formation at the site, DOE will measure static water levels in five basal sandstone unit monitor wells (0182, 0184, 0185, 0582, and 0588), and in five middle sandstone unit monitor wells (0179, 0180, 0183, 0813, and 0817) as a best management practice. The potentiometric surfaces of both aquifers will be evaluated annually. In the unlikely event that the vertical gradient reverses, DOE would implement ground water quality monitoring in the basal sandstone unit.

DOE will monitor surface water at two POE locations as a best management practice for the purpose of establishing a database of chemical concentrations for an ecologically sensitive area, not as an indicator to trigger corrective action. One monitoring location is at the confluence of Browns Wash and the Green River (0846) where discharge of the Browns Wash alluvial aquifer would occur. Samples will also be collected from Browns Wash pools, if they are present, at the location (0847) where the upper unit of the Cedar Mountain Formation crops out in the wash. It is possible for some ground water to surface as seeps in Browns Wash, though such occurrences have not been verified, and that potential ecological receptors in the area should be protected. The temporary pools are not considered to be an important source of water for those receptors because they fail to supply a continuous source of water. Although the intermittent pools of water are likely to concentrate solutes (due to evaporation) to levels that could be considered harmful, the risk to the populations of wildlife in the area is low because the exposure would have a limited duration. Monitoring will be scheduled to coincide with the time of year during which this habitat is most important to the endangered species (specifically the Colorado pikeminnow). This is anticipated to be shortly after spawning occurs in the spring on the downside of the hydrograph of the river (i.e., after peak flows in June).

After 5 years, DOE will reassess monitoring requirements and recommend modifications to NRC and the State of Utah as deemed necessary. By developing targeted performance metrics based on observed concentrations in the POC and POE locations, it is anticipated that monitoring requirements may be fulfilled within a 30-year timeframe.

Upon regulatory concurrence with the proposed monitoring program and the revised LTSP, the remaining unneeded DOE monitor wells in the vicinity of the Green River site will be decommissioned. This would provide protection of the aquifer by removing access points, decrease maintenance costs, and limit further DOE liability.

4.2 Institutional Controls

DOE, the State of Utah, and Umetco Minerals Corporation own property affected by ground water contamination. Institutional controls will be placed on ground water that is currently contaminated or that may be affected in the future (Figure 3). An environmental covenant will be implemented to prohibit use of ground water for any purpose, without the permission of both DOE and the State of Utah, on the land affected by ground water contamination (Appendix C). This restriction is essentially perpetual, although it can be lifted once concentrations have decreased to levels that allow use.

To restrict access to contaminated ground water on adjacent properties, DOE will pursue a new Utah State law. Utah Senate Bill 84, *Real Property Voluntary Environmental Restrictive Covenants*, passed in March 2003, contains provisions for creating perpetual environmental covenants that place restrictions on ground water access, including drilling and pumping of ground water from the land where remedial actions have been completed and contamination has been left in place. These covenants are legally enforceable restrictions on land and ground water use and therefore meet the definition of institutional controls under UMTRCA (42 U.S.C. 7901 *et. seq.*).

Such an environmental covenant would prohibit domestic or others uses of contaminated ground water until monitoring indicates that contaminant concentrations are at acceptable levels. DOE will work with the Utah Department of Environmental Quality to establish the covenants and to ensure that they remain in force as long as deemed necessary.

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Appendix A

Application for Alternate Concentration Limits for the Green River, Utah, (UMTRCA Title I) Disposal Site

Contents

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End of current text

1.0 Introduction

1.1 Purpose

The purpose of this document is to fulfill the U.S. Nuclear Regulatory Commission (NRC) requirements for an application for alternate concentration limits (ACL) for uranium and other constituents of potential concern (COPC) at the Uranium Mill Tailings Radiation Control Act (UMTRCA) Title I disposal site at Green River, Utah. The focus is on ground water in bedrock of the Cedar Mountain Formation beneath and downgradient from the disposal cell. Much of the information required by NRC for an ACL application (10 CFR Part 40, Appendix A and NRC 1996) has been compiled in the Baseline Risk Assessment (BLRA) (DOE 1995), Modification No. 2 to the Remedial Action Plan (DOE 1998a), the Site Observational Work Plan (SOWP) (DOE 2002) for the Green River site, and the Ground Water Compliance Action Plan (GCAP). This document is an appendix to the GCAP. The intent of this document is to provide a link between NRC evaluation criteria and relevant discussion of those criteria in previous documents. NRC guidance for preparing ACL applications for UMTRCA Title II sites (NRC 1996) was used as a model for this application. This document summarizes pertinent information from the SOWP regarding "Factors Considered in Making Present and Potential Hazard Findings" (Table 1 in NRC 1996; also specified in 40 CFR 192 with slight modifications). It also identifies sections of the SOWP that contain information corresponding to sections listed in the "Standard ACL Application Format" (Table 2 in NRC 1996). This approach ensures that all factors and information related to the proposed ACLs have been considered, while minimizing duplication of effort.

Section 2.0 of this document discusses the constituents for which ACLs are proposed and the rationale for the numerical values. Section 3.0 summarizes the factors considered in making hazard findings. Section 4.0 presents the "roadmap" to the SOWP following the standard ACL application format. References are included in Section 5.0.

1.2 Site Background

The Green River disposal site is approximately 1.5 miles southeast of the City of Green River, in Grand and Emery Counties, Utah (Figure A–1). The site is immediately south of the ephemeral Browns Wash and approximately 0.5 mile east of the Green River, with elevations ranging from 4,075 to 4,140 feet (ft). The site is surrounded by State of Utah property that is bounded on the north by the U.S. Army and private property; on the south by U.S. Army property; and on the east and west by Umetco Minerals Corporation (Umetco) property. The U.S. Army property is part of the Utah Launch Complex of the White Sands Missile Range.

The City of Green River is a community of approximately 1,000 residents on the border of Emery and Grand Counties, Utah. The economy of the area is mainly dependent on agriculture and tourism. The former uranium-ore processing site is currently owned by the State of Utah, and the disposal cell area is owned by the U.S. Department of Energy (DOE) (Figure A–1). There is no current use of the former processing site area. Several of the mill buildings were cleaned up and remain on State property. These buildings are currently abandoned and in a state of disrepair. There is also an abandoned water tower on State property immediately northwest of the disposal cell.

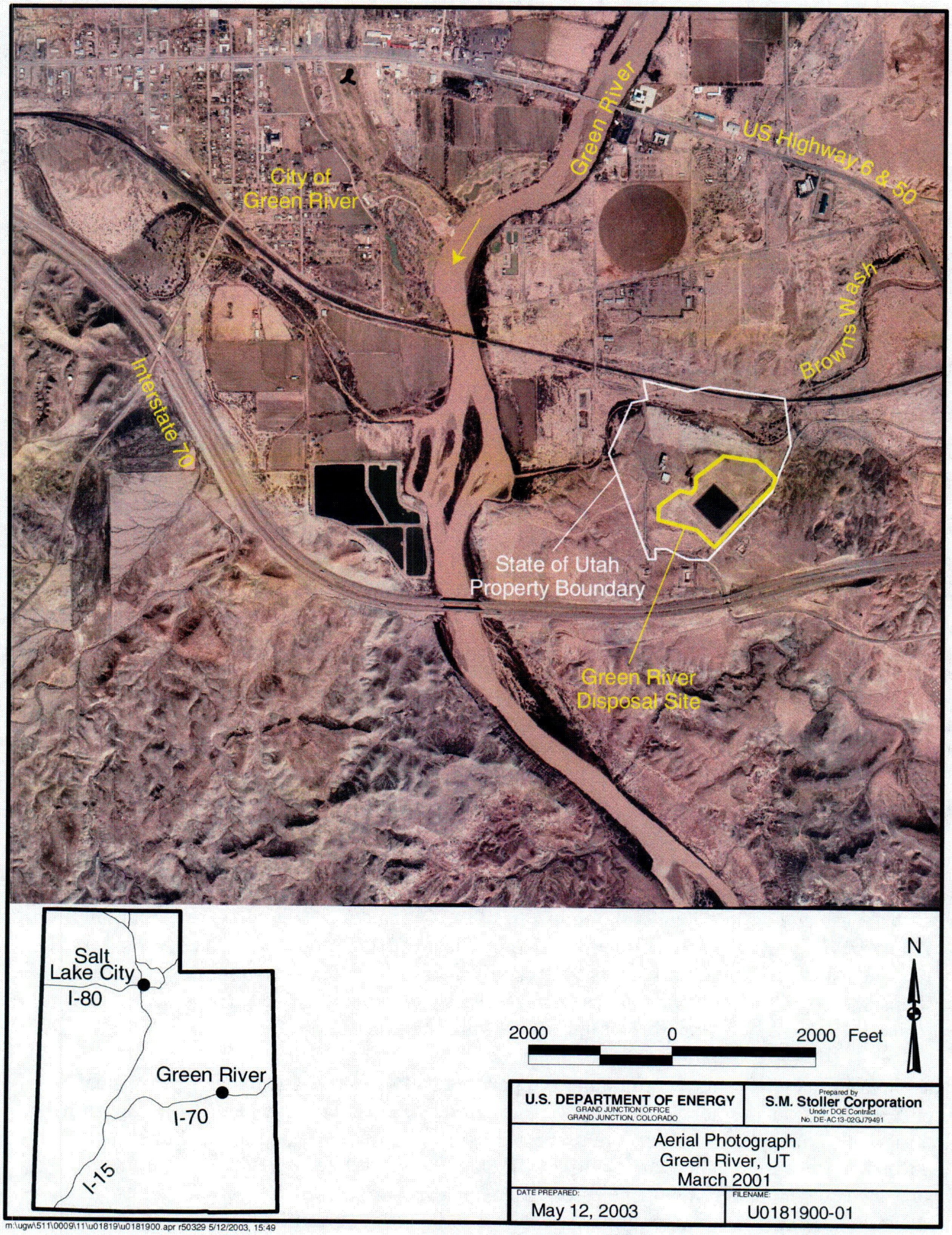

Figure A–1. Aerial Photograph of the Green River Area—March 2001

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Ground water is not a current source of drinking water in the area of the Green River site because of the availability of good quality water from the Green River municipal water supply system (DOE 1995). The source of water for the municipal system is the Green River; the water intake station and treatment plant are approximately 0.75 mile upstream and upgradient from the northwest boundary of the site. Residents of the City of Green River are connected to the municipal water system. One residence west of the site is reportedly not connected to the system, but the owner hauls water for domestic purposes from the city water supply system and stores it in a water tank. The nearest domestic wells in the area are north of U.S. Highway 6 and 50, and south of Interstate Highway 70. Ground water from these wells is used for irrigation (DOE 1995). There are no known current uses of surface water or ground water along Browns Wash in the vicinity of the site.

The uranium mill at the Green River site was constructed in 1957 and operated from March 1958 through January 1961 by Union Carbide Corporation. The plant was operated for upgrading uranium ore from the Temple Mountain mining district area approximately 60 miles southwest of the site. During its 3 years of operation, the mill processed 183,000 tons of ore with an average grade of 0.29 percent uranium oxide (FBDU 1981). The upgraded ore concentrate was shipped by rail to Rifle, Colorado, for further processing. The former Green River plant generated an estimated 137,000 tons of tailings, which covered approximately 9 acres to an average depth of 7 feet. After milling operations were completed, Union Carbide leased the site to a company under contract with the U.S. Department of Defense, which used the mill buildings for missile testing and assembly. Union Carbide owned the uranium millsite until the State of Utah acquired ownership in 1988.

The processing site was remediated from November 1988 through September 1989, and all mill tailings and residual radioactive material were stabilized in a partially below-grade disposal cell in the area just southeast of the former mill buildings (Figure A–1). The disposal cell base is approximately 35 feet below grade, and contaminated materials were emplaced in the cell to approximately 40 feet above grade. The disposal cell covers approximately 6 acres. The area of the former tailings pile and all areas disturbed at the site during the remedial action were backfilled, graded to promote surface drainage, and revegetated.

2.0 Proposed ACLs

2.1 ACL Applicability

The U.S. Environmental Protection Agency (EPA) provided guidance for applying ACLs at Resource Conservation and Recovery Act (RCRA) hazardous waste facilities (EPA 1987). The NRC used this guidance as a basis for developing ACL guidance for UMTRCA Title II uranium mills (NRC 1996). EPA further indicated that ACLs could similarly apply to UMTRCA Title I processing sites, particularly in instances where a disposal cell is present. As noted in the preamble to the final rule for Title I sites (60 FR 2854), "EPA has decided not to delete the ACL provision because it is clearly needed, if for no other reason than to deal with the possibilities of unavoidable minor seepage over the extremely long-term design life (1,000 years) of the disposal required ...". Both EPA RCRA ACL guidance and NRC Title II ACL guidance were referenced in these regulations as providing criteria for assessing the appropriateness of using ACLs at a given site.

The ACL policy was developed for use at sites where concentration levels less stringent than EPA maximum concentration limits (MCLs) or background would still be protective of human health and the environment or for application to constituents for which MCLs have not been developed. A further function of an ACL is to serve as a "trigger" to evaluate whether corrective action is required (EPA 1987). For UMTRCA Title I sites, exceedence of an ACL initiates the corrective action process (40 CFR 192.04). Furthermore, ACLs for UMTRCA Title II sites are supposed to be established at levels "as low as reasonably achievable" (ALARA) (NRC 1996).

In the case of the Green River site, a disposal cell was built at the same location where processing of uranium ores took place. Minor seepage during long-term disposal has probably resulted in somewhat elevated concentrations of mill-related constituents in the uppermost aquifer (middle sandstone unit of the Cedar Mountain Formation) below the disposal cell, though tailings did not contain appreciable moisture when disposed. Estimates are that the tailings at the Green River site were 15 to 25 percent saturated when placed in the cell (DOE 1991); no slimes were present. Water levels at the site increased immediately after disposal was completed, but have since returned to pre-disposal cell levels. Therefore, transient drainage should be minimal and probably confined to the immediate vicinity of the disposal cell. Although it is not clear if the contaminants detected in the Cedar Mountain Formation are a result of disposal cell seepage or if they pre-date cell construction, the fact that a cell exists at the site makes the use of ACLs as ground water standards reasonable.

Ground water flow direction in the middle sandstone unit of the Cedar Mountain Formation is temporally variable and, consequently, somewhat ambiguous. The ground water flow velocity in the middle sandstone unit is apparently very low. Contamination is confined to the immediate vicinity of the cell. The middle sandstone unit is not laterally continuous, especially to the south and west, and is not a significant source of ground water. Although there are no data to verify it, some ground water from the middle sandstone unit of the Cedar Mountain Formation may discharge through fractures to the alluvium in Browns Wash, which qualifies for supplemental standards due to low ground water yield, or to the Green River alluvium (DOE 2002).

Water used for domestic purposes in the Green River area is predominantly surface water obtained from the Green River and withdrawn upstream of the Browns Wash confluence. Most of the ground water used in the area is obtained from the Green River alluvium (DOE 1995). The low ground water flow velocity in the middle sandstone unit impedes the natural flushing of existing contamination from the ground water system. However, because of the limited extent of this unit and associated contamination, and the fact that use of water from this unit is unlikely, active remediation provides little, if any, benefit or risk reduction. Establishment of ACLs with no remediation appears to be the most reasonable compliance strategy for the middle sandstone unit of the Cedar Mountain Formation.

2.2 ACLs and Compliance Assessment

2.2.1 Constituents of Potential Concern

Table A–1 shows the maximum concentrations of various contaminants in the Cedar Mountain Formation. Provided for comparison are relevant human health and aquatic benchmarks.

Table A–1. Maximum Ground Water Concentrations in the Cedar Mountain Formation and Relevant Benchmarks for the Green River Site

Constituent	Human Health Benchmark (mg/L)	Aquatic Benchmark (mg/L)	Maximum in Cedar Mountain Formation[a] (mg/L)
Ammonia (total as NH_4)	30 (total as NH_3) 32 (total as NH_4)[b]	<6 (total as N) <7.7 (total as NH_4)[c]	1.1
Arsenic	0.05[d] (MCL)	0.150[c]	0.191
Manganese	1.7[e]	0.08[f]	0.87
Nitrate (as N)	10[d] (MCL)	na	426
Selenium	0.01[d] (MCL)	0.005[c]	0.849
Sodium	120[g]	na	5,000
Sulfate	500[h]	na	8,620
Uranium	0.044[d,i] (MCL)	0.0026—0.455[j]	0.229

Key: MCL = maximum concentration limit; mg/L = milligrams per liter; na = not applicable
[a]Maximum from all members of Cedar Mountain Formation; middle sandstone was generally highest
[b]EPA lifetime health advisory (EPA 2002a)
[c]National Recommended Water Quality Criteria (EPA 2002b)
[d]EPA ground water maximum concentration limit (EPA 1995, 40 CFR 192)
[e]Risk based concentration calculated from data in EPA IRIS database
[f]EPA Ecotox Threshold (EPA 1996)
[g]EPA benchmark value (nonenforceable; EPA 2002c)
[h]EPA health-based advisory for acute effects (EPA 2002d)
[i]Assumes secular equilibrium of uranium isotopes
[j]Suter and Tsao 1996

COPCs that require ACLs because concentrations exceed their respective EPA ground water standards (EPA 1995, 40 CFR 192) are arsenic, nitrate, selenium, and uranium. Sodium and sulfate were also identified as COPCs in the SOWP (DOE 2002); concentrations are substantially elevated above human health benchmarks, but no MCLs have been established for these constituents and no ACLs are proposed for them. Manganese concentrations, though they exceed an aquatic benchmark, are below human-health risk-based concentrations; therefore, manganese is not considered to be a COPC for the Cedar Mountain Formation ground water. Ammonia concentrations have never exceeded human health or aquatic benchmarks in Cedar Mountain Formation ground water samples.

Based on a comparison of detected concentrations of analytes in ground water with risk-based concentrations, arsenic is the constituent that makes up greater than 95 percent of the potential risks associated with ground water use. Nitrate, selenium, and uranium make up most of the remaining risk. Because these four constituents are the only ones of concern at the Green River site for which EPA has ground water standards, they are proposed as the contaminants for long-term monitoring at the site.

2.2.2 Point of Compliance and Point of Exposure

In establishing an ACL, two locations must be defined—the point of compliance (POC) and point of exposure (POE). The POC is defined as the site-specific locations in the uppermost aquifer where the ground water protection standards must be met. In contrast, the POE is defined as the locations where humans, wildlife, or other environmental species could reasonably be exposed to hazardous constituents from the ground water (NRC 1996). In the ACL guidance for UMTRCA Title II sites, NRC notes "The POE, in most situations, will be located at the down-gradient edge of the land that will be transferred to either the Federal government or the State where the site is located for long-term institutional control ..."

In the case of the Green River site, the disposal site itself is currently owned by DOE, and the State of Utah owns the land surrounding the disposal cell. Several monitor wells are located adjacent to the disposal cell; these have been installed into the middle sandstone unit and four of them are currently being monitored as POC wells for Subpart A compliance. It is not clear if the middle sandstone unit is actually present in any significant extent south and west of the perimeter of the state-owned property, and ground water flow direction in the middle sandstone is temporally variable and, therefore, somewhat ambiguous. However, based on information presented in the SOWP (DOE 2002), the Green River and Browns Wash are the most likely discharge areas for ground water in the middle sandstone unit. Therefore, these will be considered as potential POEs, and monitoring locations will be established for surface water in Browns Wash and at the confluence with the Green River downstream from the site. Because of the uncertainty of the discharge location for the middle sandstone unit, however, elevated contaminant levels at the POE locations may not be able to be correlated with the POC sample results and no corrective action will be triggered.

The long-term surveillance activities and ground water monitoring program for the disposal site are presented in the Long-Term Surveillance Plan (LTSP), which is the regulatory document required by NRC when the disposal site was licensed (DOE 1998b). The proposed monitoring program will satisfy requirements for both Subpart A and Subpart B and will be presented in the revised LSTP.

2.2.3 Rationale and Implementation

In establishing ACLs for the Green River site, DOE evaluated historical trends in ground water quality. Time-concentration plots for arsenic, nitrate, selenium, and uranium in monitor wells adjacent to the disposal cell are shown in Appendix B of the GCAP (Figures B–2 through B–5). Many of these plots show erratically fluctuating changes in concentration over time, and for some constituents in some wells, concentrations seem to show an apparent increase. The fluctuating solute concentrations in the ground water have not been correlated to any natural event.

In determining an appropriate method to establish numerical values for ACLs at the Green River site, the methodology used for other uranium mining and CERCLA sites was reviewed. One case study on ground water remedial actions (EPA 1988) first considered the potential effect of ground water discharge on surface water (POE). In that study of a former municipal landfill, a dilution factor of 40,000, even under low flow conditions, led to the conclusion that ground water discharge would have no impact on water quality at the POE. The ACL proposed was simply ten times the ground water concentrations observed at that time. In several other studies with surface water POEs, dilution factors were used to calculate the maximum permissible concentrations in ground water that would still be protective of discharge to surface water (Umetco 2003; EPA 1990 & 1998) and those were used as the ACLs. For most sites, one site-wide ACL was established for each constituent and the ACL was applied to all POC wells (EPA 1998). However, for one uranium milling site, compliance was determined by comparing the average concentration of POC wells against the ACL (Umetco 2003). At some sites, individual ACLs were established for each constituent at each well, resulting in over 100 ACLs for a given site (EPA RODS database). As explained below, DOE proposes ACLs for the Green River site that are 100 times the respective MCLs (40 CFR 192) and that are applied to all of the POC wells.

If the middle sandstone unit aquifer of the Cedar Mountain Formation has a surface exposure, it is likely to be the Green River. Average monthly discharge rates for the Green River, based on U.S. Geological Survey monitoring data, range from 2,300 to 18,000 cubic feet per second (cfs) in the vicinity of the Green River site. Assuming a conservative ground water discharge rate of 100 gallons per minute (0.2 cfs), the dilution would be greater than 10,000-fold during low flows in the river. This means that to meet the benchmarks contained in Table A–1, concentrations of constituents in ground water at the POC wells could be hundreds to thousands of times higher than those currently observed.

Because DOE's ACL guidance indicates that ACLs should be established at levels that are as low as reasonably achievable (ALARA), DOE did not base the proposed ACLs on maximum assumed dilution rates. Rather, ACLs are proposed to be two orders of magnitude (100 times) the respective MCLs and are expected to be achievable based on observed site conditions. Solute concentrations have fluctuated inexplicably at some of the monitor wells adjacent to the disposal cell and, depending on site conditions, some further variability may be expected. The proposed ACLs are high enough to accommodate potential future increases, and should be more than protective at the POEs given the assumed dilution rates of the Green River.

For simplicity and ease in implementation and in accordance with EPA guidance (EPA 1992), site-wide ACLs are proposed to be applied to the yearly average concentration in a group of POC wells. The proposed POC wells are existing monitor wells located adjacent to the downgradient sides of the disposal cell. Table A–2 presents the proposed ACLs along with maximum analytical results through June 2005. The observed and averaged results are from the four POC wells identified in the LTSP (0171, 0172, 0173, and 0813). The other proposed POC wells (0174, 0175, and 1076) have not been sampled since 2002. Analytical results for all the wells adjacent to the disposal cell are discussed in Section 2.2 of the GCAP and are shown as time-concentration plots in Appendix B.

Table A–2. Proposed Alternate Concentration Limits for the Green River Site

Constituent	MCL (mg/L)	Proposed ACL (mg/L)	Maximum Concentration Observed to Date in POC Wells[a] (mg/L)	Maximum Averaged Concentration in POC Wells[a] (mg/L)
Arsenic	0.05	5.0	0.191	0.057[b]
Nitrate (as N)	10	1,000	427	180[c]
Selenium	0.01	1.0	0.32[f]	0.18[d]
Uranium	0.044	4.4	0.100	0.032[e]

Key: ACL = alternate concentration limit; MCL = maximum concentration limit; mg/L = milligrams per liter; POC = point of compliance
[a]Point of compliance wells 0171, 1072, 0173, and 0813 stipulated in the LTSP (DOE 1998b).
[b]Average of samples collected during a 1995 sampling event.
[c]Average of samples collected during a 2003 sampling event.
[d]Average of samples collected during a 2003 sampling event.
[e]Average of samples collected during a 1990 sampling event.
[f]The maximum selenium concentration in all proposed POC wells is 0.849 mg/L (well 0176 in June 2001); the average for all seven proposed POC wells for that sampling event was 0.18 mg/L.

The proposed ground water monitoring network for the ACL compliance strategy for the middle sandstone unit of the Cedar Mountain Formation will consist of seven POC wells along the northwest and northeast edges of the disposal cell (0171, 0173, 0174, 0175, 0176, 0181, and 0813). The POC wells will monitor potential discharge of contaminants from the disposal cell into the middle sandstone unit of the Cedar Mountain Formation. Should the annual average of

POC well samples exceed an ACL, quarterly sampling will be initiated for the POC wells. Should two consecutive quarterly averages exceed an ACL, data will be evaluated to assess the need for additional monitoring and/or modifying institutional controls.

3.0 Factors Considered in Making Present and Potential Hazard Findings

The list of factors below is from the UMTRCA Title I regulations [40 CFR 192.02(c)(3)(ii)(B)(1) and (2)], which differ slightly from those in the NRC Title II guidance and adds another factor to the ground water quality list.

3.1 Potential Adverse Effects on Ground Water Quality

3.1.1 Physical and chemical characteristics of constituents in the residual radioactive material at the site, including their potential for migration. The processing site was remediated from November 1988 through September 1989 and all uranium mill tailings and residual radioactive material were stabilized in a partially below-grade disposal cell onsite. Uranium is the principal COPC in ground water in the uppermost aquifer; migration in ground water is limited (see Sections 3.4, 5.2, and 5.3 of the SOWP).

3.1.2 Hydrogeological characteristics of the site and surrounding land. Ground water occurs in the Browns Wash alluvium and bedrock units of the Cretaceous Cedar Mountain Formation. Characterization of the site hydrogeology was explained in Section 3.5 of Mod No. 2 of the RAP and in Section 5.1 of the SOWP.

3.1.3 Quantity of ground water and the direction of ground water flow. Ground water flow in the Browns Wash alluvial aquifer is minimal and generally to the southwest toward the Green River. Ground water flow in the middle sandstone unit of the Cedar Mountain Formation (uppermost bedrock aquifer) is temporally variable, and therefore, somewhat ambiguous (see Section 5.1 of the SOWP and Section 2.1 of the GCAP). The volume of contaminated ground water is minimal and restricted in lateral area.

3.1.4 Proximity and withdrawal rates of ground water users. There is no known ground water withdrawal in the vicinity of the site. The nearest wells, located more than a mile away from the site, are completed in the Green River alluvium and are used for irrigation.

3.1.5 Current and future uses of ground water in the region surrounding the site. There are no known current uses of ground water along Browns Wash in the vicinity of the site. The wash flows only in response to storm runoff, and its aquifer is of poor quality and classified as limited use.

Ground water from the Cedar Mountain Formation is not a current or potential source of drinking water in the area of the Green River site because of the low yield of the aquifer in the region and the generally poor water quality (several constituents exceed Safe Drinking Water Act standards) compared to the Green River municipal water supply system. The municipal system derives its water from the Green River; the intake and treatment plant are located approximately 0.75 mile upstream of the Browns Wash confluence.

3.1.6 Existing quality of ground water, including other sources of contamination and their cumulative impact on ground water quality. Background ground water quality in the Browns Wash alluvium is variable, but generally poor due to the presence of elevated concentrations of nitrate and sulfate unrelated to processing activities. Uranium is also present but at concentrations below the ground water MCL. Elevated contaminant concentrations may be affected by septic and agricultural waste, but are most likely due to natural sources. The background concentrations are insignificant compared to the elevated concentrations of contaminants in the reach of Browns Wash alluvium affected by processing activities.

Background ground water quality in the Cedar Mountain Formation aquifers in close proximity (upgradient) of the site is generally consistent and meets EPA ground water standards, and there are no known sources of contamination outside of the former processing site (see Section 5.3.1 of the SOWP). If lateral ground water flow occurs at the site and if some vertical leakage occurs from the uncontaminated basal unit aquifer due to the upward hydraulic gradient, then it is possible that dilution of the contaminated middle sandstone unit aquifer could occur over a long but undetermined period of time.

3.1.7 Potential for health risks caused by human exposure to constituents. There are no unacceptable risks to human health associated with the site because there is no human exposure to the ground water, and the ground water is not being used, or projected to be used, for any purpose (see Section 6.1 of the SOWP).

3.1.8 Potential damage to wildlife, crops, vegetation, and physical structures caused by exposure to constituents. The Green River site is highly disturbed from past use and subsequent remediation activities. The overall potential risk to all receptors was determined to be very low (see Section 6.2 of the SOWP).

3.1.9 Persistence and permanence of potential adverse effects. Contaminant levels in ground water in the Cedar Mountain Formation could remain elevated for a number of years, particularly uranium levels. However, no adverse effects from existing contamination have been observed, and no adverse effects are expected as ground water contamination concentrations will likely attenuate over time.

3.1.10 Presence of underground sources of drinking water and exempted aquifers identified under §144.7 of this chapter [i.e., 40 CFR Part 144.7]. There are no current sources of drinking water or exempted aquifers that can be affected by contamination at the site. The main source of domestic water is surface water from the Green River, which is unaffected by site-related contamination.

3.2 Potential Adverse Effects on Hydraulically Connected Surface Water Quality

3.2.1 Volume and physical and chemical characteristics of the residual radioactive material at the site. The stabilized disposal cell at the site contains 382,000 cubic yards of compacted uranium mill tailings and residual radioactive material. The calculated total activity of radium-226 in the cell is 30 curies.

3.2.2 Hydrogeological characteristics of the site and surrounding land. See Section 3.1.2 above.

3.2.3 Quantity and quality of ground water and the direction of ground water flow. The quality of ground water in Browns Wash is affected by residual contamination from the former mill tailings pile. This effect is expected to continue for an indeterminate period of time due to the low ground water flow velocity in the alluvial ground water flow system. Browns Wash is an ephemeral stream that usually flows only during heavy rainstorms. The effect that contaminated alluvial ground water has on surface water is proportional to the quantity of surface water flow in Browns Wash.

Ground water from the middle sandstone unit of the Cedar Mountain Formation may discharge to the Green River alluvium. Average monthly surface water discharge in the Green River ranges from 2,300 to greater than 18,000 cfs near the City of Green River. Because of the high dilution rate, neither the former mill site nor the disposal cell have had any measurable impact on the quality of water in the Green River. (Section 3.6, Mod. No. 2 RAP).

3.2.4 Patterns of rainfall in the region. Annual precipitation averages approximately 6 inches. Rainfall occurs during the summer and fall in high-intensity, short-duration, late afternoon thunderstorms that are conducive to runoff. Winter precipitation occurs as snowfall.

3.2.5 Proximity of the site to surface waters. The ephemeral Browns Wash is north of the site and discharges into the Green River. The Green River is approximately 0.5 mile west of the site.

3.2.6 Current and future uses of surface waters in the region surrounding the site and any water quality standards established for those surface waters. The Green River is the primary source of drinking water for the City of Green River area. The water intake station and treatment plant are approximately 0.75 mile upstream of the confluence of Browns Wash; consequently, the municipal water supply is not affected by contaminants at the Green River site. State water rights records indicate that there are several irrigation surface diversion points a short distance upstream and downstream of the Browns Wash confluence. Surface water standards for the river are established by the State of Utah, and the river meets these standards in the vicinity of the site.

3.2.7 Existing quality of surface water, including other sources of contamination and the cumulative impact on surface water quality. Water in the Green River in the vicinity of the site is designated high quality by the State of Utah. The site has no measurable effect on the surface water quality of the Green River.

3.2.8 Potential for health risks caused by human exposure to constituents. There are no unacceptable risks to human health associated with the site because of the intermittent nature of water in Browns Wash and the lack of use. Neither is there any excess human health risk associated with site-derived contamination impacting surface water in the Green River.

3.2.9 Potential damage to wildlife, crops, vegetation, and physical structures caused by exposure to constituents. There is no potential damage as site contamination has no impact on water quality of the Green River. The ecological risk assessment showed that the potentially elevated concentrations in ponded water in Browns Wash from storm runoff or ground water seeps would have no adverse effect on potential receptors, including wildlife and vegetation (Section 6.2 of the SOWP).

3.2.10 Persistence and permanence of the potential adverse effects. No adverse affects are currently present in the Green River or in Browns Wash, and none are expected in the future.

4.0 Roadmap to the SOWP and Additional Information

4.1 General Information

Introduction—Section 1.0 of SOWP

Facility Description—Section 3.0 of SOWP

Extent of Ground Water Contamination—Sections 5.2 and 5.3 of SOWP

Proposed Alternate Concentration Limits—Section 3.2 of GCAP

Hazard Assessment—Generally corresponds to Section 6 of the SOWP, which contains human health and ecological risk assessments

Source and Contamination Characterization—Sections 5.2 and 5.3 of SOWP

Transport Assessment—Section 5.3.5 of SOWP

Exposure Assessment—Section 6.1 of the SOWP for human health; Section 6.2 of SOWP for ecological risk

Corrective Action Assessment—Included in this Appendix to the GCAP

4.2 Results of Corrective Action Program

Surface remediation at the Green River site commenced in November 1988 and was completed in September 1989. Tailings and other contaminated surface material totaling approximately 382,000 cubic yards were placed in a disposal cell located onsite.

DOE, the State of Utah, and Umetco Minerals Corporation currently own property underlain by site-related ground water contamination. An environmental covenant will be implemented for the land affected by site contamination that prohibits use of ground water for any purpose, without the permission of both DOE and the State of Utah, on the land affected by ground water contamination. This restriction is essentially perpetual, though it can be lifted once concentrations have decreased to levels that permit unrestricted use.

4.3 Feasibility of Alternative Corrective Actions

DOE has performed remedial action at the Green River site to mitigate exposures to contaminated soil. The corrective action assessment in this Appendix to the GCAP indicates that active remediation of contaminated ground water would be complicated and expensive and would provide no economic benefit or reduction in risk to human health and the environment. The disposal cell at the site will remain indefinitely and ensures that institutional controls will be observed. Therefore, ACLs are proposed for constituents monitored at the POC wells that have concentrations that could remain elevated for the life of the disposal cell.

4.4 Corrective Action Costs and Benefits

Corrective action cleanup costs were not estimated for the Green River site because there was no reasonable scenario for active ground water remediation. Generally, active remediation of the uppermost aquifer would be complicated and expensive because of the thinness of the aquifer and the overall lack of water. The limited extent of the aquifer makes it a limited resource as well. No one is currently using the aquifer and there are no plans to use it in the future. Therefore, remediation of the uppermost aquifer to reduce concentrations of contaminants provides no real benefit.

4.5 ALARA Demonstration

The general aim of achieving a cleanup goal that is ALARA is satisfied by applying ACLs that are more conservative than permissible based on likely dilution at the POE. It would not be reasonable to pursue active remediation of ground water for the negligible risk reduction that could be realized, particularly considering the availability of an alternative water source (the Green River), that ground water in the vicinity of the site is not used as a water source, and environmental covenants that will prohibit ground water use.

4.6 Proposed Alternate Concentration Limits

Proposed Alternate Concentration Limits—Section 3.2 of GCAP; Section 2.2 of Appendix A

Proposed Implementation Measures—Section 7.3 of SOWP; Section 4.0 of GCAP

References—Section 8.0 of SOWP

Appendixes and Supporting Information—Appendixes A through G of SOWP

5.0 References

10 CFR Part 40. U.S. Nuclear Regulatory Commission, "Domestic Licensing of Source Material," *Code of Federal Regulations*, January 1, 2001.

40 CFR Part 192. U.S. Environmental Protection Agency, "Health and Environmental Protection Standards for Uranium and Thorium Mill Tailings," *Code of Federal Regulations*, July 1, 2001.

Colorado Department of Public Health and Environment (CDPHE), 2002. Water Quality Control Commission Regulation 35, "Classifications and Numeric Standards for Gunnison and Lower Dolores River Basins," February 20.

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Suter, G.W., II, and C.L. Tsao, 1996. Toxicological Benchmarks for Screening Potential Contaminants of Concern for Effects on Aquatic Biota, 1996 Revision, prepared by the Risk Assessment Program Health Sciences Research Division, Oak Ridge, Tennessee, ES/ER/TM-96/R2, June.

Umetco Minerals Corporation, (Umetco) 2003. Application for Alternate Concentration Limits, Uravan Project Site, July.

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———, 1998a. *Modification No. 2 to the Remedial Action Plan and Site Design for Stabilization of the Inactive Uranium Mill Tailings Site at Green River, Utah*, Final, DOE/AL/62350-050510, March.

———, 1998b. *Long-Term Surveillance Plan for the Green River, Utah Disposal Site*, DOE/AL/62350-89, Rev. 2, July.

———, 2002. *Final Site Observational Work Plan for the Green River, Utah, UMTRA Project Site*, GJO-2002-356-TAC, September.

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———, 1988. Guidance on Remedial Actions for Contaminated Ground Water at Superfund Sites, OSWER Directive9283.1-2, EPA 540 G-88 003, December.

———, 1990. EPA Superfund Record of Decision: Pickettville Road Landfill, EPA/ROD/R04-90/075, September.

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

———, 1995. Groundwater Standards for Remedial Actions at Inactive Uranium Processing Sites, Final Rule, 60FR2854, January 11, 1995.

———, 1996, ECO Update, Ecotox Thresholds, Volume 3, Number 2, EPA540/F-95/038, January.

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———, 2002a. 2002 Editions of the Drinking Water Standards and Health Advisories, EPA822-R-02-038, Summer.

U.S. Environmental Protection Agency (EPA), 2002b. National Recommended Water Quality Criteria: 2002. EPA 822-R-02-047, November.

———, 2002c. Announcement of Preliminary Regulatory Determinations for Priority Contaminants on the Drinking Water Contaminant Candidate list, 67 FR 38222, June 3, 2002.

———, 2002d. Drinking Water Advisory: Consumer Acceptability Advice and Health Effects Analysis on Sulfate, EPA 822-R-02-033, April.

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Appendix B

Hydrograph and Time-Concentration Plots

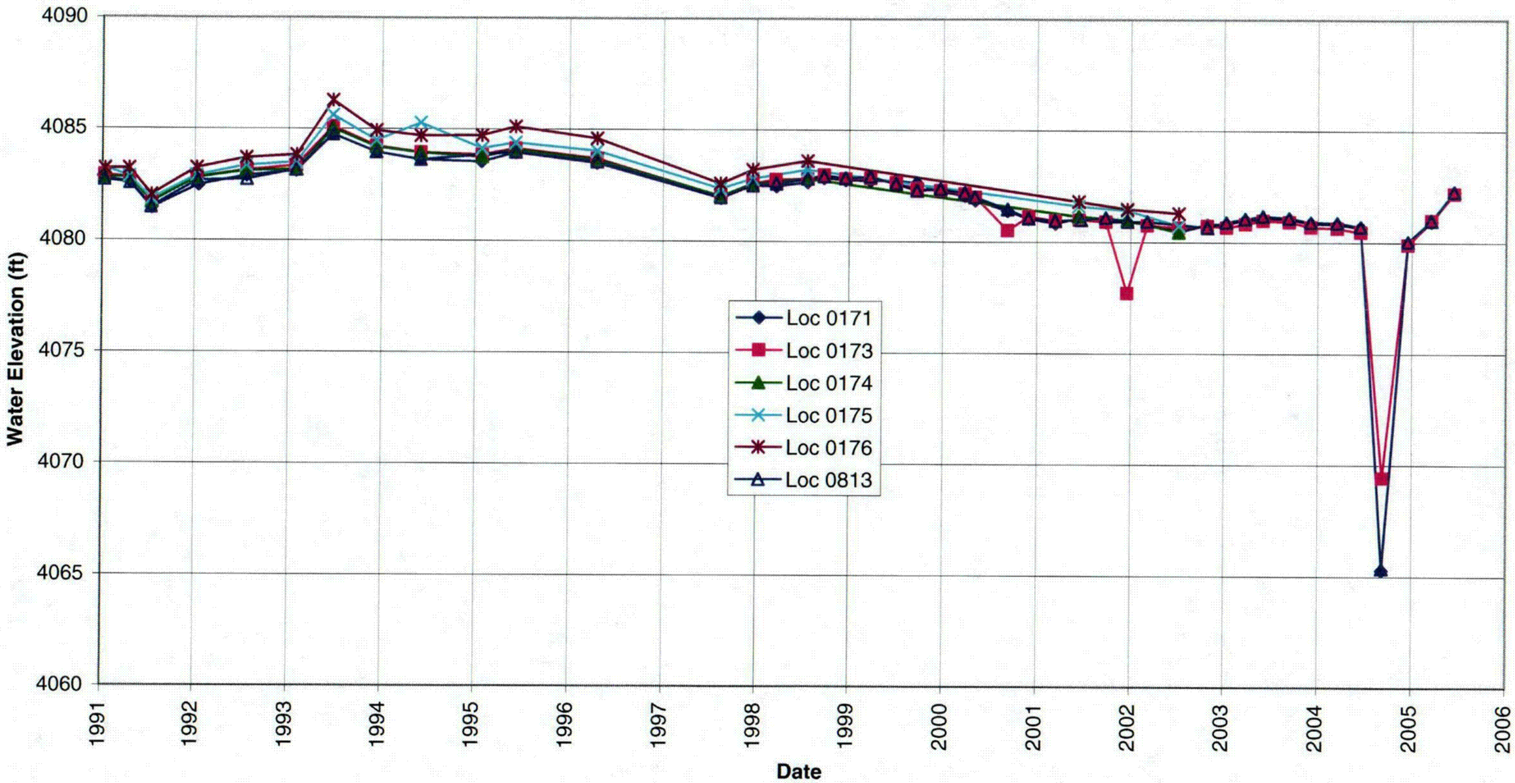

Figure B–1. Hydrograph of the Middle Sandstone Unit of the Cedar Mountain Formation at the Green River, Utah, Disposal Site

C04

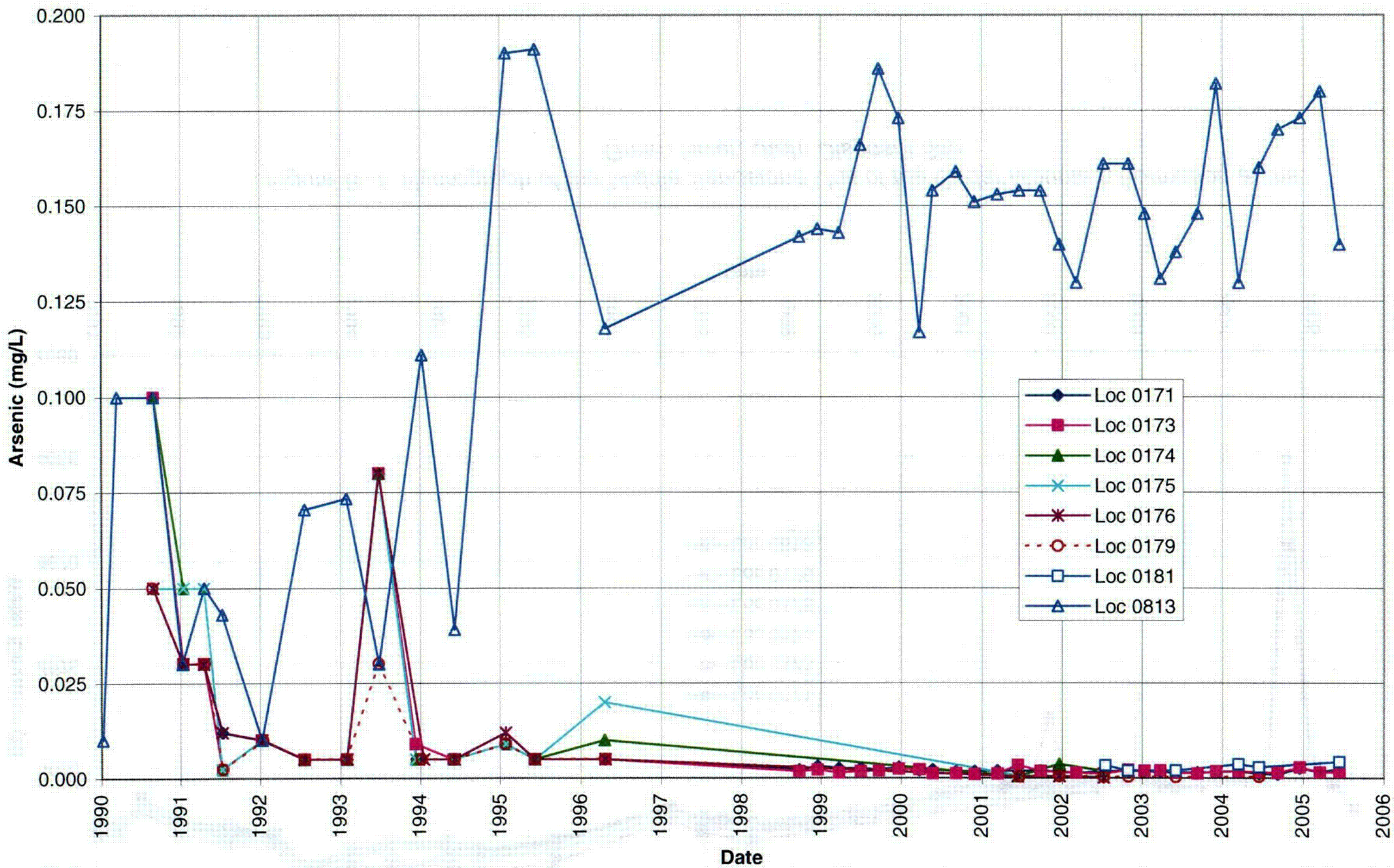

Figure B–2. Time-Concentration Plots of Arsenic in Ground Water at the Green River, Utah, Disposal Site

C05

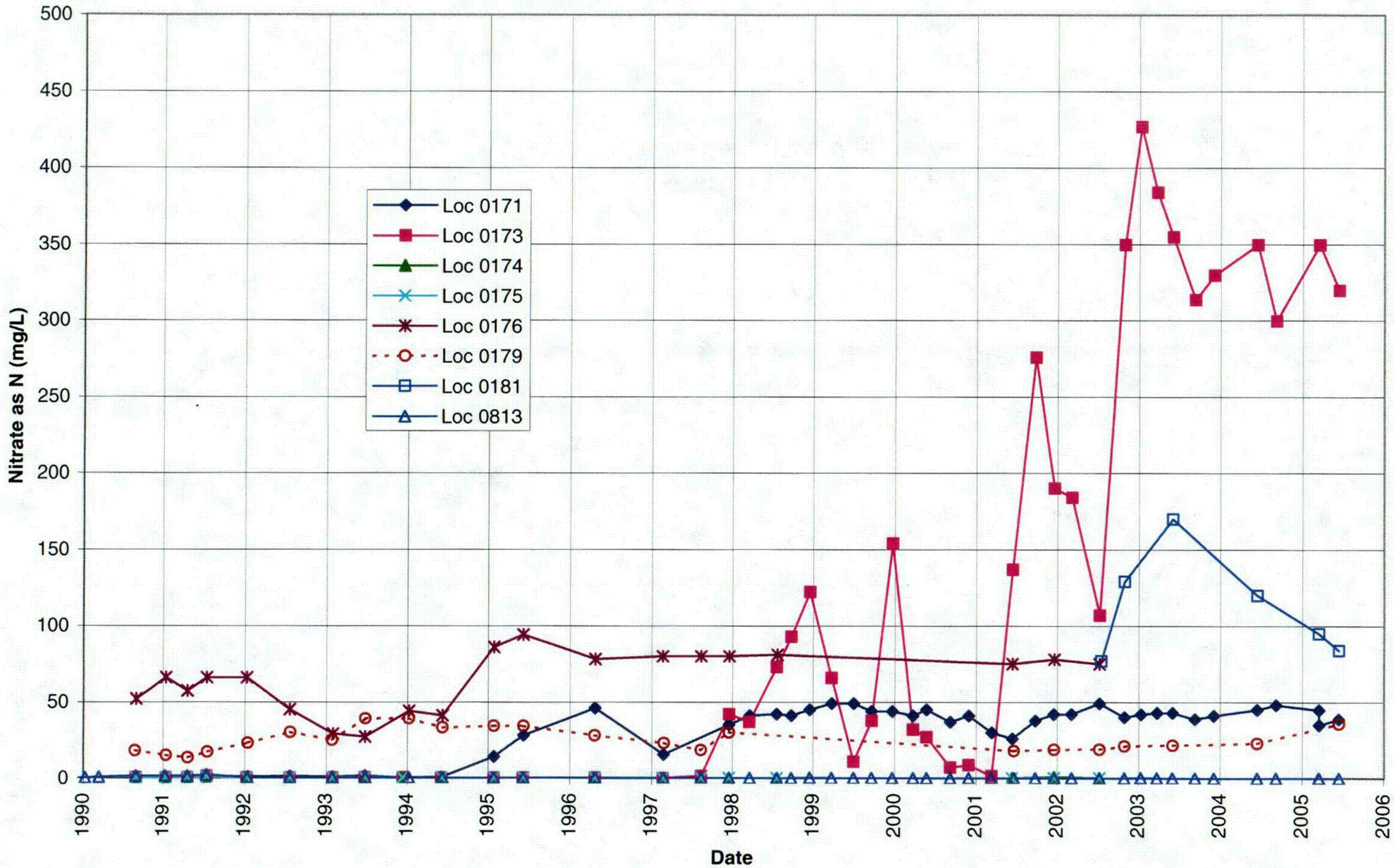

Figure B–3. Time-Concentration Plots of Nitrate (as N) in Ground Water at the Green River, Utah, Disposal Site

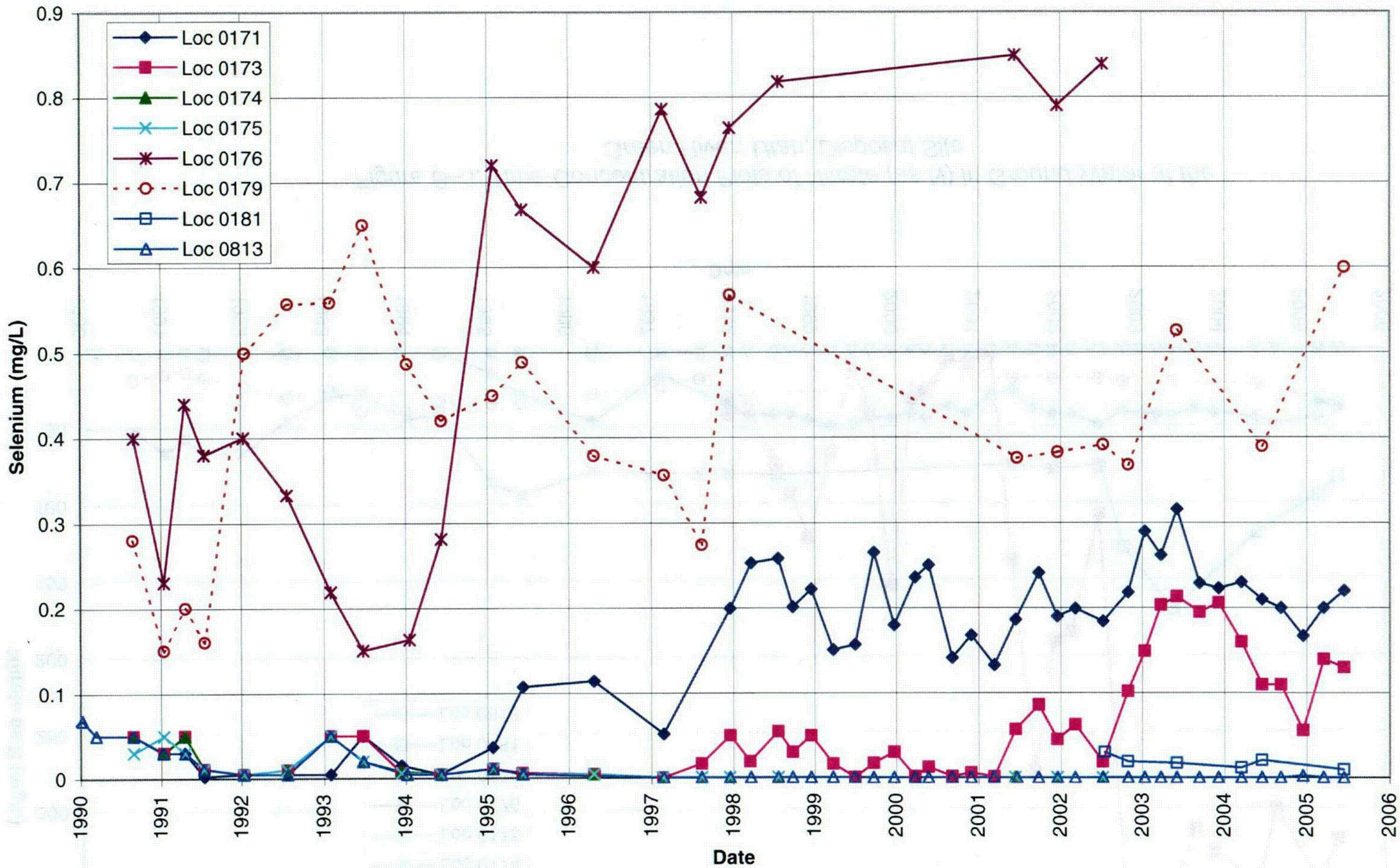

Figure B–4. Time-Concentration Plots of Selenium in Ground Water at the Green River, Utah, Disposal Site

C07

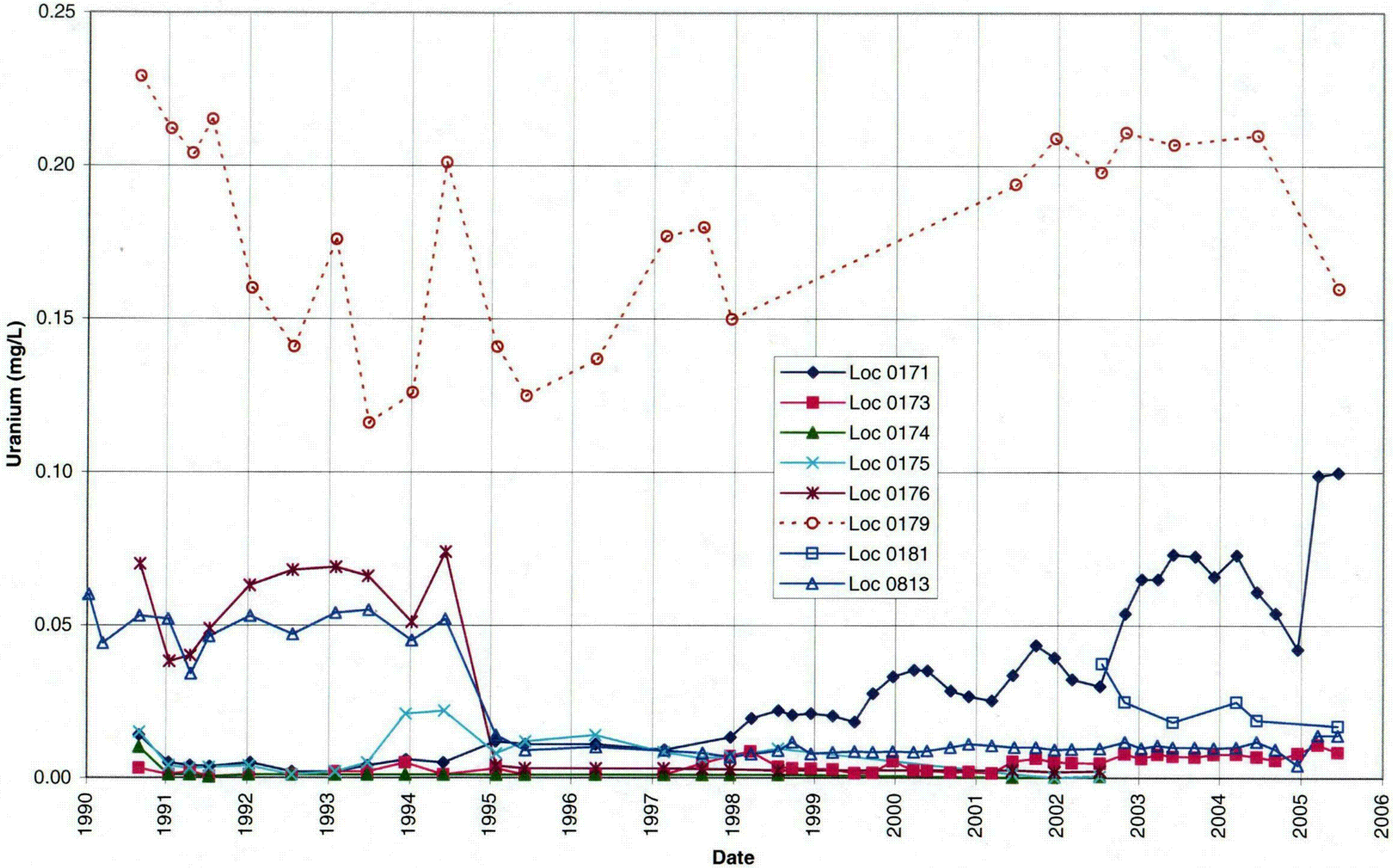

Figure B–5. Time-Concentration Plots of Uranium in Ground Water at the Green River, Utah, Disposal Site

C08

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Appendix C

Environmental Notice and Institutional Control

After recording, return to:

Mr. Rahe Junge
Umetco Minerals Corporation
2754 Compass Drive, Suite 280
Grand Junction, CO 81506

With Copies to:

Division Director
Division of Environmental Response and Remediation
Utah Department of Environmental Quality
168 North 1950 West
P.O. Box 144840
Salt Lake City, UT 84114-4840
Facility No.________________
Location:________________

Richard P. Bush
Green River Site Manager
U. S. Department of Energy
2597 B ¾ Road
Grand Junction, CO 81503

ENVIRONMENTAL NOTICE AND INSTITUTIONAL CONTROL

Pursuant to the Utah Environmental Institutional Control Act (Utah Code Sections 19-10-101, et seq.), Umetco Minerals Corporation (Owner), owner of property adjacent to the former Green River processing site (Property) in Grand County, State of Utah; more particularly described on Attachment A which is attached hereto and by this reference made a part hereof, hereby makes and imposes upon the Property the following described Institutional Controls, subject to the terms and conditions herein stated:

1. Notice is hereby given that the Property is or may be contaminated with the radioactive and other contaminates of concern as described below and, therefore, Institutional Controls must be imposed to mitigate the risk to the human health, safety, and/or the environment:

The uranium mill at the Green River site was constructed in 1957 and operated until 1961. The estimated 137,000 tons of tailings generated from the milling process were originally deposited onsite on the Browns Wash alluvial floodplain in a 7-foot-thick pile covering approximately 9 acres.

Remedial action began in 1988 and was completed in 1989 under the Uranium Mill Tailings Radiation Control Act (42 U.S.C. 7901-7942). Approximately 382,000 cubic yards of compacted residual radioactive material from the original tailings pile, from demolished or decontaminated buildings, and from contaminated vicinity properties were placed in a 6-acre unlined engineered disposal cell located on a bedrock terrace immediately south of the original tailings pile. The U.S. Department of Energy (DOE) owns 26 acres of land on which the disposal cell is located. The remainder of the former millsite is owned by the State of Utah, and the State property encompasses the DOE property.

Former uranium processing activities and the disposal cell appear to have contaminated the ground water in the Browns Wash alluvium and the middle sandstone unit of the Cedar Mountain Formation beneath the former millsite. Constituents with concentrations above U.S. Environmental Protection Agency standards or relevant benchmarks in the Browns Wash alluvium include ammonia, manganese, nitrate, selenium, sodium, sulfate, and uranium. With the exception of ammonia and manganese, these constituents are elevated above a standard or risk-based concentration for human health in the ground water aquifer of the middle sandstone unit of the Cedar Mountain Formation (the uppermost aquifer). Arsenic also occurs in elevated concentrations in this aquifer. Ground water monitoring indicated there is contamination present beneath properties owned by DOE, the State of Utah, and Umetco Minerals Corporation. Attachment B shows the properties subject to the Institutional Controls under this Notice.

2. Use of the Property is hereby restricted by the following Institutional Controls:

Within the Institutional Controls boundary shown on Attachment B, no wells will be drilled for any purpose and ground water will not be used for any purpose without the expressed written consent of the State of Utah Department of Environmental Quality (UDEQ) and DOE.

At least 30 days prior to commencement of any construction on the Property or any improvements to the Property, the Owner shall provide written notification of such activity to the Director, UDEQ Division of Environmental Response and Remediation (DERR). Such notification shall describe in detail any construction or improvement plans and a schedule of the activities to take place on the Property. Within thirty (30) days after receipt of such notification, the Director of DERR shall notify the Owner whether the proposed activities meet the requirements of the Institutional Controls and are, therefore, approved or whether the plans must be redesigned to meet the requirements of the Institutional Controls. Construction, improvements, or drilling shall not commence until the Director of DERR has approved the activities. Upon completion of activities, the Owner shall submit a certificate of completion stating that all activities were conducted in accordance with the Institutional Controls described above.

3. The Institutional Controls described above shall be maintained in perpetuity as follows unless terminated or modified as provided in Utah Code Section 19-10-105:

The Property within the Institutional Controls boundary will be visually inspected by DOE at the time of the annual disposal site inspection for evidence of unauthorized well drilling or ground water use. In addition, DOE will contact the State of Utah, Division of Water Rights, on an annual basis to verify that no drilling permits have been issued without the approval of UDEQ and DOE. Results of these activities will be included in the annual compliance report that DOE prepares for the U.S. Nuclear Regulatory Commission, a copy of which is provided to UDEQ.

4. The Institutional Controls run with the land and are binding on all successors in interest of the Owner unless or until they are removed as provided in Utah Code Section 19-10-105 and the following stipulation:

If concentrations of the constituents have decreased to allow other uses, this restriction can be altered or terminated at the request of the property owner. Such request must be approved by UDEQ and DOE.

5. The Executive Director of UDEQ, or designated representative, shall have access to the Property at all reasonable times to verify that these Institutional Controls are being maintained and that the Party or Parties in possession of the Property are complying with the Institutional Controls.

6. These Institutional Controls may be enforced and/or protected as provided in Utah Code Section 19-10-106.

7. Instruments that convey any interest in the Property (fee, leasehold, easement, etc.) shall contain a notification to the person or entity that acquires the interest that the Property is subject to this Environmental Notice and Institutional Control and shall identify the specific place at which it is recorded.

8. This Institutional Control may be terminated in accordance with the provisions if Utah Code Section 19-10-105 and with prior written approval of the Executive Director of UDEQ and DOE.

EXECUTED as of the _____ day of _______________, 20__.

____
Owner

Signature boilerplate follows

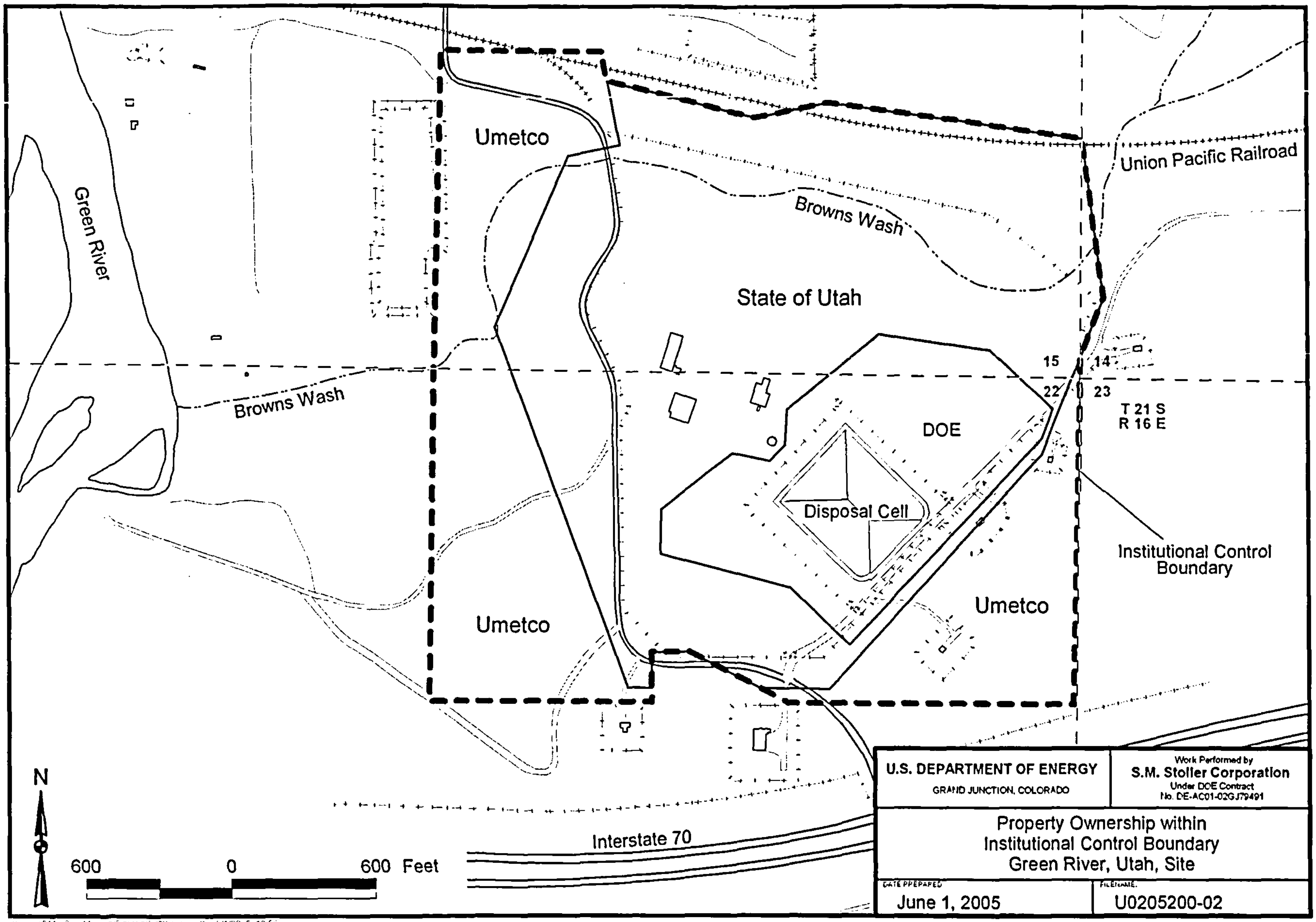
Attachment A

The following property parcels, owned by Umetco Minerals Corporation and successor owners, are subject to this Environmental Notice and Institutional Control:

Township 21 South, Range 16 East, Section 15, Lots 1, 10, and 11; and

Township 21 South, Range 16 East, Section 22, Lots 8 and 9.

Attachment B



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