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UMTRA
Ground Water Project

Verification Monitoring Report for the Durango, Colorado, UMTRA Project Site

September 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
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Acronyms and Abbreviations

ACL	alternate concentration limit
BLRA	Baseline Risk Assessment
CDPHE	Colorado Department of Public Health and Environment
COPC	contaminant of potential concern
DOE	U.S. Department of Energy
EPA	U.S. Environmental Protection Agency
ft	foot (feet)
ft^3/day	cubic feet per day
GCAP	Ground Water Compliance Action Plan
ICs	institutional controls
LTS&M	Long-Term Surveillance and Maintenance
MCL	maximum concentration limit
mg/L	milligram per liter
NRC	U.S. Nuclear Regulatory Commission
PEIS	Programmatic Environmental Impact Statement
POC	point of compliance
UMTRA	Uranium Mill Tailings Remedial Action (Project)
UMTRCA	Uranium Mill Tailings Radiation Control Act

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1.0 Introduction

The Durango Uranium Mill Tailings Remedial Action (UMTRA) Project site is in La Plata County outside the Durango city limits about 0.25 mile from the central business district (Figure 1). The site consists of two separate areas: (1) a mill tailings area, which historically provided the setting for uranium and vanadium milling operations and mill tailings piles, and (2) a raffinate ponds area, which historically contained mill-related waste ponds. The mill tailings area encompasses about 40 acres on a bedrock-supported river terrace between Smelter Mountain to the west, the Animas River to the east and south, and Lightner Creek to the north (Figure 2). The raffinate ponds area occupies about 20 acres on another river terrace 1,500 feet (ft) south of the mill tailings area.

1.1 Purpose of Report

The purpose of this Verification Monitoring Report is to evaluate ground water and surface water monitoring data collected since 2002 at the mill tailings area of the Durango, Colorado, UMTRA Project site and assess the status of the natural flushing compliance strategy for ground water cleanup. The compliance strategy for the raffinate ponds area at the Durango site is no further action in conjunction with the application of supplemental standards, and therefore, the raffinate ponds area is not addressed in this report.

1.2 Compliance Strategy

The compliance strategy for ground water cleanup at the Durango, Colorado, site is described in the *Preliminary Final Ground Water Compliance Action Plan* (GCAP) (DOE 2003) and is based on the compliance strategy selection framework presented in the *Final Programmatic Environmental Impact Statement for the Uranium Mill Tailings Remedial Action Ground Water Project* (PEIS) (DOE 1996). The compliance strategy at the mill tailings area is natural flushing in conjunction with institutional controls (ICs) and compliance monitoring. This strategy includes natural flushing to an alternate concentration limit (ACL) for selenium. Public health will be protected during the natural flushing process through an environmental covenant between the State of Colorado and the City of Durango (landowner), which will restrict access to contaminated alluvial ground water. Additionally, deed restrictions (which serve as a notice to the public) for the mill tailings area contain language that prohibits access to ground water without written permission of the U.S. Department of Energy (DOE) and the Colorado Department of Public Health and Environment (CDPHE). The Long-Term Surveillance and Maintenance (LTS&M) Program will ensure that ICs remain in place throughout the natural flushing period at the mill tailings area.

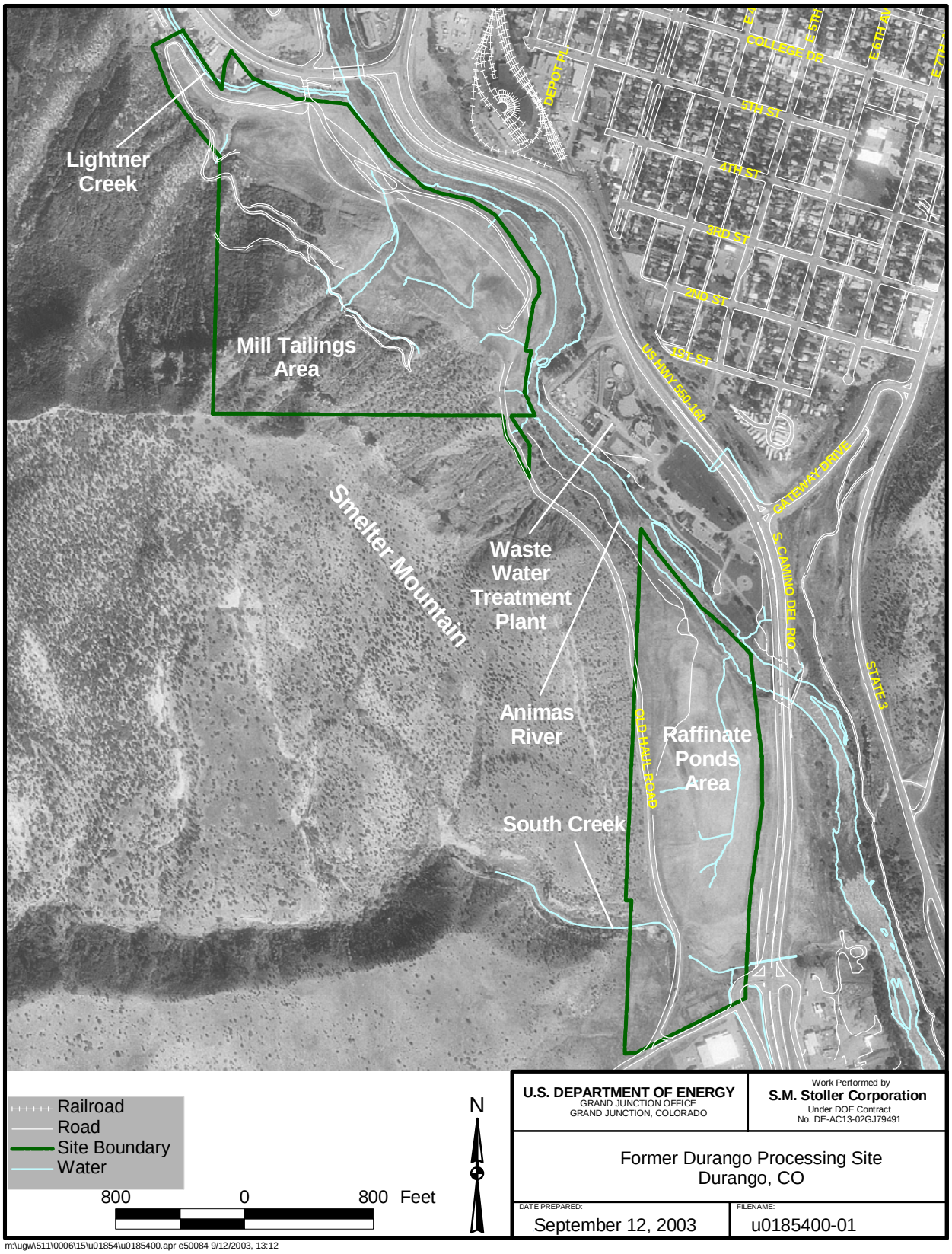

Figure 1. Durango UMTRA Project Site

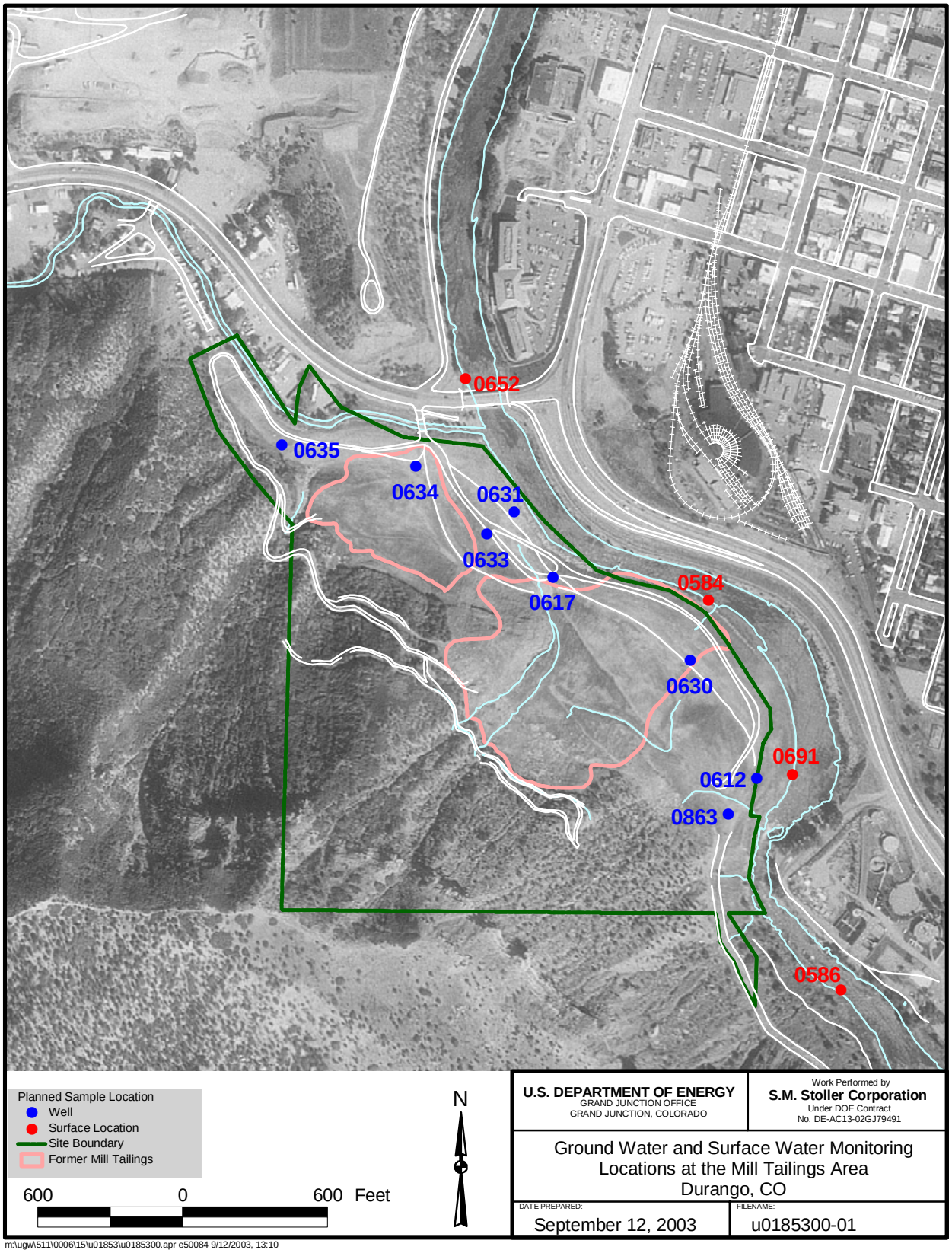

Figure 2. Durango UIMTRA Project Site Mill Tailings Area

2.0 Site Conditions

2.1 Hydrogeology

The uppermost ground water at the mill tailings area is in an unconfined alluvial aquifer, which receives recharge from infiltration of precipitation, runoff, and by contact with the Animas River and Lightner Creek. Depth to the water table ranges from about 10 to 60 ft; the base of the aquifer is in contact with Mancos Shale bedrock. Along the base of Smelter Mountain, the bedrock is overlain by up to 70 ft of colluvium, which consists of poorly sorted silty soil from Smelter Mountain. Closer to Lightner Creek and the Animas River, deposits of alluvial sand and gravel up to 15 ft thick overlie the shale bedrock. The saturated zone is generally thin in the mill tailings area, ranging up to 7 ft in thickness over most of the site.

Ground water in the colluvium near the base of Smelter Mountain is recharged primarily by runoff and infiltrating precipitation. Sand and gravel deposits receive recharge from Lightner Creek and the Animas River. During spring runoff, when the river stage is high, water flows into the aquifer. When the river stage is lower, the ground water flows from the aquifer into the Animas River. The volume of ground water discharge from the mill tailings area into the Animas River is estimated to be 1,480 cubic feet per day (ft^3/day); discharge into Lightner Creek is estimated to be 840 ft^3/day (DOE 2002). Ground water in the alluvial aquifer generally flows to the southeast with an average gradient of approximately 0.02 foot per foot. Hydraulic conductivity ranges from 10 to 70 ft per day.

Ground water in the alluvial aquifer beneath the mill tailings area was contaminated as the result of uranium processing activities. The former large and small tailings piles and residual radioactive material beneath the piles were cleaned up to meet the U.S. Environmental Protection Agency (EPA) standards for radium in soil. Supplemental standards were applied to steep slopes of Smelter Mountain and some areas along the banks of the Animas River. Erosion-protective riprap was placed over a uranium-contaminated lens under the lead slag where it surfaces on the Animas River bank. Following removal of contaminated material at the site, uncontaminated soil was backfilled and contoured for site drainage and seeded with natural vegetation.

2.2 Water Quality

Contamination of the alluvial aquifer occurred primarily as a result of historical uranium-ore processing activities. Following completion of surface remediation in 1991, concentrations of arsenic, cadmium, lead, molybdenum, net alpha, radium-226+228, selenium, and uranium continued to exceed UMTRA Project maximum concentration limits (MCLs) on-site (directly below the mill tailings area). In the last 11 years, arsenic, lead, and radium have decreased to levels below MCLs, and net alpha has been detected only sporadically in a few wells.

Currently only uranium, selenium, cadmium, and molybdenum are present in the ground water at levels that exceed MCLs. In addition, sulfate and manganese, which have no MCLs, are present in the ground water at levels that exceed the average background concentration and the risk-based concentration, respectively. Monitor well 0612 is the only location where cadmium and molybdenum exceed their MCLs and manganese exceeds the risk based benchmark at the mill tailings area.

Historically, monitor well 0612 has shown the highest levels of contamination. This well is completed through slag from an old lead smelter that operated on the site from 1880 to 1930. The slag in this area is 20- to 30-ft thick, and the presence of cadmium, molybdenum, and uranium in the well is believed to be associated with alluvial material below the slag that remained in place after surface remediation.

Although some of the selenium concentrations at the mill tailings area may be a result of past ore-processing activities, elevated concentrations also can be attributed to naturally occurring selenium, as evidenced by the concentrations above the MCL in background wells 0857 and 0866. Selenium has been detected at concentrations up to 0.011 milligrams per liter (mg/L) in background well 0857 and up to 0.0148 mg/L in background well 0866. Historical results indicate that concentrations of all other uranium-ore processing related constituents are below UMTRA MCLs in background locations.

In addition to ground water monitoring, DOE monitors surface water upgradient, adjacent to, and downgradient of the mill tailings area. All results, to date, from Lightner Creek and the Animas River verify previous observations in the *Baseline Risk Assessment of Ground Water Contamination at the Uranium Mill Tailings Site near Durango, Colorado* (BLRA) (DOE 1995) that past milling operations have had very little effect on surface water quality. Historical surface water results adjacent to and downgradient of the mill tailings area indicate constituent concentrations did not exceed CDPHE surface water quality standards for aquatic life, with the exception of manganese. Manganese occasionally has been detected at concentrations above the water quality standard at several locations. However, manganese levels also have exceeded the standard in the upgradient background surface water locations on the Animas River. Manganese concentrations from downgradient surface water locations have not exceeded the maximum observed concentrations from the upgradient background locations.

2.3 Remediation Activities

In 1978, the Uranium Mill Tailings Radiation Control Act (UMTRCA) (42 U.S. Code Section 4321 et seq.) was enacted to control and mitigate risks to human health and the environment from residual radioactive material that resulted from processing uranium ore. UMTRCA authorized DOE to perform remedial action at 24 inactive uranium-ore processing sites; subsequently, two sites were deleted from the project. The Durango site was one of the 22 sites identified for cleanup. After completing an Environmental Impact Statement (DOE 1985), DOE began surface cleanup of the mill tailings and raffinate ponds areas in November 1986. A total of 2.5 million cubic yards of contaminated material was relocated to the Bodo Canyon disposal cell several miles southwest of the Durango site. Following removal of the contaminated material, approximately 230,000 cubic yards of uncontaminated soil was backfilled, contoured, and seeded. Remedial action was completed in May 1991, and today, a healthy stand of grass covers both areas.

2.4 Land and Water Use

Potential development plans for the mill tailings area include construction of a park, visitor's center, parking lots, and a museum or other type of public building. There are no plans to develop the site for residential use (DOE 2002).

Durango's primary water source is the Florida River; additional water is taken from the Animas River during high-demand periods (usually during the summer). The pumping station for this Animas River water is about 2 miles upstream of the mill tailings area. Although the City is considering developing additional water resources to supplement the current supply, ground water has not been considered as a water source for the municipal system. Ground water in the area is considered to be of poor quality because of elevated levels of hardness, iron, manganese, and hydrogen sulfide (DOE 2002).

Portions of the Animas River that border the mill tailings area of the Durango site are used for recreation during the warmer months. Kayaking and rafting are common in this stretch of the river when a sufficient volume of water is flowing, and trout fishing is popular during times of lower flows.

3.0 Monitoring Program

3.1 Monitoring Network

Verification monitoring is to be performed annually for the first 5 years after U.S. Nuclear Regulatory Commission (NRC) concurrence with the GCAP to ascertain that natural flushing is progressing as predicted by ground water flow and transport modeling (DOE 2003).

Natural flushing will be considered complete after a contaminant of potential concern (COPC) is below its respective benchmark (MCL, ACL, or background) for three consecutive annual sampling events. After 5 years (2007) a Confirmation Report will be prepared and the site will be turned over to the LTS&M Program for long-term management. The site will be transferred to LTS&M with a Long-Term Management Plan that requires annual monitoring for an additional 5 years (until 2012) for cadmium.

Standards for molybdenum and uranium are the UMTRA MCLs of 0.1 mg/L and 0.044 mg/L, respectively. The cleanup goal for selenium is 0.05 mg/L, which is the standard in EPA's Safe Drinking Water Act. Monitoring for these three contaminants will continue annually for the next 5 years to verify modeling results, that is, that concentrations are decreasing. Monitoring for cadmium will continue on an annual basis for 10 years and focus on observing trends in well 0612, to establish a larger database to support future modeling efforts, and to ensure that human health risks remain minimal. Cadmium also will be analyzed in samples from Animas River surface water locations adjacent to the site and downgradient, to verify that there continues to be no ecological risks in the Animas River. Monitoring requirements are summarized in Table 1.

To determine when natural flushing is complete, wells 0612, 0617, 0630, 0631, 0633, 0634, 0635, and 0863 have been established as point-of-compliance (POC) wells. These wells will be used for monitoring progress of natural flushing in the alluvial aquifer; and natural flushing will be considered complete when the concentrations of COPCs in the POC wells no longer exceed their compliance standard. Well 0612 sample results also will be used to verify that cadmium concentrations continue to decrease as expected. The ground water and surface water monitoring locations are shown on Figure 2.

Surface water locations 0652, 0584, 0691, and 0586 along the Animas River also will be monitored to verify that the natural flushing strategy is protective of the environment.

Table 1. Summary of Ground Water and Surface Water Monitoring Requirements at the Mill Tailings Area

Sampling Location	Monitoring Purpose	Analytes	Location
0617, 0630, 0631, 0633, 0634, 0635	Point of compliance monitoring of plume migration on site.	Manganese Molybdenum Selenium Sulfate Uranium	On site
0612, 0863	Verify decrease in cadmium concentrations	Cadmium Manganese Molybdenum Selenium Sulfate Uranium	Downgradient
0652	Surface water background	Cadmium Molybdenum Selenium Uranium	Off site, upgradient
0584, 0586, 0691	Downgradient surface water concentrations		Off site, downgradient

3.2 Results of Monitoring Program

The GCAP (DOE 2003) describes a ground water flow and transport model that was developed to evaluate natural processes and their ability to reduce concentrations of site-related constituents to regulatory levels in the alluvial aquifer within 100 years. Forecasts of cadmium, manganese, molybdenum, selenium, sulfate, and uranium concentrations were developed for a 100-year planning horizon.

Modeling results predict that (1) concentrations of molybdenum will decrease below the UMTRA Project standard within 5 years; (2) uranium concentrations will decrease to below the UMTRA project standard after 80 years; (3) manganese and sulfate concentrations will decrease below their risk-based and background levels in 70 years and 100 years, respectively (there are no UMTRA Project standards for manganese and sulfate); (4) selenium concentrations will decrease from 0.078 to 0.025 mg/L within 100 years, and therefore, decline below the alternate concentration limit (ACL) of 0.05 mg/L; and (5) cadmium is not forecasted to flush naturally within 100 years from the area around monitor well 0612. A plan was developed whereby cadmium would be monitored for 10 years at well 0612. If a downward trend in concentration is observed which exceeds the model-forecasted rate, then natural flushing will likely succeed in meeting the UMTRA Project standard of 0.01 mg/L within 100 years. If not, then the risks associated with cadmium near well 0612 will be reevaluated, and contingency remedies will be considered and implemented.

Results of two monitoring events (June 2002 and June 2003) have been added to the database since the GCAP was issued and are used to evaluate the effectiveness of natural flushing. In addition, trends in concentration observed since surface-remedial action was completed in 1991 are also used to evaluate the effectiveness of natural flushing. Constituents that exceed the compliance criteria above are described in the following paragraphs.

Cadmium exceeds the UMTRA standard of 0.01 mg/L only at well 0612; the remaining monitor wells contain only trace levels of cadmium. Figure 3 presents a map of the posted cadmium concentrations for June 2003. The transport model results suggest that cadmium will not flush naturally from the area of well 0612 because the laboratory-determined adsorption coefficient (Kd) is too high. Figure 4 presents a graph of cadmium results from the four most recent monitoring events and shows how those results compare to the historic ground water monitoring results and to the ground water modeling results. The trend of cadmium concentrations established in the GCAP shows that concentrations near well 0612 will decline to the UMTRA ground water standard by year 2011. The trend upon which the GCAP prediction is based was obtained from monitoring after completion of surface remediation. Because laboratory tests indicated that cadmium would be relatively immobile in the ground water system, the model-predicted concentrations in Figure 4 show a very gradual decline in the cadmium concentration. Monitoring of cadmium concentrations during the first decade of the post-GCAP period will be required to obtain a more confident prediction of future cadmium concentrations and of the effectiveness of the compliance strategy.

Manganese from the June 2003 sampling exceeded the risk-based concentration level of 1.7 mg/L only in well 0612. A map of the manganese distribution at the mill tailings area for June 2003 is presented in Figure 5. Model predictions indicate that manganese will decline to below 1.7 mg/L by year 2040. Figure 6 shows the model-forecasted manganese concentrations together with the two most recent results for well 0612. Based on the past two monitoring results (June 2002 and June 2003), the manganese concentration exceeds the model predicted concentrations by approximately 20 percent. At well 0612 measured concentrations exceeded the risk levels during the entire period of monitoring that extends back to 1987. Linear extrapolation of the trend in measured concentrations for well 0612 indicates that the target concentration of 1.7 mg/L might be achieved by the year 2052. The most recent monitoring results are in accord with these predictions. Monitoring at well 0630 indicates that manganese declined from over 4 mg/L to below the risk-based standard between 1994 and the June 2003 sampling result. Figure 7 presents a comparison between model-predicted and measured manganese concentrations for well 0630.

Molybdenum from the June 2003 sampling exceeded the UMTRA MCL of 0.1 mg/L only in well 0612. A map of the molybdenum distribution for June 2003 is presented in Figure 8. Molybdenum concentrations had spiked above the MCL in wells 0612 and 0617 in 1987 presumably in response to the beginning of the UMTRA surface remediation. Whereas the molybdenum concentration in well 0617 declined below the MCL in subsequent years, the concentrations in well 0612 have persistently hovered above the MCL since 1991. Figure 9 shows the results of predictive transport modeling for molybdenum. The results predict that molybdenum concentrations will flush below the MCL prior to 2005. The two most recent results of 0.0989 and 0.123 mg/L for June 2002 and 2003, respectively, indicate that the molybdenum concentration is on the verge of dropping below the MCL.

Selenium from the June 2003 sampling event exceeded the ACL of 0.05 mg/L in wells 0617 and 0633 with concentrations of 0.0633 and 0.0651 mg/L, respectively. Figure 10 presents a map of the selenium concentrations for June 2003. At well 0617 concentrations have been declining since monitoring began in 1982, and transport-modeling results presented in Figure 11 indicate that selenium in well 0633 will drop below the ACL by year 2020. Thus far, there is no reason to revise this prediction. For well 0633 concentrations have been increasing since monitoring began in 1994. Figure 12 presents the results of the June 2002 and June 2003 monitoring for selenium

at well 0633 in comparison to the predicted concentrations obtained from the transport model. Because well 0633 is screened 90-percent in Mancos Shale, a known natural source of selenium in the four-corners region (DOE 2002, p 4-40), the concentration could be elevated because of natural conditions. However, if future selenium levels decline at well 0633, then the June 2003 concentrations might represent the passage of a selenium plume.

Sulfate from the June 2003 sampling was elevated above the human-health risk-based level of 1,500 mg/L at wells 0612, 0617, 0630, and 0633, which contained sulfate levels of 2,350 mg/L, 2,230 mg/L, 1,740 mg/L, and 3,380 mg/L, respectively. Figure 13 presents a map of sulfate concentrations for June 2003. Background well 0629, which is predominantly screened in the Mancos Shale, has been in service since 1994 and sulfate results from it were 2,450 mg/L during the most recent sampling in November 2001. The concentration at well 0629 shows that wells tapping the Mancos Shale, such as wells 0633 and 0630, could easily contain natural levels of sulfate that exceed the risk-based level of 1,500 mg/L. The alluvial aquifer, however, may contain relict sulfate introduced during milling because sulfuric acid was used during milling to reclaim tailings from the carbonate leach operations and also to remove zinc from the feed solution (Merritt 1971, p 540-541). Well 0612, which has been monitored since 1981, has shown generally declining concentrations since monitoring began, and the trend is forecasted to continue. Transport modeling results presented in Figure 14 show that sulfate will probably flush out of the area of well 0612 by the year 2070. Well 0617, which also has been monitored since 1982, shows a steady trend of increasing sulfate. The initial monitoring result collected in September 1982 was the only result less than the risk-based level. The post-construction results, however, indicate the sulfate concentration at well 0617 is declining. Transport modeling results presented in Figure 15 also show that sulfate concentrations in well 0617 will decline to below the risk-based level of 1,500 mg/L by approximately year 2075.

Uranium concentrations exceeded the UMTRA standard of 0.044 mg/L in six wells during June 2003. Figure 16 presents a map of the uranium concentrations for June 2003. Wells 0612 and 0617 each exceed the UMTRA standard and are both completed exclusively in the alluvium. The remaining wells that exceed the uranium standard in June 2003 are either partly or completely screened in the Mancos Shale.

Well 0612 has been monitored for uranium since 1982 and has historically contained the highest uranium concentration of any well at the Durango mill tailings site. During the 1980s through the mid 1990s, the uranium concentration exceeded 3 mg/L much of the time and then declined to approximately 2 mg/L, where it was in June 2003. Transport modeling predictions shown in Figure 17 indicate that the concentration will continue to decline and reach the UMTRA standard of 0.044 mg/L by year 2045. Extrapolation of the trend in measured uranium concentrations suggests that concentrations are declining faster than the model-predicted rate, and that the UMTRA standard might be reached by year 2015 at well 0612.

Well 0617 has been monitored since 1982 and the June 2003 result is the second lowest concentration ever recorded at the well. The trend of post-construction monitoring results for well 0617 indicates that the concentrations are declining and that they should reach the UMTRA standard of 0.044 mg/L by year 2025.

Well 0633 is screened approximately 90-percent into the Mancos Shale; since monitoring began in October 1994, it has had the highest uranium concentration of any well that taps into the Mancos Shale. The June 2003 result for uranium of 0.91 mg/L is the second lowest result of

14 monitoring events recorded for well 0633. Uranium concentrations in well 0633 have been trending downward at a rate that would intercept the UMTRA standard of 0.044 mg/L by year 2060.

Well 0631 is screened completely in the Mancos Shale; based on 14 results since monitoring began in October 1994, there has been a declining trend in the uranium concentration. If the trend continues, well 0631 would intercept the UMTRA standard of 0.044 mg/L for uranium by year 2008.

Well 0630 is screened approximately 50 percent in the Mancos Shale and 50 percent in the alluvium. Based on 14 results since monitoring began in October 1994, the uranium concentration has been on an increasing trend, which contradicts the declining concentrations that were predicted with the transport model. The June 2003 result of 0.212 mg/L is the second highest uranium concentration ever recorded at well 0630. The highest recorded result of 0.214 mg/L occurred in June 2001. Because well 0630 is situated within the footprint of the former east tailings pile, the increasing concentration might reflect the passing of the uranium plume in the ground water. Additional monitoring will be required to track the uranium at this location.

Well 0634 is screened approximately 75 percent in the Mancos Shale and 25 percent in the overlying alluvium. Based on 14 results that began in October 1994, the uranium concentration has been increasing, which contradicts the declining uranium concentrations that were predicted with the transport model. The June 2003 result of 0.0608 mg/L of uranium is the second highest result recorded at well 0634. The highest result of 0.184 mg/L was recorded in March 2001. Prior to that date, each of the eight measured uranium concentrations were below the UMTRA standard of 0.044 mg/L. Since that date, only one of six results was below the UMTRA standard. Because well 0634 is situated within the footprint of the west tailings pile, the increasing concentration might reflect the passing of the uranium plume in the ground water. Additional monitoring will be required to track the uranium at this location.

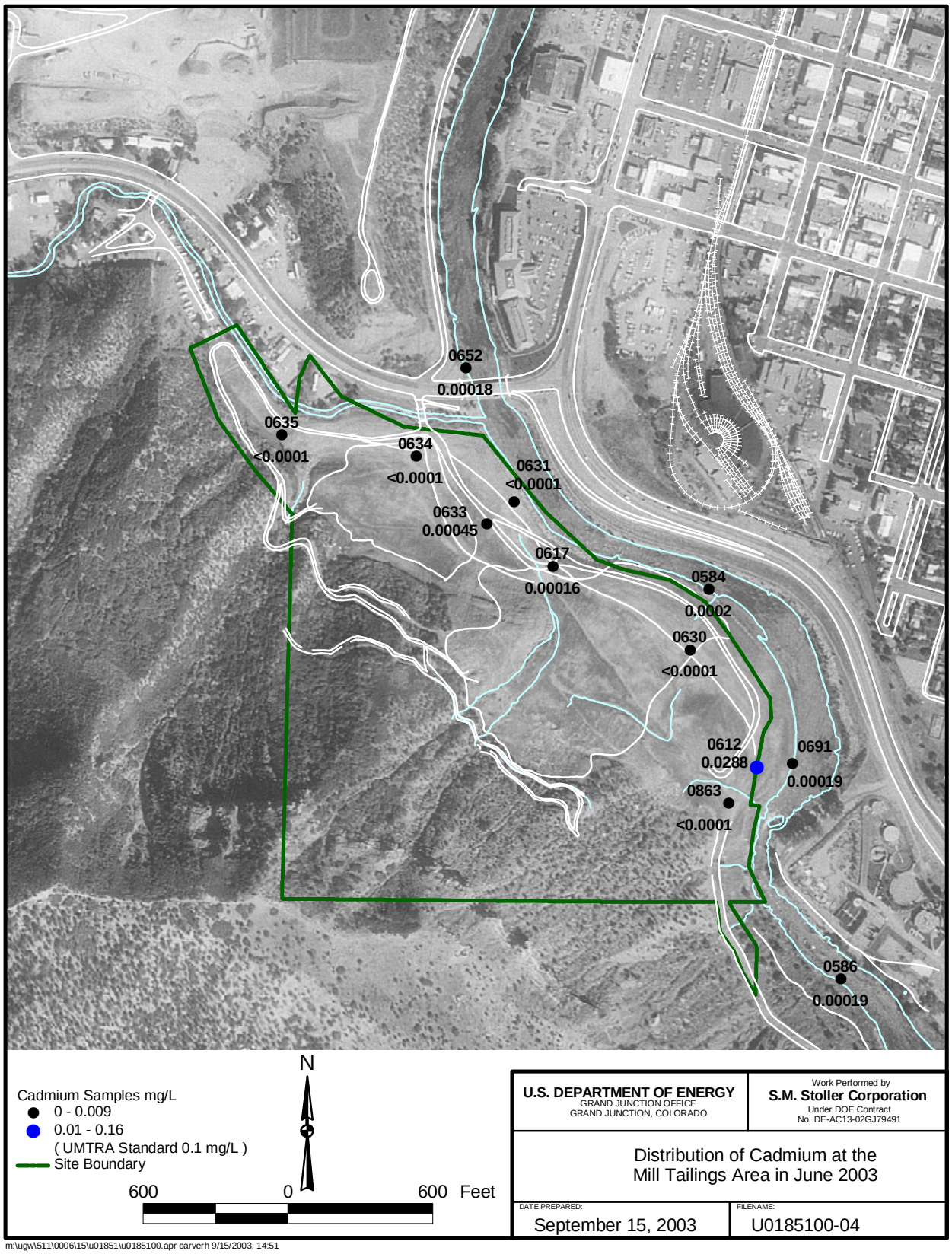

Figure 3. Distribution of Cadmium at the Mill Tailings Area in June 2003

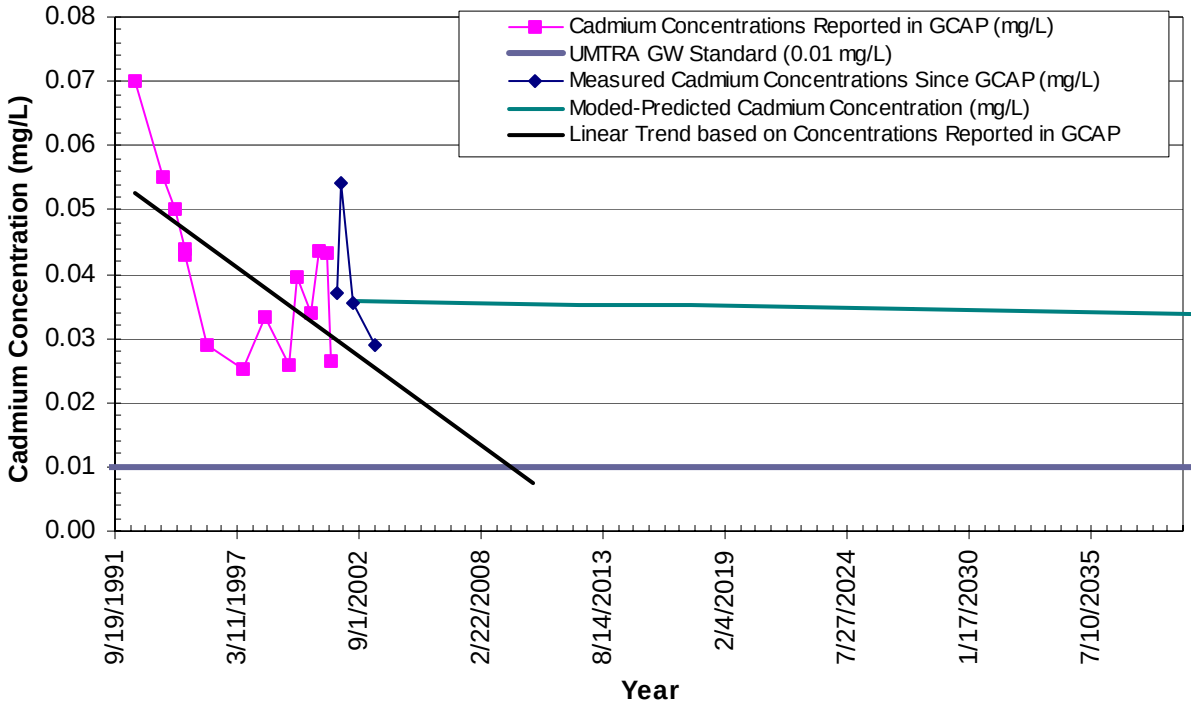

Figure 4. Measured Cadmium Concentrations Compared to Model-Predicted Concentrations and the UMTRA Ground Water Standard at Well 0612

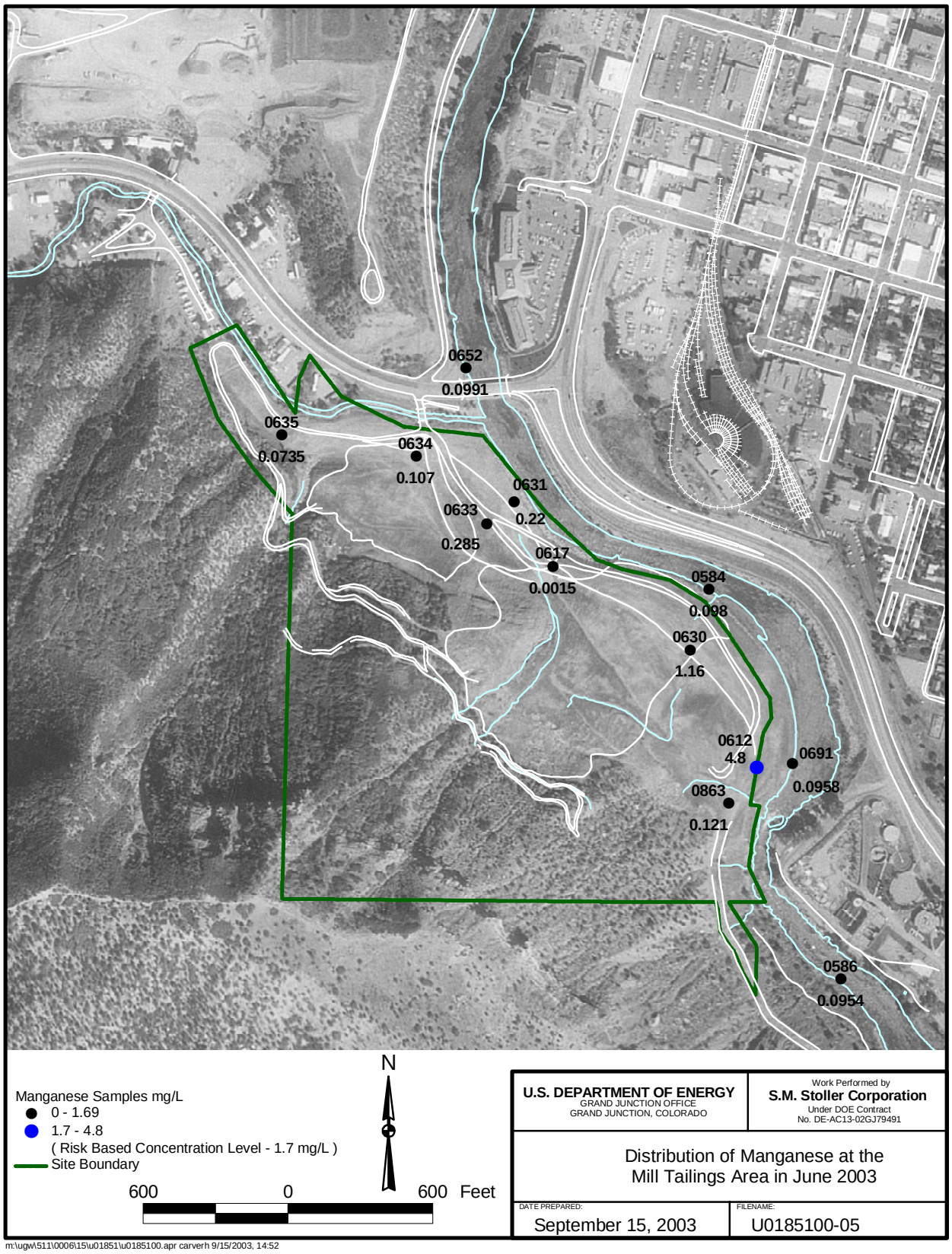

Figure 5. Distribution of Manganese at the Mill Tailings Area in June 2003

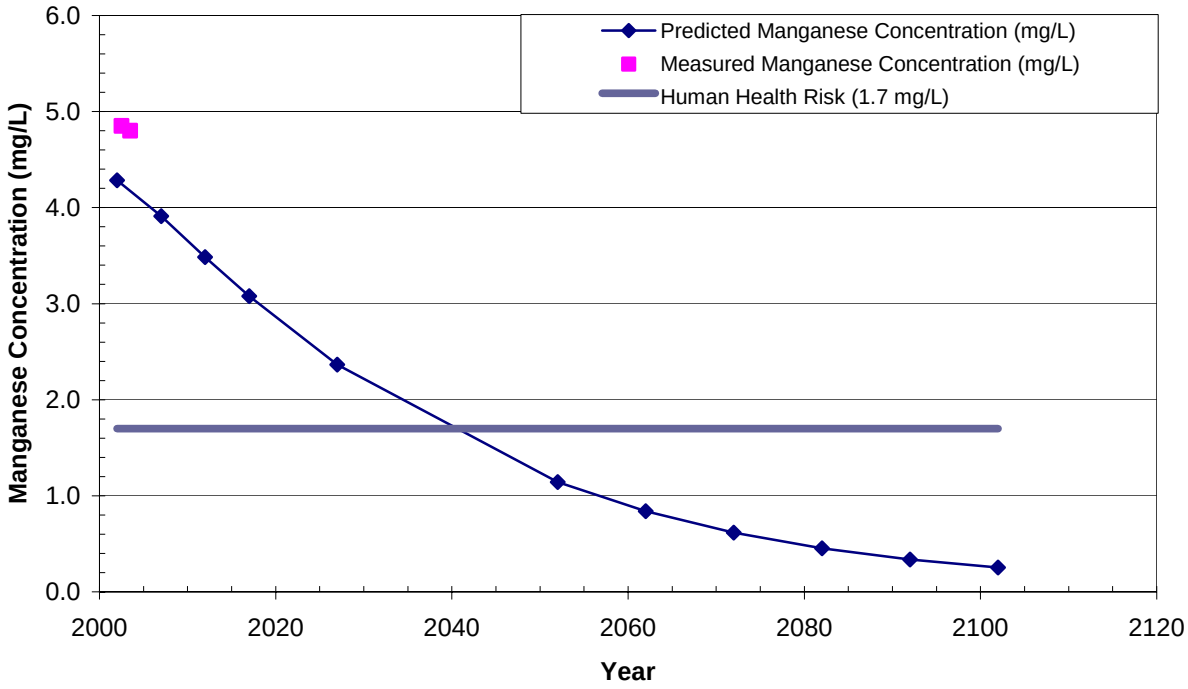

Figure 6. Measured Manganese Concentrations Compared to Model-Predicted Concentrations and the Human Health Risk Level at Well 0612

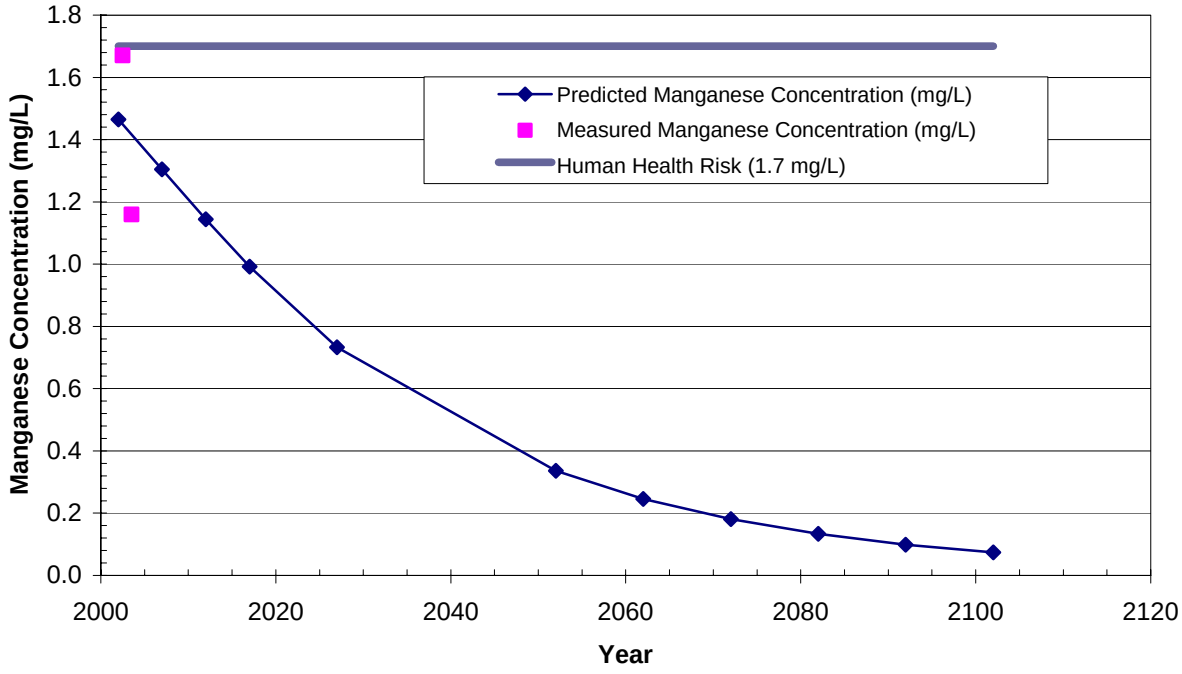

Figure 7. Measured Manganese Concentrations Compared to Model-Predicted Concentrations and the Human Health Risk Level at Well 0630

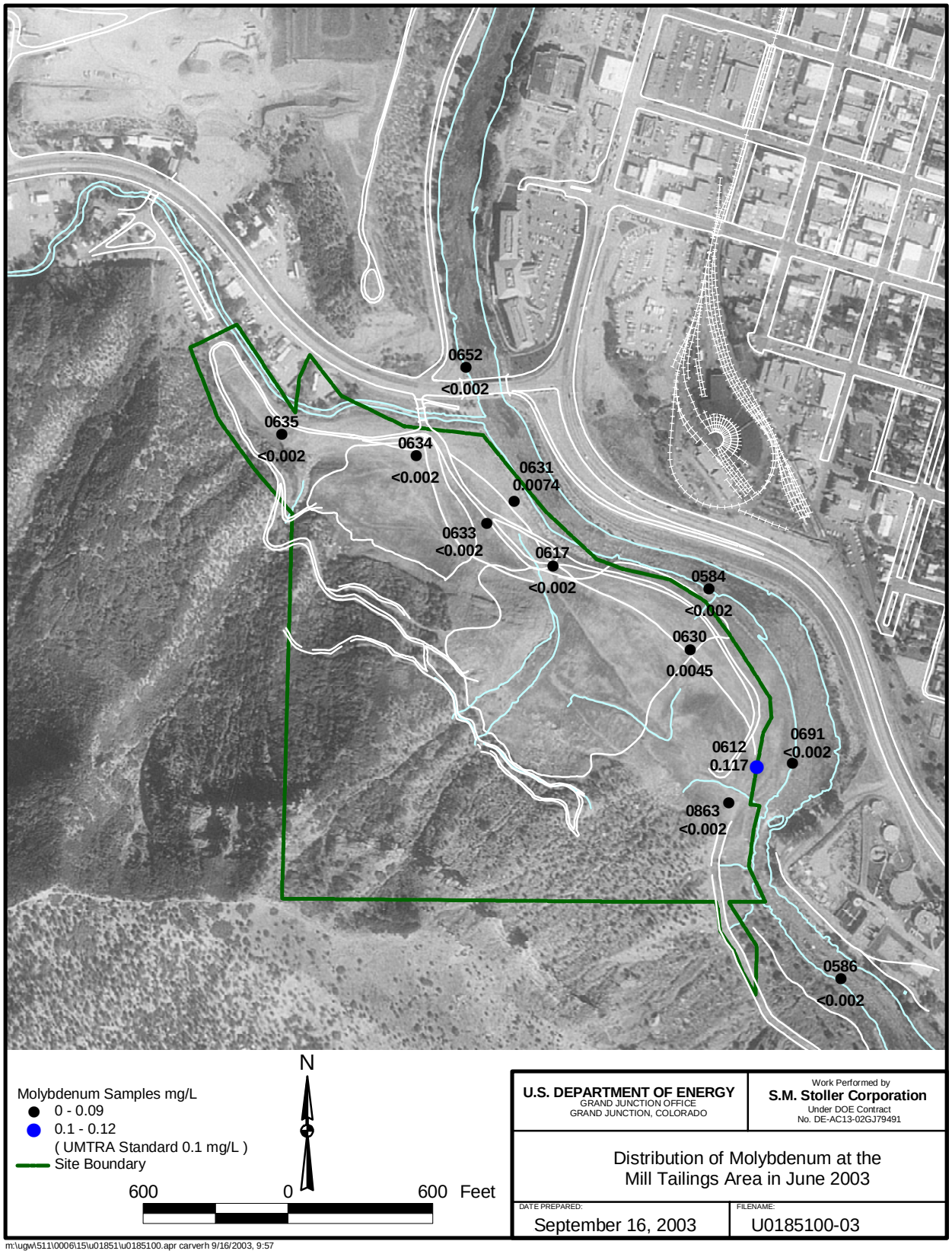

Figure 8. Distribution of Molybdenum a the Mill Tailings Area in June 2003

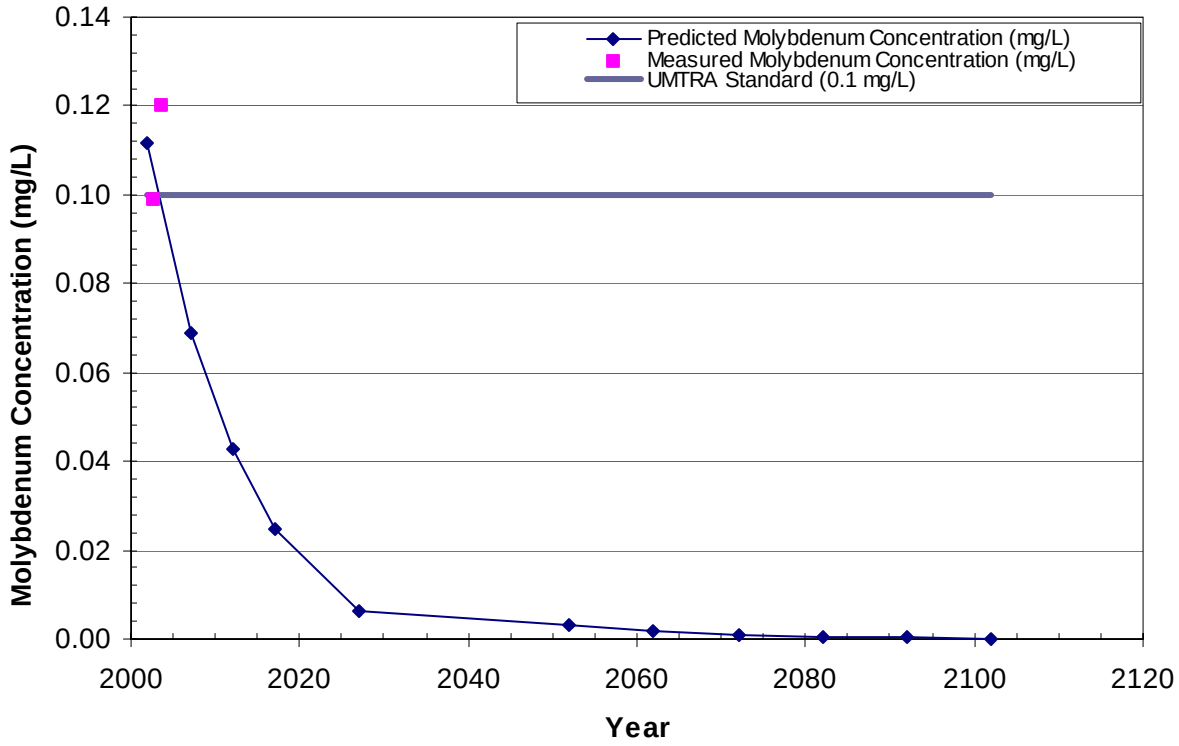

Figure 9. Measured Molybdenum Concentrations Compared to Model-Predicted Concentrations and the UMTRA Standard at Well 0612

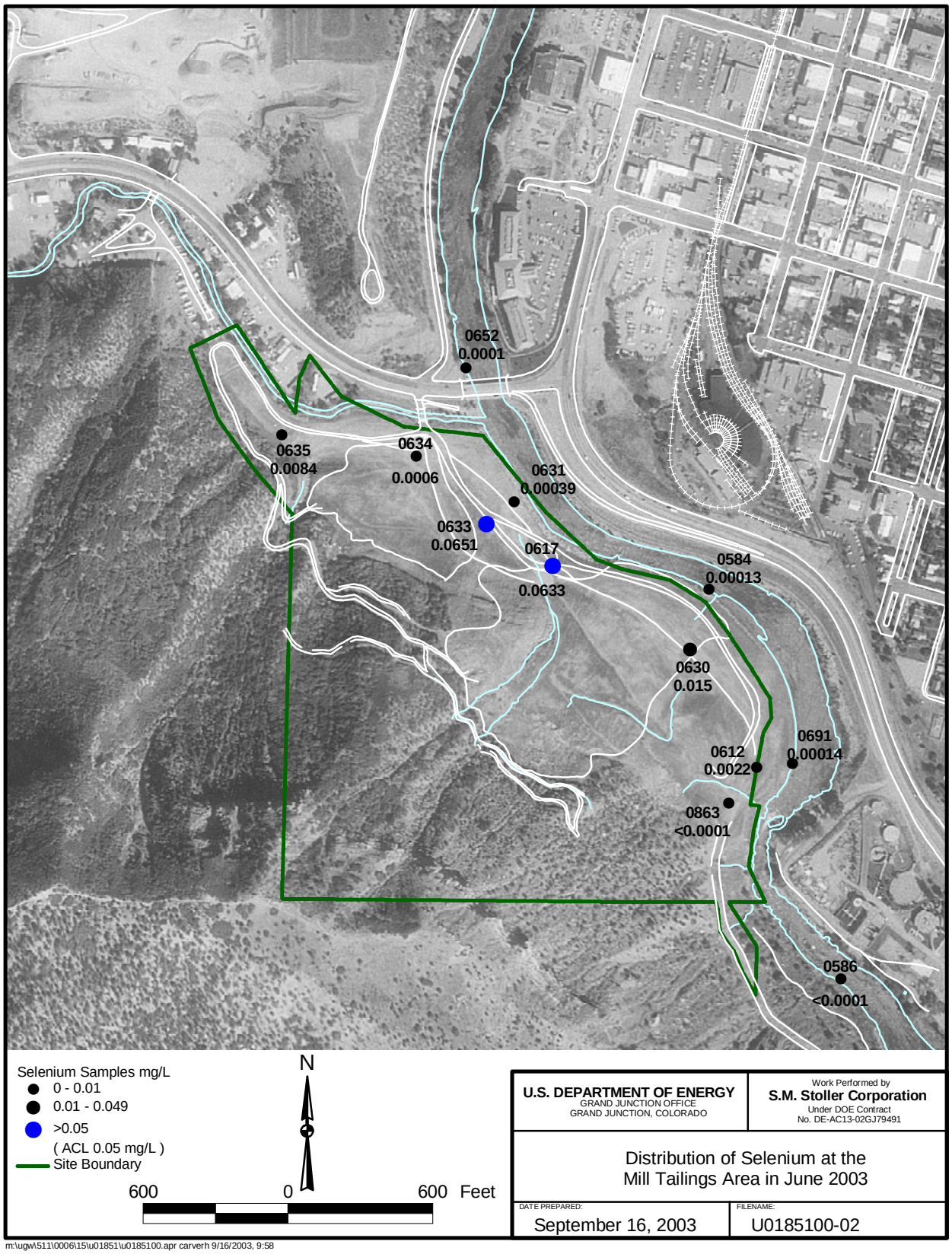

Figure 10. Distribution of Selenium at the Mill Tailings Area in June 2003

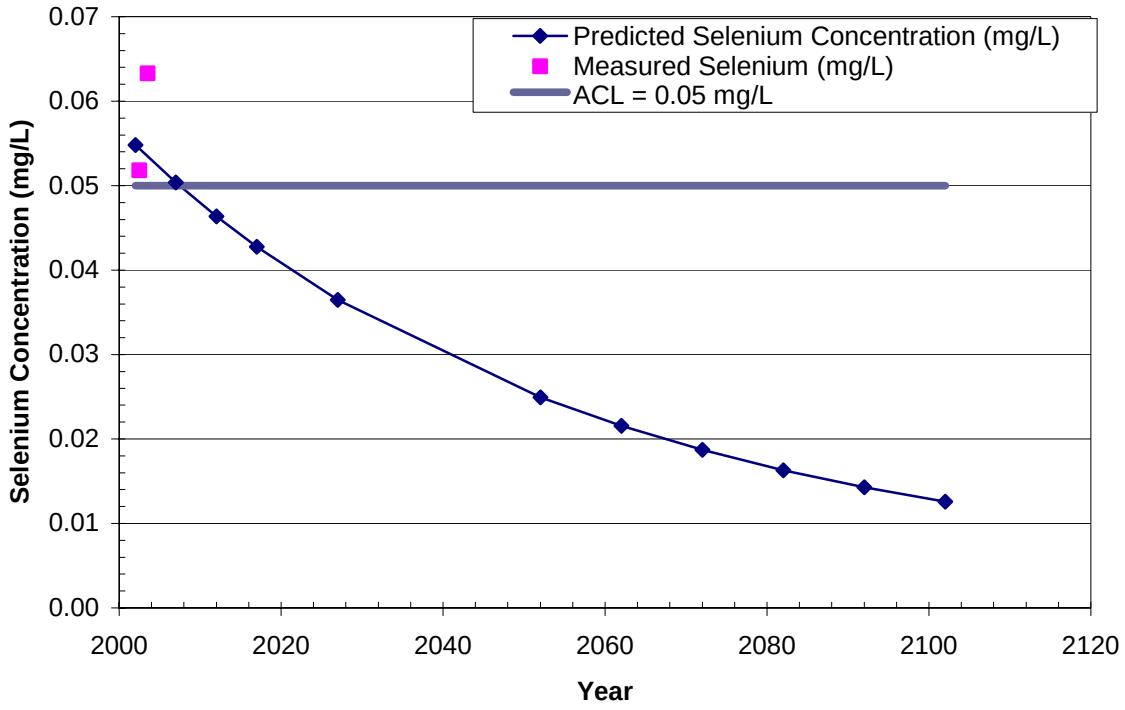

Figure 11. Measured Selenium Concentrations compared to Model-Predicted Concentrations and the UMTRA Standard at Well 0617

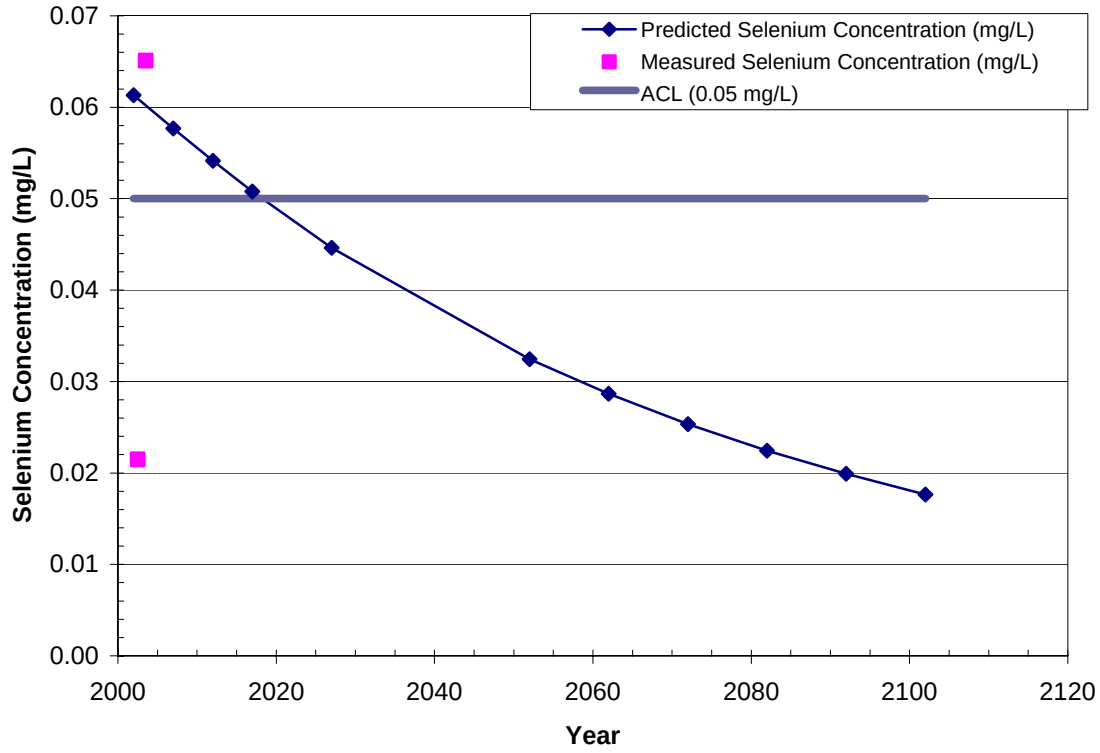

Figure 12. Measured Selenium Concentrations Compared to Model-Predicted Concentrations and the UMTRA Standard at Well 0633

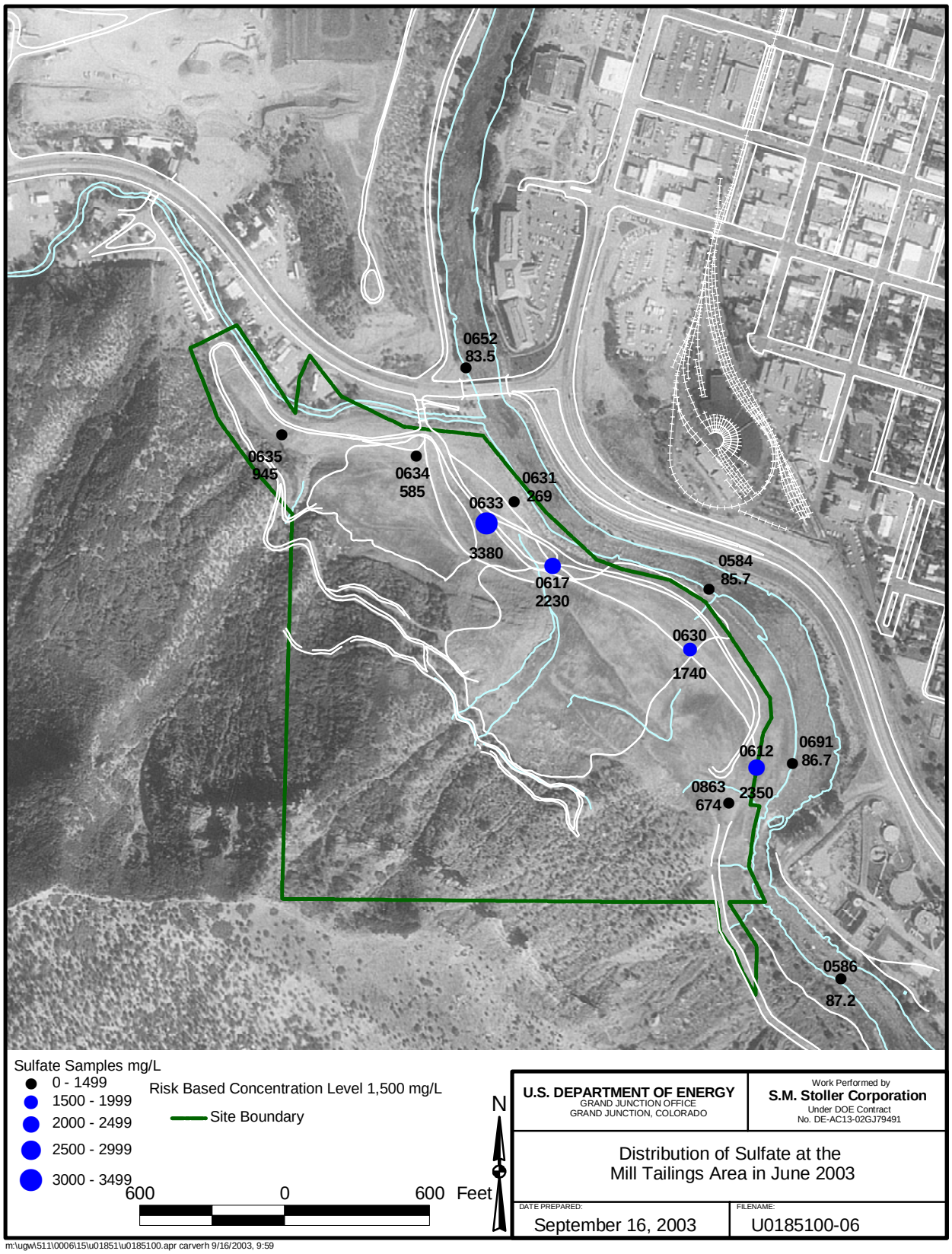

Figure 13. Distribution of Sulfate at the Mill Tailings Area in June 2003

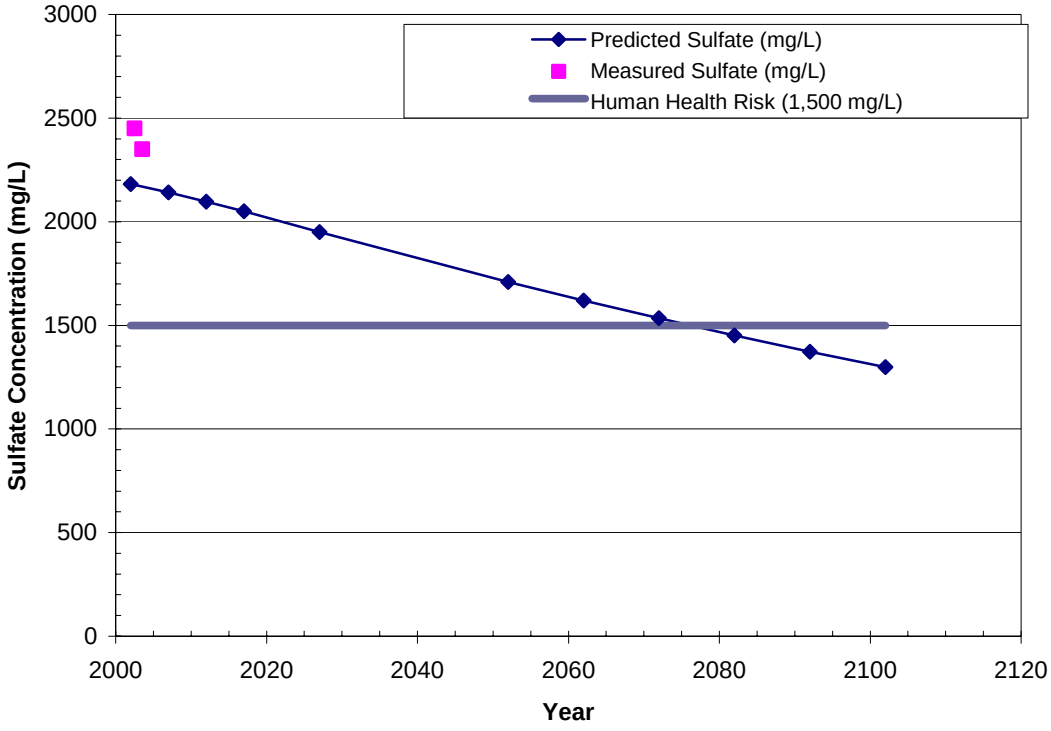

Figure 14. Measured Sulfate Concentrations Compared to Model-Predicted Concentrations and the UMTRA Standard at Well 0612

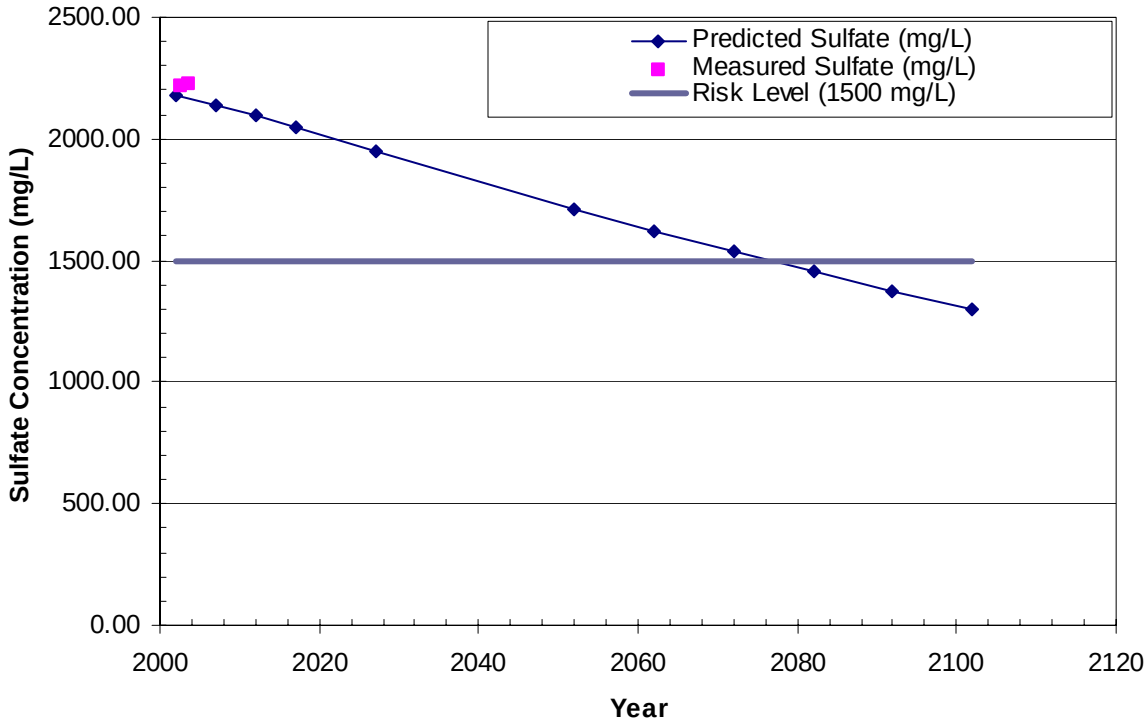

Figure 15. Measured Sulfate Concentrations Compared to Model-Predicted Concentrations and the UMTRA Standard at Well 0617

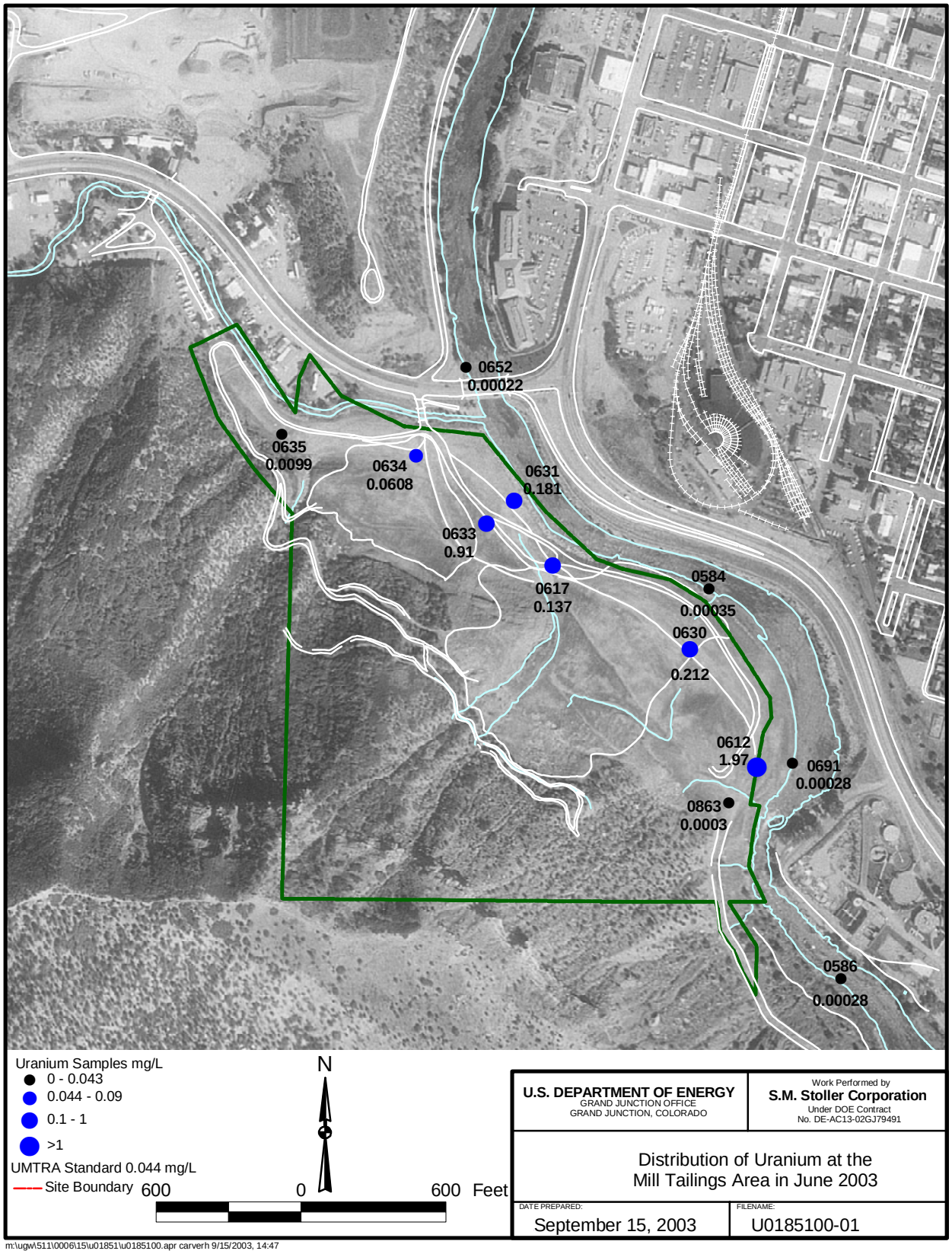

Figure 16. Distribution of Uranium at the Mill Tailings Area in June 2003

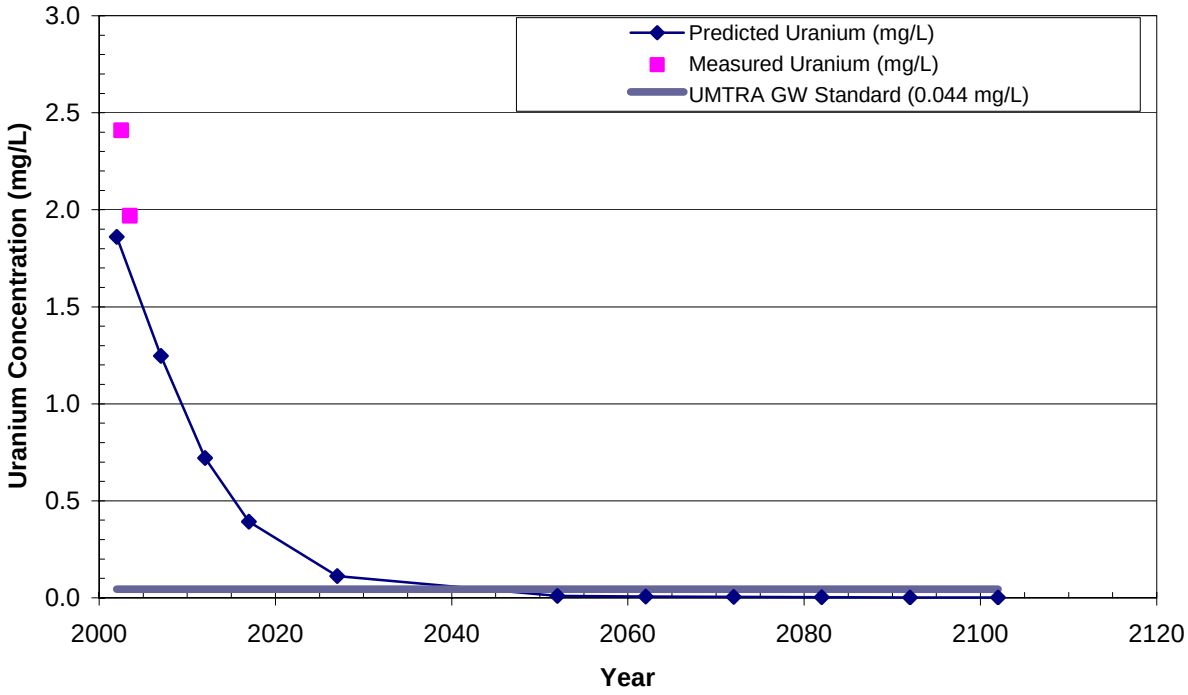

Figure 17. Measured Uranium Concentrations Compared to Model-Predicted Concentrations in and the UMTRA MCL at Well 0612

4.0 Conclusions

4.1 Status of Site Compliance

The concentration of cadmium continues to exceed the MCL of 0.01 mg/L only in well 0612. The most recent result (June 2003) at this location is below the model-forecasted concentration, indicating that the observed downward trend in cadmium concentration is continuing.

Manganese from the June 2003 sampling exceeded the risk-based concentration level of 1.7 mg/L only in well 0612. Based on the past two monitoring results (June 2002 and June 2003), the manganese concentration exceeds the model predicted concentrations; however, linear extrapolation of measured concentrations for well 0612 indicates that the target concentration of 1.7 mg/L might be achieved by the year 2052.

Molybdenum from the June 2003 sampling exceeded the MCL of 0.1 mg/L only in well 0612. The two most recent results of 0.0989 and 0.123 mg/L for June 2002 and 2003, respectively, indicate that the molybdenum concentration is on the verge of dropping below the MCL.

Selenium from the June 2003 sampling event exceeded the ACL of 0.05 mg/L in wells 0617 and 0633 with concentrations of 0.0633 and 0.0651 mg/L, respectively. At well 0617 the concentrations have been declining within the range forecasted by the model. For well 0633 the concentrations have been increasing which is not unexpected with passage of the selenium plume associated with the small tailings pile.

Sulfate from the June 2003 sampling was elevated above the human-health risk-based level of 1,500 mg/L at wells 0612, 0617, 0630, and 0633. With the exception of well 0633 (3,380 mg/L), sulfate levels are less than the maximum observed background concentration. Wells tapping the Mancos Shale, such as wells 0633 and 0630, could easily contain natural levels of sulfate that exceed the risk-based level. Alluvial well 0612 has shown generally declining concentrations since monitoring began, and the trend is forecasted to continue. Post-remediation results at well 0617 also are declining as predicted by the transport model.

Uranium concentrations in wells 0630 and 0634 have been on an increasing trend. The upward trend in both of these wells is not unexpected because these wells are situated within the footprint of the former tailings piles and the increasing concentration might reflect the passing of the uranium plume in the ground water.

4.2 Recommendations

Verification monitoring of ground water from designated mill tailings area monitor wells (POC wells) and surface water locations will continue on an annual basis for another 4 years (until 2007) as specified in the GCAP (DOE 2003).

5.0 References

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End of current text

Appendix A

Ground Water Quality Data by Parameter

GROUND WATER QUALITY DATA BY PARAMETER WITH DEPTH (USEE200) FOR SITE DUR01, DURANGO MILL TAILINGS
REPORT DATE: 9/22/2003 11:03 am

PARAMETER	UNITS	LOCATION ID	LOCATION TYPE	SAMPLE: DATE	SAMPLE: ID	DEPTH RANGE (FT BLS)	RESULT	QUALIFIERS: LAB	QUALIFIERS: DATA	QUALIFIERS: QA	DETECTION LIMIT	UN-CERTAINTY
Alkalinity, Total (As CaCO3	mg/L	0612	WL	06/04/2003	0001	37.41 - 57.41	459		F	#	-	-
	mg/L	0617	WL	06/05/2003	0001	14.00 - 29.00	397		F	#	-	-
	mg/L	0630	WL	06/04/2003	0001	28.30 - 38.30	277		F	#	-	-
	mg/L	0631	WL	06/03/2003	0001	6.00 - 16.00	206		F	#	-	-
	mg/L	0633	WL	06/05/2003	0001	4.00 - 14.00	500		F	#	-	-
	mg/L	0634	WL	06/05/2003	0001	8.00 - 18.00	451		QF	#	-	-
	mg/L	0635	WL	06/05/2003	0001	5.50 - 15.50	397		F	#	-	-
	mg/L	0863	WL	06/11/2003	0001	58.00 - 67.50	532		F	#	-	-
Cadmium	mg/L	0612	WL	06/04/2003	0001	37.41 - 57.41	0.0288		F	#	0.0001	-
	mg/L	0612	WL	06/04/2003	0002	37.41 - 57.41	0.0287		F	#	0.0001	-
	mg/L	0617	WL	06/05/2003	0001	14.00 - 29.00	0.00016	B	F	#	0.0001	-
	mg/L	0630	WL	06/04/2003	0001	28.30 - 38.30	0.00010	U	F	#	0.0001	-
	mg/L	0631	WL	06/03/2003	0001	6.00 - 16.00	0.00010	U*	JF	#	0.0001	-
	mg/L	0633	WL	06/05/2003	0001	4.00 - 14.00	0.00045	B	F	#	0.0001	-
	mg/L	0634	WL	06/05/2003	0001	8.00 - 18.00	0.00010	U	QF	#	0.0001	-
	mg/L	0635	WL	06/05/2003	0001	5.50 - 15.50	0.00010	U	F	#	0.0001	-
	mg/L	0863	WL	06/11/2003	0001	58.00 - 67.50	0.00010	U	F	#	0.0001	-
Manganese	mg/L	0612	WL	06/04/2003	0001	37.41 - 57.41	4.800		F	#	0.0001	-
	mg/L	0612	WL	06/04/2003	0002	37.41 - 57.41	4.770		F	#	0.0001	-
	mg/L	0617	WL	06/05/2003	0001	14.00 - 29.00	0.00150	B	F	#	0.0001	-
	mg/L	0630	WL	06/04/2003	0001	28.30 - 38.30	1.160		F	#	0.0001	-
	mg/L	0631	WL	06/03/2003	0001	6.00 - 16.00	0.220		F	#	0.0001	-
	mg/L	0633	WL	06/05/2003	0001	4.00 - 14.00	0.285		F	#	0.0001	-
	mg/L	0634	WL	06/05/2003	0001	8.00 - 18.00	0.107		QF	#	0.0001	-
	mg/L	0635	WL	06/05/2003	0001	5.50 - 15.50	0.0735		F	#	0.0001	-
	mg/L	0863	WL	06/11/2003	0001	58.00 - 67.50	0.121		F	#	0.0001	-

GROUND WATER QUALITY DATA BY PARAMETER WITH DEPTH (USEE200) FOR SITE DUR01, DURANGO MILL TAILINGS
REPORT DATE: 9/22/2003 11:03 am

PARAMETER	UNITS	LOCATION ID	LOCATION TYPE	SAMPLE: DATE	SAMPLE: ID	DEPTH RANGE (FT BLS)	RESULT	QUALIFIERS: LAB	QUALIFIERS: DATA	QUALIFIERS: QA	DETECTION LIMIT	UN-CERTAINTY
Molybdenum	mg/L	0612	WL	06/04/2003	0001	37.41 - 57.41	0.117		F	#	0.002	-
	mg/L	0612	WL	06/04/2003	0002	37.41 - 57.41	0.123		F	#	0.002	-
	mg/L	0617	WL	06/05/2003	0001	14.00 - 29.00	0.00200	U	F	#	0.002	-
	mg/L	0630	WL	06/04/2003	0001	28.30 - 38.30	0.00450	B	F	#	0.002	-
	mg/L	0631	WL	06/03/2003	0001	6.00 - 16.00	0.00740	B	F	#	0.002	-
	mg/L	0633	WL	06/05/2003	0001	4.00 - 14.00	0.00200	U	F	#	0.002	-
	mg/L	0634	WL	06/05/2003	0001	8.00 - 18.00	0.00200	U	QF	#	0.002	-
	mg/L	0635	WL	06/05/2003	0001	5.50 - 15.50	0.00200	U	F	#	0.002	-
	mg/L	0863	WL	06/11/2003	0001	58.00 - 67.50	0.00200	U	F	#	0.002	-
Oxidation Reduction Potent	mV	0612	WL	06/04/2003	N001	37.41 - 57.41	126		F	#	-	-
	mV	0617	WL	06/05/2003	N001	14.00 - 29.00	177		F	#	-	-
	mV	0630	WL	06/04/2003	N001	28.30 - 38.30	-10		F	#	-	-
	mV	0631	WL	06/03/2003	N001	6.00 - 16.00	18.9		F	#	-	-
	mV	0633	WL	06/05/2003	N001	4.00 - 14.00	79		F	#	-	-
	mV	0634	WL	06/05/2003	N001	8.00 - 18.00	40		QF	#	-	-
	mV	0635	WL	06/05/2003	N001	5.50 - 15.50	56		F	#	-	-
	mV	0863	WL	06/11/2003	N001	58.00 - 67.50	-69		F	#	-	-
pH	s.u.	0612	WL	06/04/2003	N001	37.41 - 57.41	6.86		F	#	-	-
	s.u.	0617	WL	06/05/2003	N001	14.00 - 29.00	6.8		F	#	-	-
	s.u.	0630	WL	06/04/2003	N001	28.30 - 38.30	6.83		F	#	-	-
	s.u.	0631	WL	06/03/2003	N001	6.00 - 16.00	6.92		F	#	-	-
	s.u.	0633	WL	06/05/2003	N001	4.00 - 14.00	6.74		F	#	-	-
	s.u.	0634	WL	06/05/2003	N001	8.00 - 18.00	6.92		QF	#	-	-
	s.u.	0635	WL	06/05/2003	N001	5.50 - 15.50	6.85		F	#	-	-
	s.u.	0863	WL	06/11/2003	N001	58.00 - 67.50	6.92		F	#	-	-
Selenium	mg/L	0612	WL	06/04/2003	0001	37.41 - 57.41	0.00220	B	F	#	0.0001	-

GROUND WATER QUALITY DATA BY PARAMETER WITH DEPTH (USEE200) FOR SITE DUR01, DURANGO MILL TAILINGS
REPORT DATE: 9/22/2003 11:03 am

PARAMETER	UNITS	LOCATION ID	LOCATION TYPE	SAMPLE: DATE	SAMPLE: ID	DEPTH RANGE (FT BLS)	RESULT	QUALIFIERS: LAB	QUALIFIERS: DATA	QUALIFIERS: QA	DETECTION LIMIT	UN-CERTAINTY
Selenium	mg/L	0612	WL	06/04/2003	0002	37.41 - 57.41	0.00230	B	F	#	0.0001	-
	mg/L	0617	WL	06/05/2003	0001	14.00 - 29.00	0.0633		F	#	0.001	-
	mg/L	0630	WL	06/04/2003	0001	28.30 - 38.30	0.0150		F	#	0.0001	-
	mg/L	0631	WL	06/03/2003	0001	6.00 - 16.00	0.00039	B	F	#	0.0001	-
	mg/L	0633	WL	06/05/2003	0001	4.00 - 14.00	0.0651		F	#	0.0005	-
	mg/L	0634	WL	06/05/2003	0001	8.00 - 18.00	0.00060	B	QF	#	0.0001	-
	mg/L	0635	WL	06/05/2003	0001	5.50 - 15.50	0.00840		F	#	0.0001	-
	mg/L	0863	WL	06/11/2003	0001	58.00 - 67.50	0.00010	U	F	#	0.0001	-
Specific Conductance	umhos/cm	0612	WL	06/04/2003	N001	37.41 - 57.41	4712		F	#	-	-
	umhos/cm	0617	WL	06/05/2003	N001	14.00 - 29.00	4201		F	#	-	-
	umhos/cm	0630	WL	06/04/2003	N001	28.30 - 38.30	3654		F	#	-	-
	umhos/cm	0631	WL	06/03/2003	N001	6.00 - 16.00	1447		F	#	-	-
	umhos/cm	0633	WL	06/05/2003	N001	4.00 - 14.00	5555		F	#	-	-
	umhos/cm	0634	WL	06/05/2003	N001	8.00 - 18.00	4047		QF	#	-	-
	umhos/cm	0635	WL	06/05/2003	N001	5.50 - 15.50	2359		F	#	-	-
	umhos/cm	0863	WL	06/11/2003	N001	58.00 - 67.50	2127		F	#	-	-
Sulfate	mg/L	0612	WL	06/04/2003	0001	37.41 - 57.41	2350.000		F	#	0.875	-
	mg/L	0612	WL	06/04/2003	0002	37.41 - 57.41	2330.000		F	#	0.875	-
	mg/L	0617	WL	06/05/2003	0001	14.00 - 29.00	2230.000		F	#	0.875	-
	mg/L	0630	WL	06/04/2003	0001	28.30 - 38.30	1740.000		F	#	0.35	-
	mg/L	0631	WL	06/03/2003	0001	6.00 - 16.00	269.000		F	#	0.175	-
	mg/L	0633	WL	06/05/2003	0001	4.00 - 14.00	3380.000		F	#	0.875	-
	mg/L	0634	WL	06/05/2003	0001	8.00 - 18.00	585.000		QF	#	0.875	-
	mg/L	0635	WL	06/05/2003	0001	5.50 - 15.50	945.000		F	#	0.35	-
	mg/L	0863	WL	06/11/2003	0001	58.00 - 67.50	674.000		F	#	0.175	-
Temperature	C	0612	WL	06/04/2003	N001	37.41 - 57.41	12.57		F	#	-	-

GROUND WATER QUALITY DATA BY PARAMETER WITH DEPTH (USEE200) FOR SITE DUR01, DURANGO MILL TAILINGS
REPORT DATE: 9/22/2003 11:03 am

PARAMETER	UNITS	LOCATION ID	LOCATION TYPE	SAMPLE: DATE	SAMPLE: ID	DEPTH RANGE (FT BLS)	RESULT	QUALIFIERS: LAB	QUALIFIERS: DATA	QUALIFIERS: QA	DETECTION LIMIT	UN-CERTAINTY
Temperature	C	0617	WL	06/05/2003	N001	14.00 - 29.00	11.46		F	#	-	-
	C	0630	WL	06/04/2003	N001	28.30 - 38.30	12.19		F	#	-	-
	C	0631	WL	06/03/2003	N001	6.00 - 16.00	10.44		F	#	-	-
	C	0633	WL	06/05/2003	N001	4.00 - 14.00	13		F	#	-	-
	C	0634	WL	06/05/2003	N001	8.00 - 18.00	13.88		QF	#	-	-
	C	0635	WL	06/05/2003	N001	5.50 - 15.50	11.65		F	#	-	-
	C	0863	WL	06/11/2003	N001	58.00 - 67.50	11.9		F	#	-	-
Turbidity	NTU	0612	WL	06/04/2003	N001	37.41 - 57.41	17.3		F	#	-	-
	NTU	0617	WL	06/05/2003	N001	14.00 - 29.00	1.03		F	#	-	-
	NTU	0630	WL	06/04/2003	N001	28.30 - 38.30	3.13		F	#	-	-
	NTU	0631	WL	06/03/2003	N001	6.00 - 16.00	0.67		F	#	-	-
	NTU	0633	WL	06/05/2003	N001	4.00 - 14.00	0.59		F	#	-	-
	NTU	0634	WL	06/05/2003	N001	8.00 - 18.00	0.8		QF	#	-	-
	NTU	0635	WL	06/05/2003	N001	5.50 - 15.50	6.88		F	#	-	-
	NTU	0863	WL	06/11/2003	N001	58.00 - 67.50	6.29		F	#	-	-
Uranium	mg/L	0612	WL	06/04/2003	0001	37.41 - 57.41	1.970		F	#	0.0005	-
	mg/L	0612	WL	06/04/2003	0002	37.41 - 57.41	1.930		F	#	0.0005	-
	mg/L	0617	WL	06/05/2003	0001	14.00 - 29.00	0.137		F	#	0.0001	-
	mg/L	0630	WL	06/04/2003	0001	28.30 - 38.30	0.212		F	#	0.0001	-
	mg/L	0631	WL	06/03/2003	0001	6.00 - 16.00	0.181		F	#	0.0001	-
	mg/L	0633	WL	06/05/2003	0001	4.00 - 14.00	0.910		F	#	0.0001	-
	mg/L	0634	WL	06/05/2003	0001	8.00 - 18.00	0.0608		QF	#	0.0001	-
	mg/L	0635	WL	06/05/2003	0001	5.50 - 15.50	0.00990		F	#	0.0001	-
	mg/L	0863	WL	06/11/2003	0001	58.00 - 67.50	0.00030	B	F	#	0.0001	-

GROUND WATER QUALITY DATA BY PARAMETER WITH DEPTH (USEE200) FOR SITE DUR01, DURANGO MILL TAILINGS
REPORT DATE: 9/22/2003 11:03 am

PARAMETER	UNITS	LOCATION ID	LOCATION TYPE	SAMPLE: DATE	ID	DEPTH RANGE (FT BLS)	RESULT	QUALIFIERS: LAB	DATA	QA	DETECTION LIMIT	UN-CERTAINTY

RECORDS: SELECTED FROM USEE200 WHERE site_code='DUR01' AND quality_assurance = TRUE AND (data_validation_qualifiers IS NULL OR data_validation_qualifiers NOT LIKE '%R%' AND data_validation_qualifiers NOT LIKE '%X%') AND DATE_SAMPLED between #1/1/2003# and #9/1/2003#

SAMPLE ID CODES: 000X = Filtered sample (0.45 µm). N00X = Unfiltered sample. X = replicate number.

LOCATION TYPES: WL WELL

LAB QUALIFIERS:

*	Replicate analysis not within control limits.
+	Correlation coefficient for MSA < 0.995.
>	Result above upper detection limit.
A	TIC is a suspected aldol-condensation product.
B	Inorganic: Result is between the IDL and CRDL. Organic: Analyte also found in method blank.
C	Pesticide result confirmed by GC-MS.
D	Analyte determined in diluted sample.
E	Inorganic: Estimate value because of interference, see case narrative. Organic: Analyte exceeded calibration range of the GC-MS.
H	Holding time expired, value suspect.
I	Increased detection limit due to required dilution.
J	Estimated
M	GFAA duplicate injection precision not met.
N	Inorganic or radiochemical: Spike sample recovery not within control limits. Organic: Tentatively identified compund (TIC).
P	> 25% difference in detected pesticide or Arochlor concentrations between 2 columns.
S	Result determined by method of standard addition (MSA).
U	Analytical result below detection limit.
W	Post-digestion spike outside control limits while sample absorbance < 50% of analytical spike absorbance.
X	Laboratory defined (USEPA CLP organic) qualifier, see case narrative.
Y	Laboratory defined (USEPA CLP organic) qualifier, see case narrative.
Z	Laboratory defined (USEPA CLP organic) qualifier, see case narrative.

DATA QUALIFIERS:

F	Low flow sampling method used.	G	Possible grout contamination, pH > 9.	J	Estimated value.
L	Less than 3 bore volumes purged prior to sampling.	Q	Qualitative result due to sampling technique	R	Unusable result.
U	Parameter analyzed for but was not detected.	X	Location is undefined.		

QA QUALIFIER: # = validated according to Quality Assurance guidelines.

Appendix B

Surface Water Quality Data by Parameter

SURFACE WATER QUALITY DATA BY PARAMETER (USEE800) FOR SITE DUR01, DURANGO MILL TAILINGS
REPORT DATE: 9/22/2003 11:04 am

PARAMETER	UNITS	LOCATION ID	SAMPLE: DATE	ID	RESULT	QUALIFIERS: LAB	DATA	QA	DETECTION LIMIT	UN-CERTAINTY
Alkalinity, Total (As CaCO3	mg/L	0584	06/04/2003	0001	47			#	-	-
	mg/L	0586	06/04/2003	0001	24			#	-	-
	mg/L	0652	06/03/2003	0001	16			#	-	-
	mg/L	0691	06/04/2003	0001	51			#	-	-
Cadmium	mg/L	0584	06/04/2003	0001	0.0002 B			#	0.0001	-
	mg/L	0586	06/04/2003	0001	0.0001 B			#	0.0001	-
	mg/L	0652	06/03/2003	0001	0.0001 B*		J	#	0.0001	-
	mg/L	0691	06/04/2003	0001	0.0001 B			#	0.0001	-
Molybdenum	mg/L	0584	06/04/2003	0001	0.0020 U			#	0.002	-
	mg/L	0586	06/04/2003	0001	0.0020 U			#	0.002	-
	mg/L	0652	06/03/2003	0001	0.0020 U			#	0.002	-
	mg/L	0691	06/04/2003	0001	0.0020 U			#	0.002	-
Oxidation Reduction Potent	mV	0584	06/04/2003	N001	17.2			#	-	-
	mV	0586	06/04/2003	N001	152			#	-	-
	mV	0652	06/03/2003	N001	175			#	-	-
	mV	0691	06/04/2003	N001	156			#	-	-
pH	s.u.	0584	06/04/2003	N001	7.51			#	-	-
	s.u.	0586	06/04/2003	N001	7.4			#	-	-
	s.u.	0652	06/03/2003	N001	7.13			#	-	-
	s.u.	0691	06/04/2003	N001	7.51			#	-	-
Selenium	mg/L	0584	06/04/2003	0001	0.0001 B			#	0.0001	-
	mg/L	0586	06/04/2003	0001	0.0001 U			#	0.0001	-
	mg/L	0652	06/03/2003	0001	0.0001 B			#	0.0001	-
	mg/L	0691	06/04/2003	0001	0.0001 B			#	0.0001	-
Specific Conductance	umhos/cm	0584	06/04/2003	N001	328			#	-	-
	umhos/cm	0586	06/04/2003	N001	370			#	-	-
	umhos/cm	0652	06/03/2003	N001	312			#	-	-
	umhos/cm	0691	06/04/2003	N001	364			#	-	-
Temperature	C	0584	06/04/2003	N001	13.04			#	-	-
	C	0586	06/04/2003	N001	12.62			#	-	-
	C	0652	06/03/2003	N001	11.96			#	-	-
	C	0691	06/04/2003	N001	12.45			#	-	-
Turbidity	NTU	0584	06/04/2003	N001	26.4			#	-	-
	NTU	0652	06/03/2003	N001	30			#	-	-
Uranium	mg/L	0584	06/04/2003	0001	0.0003 B			#	0.0001	-
	mg/L	0586	06/04/2003	0001	0.0002 B			#	0.0001	-

SURFACE WATER QUALITY DATA BY PARAMETER (USEE800) FOR SITE DUR01, DURANGO MILL TAILINGS
REPORT DATE: 9/22/2003 11:04 am

PARAMETER	UNITS	LOCATION ID	SAMPLE: DATE	ID	RESULT	QUALIFIERS: LAB	DATA	QA	DETECTION LIMIT	UN-CERTAINTY
Uranium	mg/L	0652	06/03/2003	0001	0.0002	B		#	0.0001	-
	mg/L	0691	06/04/2003	0001	0.0002	B		#	0.0001	-

RECORDS: SELECTED FROM USEE800 WHERE site_code='DUR01' AND quality_assurance = TRUE AND (data_validation_qualifiers IS NULL OR data_validation_qualifiers NOT LIKE '%R%' AND data_validation_qualifiers NOT LIKE '%X%') AND DATE_SAMPLED between #1/1/2003# and #9/1/2003#

SAMPLE ID CODES: 000X = Filtered sample (0.45 µm). N00X = Unfiltered sample. X = replicate number.

LAB QUALIFIERS:

- * Replicate analysis not within control limits.
- + Correlation coefficient for MSA < 0.995.
- > Result above upper detection limit.
- A TIC is a suspected aldol-condensation product.
- B Inorganic: Result is between the IDL and CRDL. Organic: Analyte also found in method blank.
- C Pesticide result confirmed by GC-MS.
- D Analyte determined in diluted sample.
- E Inorganic: Estimate value because of interference, see case narrative. Organic: Analyte exceeded calibration range of the GC-MS.
- H Holding time expired, value suspect.
- I Increased detection limit due to required dilution.
- J Estimated
- M GFAA duplicate injection precision not met.
- N Inorganic or radiochemical: Spike sample recovery not within control limits. Organic: Tentatively identified compund (TIC).
- P > 25% difference in detected pesticide or Arochlor concentrations between 2 columns.
- S Result determined by method of standard addition (MSA).
- U Analytical result below detection limit.
- W Post-digestion spike outside control limits while sample absorbance < 50% of analytical spike absorbance.
- X Laboratory defined (USEPA CLP organic) qualifier, see case narrative.
- Y Laboratory defined (USEPA CLP organic) qualifier, see case narrative.
- Z Laboratory defined (USEPA CLP organic) qualifier, see case narrative.

DATA QUALIFIERS:

- F Low flow sampling method used.
- J Estimated value.
- Q Qualitative result due to sampling technique
- U Parameter analyzed for but was not detected.
- G Possible grout contamination, pH > 9.
- L Less than 3 bore volumes purged prior to sampling.
- R Unusable result.
- X Location is undefined.

QA QUALIFIER: # = validated according to Quality Assurance guidelines.