6.1.3 Results

6.1.3.1 Ground Water—Residential: Mill Tailings Area

Results of calculations for ingestion of ground water through residential use are provided in Table 6–3. Noncarcinogenic risks were calculated for both children and adults; risks are slightly higher for children because of their lower body weights. The greatest risks for both children and adults are from exposure to uranium and manganese. The HQ for these contaminants is greater than 1 under the ground water ingestion by children scenario and accounts for about 85 percent of the total risks. Cadmium contributes about 6 percent of the total risk and exceeds the UMTRA standard at one location. The contribution from other contaminants that can be quantified (antimony, molybdenum, selenium, and vanadium) is less than 9 percent. The mean concentration of selenium exceeds the UMTRA standard by nearly a factor of 2 and should be retained as a COPC. From a risk perspective, antimony, molybdenum, and vanadium could probably be eliminated as COPCs, though molybdenum slightly exceeds the UMTRA standards at one location. Carcinogenic risk for uranium exceeds the high end of EPA's acceptable risk range of 1×10^{-4} by a factor of more than 5.

Sodium, sulfate, and lead could not be evaluated quantitatively due to lack of toxicity data. A recent survey by EPA (1999) indicated no adverse affects resulted from exposures to sulfate of 500 mg/L or less in drinking water in any study conducted. Some studies of adult populations showed negligible effects were associated with concentrations up to 1,200 mg/L. Infants are the receptors most sensitive to sulfate exposure. It is likely that sulfate levels present at the mill tailings area (up to 3,510 mg/L) would result in diarrhea and dehydration if ingested by infants on a regular basis.

Intakes of sodium based on concentrations at the mill tailings area are well within typical dietary ranges. The National Research Council recommends that most healthy adults consume at least 500 mg/day and sodium intake be limited to 2,400 mg/day. A Food and Drug Administration publication, *Scouting for Sodium and Other Nutrients Important to Blood Pressure* (FDA 1995) indicates that most adults tend to eat between 4,000 and 6,000 mg of sodium per day. Therefore, levels associated with the mill tailings area, even with a residential scenario, would not be expected to result in significant adverse affects. The level of sodium ingested by children would be less than 700 mg/day and for adults would be less than 900 mg/day.

Considerable information on the health effects of lead has been gathered through decades of medical research and epidemiologic evaluations. More recent evidence indicates negative effects of lead exposure, particularly concerning children's neurobehavioral development, may occur at blood levels so low that a threshold may not exist (EPA 2001).

6.1.3.2 Ground Water—Residential: Raffinate Ponds Area

The plume at the raffinate ponds area was defined by the wells in which at least one of several key constituents exceeded the maximum concentration in background wells (Table 6–4). Based on this plume, estimated risks for ingestion of ground water at the raffinate area were calculated and are listed in Table 6–5. The greatest noncarcinogenic risks occur from selenium, which accounts for approximately 87 percent of the total risk. Other important

Table 6–3. Intake/Risk Calculation Spreadsheet (ground water ingestion pathway)

Durango Mill Tailings Area- Residential Exposure

Noncarcinogens—Ground Water Ingestion Only (children)

Contaminant	Cw[a]	Irw	EF	ED	BW	AT	Intake	RfD[b]	HQ
Antimony	0.000665	1.5	350	7	38.3	2555	0.00002	0.0004	0.062
Cadmium	0.0086	1.5	350	7	38.3	2555	0.00032	0.0005	0.646
Lead	0.000879	1.5	350	7	38.3	2555	0.00003	NA	NA
Manganese	1.35	1.5	350	7	38.3	2555	0.05070	0.047	1.079
Molybdenum	0.0304	1.5	350	7	38.3	2555	0.00114	0.005	0.228
Selenium	0.0336	1.5	350	7	38.3	2555	0.00126	0.005	0.252
Sodium	427	1.5	350	7	38.3	2555	16.03598	NA	NA
Sulfate	2062	1.5	350	7	38.3	2555	77.43839	NA	NA
infants	2062	0.64	350	1	4	365	316.36164	NA	NA
Uranium	0.681	1.5	350	7	38.3	2555	0.02557	0.003	8.525
Vanadium	0.0856	1.5	350	7	38.3	2555	0.00321	0.007	0.459
								HI=	11.252

Noncarcinogens—Ground Water Ingestion Only (adults)

Contaminant	Cw	Irw	EF	ED	BW	AT	Intake	RfD[b]	HQ
Antimony	0.000665	2	350	30	70	10950	0.00002	0.0004	0.046
Cadmium	0.0086	2	350	30	70	10950	0.00024	0.0005	0.471
Lead	0.000879	2	350	30	70	10950	0.00002	NA	NA
Manganese	1.35	2	350	30	70	10950	0.03699	0.047	0.787
Molybdenum	0.0304	2	350	30	70	10950	0.00083	0.005	0.167
Selenium	0.0336	2	350	30	70	10950	0.00092	0.005	0.184
Sodium	427	2	350	30	70	10950	11.69863	NA	NA
Sulfate	2062	2	350	30	70	10950	56.49315	NA	NA
Uranium	0.681	2	350	30	70	10950	0.01866	0.003	6.219
Vanadium	0.0856	2	350	30	70	10950	0.00235	0.007	0.335
								HI =	7.737

Carcinogens—Ground Water Ingestion Only (adults)

Contaminant	Cw	Irw	EF	ED	BW	AT	Intake	SF	Risk
U-234+238[b]	467	2	350	30	na	na	9.81E+06	5.32E-11	5.22E-04
								Total risk	5.22E-04

[a]Water concentrations used are UCL_{95}
[b]Assumes equilibrium; 1 mg = 686 pCi; slope factor is average of U-234 and U-238
NA - Not available
na - Not applicable

Table 6–4. Raffinate Ponds Area Wells Included as Part of the Plume for the Risk Evaluation

	Exceeds Maximum Background Concentration[a]				
Well No.	**Sulfate**	**Manganese**	**Cadmium**	**Selenium**	**Uranium**
0597	✔				
0881	✔				
0889	✔				
0596	✔				✔
0892	✔	✔			✔
0880	✔	✔		✔	✔
0887	✔				
0888	✔				
0628	✔			✔	✔
0902	✔				
0598	✔	✔			✔
0593	✔	✔			
0882	✔	✔			
0879	✔	✔	✔	✔	✔
0876	✔				
0878	✔				
0890	✔				
0884	✔		✔	✔	
0594					✔
0607				✔	

[a]Background wells are defined as wells 0903, 0875, 0592, 0599, and 0886. Maximum concentrations (mg/L) in these wells in August 2001 were as follows: sulfate 1,660; manganese 0.464; cadmium 0.001; selenium 0.087; and uranium 0.0056.

contributors to the quantifiable risks are manganese and uranium; these two contaminants and selenium account for nearly 99 percent of the noncarcinogenic risks. Noncarcinogenic risks from antimony, arsenic, cadmium, and molybdenum contribute less than 2 percent of the total risk, and these compounds should be eliminated as noncarcinogenic COPCs. Although risks from thallium could not be quantified, recent plume data indicate concentrations are indistinguishable from background. Mean concentrations have dropped by over two orders of magnitude from the historical plume data, in large part because of a significant improvement in the detection limit. Because thallium concentrations in the plume are similar to or less than background concentrations, thallium should be eliminated as a COPC.

Other noncarcinogenic COPCs that could not be quantified should be retained since their concentrations are all elevated above background and may result in negative health impacts. Of these compounds, sulfate is of particular concern because it is found at levels known to result in diarrhea and dehydration if ingested on a regular basis.

Two carcinogenic COPCs were identified: uranium and arsenic. Uranium risks are at the upper end of EPA's acceptable risk range and should be retained as a COPC. Although arsenic concentrations are also within the risk range, the risk is caused by the high toxicity coupled with the higher detection limit for arsenic (i.e., concentrations of arsenic at the detection limit result in carcinogenic risks within the risk range). In addition, arsenic concentrations in background wells are greater than those in the plume wells. Concentrations in the plume have decreased by over two orders of magnitude since the data for the original BLRA were gathered. For these reasons, arsenic should be eliminated as a COPC.

Table 6–5. Intake/Risk Calculation Spreadsheet (ground water ingestion pathway)

Durango Raffinate Ponds Area—Residential Exposure									
Noncarcinogens—Ground Water Ingestion Only (children)									
Contaminant	**Cw[a]**	**Irw**	**EF**	**ED**	**BW**	**AT**	**Intake**	**RfD[b]**	**HQ**
Antimony	0.000756	1.5	350	7	38.3	2555	0.00003	0.0004	0.071
Arsenic	0.00056	1.5	350	7	38.3	2555	0.00002	0.0003	0.070
Cadmium	0.00112	1.5	350	7	38.3	2555	0.00004	0.0005	0.084
Chloride	561	1.5	350	7	38.3	2555	21.06835	NA	NA
Lead	0.000965	1.5	350	7	38.3	2555	0.00004	NA	NA
Manganese	1.62	1.5	350	7	38.3	2555	0.06084	0.047	1.294
Molybdenum	0.00309	1.5	350	7	38.3	2555	0.00012	0.005	0.023
Selenium	2.17	1.5	350	7	38.3	2555	0.08149	0.005	16.299
Sodium	1750	1.5	350	7	38.3	2555	65.72123	NA	NA
Sulfate	4320	1.5	350	7	38.3	2555	162.23756	NA	NA
Infants	4320	0.64	350	1	4	365	662.79452	NA	NA
Thallium	0.000156	1.5	350	7	38.3	2555	0.00001	NA	NA
Uranium	0.0747	1.5	350	7	38.3	2555	0.00281	0.003	0.935
								HI=	18.777
Noncarcinogens—Ground Water Ingestion Only (adults)									
Antimony	0.000675	2	350	30	70	10950	0.00002	0.0004	0.046
Arsenic	0.00056	2	350	30	70	10950	0.00002	0.0003	0.051
Cadmium	0.00112	2	350	30	70	10950	0.00003	0.0005	0.061
Chloride	561	2	350	30	70	10950	15.36986	NA	NA
Lead	0.000965	2	350	30	70	10950	0.00003	NA	NA
Manganese	1.62	2	350	30	70	10950	0.04438	0.047	0.944
Molybdenum	0.00309	2	350	30	70	10950	0.00008	0.005	0.017
Selenium	2.17	2	350	30	70	10950	0.05945	0.005	11.890
Sodium	1750	2	350	30	70	10950	47.94521	NA	NA
Sulfate	4320	2	350	30	70	10950	118.35616	NA	NA
Thallium	0.000156	2	350	30	70	10950	0.000004	NA	NA
Uranium	0.0747	2	350	30	70	10950	0.00205	0.003	0.682
								HI =	13.693
								Total risk	6.72E-05

Table 6–5 (continued). Intake/Risk Calculation Spreadsheet (ground water ingestion pathway)

Durango Raffinate Ponds Area—Residential Exposure									
Carcinogens—Ground Water Ingestion Only (children)									
Contaminant	**Cw[a]**	**Irw**	**EF**	**ED**	**BW**	**AT**	**Intake**	**RfD[b]**	**HQ**
Arsenic	0.000566	2	350	30	70	25550	6.6458E-06	1.5	9.97E-06
U234+238[b]	51	2	350	30	na	na	1.08E+06	5.32E-11	5.73E-05
								Total risk	6.72E-05

[a]Water concentrations used are UCL_{95}
[b]Assumes equilibrium; 1 mg = 686 pCi; slope factor is average of U-234 and U-238
NA - Not available
na - Not applicable

With the exception of selenium, all other contaminants have exhibited decreasing concentrations since the original BLRA data were obtained. Selenium has shown significant increases in several on-site wells (up to two orders of magnitude), most likely because of a change in oxidation/reduction conditions. These increasing selenium concentrations have become the major risk driver for the raffinate ponds area.

6.1.3.3 Uncertainty in the BLRA

There are many sources of uncertainty associated with the results from any risk assessment. These include limited site characterization, uncertainty of future land use, and uncertainty in toxicity values used. Generally, because of the conservative nature of assumptions used in calculating risks, risks are most often overestimated for any given exposure scenario. Some of the sources of uncertainty specific to this BLRA update are listed below along with their overall effect on estimates of site-related risks.

- **Toxicity data and contaminant interactions**—The toxicity values were obtained from EPA's Integrated Risk Information System (IRIS) database and represent the best data available. However, these values are often extrapolated from animal data or from laboratory tests conducted under conditions that differ from those by which actual exposure to environmental contaminants occurs. Most of the studies do not include data on more sensitive populations (e.g., children, the elderly). Uncertainty factors are often applied to these values to account for such circumstances. The RfDs for arsenic and selenium were developed using an uncertainty factor of 3; the RfD for cadmium includes an uncertainty factor of 10. Manganese has an uncertainty factor of 3. Uncertainty factors of 100 and 1,000 were applied in developing the RfDs for vanadium and uranium, respectively. Thus, the actual risks associated with vanadium and uranium are least understood. The application of highly conservative uncertainty factors may overestimate the risks.

- **Chemical interaction**—To get hazard indices and total carcinogenic risks, HQs and risks for all chemicals were simply summed. In reality, certain chemicals can have interactions that are either synergistic or antagonistic. This is not accounted for by summing risks. Lack of data on chemical interaction could either overestimate or underestimate actual risks.

- **Future water and land use**—Risks were calculated assuming future residential use of the site and consumption of ground water as the primary drinking water source. This was assumed as a likely scenario because of the proximity of the site to the city of Durango; however, there are currently no complete exposure pathways to ground water, and the current land ownership (City of Durango and the Animas-La Plata Water Conservancy District) reduce the potential for future residential development. This likely overestimates future risks because residential development of this area would likely include access to municipal water. In addition, risks presented here are overestimates based on exposure to current ground water contamination levels, future concentrations would be lower because of natural flushing. Finally, many of the wells with contaminated ground water yield insufficient water to serve as a primary source of drinking water.

- **Exposure parameters**—Exposure parameters for the residential scenario are default parameters used regularly by EPA. Most of the parameters are based on statistical analyses of population data. Actual exposures vary considerably. Numbers used represent values from the high end of the actual exposure distribution and are therefore conservative estimates.

Because each parameter is set at the high end of its respective distribution, overall risks are probably overestimated.

6.1.4 Human Health Risk Summary

Risk calculations show the only unacceptable exposure pathway is ingestion of ground water as drinking water. Table 6–6 summarizes the COPCs. Results of the risk calculations indicate controls should be put in place to prevent alluvial aquifer use for drinking water until contamination is reduced to acceptable levels.

Table 6–6. List of COPCs for the Durango, Colorado, Site

Mill Tailings Area	Raffinate Ponds Area
Cadmium	Chloride
Lead	Lead
Manganese	Manganese
Selenium	Selenium
Sodium	Sodium
Sulfate	Sulfate
Uranium	Uranium

For the mill tailings area, most of the risk is contributed by uranium and manganese. Cadmium accounts for approximately 6 percent of the total risk and has concentrations in only one well that exceed the standard. Although selenium contributes only 2 percent of the total risk, the UCL_{95} exceeds the MCL by a factor greater than 3. The other constituents combined contribute only about 7 percent of the total risk. Residential carcinogenic and noncarcinogenic risk thresholds are exceeded. Risks could not be calculated quantitatively for sodium, sulfate, and lead, but it appears the most significant potential adverse effect would be associated with infant or child exposure to the sulfate in ground water when used as a drinking water.

For the raffinate ponds area, risks are dominated by selenium with significant quantifiable contributions from manganese and uranium. Although risks could not be quantified, exposure to sulfate in the ground water would result in negative health impacts, particularly for infants.

6.2 Ecological Risk Assessment

6.2.1 Introduction

Ecological risk assessment (ERA) is a process that evaluates the likelihood of adverse ecological effects occurring or may occur in the future as a result of exposure to one or more environmental stressors. A stressor is defined as any physical, chemical, or biological entity that can induce an adverse ecological response. The risk assessment process is outlined in EPA guidance documents, particularly the "Guidelines for Ecological Risk Assessment" (EPA 1998a) and the "Framework for Ecological Risk Assessment" (EPA 1992). The Ecological Risk Assessment for the Durango UMTRA site generally follows this EPA framework and guidance.

The overall goal of this ERA is to identify ecological COPCs (E-COPCs) that can be related to the dispersal of contaminants in ground water and to characterize the potential for adverse effects of these E-COPCs on ecosystems at this site and along the Animas River and its tributaries. In particular, potential effects on special status species and sensitive environments are considered. This assessment is an update and expansion of the BLRA screening-level assessment conducted in

1995 (DOE 1995a). However, it is still primarily a screening assessment to identify E-COPCs and areas for which future monitoring may be necessary. This section summarizes the BLRA findings and evaluates data collected subsequent to the BLRA evaluation. This assessment will also apply data from new studies as well as updated ecological benchmarks and regulatory requirements that have been developed since completion of the BLRA.

Predicting the effects of chemicals on ecological receptors is complicated by the variable interactions and influences within an ecosystem. To a great extent, ecological risk assessment is an emerging science. Little data exist for most chemicals and their effects on ecological receptors. Therefore, attempting to integrate and evaluate individual and synergistic chemical effects with other stressors (predation, drought, disease, etc.) is problematic. Generally, for ecological risks to occur now or in the future there must be a contaminant source, which is assumed to be limited to ground water, and a pathway must exist for exposure of ecological receptors to contaminated ground water. The simplified ecological risk scenario gives a generalized overview of the ecological risk assessment process:

Contamination Source	—	Release	—	Contaminated Media	—	Pathway	—	Receptor	—	Effect
(Durango mill site)		(Migration into soil and ground water)		(Ground Water, Surface Water, and Sediments)		(Ingestion or Absorption)		(Plants, Wildlife)		(No effect, non-lethal effects, or mortality)

The following sections provide a summary of the BLRA and evaluation of potential risks based on a review of all relevant data, with emphasis on the 2000-2001 data.

6.2.2 Ecological Risk Assessment Process

As shown in Figure 6–2, the framework of the ERA contains three main components: (1) problem formulation, (2) analysis, and (3) risk characterization. The overall goal of the problem formulation is to "set the stage" for the analysis and risk characterization phases of the process. In the problem formulation, the need for a risk assessment is identified and the scope of the problem is defined. Available data are evaluated to identify potential stressors (in this case, the potential stressors are E-COPCs associated with the ground water at the Durango mill site), key ecological receptors, and potential exposure pathways linking the receptors to the stressors. This information is used to develop a site conceptual model and risk hypotheses. Finally, assessment and measurement endpoints are defined for the determination of specific risk to these receptors and the environmental resources they represent. These endpoints are directly tied to overall management goals for the site.

The analysis phase of the ERA includes two concurrent steps—the exposure assessment and the effects characterization. In the exposure assessment, the potential for each receptor to be exposed to each stressor is evaluated and, where possible, quantified. The effects characterization describes the potential for the stressor to adversely affect the receptors exposed to it. Because stressors at the Durango site are chemical, the principal effects to ecological receptors will be toxicological; however, they may also include physical effects, such as those related to radiation.

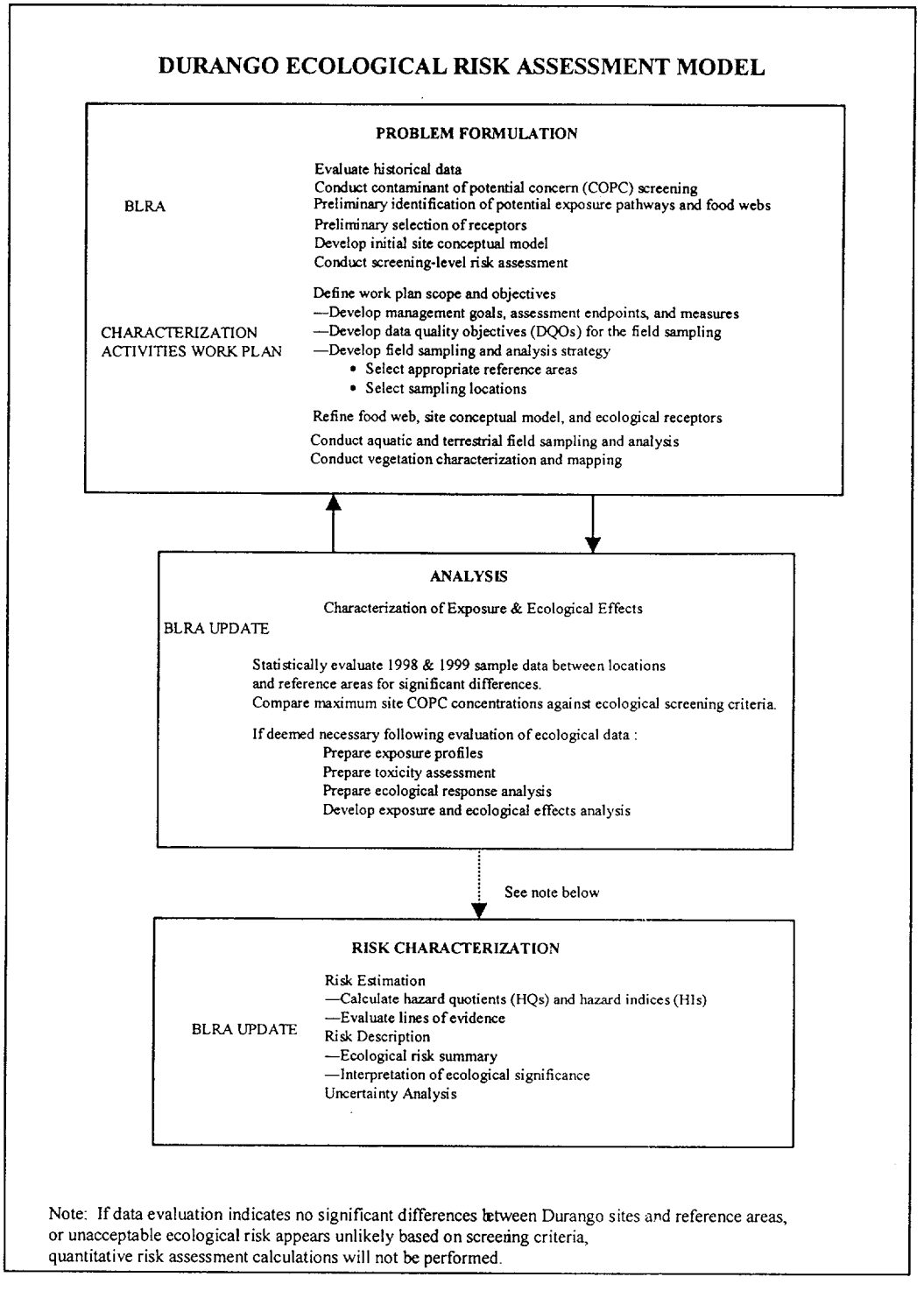


Figure 6–2. Durango Ecological Risk Assessment Model

The risk characterization phase evaluates (either qualitatively or quantitatively) the combined results of the exposure assessment and effects characterization to determine the potential for risk to the receptors due to their exposure to the stressors. A critical aspect of risk characterization is the analysis of uncertainties associated with predictions of potential risk. Typically, uncertainties result from data gaps, which necessitate the incorporation of assumptions into the analysis and risk characterization phases. In general, these assumptions are conservatively biased toward results that will lead to overestimations rather than underestimations of risk. The uncertainty analysis provides an analysis of these assumptions in terms of their potential for introducing significant bias in the risk estimation.

As described in the EPA guidance (EPA 1998a), ecological risk assessment is an iterative process in which the evaluation of potential risks to ecological receptors is refined as additional data are collected to fill data gaps and reduce uncertainties. At the conclusion of each iteration (or "tier") in the process, decisions are made as to whether sufficient data have been collected and analyzed to proceed with risk management actions (if required), or whether additional data should be collected. Such a tiered approach to the ecological risk assessment process began at the Durango site in 1995 by the performance of the screening-level BLRA (DOE 1995a).

Subsequently, additional data have been collected from key environmental media. The ERA presented here incorporates these new data as a refinement and update of the screening-level assessment presented in the BLRA. Sampling of ground water and surface water (from the Animas River) for chemical analysis was conducted between 1999 and 2001 as discussed in Section 4.7, "Ecological Investigation." Samples of sediment were collected and analyzed in November 1993 and January 2001.

Problem Formulation

The problem formulation phase in this ERA is represented in part by information presented in the BLRA (DOE 1995a). The BLRA was based on analytical data collected at the Durango site prior to 1995. These data were reviewed to determine if concentrations of analytes in ground water, surface water, and sediment may pose a potential ecological risk. Information on the geologic setting, ground water hydrology, geochemistry, and habitats of the site were incorporated in the BLRA evaluation. Principal results of the BLRA included an initial screening of chemical analytes as E-COPCs and an assessment of potential risk to biota, including livestock and irrigated crops. The assessment of potential risk, however, was primarily qualitative. The BLRA provided a basis for the preparation of a characterization work plan (DOE 2000b).

Since the completion of the BLRA, additional ground water and surface water samples have been collected on site and at upgradient reference locations. These new analytical data, which include the June 1999 through June 2001 sampling results, are included in this update.

Potentially Affected Habitats and Populations

The ground surfaces of the Durango mill tailings and raffinate ponds areas are highly disturbed from past use and subsequent soil remediation activities. These disturbed areas were reseeded with grasses, including smooth brome, Kentucky bluegrass, western wheatgrass, blue grama, galleta, and saltgrass (DOE 1995a). Along the Animas River, the habitat is mostly an open, rocky shoreline, with only scattered willows, cottonwoods, and boxelders. On the opposite shore, however, are larger trees and thickets of these species (DOE 1995a). Wildlife that use the site

include several species of birds, as well as deer mice, cottontail, deer, and beaver. The cold water of the Animas River in the area of these sites supports trout, which are stocked by the Colorado Division of Wildlife (DOE 1995a). The flora and fauna of the sites as they existed prior to the surface remediation are described in the *Final Environmental Impact Statement, Remedial Actions at the Former Vanadium Corporation of America Uranium Mill Site, Durango, La Plata County, Colorado* (DOE 1985) which documents the results of site-specific biological investigations.

As a result of consultation with the U.S. Fish and Wildlife Service Grand Junction Office (June 27, 2000), three threatened or endangered species have been identified as potentially occurring in the vicinity of the areas. These are the razorback sucker, the Colorado pikeminnow, and southwestern willow flycatcher. Neither the razorback sucker nor the Colorado pikeminnow are likely to occur in the vicinity; however, suitable habitat for the southwestern willow flycatcher occurs along the Animas River, although not close to the site. In addition to these species, bald eagles are known to winter along the Animas River near Durango, but are not known to have nested there in recent history.

Summary of the 1995 Ecological Risk Assessment Results

In the 1995 BLRA (DOE 1995a), analytical data from surface water and sediment samples from Lightner Creek and the Animas River were evaluated for E-COPCs based on comparisons of maximum detected concentrations to background data, when available. As shown in Table 6–7, the BLRA initially identified 31 ground-water-based constituents as possible E-COPCs for further screening and evaluation. Twenty-two of these analytes were detected in surface water and 11 in sediment. Of the 22 analytes detected in surface water, 11 (ammonium, barium, chloride, chromium, copper, fluoride, potassium, sodium, sulfide, tin, and vanadium) did not have corresponding background data. The other 11 had maximum detected concentrations exceeding the background concentrations. For sediment, six analytes (arsenic, iron, lead, nitrate, selenium, and zinc) were detected at concentrations greater than background in samples from the Animas River. One sample designated as sediment (from location 0655) was not included here in the sediment database because it was located above the Animas River water line and had associated evaporite minerals. Sulfate and molybdenum concentrations exceeded the upstream concentrations in this sample, but it is questionable whether this may be due to the concentration of these constituents by surface evaporation.

Although limited media-specific benchmark values and receptor-specific toxicity information were found, results of the screening ecological risk assessment presented in the BLRA indicated the potential for risk to ecological receptors exposed to E-COPCs in the surface water is probably low. For sediment, concentrations of iron, lead, and zinc exceeded benchmark values for sediment quality. Some E-COPCs in ground water, such as arsenic, cadmium, lead, manganese, and selenium, may be taken up by deep-rooted plants and thereby enter the food chain. Although insufficient information was available to assess the potential impact of this pathway, the BLRA concluded that the potential hazard was low due to the limited amount of vegetation covering the sites. Ground water was found to be unsuitable for use in a surface pond due to potential risks to aquatic life.

Table 6–7. Summary of E-COPC in Ground Water, Surface Water, and Sediments from the Baseline Risk Assessment

Constituent	Constituents Detected Above Background in Ground Water at the Mill Tailings Area	Constituents Detected Above Background in Ground Water at the Raffinate Ponds Area	Constituents Detected in the Animas River Surface Water or Sediment
Ammonium	X	X	SW[a]
Antimony	X	X	
Arsenic		X	SD
Barium	X		SW[a]
Cadmium	X	X	(SD)
Calcium	X	X	SW
Chloride	X	X	SW[a]
Chromium		X	SW[a]
Cobalt		X	
Copper		X	SW[a]
Fluoride	X	X	SW[a]
Iron		X	SW, SD
Lead	X	X	SW, (SD)
Magnesium	X	X	SW
Manganese	X	X	SW, (SD)
Molybdenum	X	X	SW, (SD)
Nickel		X	
Nitrate	X		SW, SD
Potassium	X	X	SW[a]
Selenium	X	X	SW, SD
Silica	X	X	
Silver	X		
Sodium	X	X	SW[a]
Strontium	X	X	
Sulfate	X	X	SW, (SD)
Sulfide		X	SW[a]
Thallium		X	
Tin	X	X	SW[a]
Uranium	X	X	SW, (SD)
Vanadium	X	X	SW[a]
Zinc	X	X	SW, SD

[a]Analyte was not measured in upstream (background) samples; therefore, it could not be eliminated as an E-COPC based on background comparison.
SW = Detected in surface water samples from the river
SD = Detected in sediment samples from the river
(SD) indicates that the upstream (background) sediment concentration was greater than the site sample concentrations.

Update of the 1995 E-COPCs

For the current ERA, additional data collected and information received subsequent to the issuance of the BLRA are used to reevaluate the list of E-COPCs and to further assess these constituents for potential ecological risk at the Durango areas. This update to the 1995 BLRA is based on ground

water and surface water data collected between June 1999 and June 2001, and sediment samples collected in November 1993 and January 2001.

Recent ground water data were reevaluated to identify current E-COPCs. Results of this reevaluation are presented in Table 6–8. In this reevaluation, an analyte was identified as an E-COPC if its maximum detected concentration from the site exceeded the maximum upgradient concentration. Constituents that are considered to be essential nutrients (calcium, magnesium, potassium, and sodium) are also excluded as E-COPCs. Sulfate and chloride are anions of low potential toxicity in biota. However, because both sulfate and chloride have State of Colorado water quality standards for the Animas River, they were included for consideration as E-COPCs. Despite the relatively low toxicities of these anions and cations, at high concentrations in water, they can contribute to adverse ecological effects due to high osmotic potentials, and some can affect the use of water by wildlife and livestock by imparting strong tastes to the water. Those types of effects, however, are not addressed in this risk assessment.

As seen in Table 6–8, all nonradiological constituents not excluded as essential nutrients were identified as E-COPCs in ground water at either the mill tailings area or the raffinate ponds area. All were found to be E-COPCs at raffinate ponds area; however, at the mill tailings area, only concentrations of arsenic, cadmium, chloride, chromium, manganese, molybdenum, selenium, sulfate, uranium, vanadium, and zinc exceeded the upper limit of the background range. Of the radionuclides analyzed in ground water, lead-210 and thorium-230 were not detected. Radium-226 was identified as an E-COPC at only the mill tailings area; concentrations of all other radionuclides exceeded background at both areas.

Table 6–9 presents the E-COPC selection results for surface water in the Animas River and Lightner Creek. For surface water, data from both the mill area (including Lightner Creek) and the raffinate ponds area were combined and evaluated as a single unit. As with the ground water evaluation of E-COPCs, a constituent was considered an E-COPC if its maximum detected concentration exceeded the maximum concentration from the upstream (background) locations (including both the Animas River and Lightner Creek upstream samples). Also as with ground water, the essential nutrients calcium, magnesium, potassium, and sodium, were excluded from the E-COPC selection process due to their low toxicities.

Of the nonradiological analytes, only ammonium, cadmium, calcium, lead, selenium, and sulfate concentrations exceeded the background maximum concentration in surface water. Calcium was excluded as an E-COPC because it is an essential nutrient. Cadmium was also dropped because its maximum value only very slightly exceeded the maximum background value. Maximum concentrations of lead, selenium, and sulfate were also very close to their corresponding background concentrations. In fact, of the 41 data points collected for each of these analytes, only one exceeded the background range for both lead and sulfate and two exceeded the background range for selenium. These results confirm the conclusion in the BLRA that contaminants in ground water have not adversely affected water quality of the Animas River and Lightner Creek.

Of the nine radionuclides analyzed in surface water samples, only lead-210 and radium-228 had maximum values less than the background maximum. However, as with the nonradiological analytes, the maximum concentrations of the other radionuclides were generally close to the background range.

Table 6–8. Summary of Preliminary E-COPCs in Ground Water at the Durango Site Based on Sampling Data from June 1999 through June 2001

Constituent	Maximum Concentration in Ground Water				E-COPC? (Site)	Reason
	Mill Tailings Background	Mill Tailings Area	Raffinate Ponds Background	Raffinate Ponds Area		
Nonradiological Analytes (mg/L)						
Ammonium	2.28	1.33	1.4	**9.08**	DUR02	Exceeds background range
Antimony	<0.0045	<0.002	<0.0014	**0.0022**	DUR02	Exceeds background range
Arsenic	0.0013	**0.0015**	0.0034	**0.0041**	DUR01, DUR02	Exceeds background range
Cadmium	0.00034	**0.0435**	0.00031	**0.0037**	DUR01, DUR02	Exceeds background range
Calcium	583	499	242	**462**	No	Essential nutrient
Chloride	265	**358**	83.6	**1,400**	DUR01, DUR02	Exceeds background range
Chromium	<0.0059	**0.005**	0.0053	**0.0068**	DUR01, DUR02	Exceeds background range
Copper	0.0153	0.0085	0.0069	**0.0518**	DUR02	Exceeds background range
Iron	11.8	6.76	1.71	**9.78**	DUR02	Exceeds background range
Lead	0.0023	0.00043	0.00011	**0.0107**	DUR02	Exceeds background range
Magnesium	254	**451**	216	**455**	No	Essential nutrient
Manganese	1.05	**5.4**	0.58	**7.07**	DUR01, DUR02	Exceeds background range
Molybdenum	0.0057	**0.15**	0.0155	**0.0899**	DUR01, DUR02	Exceeds background range
Nitrate	11.2	7.01	4.99	**50**	DUR02	Exceeds background range
Potassium	8.17	**39.8**	8.85	**73.6**	No	Essential nutrient
Selenium	0.0148	**0.123**	0.0077	**12.3**	DUR01, DUR02	Exceeds background range
Sodium	488	**1,550**	626	**3,520**	No	Essential nutrient
Sulfate	2,160	**3,450**	1,330	**8,530**	DUR01, DUR02	Exceeds background range
Thallium	0.00038	0.0001	<0.00037	**0.00024**	DUR02	Exceeds background range
Uranium	0.0354	**2.12**	0.0321	**0.356**	DUR01, DUR02	Exceeds background range
Vanadium	0.00098	**0.448**	0.00075	**0.0235**	DUR01, DUR02	Exceeds background range
Zinc	0.0265	**2.61**	0.23	**0.464**	DUR01, DUR02	Exceeds background range
Radiological Analytes (pCi/L)						
Gross Alpha	25.93	**1,655**	54.0	**261**	DUR01, DUR02	Exceeds background range
Gross Beta	30.32	**666**	23.7	**161**	DUR01, DUR02	Exceeds background range
Lead-210	<1.47	<1.47	<1.47	<1.5	No	Not detected
Polonium-210	0.09	**0.1**	0.12	**1.12**	DUR01, DUR02	Exceeds background range
Radium-226	0.22	**0.46**	0.7	0.54	DUR01	Exceeds background range
Radium-228	<1.39	**0.7**	0.5	**0.99**	DUR01, DUR02	Exceeds background range
Thorium-230	<2.6	<2.6	<3.1	<2.7	No	Not detected
Uranium-234	14.1	**732**	4.1	**105**	DUR01, DUR02	Exceeds background range
Uranium-238	14.2	**766**	2.6	**111**	DUR01, DUR02	Exceeds background range

Bold text indicates value exceeds the maximum background concentration.
DUR01 = Mill Tailings Area
DUR02 = Raffinate Ponds Area

Table 6–9. Surface Water Constituents Retained for Evaluation Based on Sampling Data from June 1999 through June 2001

Constituent	Maximum Concentration in Surface Water		E-COPC?	Reason
	Background	Durango Site		
Nonradiological Analytes (mg/L)				
Ammonium	0.0456	**0.49**	Yes	Exceeds background range
Antimony	<0.0013	<0.0019	No	Not detected
Arsenic	0.00096	0.0004	No	Within background range
Cadmium	0.00053	**0.00054**	No	Within background range
Calcium	167	**173**	No	Essential nutrient
Chloride	20.9	20.5	No	Within background range
Chromium	0.0111	0.0079	No	Within background range
Copper	0.0063	0.006	No	Within background range
Iron	0.101	0.0637	No	Within background range
Lead	0.00026	**0.00033**	Yes	Exceeds background range
Magnesium	137	135	No	Essential nutrient
Manganese	0.205	0.158	No	Within background range
Molybdenum	0.0019	0.0017	No	Within background range
Nitrate	3.15	2.11	No	Within background range
Potassium	7.08	5.05	No	Essential nutrient
Selenium	0.0026	**0.003**	Yes	Exceeds background range
Sodium	111	85	No	Essential nutrient
Sulfate	793	**809**	Yes	Exceeds background range
Thallium	<0.00037	<0.00044	No	Not detected
Uranium	0.0333	0.031	No	Within background range
Vanadium	0.0017	0.0016	No	Within background range
Zinc	0.0788	0.0691	No	Within background range
Radiological Analytes (pCi/L)				
Gross Alpha	<12.1	**17.9**	Yes	Exceeds background range
Gross Beta	16.1	**16.7**	Yes	Exceeds background range
Lead-210	<1.38	<1.4	No	Not detected
Polonium-210	0.06	**0.08**	Yes	Exceeds background range
Radium-226	0.15	**0.21**	Yes	Exceeds background range
Radium-228	1.1	<1	No	Within background range
Thorium-230	<2.6	**4.1**	Yes	Exceeds background range
Uranium-234	3.6	**5.6**	Yes	Exceeds background range
Uranium-238	4.1	**4.6**	Yes	Exceeds background range

Bold text indicates value exceeds the maximum background concentration.

Data from sample location 0655 were not included with the sediment samples in this analysis because the sample was collected above the water line of the Animas River and was associated with evaporites (DOE 1995a). Six analytes (arsenic, iron, lead, nitrate, selenium, and zinc) were detected in sediments of the site at concentrations greater than background. These analytes were identified as E-COPCs.

A summary of results of the reevaluation of E-COPCs is presented in Table 6–10. These lists of E-COPCs are media-specific and location-specific.

Table 6–10. Summary of E-COPCs at the Durango Sites Based on Analytical Data from June 1999 through June 2001

Ground Water		Surface Water	Sediment
Mill Tailings Area	**Raffinate Ponds Area**		
Arsenic	Ammonium	Ammonium	Arsenic
Cadmium	Antimony	Lead	Iron
Chloride	Arsenic	Selenium	Lead
Chromium	Cadmium	Sulfate	Nitrate
Manganese	Chloride	Gross Alpha	Selenium
Molybdenum	Chromium	Gross Beta	Zinc
Selenium	Copper	Polonium-210	
Sulfate	Iron	Radium-226	
Uranium	Lead	Thorium-230	
Vanadium	Manganese	Uranium-234	
Zinc	Molybdenum	Uranium-238	
Gross Alpha	Nitrate		
Gross Beta	Selenium		
Polonium-210	Sulfate		
Radium-226	Thallium		
Radium-228	Uranium		
Uranium-234	Vanadium		
Uranium-238	Zinc		
	Gross Alpha		
	Gross Beta		
	Polonium-210		
	Radium-228		
	Uranium-234		
	Uranium-238		

6.2.3 Ecological Site Conceptual Model

The conceptual model for an ERA is developed from information about stressors, predicted exposure pathways, and the potential effects of exposure on ecological receptors. Conceptual models consist of two principal components:

- A set of risk hypotheses that provide descriptions of predicted relationships among stressor, exposure, and assessment endpoint response, along with the rationale for their selection.
- A diagram that illustrates the relationships presented in the risk hypotheses.

A complete exposure pathway is the mechanism by which a contaminant in an environmental medium (i.e., the source) can contact an ecological receptor. A complete exposure pathway includes

- Contaminant source,
- Release mechanism that allows contaminants to become mobile or accessible,
- Transport mechanism that moves contaminants away from the release,
- Ecological receptor, and
- Route of exposure (e.g., dermal or direct contact, inhalation, or ingestion).

Because stressors at the Durango site are chemical contaminants, the risk hypotheses are considered to be stressor-initiated.

As part of the initial problem formulation in the BLRA, a generalized site conceptual model was developed for the Durango site. That model has since been revised to address current and potential exposure pathways based on all the available data (Figure 6–3). At this site, the movement of contaminated ground water from the mill tailings area and raffinate ponds area is not known to have resulted in surface expressions, such as seeps and springs; however, discharges into the Animas River and possibly Lightner Creek may be occurring at low rates. For this reason, risk hypotheses are developed for these surface water features based on this possible contact.

Risk Hypotheses Based on Current Exposure Scenarios

The following are the risk hypotheses proposed where complete exposure pathways to ecological receptors may exist based on the current site conditions. Contaminants in the near-surface ground water of the site may be taken up by deep roots of phreatophytes. These contaminants may produce phytotoxic effects on the plant and may transport to plant tissues that are accessible to wildlife. Contaminated ground water may be discharging into the Animas River, thereby adversely affecting surface water and sediment quality of the area. Aquatic organisms in direct contact with these media may be affected and may provide a link for bioaccumulation of the contaminants up the food chain. Wildlife could be directly exposed to these contaminants through ingestion of this water and/or food items exposed to the water, and sediment and the incidental ingestion of the sediment.

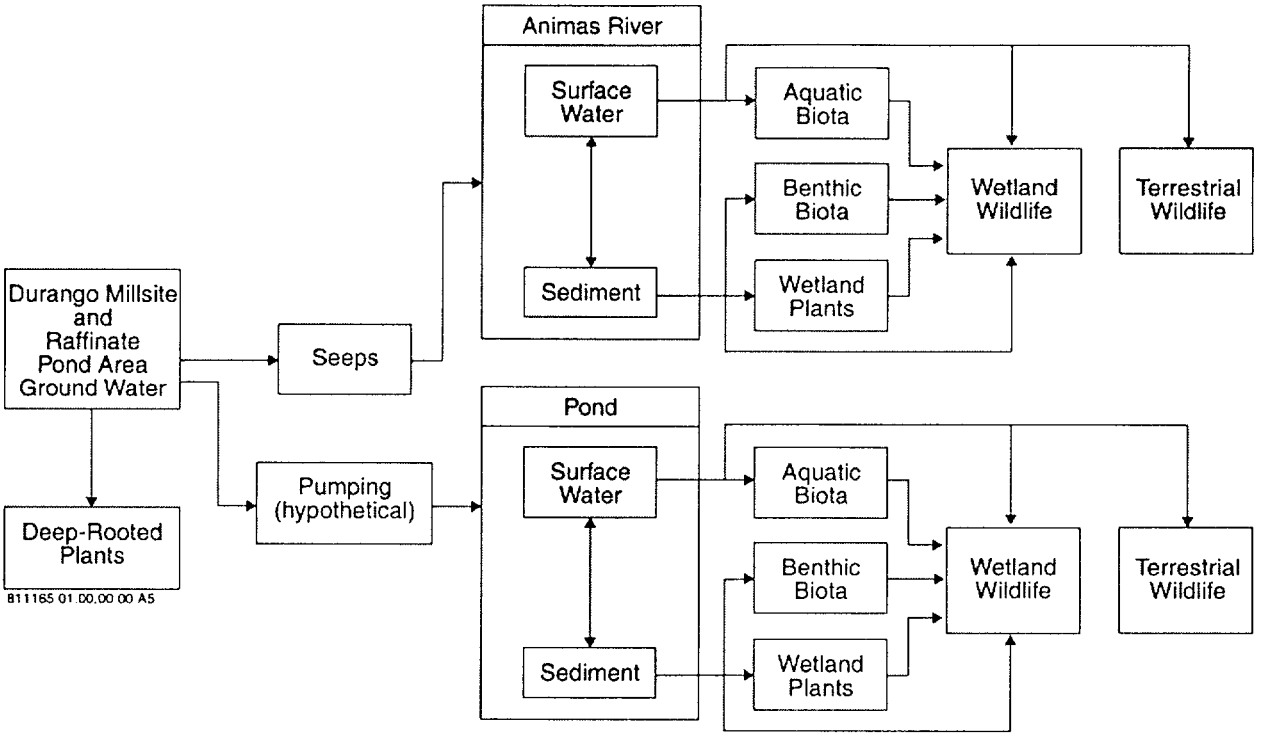


Figure 6–3. Ecological Site Conceptual Model for the Durango UMTRA Site

Risk Hypotheses Based on Hypothetical Future Exposure Scenario

Without institutional controls, ground water could possibly be pumped and used for irrigation, surface ponds, livestock watering, or industrial uses. This practice would create a source for potential ingestion of ground water, direct contact with terrestrial vegetation, and deposition of ground water on the soil. The soil would then represent an additional source medium for ingestion and direct contact.

Ecological Receptors

Ecological receptors that could potentially be exposed to E-COPCs were identified in the BLRA (DOE 1995a) and include mammalian and avian species. Section 6.2.2 summarizes the habitats and populations that may be affected by exposures to E-COPCs at the Durango site. The food web for this site (Figure 6–4) illustrates the significant dietary interactions among and between the wetland and aquatic receptors associated with the Animas River. The food web also depicts the major trophic interactions and shows nutrient flow and transfer of matter and energy through the trophic levels. This food web model was developed from the species lists and consideration of the exposure pathways. The food web diagram was used to portray potential pathways of E-COPCs from the ground water to biota at various trophic levels, with potential receptor species being identified as having potentially complete ecological exposure pathways. These potential receptors are as follows:

The Animas River. The habitat of the river channel is primarily riparian. The potential receptors of these areas include:

- Plants—Wetland and riparian plants that grow along the channel course in direct contact with water and sediments.
- Aquatic receptors—Aquatic receptors include fish, aquatic invertebrates, and aquatic plants that live in direct contact with water and sediments.
- Wetland wildlife—Wetland wildlife may be exposed to E-COPCs along the river as a result of drinking surface water and feeding on the aquatic organisms and wetland plants. Potential receptors include insectivorous birds, such as swallows and flycatchers; shorebirds, such as sandpipers and killdeer; piscivorous birds, such as belted kingfishers and herons; and mammals associated with wetland habitats, including muskrats and raccoons.

As described in Section 6.2.2, potential receptors associated with the Animas River include the endangered southwestern willow flycatcher and the threatened bald eagle. However, neither of the two species of endangered fish discussed in Section 6.2.2 are considered potential receptors at this site.

The River Floodplain and the Uplands. The habitats of the Animas River floodplain and adjacent uplands are primarily terrestrial; however, many of the wildlife receptors that occur in these habitats probably live and feed in close association with the aquatic habitats of the river. These receptors may use the river as a source of drinking water, and may thereby be exposed to E-COPCs. Because the areas of the millsite and raffinate ponds on these upland areas are highly disturbed, little wildlife use of these areas is expected. However, small mammals and birds use the area, and terrestrial predators may sometimes hunt these animals. Larger species, such as deer, probably cross the area while going to and from the river, and may forage in the area on occasion.

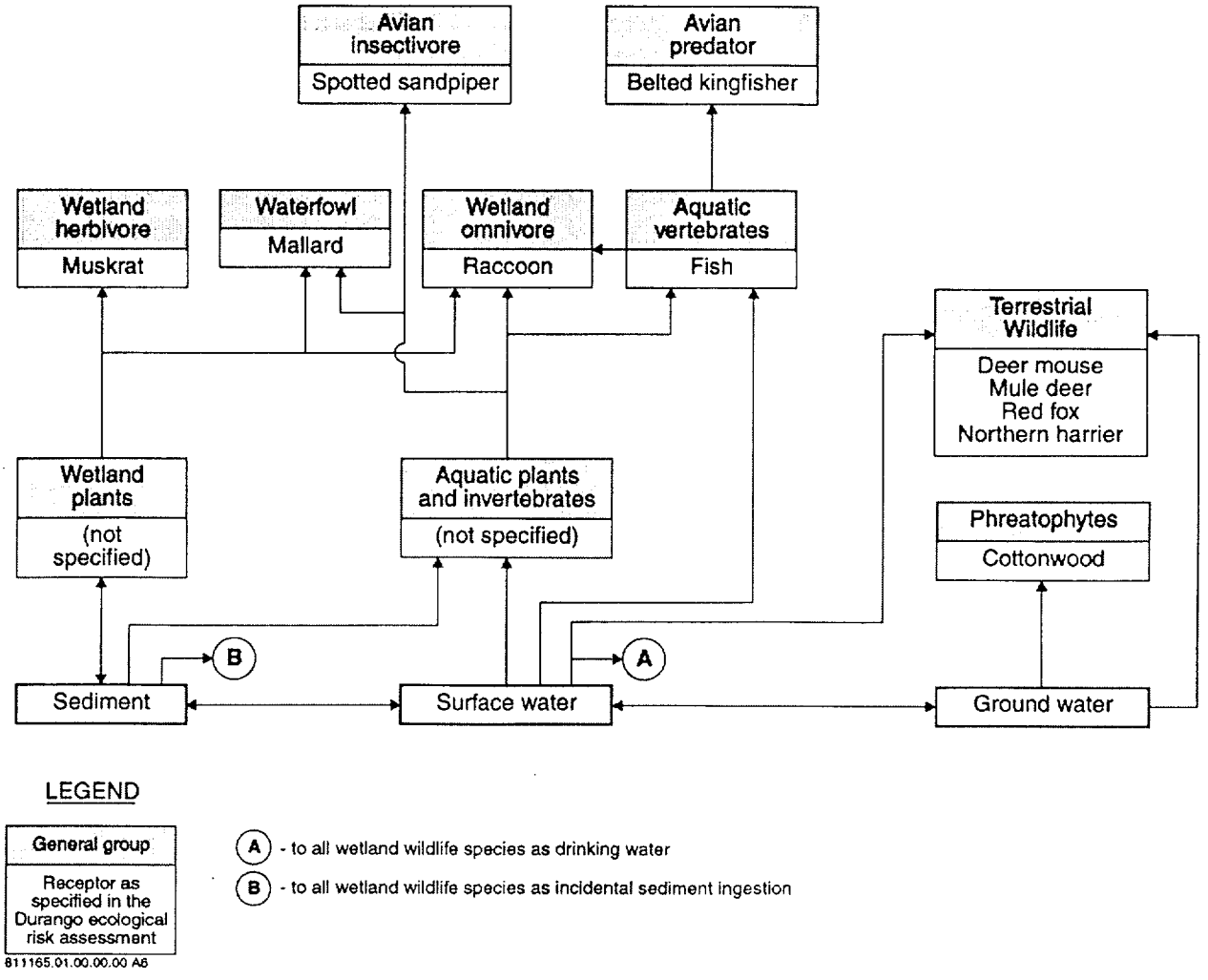


Figure 6–4. Generalized Food Web for Ecological Receptors at the Durango Site.

6.2.3.1 Management Goals and Endpoints

Table 6–11 presents the primary goals for protection of environmental resources with respect to contaminants associated with ground water, and the assessment and measurement endpoints that will be used to evaluate potential risk to these resources in support of achieving these goals.

6.2.4 Analysis

6.2.4.1 Exposure Assessment

Exposure Modeling and Assumptions

Only complete exposure pathways are quantitatively and qualitatively evaluated in an ERA. In this assessment, the following potential exposure pathways were considered for evaluation:

- Surface water ingestion and direct contact
- Sediment ingestion and direct contact
- Dietary ingestion of forage or prey, as appropriate, by receptor

Table 6–11. Management Goals, Assessment Endpoints, and Measurement Endpoints for the Evaluation of Ecological Risks at the Durango Site

Management Goals	Assessment Endpoints	Measurement Endpoints
Maintain the quality of aquatic habitats in the Animas River	Surface water quality of the Animas River	Concentrations of E-COPCs in the surface water of the Animas River meet applicable water quality criteria or equivalent benchmarks for the protection of aquatic life.
	Sediment quality of the Animas River	Concentrations of E-COPCs in the sediment of the Animas River meet applicable sediment quality benchmarks for the protection of benthic organisms.
Maintain habitat quality of the floodplain for the protection of wildlife diversity	Potential for adverse effects on survival and reproduction in wildlife from exposures to E- COPCs in various environmental media of the Animas River floodplain and adjacent uplands	Hazard quotients comparing estimated exposure to toxicity benchmarks for key indicator receptor species are less than unity.
	Ground water quality of the Animas River floodplain	Concentrations of E- COPCs in the ground water of the Animas River floodplain meet benchmarks for the protection of riparian plants.

Contaminants associated with the Durango site are inorganic and are associated with surface water, ground water, and sediments. Estimates of potential exposures to key ecological receptors are based on the dominant pathways from these media for the specific receptor. Exposures in wetland plants are dominated by direct contact with the sediment in which they are rooted. Phreatophytes may be exposed through direct contact with the ground water. Exposures to aquatic organisms (those that live within the water column) and benthic organisms (those that live within the sediment) are dominated by direct contact with the external media (water and sediment) in which they live, but in the cases of aquatic and benthic animals also include the ingestion of food associated with these media. In all of these cases, potential exposure to an E-COPC is based on the concentration of that E-COPC in the media of principal contact.

Exposures in wildlife involve multiple potential pathways that may include ingestion of food, water, and sediment; direct contact and dermal absorption; and inhalation. In this assessment, the inhalation and dermal absorption pathways are assumed to be minor pathways with respect to the combined exposures based on ingestion. Most wildlife of the area have very little and infrequent direct dermal contact with potentially contaminated media due to their protective covers of feathers or fur and their habits and behaviors, such as preening and grooming, and (in the cases of most birds) living principally in trees and shrubs. The E-COPCs are not highly volatile. Therefore, their occurrence in the air is minimal. The assessment of exposures in wildlife through inhalation was considered a minor exposure pathway relative to sediment ingestion. Although both dermal absorption and inhalation will contribute to the overall exposure in these receptors, these contributions are assumed to be included within the conservatisms incorporated in the estimation of exposures through the ingestion pathways.

For the estimation of ingestion-related exposure for wildlife receptors, the E-COPCs are assumed to be 100 percent bioavailable and the receptors are assumed to be exposed only at the selected exposure point concentration, regardless of home range size or seasonal use patterns. The exposure through multiple ingestion pathways is modeled using the methods described in the EPA's *Wildlife Exposure Factors Handbook* (EPA 1993). The basic model for estimating the daily intake of an E-COPC per kilogram of body weight (i.e., the estimated daily dose of the E-COPC) through these ingestion pathways is

$$D_x = \frac{\sum_{k=1}^{m}(C_k \cdot F_k \cdot I_k) + C_s \cdot F_s \cdot I_s + C_w \cdot F_w \cdot I_w}{W}$$

where

D_x is the estimated daily dose (mg/kg-day) of E-COPC x,
C_k is the concentration of E-COPC x in the kth food type (mg/kg dry weight),
F_k is the fraction of the kth food type that comes from the site,
I_k is the ingestion rate of the kth food type (kg dry weight/day),
m is the number of food items in the receptor's diet,
C_s is the concentration of E-COPC x in the sediment or soil (mg/kg dry weight),
F_s is the fraction of ingested sediment or soil that comes from the site,
I_s is the ingestion rate of sediment or soil (kg dry weight/day),
C_w is the concentration of E-COPC x in water (mg/L),
F_w is the fraction of the ingested water that comes from the site,
I_w is the ingestion rate of water (L/day), and
W is the body weight of the receptor (kg wet weight).

F_k, F_s, and F_w are commonly assumed to be the area use factor (the area of the site divided by the home range of the receptor or 1, whichever is smaller) but may also be modified by a seasonal use factor (number of days at the site divided by 365 days per year) if the home range is used for only part of the year. For estimating risk in this assessment, both area use and seasonal use are conservatively assumed to be 100 percent; therefore, F_k, F_s, and F_w are assumed to be 1.

For the purposes of estimating exposure in wildlife, E-COPC concentrations in plants were principally based on empirically derived uptake models (nonlinear or linear) as recommended by Oak Ridge National Laboratory (Bechtel Jacobs Company 1998a). The nonlinear form of the uptake model is

$$C_{plant} = B_0 \cdot C_{soil}^{\ B_1}$$

where

C_{plant} is the concentration of the E-COPC in the plant (mg/kg dry weight),
C_{soil} is the soil concentration of the E-COPC (mg/kg dry weight), and
B_0 and B_1 are empirically derived model parameters for the E-COPC.

In the linear form of this model, B_1 is assumed to be exactly 1 and B_0 becomes a soil-to-plant transfer factor, where

$$C_{plant} = B_0 \cdot C_{soil}$$

In cases where parameters were not available in the Oak Ridge National Laboratory uptake model documents, soil-to-plant transfer factors from other literature sources (e.g., Baes and others 1984) were used in this linear model.

For aquatic prey species (invertebrates and fish), linear uptake models based on bioaccumulation factors (BAFs) were used to estimate concentrations of E-COPCs in tissues. These models are of the form:

$$C_{organism} = BAF \cdot C_{water}$$

where

$C_{organism}$ is the concentration of the E-COPC in the invertebrate or fish prey species (mg/kg dry weight),
C_{water} is the concentration of the E-COPC in the water (mg/L), and
BAF is the bioaccumulation factor for the E-COPC.

BAFs account for all exposure pathways (dermal absorption, uptake through respiratory organs, and ingestion). In contrast, bioconcentration factors (BCFs) account for uptake through pathways other than ingestion. However, for most inorganic constituents, uptake through ingestion is insignificant, and BAFs are considered to be equal to BCFs. Therefore, BCFs are used as BAFs in this assessment when the latter values are not available. Whenever possible, however, BAFs and BCFs specific to either invertebrates or fish were used to model the concentrations in these respective prey types. Data specific to ammonium and nitrate uptake could not be found; however, because of its high biological activity, ammonium was assumed not to accumulate in tissues or be transferred through the food web. Nitrate concentrations in the prey species were assumed to equal its concentration in the surrounding media. Table 6–12 presents the uptake model parameters (B_0, B_1, BAF, and/or BCF values) used in modeling the concentrations of E-COPCs through the food chain at the Durango site.

Key Indicator Receptors

The receptors used to evaluate potential risks were selected based on their potential presence in the habitats of the site, their potential for exposure to E-COPCs in the media at the site, and their potential for conservatively representing potential exposures to a range of other receptors at the site. Receptors for the habitats identified as having potentially complete ecological pathways are discussed in Section 6.2.3.1. The indicator receptors are representative of key links in the food webs associate with these habitats.

These indicator receptors are as follows:

- Terrestrial habitats—deep-rooted plant (phreatophyte), deer mouse (herbivorous), red fox, mule deer, northern harrier
- Wetland habitats—wetland plant, muskrat, raccoon, mallard, spotted sandpiper, belted kingfisher
- Aquatic habitats—aquatic and benthic organisms

Table 6–12. Uptake Model Parameters and Bioaccumulation Factors for E-COPC

Ecological Contaminant of Potential Concern	Plant Uptake Model Parameters		Bioaccumulation Factors	
	B_0	B_1	Invertebrates	Fish
Ammonium	0.0[a]	1.0	0.0[a]	0.0[a]
Antimony	0.20[b]	1.0[c]	10[d]	1.0[d]
Arsenic	0.136[e]	0.564[e]	73.0[f]	17.0[g]
Cadmium	0.621[e]	0.546[e]	3,460[f]	12,400[g]
Chloride	70[b]	1.0[c]	1.0[h]	1.0[h]
Chromium	0.04[i]	1.0[c]	3,000[f]	40[d]
Copper	1.95[e]	0.394[e]	3,720[f]	290[g]
Iron	0.004[b]	1.0[c]	200[j]	200[k]
Lead	0.265[e]	0.561[e]	5,060[f]	45[g]
Manganese	3.0[l]	1.0[c]	65[l]	17.8[l]
Molybdenum	0.8[k]	1.0[c]	10[j]	10[k]
Nitrate	1.0[h]	1.0[h]	1.0[h]	1.0[h]
Selenium	0.508[e]	1.10[e]	269[m]	129[f]
Sulfate	1.0[h]	1.0[h]	1.0[h]	1.0[h]
Thallium	0.004[b]	1.0[c]	67.0[j]	67.0[n]
Uranium	0.023[k]	1.0[c]	27.1[j]	27.1[l]
Vanadium	0.0055[b]	1.0[c]	3,000[d]	10[d]
Zinc	4.831[e]	0.555[e]	1,130[o]	161[n]

[a]Ammonium assumed not to accumulate in tissue.
[b]From Baes and others (1984).
[c]The uptake model is linear; therefore, B_1 = 1.0.
[d]From Bodek and others (1988).
[e]From Bechtel Jacobs Company (1998).
[f]From NMED (2000).
[g]From Sample and others (1996).
[h]Default value.
[i]From NCRP (1989).
[j]Invertebrate bioaccumulation factor based on fish bioaccumulation factor.
[k]From IAEA (1974).
[l]From EPA (2000).
[m] From EPA 2000; geometric mean of selenite bioaccumulation factors for water fleas based on 14-day exposure.
[n]EPA (1995).
[o]From Eisler (1993).

Terrestrial exposure pathways are found on the floodplain and adjacent uplands. Deep-rooted plants (e.g., cottonwood) are considered only as potential receptors for E-COPCs in the ground water underlying the floodplain. For terrestrial wildlife on the floodplain, surface water is considered to be the primary source medium for E-COPC exposures, and therefore, risks to all terrestrial receptors listed above are evaluated based on potential consumption of drinking water from the various sources, including hypothetical pumping of ground water to a surface pond. Terrestrial wildlife receptors used represent both mammals and birds; mammals are represented by a range of body sizes, from a deer mouse to a mule deer.

For wetland habitats, emergent plants are considered to be the primary producers, and the muskrat and mallard are considered to be representative of herbivores that may consume such plants. The raccoon represents an omnivore in this habitat. The spotted sandpiper represents an insectivorous bird and the belted kingfisher represents a piscivorous bird. All animal prey of

these wildlife receptors (the muskrat being the only one modeled as purely herbivorous) are assumed to be aquatic (invertebrates or fish).

Receptors in the aquatic habitats are not specified. Risk to these receptors is based on comparisons of the media E-COPC concentrations (water and sediment) to broad-based benchmark values, such as ambient water quality criteria (AWQC), that are protective of a wide range of aquatic and benthic organisms. For the Animas River, fish are assumed to be included as potential aquatic receptors within this broad categorization. All wildlife receptors are modeled as potential receptors of E-COPCs in surface water through the consumption of that water at all sites where surface water is present as a medium of concern.

The species-specific parameters used to model exposures to these key indicator receptors (wildlife only) are presented in Table 6–13.

6.2.4.2 Effects Characterization

The potential for adverse effects to ecological receptors resulting from exposures to E-COPCs at the Durango site was evaluated through the comparison of the potential exposure in the receptor to a toxicity-based benchmark of exposure representing the threshold of potential adverse effects.

For aquatic and benthic receptors and plants, the exposure to an E-COPC is characterized by the concentration of that E-COPC in the medium (water or sediment, respectively) with which the receptor is principally in direct contact. Therefore, the benchmarks by which the potential for adverse effects is evaluated are also based on media concentrations. For surface water, either AWQC (EPA 1999) or Colorado Department of Public Health and Environment (CDPHE) Water Quality Standards (whichever was lesser) were used as the principal benchmarks for evaluating potential risk to aquatic life. When neither was available for an E-COPC, Tier II secondary values (Suter and Tsao 1996) or other ambient water quality standards for chronic exposure (e.g., Buchman 1999) were used. These water quality standards are lower than, and therefore inclusive of, the CDPHE standards for agricultural uses of the water. Sediment benchmarks were principally based on the lowest threshold effect levels (TELs) as presented in Buchman (1999), and supplemented from other sources (e.g., Haines and others 1994). Table 6–14 and Table 6–15 present these water and sediment quality benchmark values, respectively.

For plants, toxicity benchmarks are based primarily on the information provided in Efroymson and others (1997). These benchmarks are based on lowest-observed-adverse-effect levels (LOAELs) using 20 percent reduction in growth as the endpoint. Both the soil-based and solution-based benchmarks were used. Soil-based benchmarks were used to evaluate risk to wetland species exposed to sediments, while solution-based benchmarks were used to evaluate potential risk to phreatophytes that may be in contact with ground water. Although based on LOAELs, these benchmarks are considered conservative. The endpoint is sublethal; and reductions in plant growth may have no significant effect on the reproductive potential or the continued existence of a plant population. Further, these benchmarks are primarily based on studies in which the chemical of interest is added freshly to a soil (often as a soluble salt) and is typically more bioavailable than the COPCs in field situations where they have had time to bind more strongly with soil particles. The plant toxicity benchmarks are presented in Table 6–16.

Table 6–13. Exposure Parameters for Wildlife Receptors

Receptor	Body weight (kg)[a]	Food ingestion rate (kg [dry wt]/day)[b]	Soil/sediment ingestion rate (percent of food ingestion)[c]	Water ingestion rate (L/day)[d]	Dietary Composition (percent)[e]
Deer mouse (*Peromyscus maniculatus*)	0.0239[f]	NA	NA	0.00344	NA
Muskrat (*Ondatra zibethicus*)	1.135	0.0772[g]	9.4[h]	0.111	Plant: 100
Raccoon (*Procyon lotor*)	5.74	0.289	9.4[h]	0.477	Plant: 40 Invertebrate: 50 Fish: 10
Red fox (*Vulpes vulpes*)	4.54	NA	NA	0.386	NA
Mule deer (*Odocoileus hemionus*)	65[f]	NA	NA	4.24	NA
Northern harrier (*Circus cyaneus*)	0.180[i]	NA	NA	0.0187	NA
Mallard (*Anas platyrhynchos*)	1.134	0.0592	3.3	0.0642	Plant: 90 Invertebrate: 10
Spotted sandpiper (*Actitis macularia*)	0.0425	0.00503	18[j]	0.0711	Invertebrate: 100
Belted kingfisher (*Ceryle alcyon*)	0.147	0.0128	2.0[k]	0.0163	Invertebrate: 20 Fish 80

[a]From EPA (1993), except where noted.
[b]Based on allometric equations from Nagy (1987), as presented in EPA (1993), except where noted.
[c]From Beyer and others (1994). Data are species-specific except where noted.
[d]Based on allometric equations from Calder and Braun (1983), as presented in EPA (1993), except where noted.
[e]Diets are generalized to emphasize specific trophic levels. Dietary compositions of the river otter, mallard, and belted kingfisher are based on species-specific information presented in EPA (1993) and Martin and others (1951) and have generally been rounded to increments of 10 percent.
[f]From Silva and Downing (1995).
[g]Based on species-specific food intake rate from EPA (1993), with assumed water content of food of 80 percent.
[h]Based on soil/sediment ingestion for raccoon from Beyer and others (1994).
[i]From Dunning (1993).
[j]Based on the mean soil/sediment ingestion rate of four species of sandpipers as reported by Beyer and others (1994).
[k]No data available. Assumed value of 2 percent is based on the detection limit of the method used by Beyer and others (1994).

Table 6–14. Surface Water Quality Benchmarks for E-COPC for the Protection of Freshwater Aquatic Life

Constituent of Potential Concern	Water Quality Benchmarks (mg/L)		
	AWQC[a]	CDPHE SWQS[b]	Other
Ammonium	--	0.02[c]	--
Antimony	--	--	0.03[d]
Arsenic	0.15	0.05	--
Cadmium	0.0022	0.0011	--
Chloride	230	250	--
Chromium	0.074	0.207	--
Copper	0.009	0.012	--
Iron	1.0	1.0	--
Lead	0.0025	0.0039	--
Manganese	--	0.05	0.08[e]
Molybdenum	--	--	0.24[e]
Nitrate	--	10[f]	--
Selenium	0.005	0.010	--
Sulfate	--	250	--
Thallium	--	--	0.04[d]
Uranium	--	1.5	--
Vanadium	--	--	0.019[e]
Zinc	0.120	0.106	--

[a]EPA ambient water quality criteria (EPA 1999). Hardness of 100 mg/L $CaCO_3$ was used for all hardness-dependent values.
[b]Colorado Department of Public Health and Environment Surface Water Quality Standard for aquatic life for the Animas River. Hardness of 100 mg/L $CaCO_3$ was used for all hardness-dependent values.
[c]Standard for NH_3 as N.
[d]Chronic freshwater value from Buchman (1999).
[e]Tier II secondary chronic value from Suter and Tsao (1996).
[f]Standard for NO_3 as N.
-- = No value available.

Table 6–15. Sediment Quality Benchmarks for E-COPC

Contaminant of Potential Concern	Sediment Quality Benchmark (mg/kg)
Arsenic	5.9[a]
Iron	188,400[a]
Lead	35[a]
Nitrate	2,440[b]
Selenium	5.0[c]
Zinc	123.1[a]

[a]From Buchman (1999) (Threshold Effects Level)
[b]Lowest effect level (Ontario) for total kjeldahl nitrogen (from Haines and others 1994) and converted from milligrams mitrogen per liter to milligrams nitrate per liter.
[c]Sediment quality criterion from British Columbia (Haines and others 1994).

Table 6–16. Plant Toxicity Benchmarks for E-COPC

Ecological Contaminant of Potential Concern	Plant Toxicity Benchmark for Soil[a] (mg/kg)	Plant Toxicity Benchmark for Water[a] (mg/L)
Ammonium	NA	--
Antimony	NA	--
Arsenic	10	0.001
Cadmium	NA	0.1
Chloride	NA	--
Chromium	NA	0.05
Copper	NA	0.06
Iron	--	10
Lead	50	0.02
Manganese	NA	4.0
Molybdenum	NA	0.5
Nitrate	--	--
Selenium	1.0	0.7
Sulfate	NA	--
Thallium	NA	0.05
Uranium	NA	40
Vanadium	NA	0.2
Zinc	50	0.4

[a]From Efroymson and others (1997).

NA = Not applicable
-- = No benchmark available.

For the wildlife receptors, no-observed-adverse-effect levels (NOAELs) for chronic oral exposure are used as benchmarks for toxic effects. The endpoints of particular interest in this assessment are those associated with reproductive health, development, and mortality. Therefore, NOAELs are defined as the maximum dosage tested that produced no effect that would be considered adverse to the receptor's survival, growth, or reproductive capacity. Because the NOAELs for the wildlife receptor species are based on NOAELs from test species, the latter are scaled to NOAELs specific to the wildlife receptor species using a power function of the ratio of body weights, as described by Sample and others (1996) and Sample and Arenal (1999). This scaling is based on the equation:

$$NOAEL_W = NOAEL_T \left(\frac{BW_T}{BW_W}\right)^s$$

where

$NOAEL_W$ is the no-observed-adverse-effect level for the wildlife receptor species (mg/kg-day),
$NOAEL_T$ is the no-observed-adverse-effect level for the test species (mg/kg-day),
BW_T is the body weight of the test species (kg),
BW_W is the body weight of the wildlife receptor species (kg), and
s is the body weight scaling factor; (s = 0.06 for mammals and s = -0.2 for birds (Sample and Arenal 1999).

Toxicity studies were considered to be studies of chronic toxicity if they are conducted over a period of 26 weeks (one-half year) or more. This period represents the period of seasonal use by migratory and hibernating species and is sufficient time for small animals to complete their

reproductive cycles. Studies of lesser duration (i.e., 1 to 25 weeks) are considered of subchronic toxicity, unless they specifically included reproductive effects as endpoints (Sample and others 1996). When only subchronic oral $NOAEL_T$ values were available, these are converted to chronic $NOAEL_T$ values by applying an uncertainty factor of 0.1 (Sample and others 1996).

When only a chronic LOAEL value was available for test data, an uncertainty factor of 0.1 was used to convert it to the chronic $NOAEL_T$. If only a subchronic LOAEL was available, then an uncertainty factor of 0.01 was used to estimate the chronic $NOAEL_T$. This uncertainty factor is the product of two uncertainty factors of 0.1, one to convert the subchronic value to a chronic value and the other to convert the LOAEL to an NOAEL. NOAELs were not determined if toxicity data could not be found for test species within the same class. Therefore, NOAELs for mammalian receptors are derived only from mammalian test species data and NOAELs for avian receptors are derived only from avian test species data. The toxicity data and receptor-specific NOAELs used in this assessment for mammalian and avian receptors are presented in Table 6–17 and Table 6–18, respectively.

6.2.5 Risk Characterization

The potential for risk to ecological receptors is determined through hazard quotients (HQs). HQs are specific to a particular receptor for exposure to a particular E-COPC. An HQ is defined by:

$$HQ = \frac{Exposure}{Benchmark}$$

For aquatic and benthic organisms and plants, exposures are equivalent to media concentrations (surface water or sediment) with which the organism is in contact. For wetland wildlife, exposures are modeled from multiple pathways by the methods described in Section 6.2.4.1. The methods for determining toxicity benchmark values for these receptors are discussed in Section 6.2.4.2.

The value of the HQ is greater than 1.0 if the magnitude of the exposure is greater than the corresponding benchmark, and conversely, the HQ is less than or equal to 1.0 if the exposure is less than or equal to the benchmark. An HQ value less than or equal to 1.0 is interpreted as evidence of no potential risk to that receptor for that E-COPC. If the HQs for an E-COPC are less than unity for all receptors, that E-COPC is eliminated from further consideration as a potential ecological risk driver. However, because exposure for the screening of E-COPCs is conservatively estimated, an HQ value greater than unity is not interpreted as evidence of risk, but only as evidence that the potential for risk cannot be ruled out.

For the purposes of this evaluation, potential exposures were conservatively based on the maximum measured E-COPC in each medium of ecological concern (surface water, sediment, and ground water) at each of the areas evaluated. When sufficient data existed, the UCL_{95} concentrations were used to calculate HQs that better reflect average (yet still conservatively estimated) risks to receptors in these areas. The following are summaries of the risk assessment results for specific media and associated receptor groups.

Table 6–17. Mammal Toxicity Benchmarks for E-COPCs

E-COPC	Mammalian Test Data[a]			Mammalian Receptor NOAELs (mg/kg-day)				
	Test Species	Body weight (kg)	NOAEL (mg/kg-day)	Deer mouse	Muskrat	Raccoon	Red fox	Mule deer
Ammonium	---	---	---	---	---	---	---	---
Antimony	Mouse	0.03	0.125	0.127	0.101	0.0912	0.0925	0.0788
Arsenic	Rabbit	4.396	0.396	0.541	0.430	0.390	0.395	0.37
Cadmium	Rat	0.303	1.0	1.16	0.924	0.838	0.850	0.725
Chloride	---	---	---	---	---	---	---	---
Chromium	Rat	0.350	2,737	3,220	2,550	2,310	2,350	2,000
Copper	Mink	1.0	11.7	14.6	11.6	10.5	10.7	9.11
Iron	---	---	---	---	---	---	---	---
Lead	Rat	0.350	42.0	49.3	39.1	35.5	36.0	30.7
Manganese	Rat	0.35	88.0	103	82.0	74.4	75.5	64.3
Molybdenum	Mouse	0.03	0.26	0.264	0.209	0.190	0.192	0.164
Nitrate	Guinea pig	0.86	507	629	499	452	459	391
Selenium	Rat	0.35	0.20	0.235	0.186	0.169	0.171	0.146
Sulfate	---	---	---	---	---	---	---	---
Thallium	Rat	0.365	0.0074	0.00871	0.00691	0.00627	0.00636	0.00542
Uranium	Mouse	0.028	3.07	3.10	2.46	2.23	2.26	1.93
Vanadium	Rat	0.26	0.21	0.242	0.192	0.174	0.177	0.151
Zinc	Rat	0.35	160	188	149	135	137	117

[a]From Sample and others (1996), except where noted.
[b]Based on information from the Integrated Risk Information System database (EPA 2001).
NA = Not applicable.
--- = Insufficient toxicity information.

Table 6–18. Avian Toxicity Benchmarks for E-COPCs

E-COPC	Avian Test Data[a]			Avian Receptor NOAELs (mg/kg-day)			
	Test Species	Body weight (kg)	NOAEL (mg/kg-day)	Northern harrier	Mallard	Spotted Sandpiper	Belted kingfisher
Ammonium	---	---	---	---	---	---	---
Antimony	---	---	---	---	---	---	---
Arsenic	Mallard	1.0	5.14	3.65	5.27	2.73	3.50
Cadmium	Mallard	1.153	1.45	1.00	1.45	0.749	0.960
Chloride	---	---	---	---	---	---	---
Chromium	Black duck	1.25	1.0	0.679	0.981	0.509	0.652
Copper	Chicken	0.534	47.0	37.8	54.6	28.3	36.3
Iron	---	---	---	---	---	---	---
Lead	Japanese quail	0.15	1.13	1.17	1.69	0.878	1.13
Manganese	Japanese quail	0.072	977	1,170	1,700	879	1,130
Molybdenum	Chicken	1.5	3.53	2.31	3.34	1.73	2.22
Nitrate	---	---	---	---	---	---	---
Selenium	Mallard	1.0	0.40	0.284	0.410	0.213	0.273
Sulfate	---	---	---	---	---	---	---
Thallium	---	---	---	---	---	---	---
Uranium	Black duck	1.25	16.0	10.9	15.7	8.14	10.4
Vanadium	Mallard	1.17	11.4	7.84	11.3	5.87	7.53
Zinc	Chicken	1.935	14.5	9.02	13.0	6.76	8.66

[a]From Sample and others (1996).
NA = Not applicable.
--- = Insufficient toxicity information.

6.2.5.1 Risk to Ecological Receptors Associated with Surface Water and Sediment

Table 6–19 presents the comparison of surface water concentrations (from the Animas River and Lightner Creek) to water quality benchmarks for the protection of aquatic life. These data represent existing surface water conditions at the Durango site. Comparisons are made with both the maximum measured concentration and UCL_{95} values. Of the E-COPCs identified for surface water, only ammonium and sulfate exceeded their respective water quality benchmarks. In the case of ammonium, this was true for both the maximum and UCL_{95} concentrations. However, the HQ value for the UCL_{95} was relatively low (HQ = 2.21). The UCL_{95} for sulfate did not exceed the water quality benchmark.

Table 6–19. Hazard Quotients for Aquatic and Benthic Communities at the Durango Site

E-COPC	Surface Water				Sediment			
	Maximum		UCL_{95}		Maximum		UCL_{95}	
	Concentration (mg/L)	Hazard Quotient	Concentration (mg/L)	Hazard Quotient	Concentration (mg/kg)	Hazard Quotient	Concentration (mg/kg)	Hazard Quotient
Ammonium	0.49	**19.1**	0.0575	**2.21**	Not an E-COPC for sediment			
Arsenic	Not an E-COPC for surface water				31.2	**5.29**	19.6	**3.32**
Iron	Not an E-COPC for surface water				32,800	0.174	25,290	0.134
Lead	0.00033	0.132	0.000204	0.0816	159	**4.54**	106	**3.18**
Nitrate	Not an E-COPC for surface water				2.3	0.000943	1.55	0.000635
Selenium	0.003	0.600	0.000764	0.153	1.9	0.380	1.60	0.320
Sulfate	809	**3.24**	146	0.584	Not an E-COPC for sediment			
Zinc	Not an E-COPC for surface water				702	**5.70**	417	**3.39**

Note: Based on comparison of surface water and sediment concentrations to water and sediment quality benchmarks for the protection of aquatic life. See Table 6–14 and Table 6–15 for the surface water and sediment quality benchmarks, respectively.
Hazard quotient values in **Bold** are greater than 1.

The small number of E-COPCs identified for surface water at this site, as determined by comparisons to upstream concentrations, verify previous observations that past milling operations have had very little effect on water quality of the Animas River and Lightner Creek (DOE 1995a). Of the four nonradiological constituents with maximum measured concentrations exceeding the maximum background concentration, three (lead, selenium, and sulfate) had maximum values that only marginally exceeded background and had UCL_{95} values that were approximately equal to or less than their respective UCL_{95} for background. Only ammonium concentrations appear to increase significantly in the Animas River as it passes the Durango site. However, concentrations of ammonium exceeding the water quality standard are sporadic. Of the 61 surface water samples collected at this site between June 1999 and June 2001, only 12 (approximately 1 in 5) have shown ammonium concentrations exceeding the standard. Thus, exposure to high ammonium levels does not appear to be a chronic condition in these surface waters.

Table 6–19 also presents a comparison of the maximum measured E-COPC concentrations in sediment (from the 1993 sampling effort) to sediment quality benchmarks. The maximum and UCL_{95} concentrations of arsenic, lead, and zinc exceeded their respective benchmark values; however, the HQs were relatively low (all HQs for the maximum concentrations were less than 6 and those for the UCL_{95} were less than 3.4). For all three of these E-COPCs, the Animas River background concentrations also exceeded the sediment quality benchmark, and for both lead and zinc, the UCL_{95} values for the site are less than the background concentrations. (At Lightner Creek, all three constituents were found at concentrations less than their corresponding upstream concentrations.) Therefore, these constituents are relatively high in background and HQs within

the range the range of 2 to 4 might well be expected based on background conditions in this area. The contribution of the Durango site appears to be small with regard to potential risk to the benthic communities of the river.

Table 6–20 shows the comparison of maximum sediment concentrations to plant toxicity benchmarks. Arsenic, lead, and zinc again result in HQs greater than unity, as well as selenium. As discussed above, the HQs for arsenic, lead, and zinc can be ascribed primarily to relatively high background concentrations in this area. Selenium can similarly be ascribed to background; the UCL_{95} is equal to the upstream concentration measured at Lightner Creek. Again, the fact that the HQ for zinc exceeded 8 for the UCL_{95}, which was less than the background zinc concentration, indicates both the high background concentrations at this site and the conservative nature of the plant toxicity benchmarks.

Table 6–20. Hazard Quotients for Wetland Plants at the Durango Site

E-COPC	Maximum		UCL_{95}	
	Concentration (mg/kg)	Hazard Quotient	Concentration (mg/kg)	Hazard Quotient
Arsenic	31.2	**3.12**	19.6	**1.96**
Iron	32,800	--	25,290	--
Lead	159	**3.18**	106	**2.12**
Nitrate	2.3	--	1.55	--
Selenium	1.9	**1.90**	1.60	**1.60**
Zinc	702	**14.0**	417	**8.34**

Note: Based on comparison of sediment concentrations to plant toxicity benchmarks. See Table 6–16 for the plant toxicity benchmarks.
-- = No benchmark value available
Hazard quotient values in **Bold** are greater than 1.

Table 6–21 presents the risk results for wetland wildlife exposed to E-COPCs in surface water and sediment at the Durango site through ingestion of water and food. These results indicate only lead and zinc have been measured in these media at concentrations sufficient to indicate potential risk to wildlife. In both cases, the HQs that exceed unity are limited to the spotted sandpiper, which is modeled as having a diet of aquatic invertebrates, with a high incidental consumption rate (18 percent) of sediment. However, as discussed above, neither of these constituents have concentrations that are highly elevated above background levels for sediments, and the UCL_{95} values for these E-COPCs in both water and sediment are within background range. Therefore, the HQs do not represent significant risk to this receptor above background conditions. Table 6–22 presents the HQs for the terrestrial wildlife receptors based on exposures through the ingestion of surface water at the Durango site. All of the HQs that could be determined for these E-COPCs are well below unity for these receptors.

Table 6–21. Hazard Quotients for Wetland Wildlife Along the Animas River at the Durango Site

E-COPC	Muskrat		Raccoon		Mallard		Spotted Sandpiper		Belted Kingfisher	
	Maximum	UCL_{95}	Maximum	UCL_{95}	Maximum	UCL_{95}	Maximum	UCL_{95}	Maximum	UCL_{95}
Ammonium	--	--	--	--	--	--	--	--	--	--
Arsenic	0.615	0.407	0.430	0.277	0.0187	0.0129	0.244	0.154	0.0162	0.0102
Iron	--	--	--	--	--	--	--	--	--	--
Lead	0.0339	0.0236	0.0250	0.0169	0.293	0.212	**4.08**	**2.71**	0.275	0.182
Nitrate	0.000757	0.000386	0.000725	0.000310	--	--	--	--	--	--
Selenium	0.443	0.366	0.344	0.189	0.137	0.107	0.642	0.275	0.459	0.124
Sulfate	--	--	--	--	--	--	--	--	--	--
Zinc	0.114	0.0806	0.0681	0.0462	0.787	0.573	**3.58**	**2.25**	0.656	0.436

Note: Exposure based on surface water- and sediment-based pathways, including direct ingestion of water and sediment, and ingestion of plants, invertebrates, and fish with tissue concentrations estimated from water concentrations.
-- = No toxicity benchmark available.
Hazard quotient values in **Bold** are greater than 1.

Table 6–22. Hazard Quotients for Terrestrial Wildlife from Drinking Water Along the Animas River at the Durango Site

E-COPC	Deer Mouse		Red Fox		Mule Deer		Northern Harrier	
	Maximum	UCL_{95}	Maximum	UCL_{95}	Maximum	UCL_{95}	Maximum	UCL_{95}
Ammonium	--	--	--	--	--	--	--	--
Lead	9.62×10^{-7}	5.95×10^{-7}	7.80×10^{-7}	4.82×10^{-7}	7.01×10^{-7}	4.33×10^{-7}	2.93×10^{-5}	1.81×10^{-5}
Selenium	0.00184	0.000468	0.00149	0.000379	0.00134	0.000341	0.00110	0.000280
Sulfate	--	--	--	--	--	--	--	--

Note: Exposure limited to surface water ingestion from the Animas River and Lightner Creek adjacent to the Durango site.
-- = No toxicity benchmark available.

6.2.5.2 Risk to Ecological Receptors Associated with Ground Water

Few complete exposure pathways potentially exist between ground water at the Durango site and ecological receptors. The most credible of these is the potential for contact with contaminated ground water and by deep-rooted plants, such as phreatophytes (e.g., cottonwoods). Potential risk to such plants was assessed by the comparison of ground water concentrations (maximum and UCL_{95}) to plant toxicity benchmarks based on water concentrations (see Table 6–16). Table 6–23 presents the results of these comparisons for both the mill tailings area and the raffinate ponds area. For the maximum ground water concentrations from the mill tailings area, HQs were greater than unity for arsenic, manganese, vanadium, and zinc. The highest HQ was 6.53 (for zinc). Based on the UC_{95} concentrations, however, only one E-COPC showed an HQ greater than unity (1.28 for zinc). For the maximum ground water concentrations measured at the raffinate ponds area, HQs were greater than unity for arsenic, iron, lead, manganese, selenium, and zinc. The highest HQ among these was 17.6 (for selenium). Again, however, based on the UC_{95} concentrations, only one E-COPC showed an HQ greater than unity (1.22 for selenium). Therefore, the potential for significant risk to deep-rooted plants that may contact either of these ground water plumes is low.

Table 6–23. Hazard Quotients for Deep-Rooted Plants

E-COPC	Ground Water at the Mill Tailings Area				Ground Water at the Raffinate Ponds Area			
	Maximum		UCL_{95}		Maximum		UCL_{95}	
	Concentration (mg/L)	Hazard Quotient	Concentration (mg/L)	Hazard Quotient	Concentration (mg/L)	Hazard Quotient	Concentration (mg/L)	Hazard Quotient
Ammonium	Not an E-COPC for ground water at this area				9.08	--	2.36	--
Antimony	Not an E-COPC for ground water at this area				0.0022	--	0.000477	--
Arsenic	0.0015	**1.50**	0.000376	0.376	0.0041	0.0015	**1.50**	0.000376
Cadmium	0.0435	0.435	0.00699	0.0699	0.0037	0.0435	0.435	0.00699
Chloride	358	--	96.4	--	1,400	358	--	96.4
Chromium	0.005	0.100	0.00173	0.0346	0.0068	0.005	0.100	0.00173
Copper	Not an E-COPC for ground water at this area				0.0518	0.863	0.00425	0.0708
Iron	Not an E-COPC for ground water at this area				9.78	0.978	1.34	0.134
Lead	Not an E-COPC for ground water at this area				0.0107	0.535	0.000836	0.0418
Manganese	5.4	**1.35**	1.06	0.265	7.07	5.4	**1.35**	1.06
Molybdenum	0.15	0.300	0.0260	0.0520	0.0899	0.15	0.300	0.0260
Nitrate	Not an E-COPC for ground water at this area				50	--	2.33	--
Selenium	0.123	0.176	0.0238	0.0340	12.3	0.123	0.176	0.0238
Sulfate	3,450	--	1,808	--	8,530	3,450	--	1,808
Thallium	Not an E-COPC for ground water at this area				0.00024	0.0048	0.000103	0.00206
Uranium	2.12	0.0530	0.538	0.0135	0.356	2.12	0.0530	0.538
Vanadium	0.448	**2.24**	0.0749	0.375	0.0235	0.448	**2.24**	0.0749
Zinc	2.61	**6.53**	0.510	**1.28**	0.464	2.61	**6.53**	0.510

Note: Based on comparison of ground water concentrations to plant toxicity benchmarks. See Table 6–16 for the plant toxicity benchmarks.
-- = No benchmark available
Hazard quotient values in **Bold** are greater than 1.

Another way by which ecological receptors could be exposed to ground water would be under the hypothetical situation whereby ground water is pumped to a surface pond, and made available to wildlife as a source of drinking water, or creates a habitat for the development of an aquatic or wetland community. To assess potential risk to aquatic and wetland receptors under this hypothetical scenario, the ground water data were evaluated by comparing the maximum and UCL_{95} concentrations to the surface water quality benchmarks for the protection of aquatic life and by evaluating the potential risk to terrestrial and wetland wildlife based on using this water as a sole drinking water source or feeding on the organisms associated with such a habitat. Table 6–24 through Table 6–26 present the results of these evaluations.

Table 6–24. Hazard Quotients for Aquatic Communities

E-COPC	Ground Water at the Mill Tailings Area				Ground Water at the Raffinate Ponds Area			
	Maximum		UCL_{95}		Maximum		UCL_{95}	
	Concentration (mg/L)	Hazard Quotient	Concentration (mg/L)	Hazard Quotient	Concentration (mg/L)	Hazard Quotient	Concentration (mg/L)	Hazard Quotient
Ammonium	Not an E-COPC for ground water at this area				9.08	**349**	2.36	**90.8**
Antimony	Not an E-COPC for ground water at this area				0.0022	0.0733	0.000477	0.0159
Arsenic	0.0015	0.0300	0.000376	0.00752	0.0041	0.0820	0.000619	0.0124
Cadmium	0.0435	**39.5**	0.00699	**6.35**	0.0037	**3.36**	0.000514	0.467
Chloride	358	**1.56**	96.4	0.419	1,400	**6.09**	557	**2.42**
Chromium	0.005	0.0676	0.00173	0.0234	0.0068	0.0919	0.00168	0.0227
Copper	Not an E-COPC for ground water at this area				0.0518	**5.76**	0.00425	0.472
Iron	Not an E-COPC for ground water at this area				9.78	**9.78**	1.34	**1.34**
Lead	Not an E-COPC for ground water at this area				0.0107	**4.28**	0.000836	0.334
Manganese	5.4	**108**	1.06	**21.2**	7.07	**141**	1.07	**21.4**
Molybdenum	0.15	0.625	0.0260	0.108	0.0899	0.375	0.00861	0.0359
Nitrate	Not an E-COPC for ground water at this area				50	**1.13**	2.33	0.0526
Selenium	0.123	**24.6**	0.0238	**4.76**	12.3	**2,460**	0.851	**170**
Sulfate	3,450	**13.8**	1,808	**7.23**	8,530	**34.1**	3,499	**14.0**
Thallium	Not an E-COPC for ground water at this area				0.00024	0.00600	0.000103	0.00258
Uranium	2.12	**1.41**	0.538	0.359	0.356	0.237	0.0593	0.0395
Vanadium	0.448	**23.6**	0.0749	**3.94**	0.0235	**1.24**	0.00137	0.0721
Zinc	2.61	**24.6**	0.510	**4.81**	0.464	**4.38**	0.0497	0.469

Note: Based on comparison of ground water concentrations to water quality benchmarks for the protection of aquatic life. See Table 6-28 for the water quality benchmarks.
Hazard quotient values in **Bold** are greater than 1.

At the mill tailings area, maximum ground water concentrations exceeded surface water quality benchmarks for cadmium, chloride, manganese, selenium, sulfate, uranium, vanadium, and zinc. Based on the UCL_{95} values for this plume, only chloride and uranium drop from this list; the rest still show the potential for risk to aquatic organisms. Manganese showed the highest HQs at this area, with a HQ of 108 for the maximum measured concentration, dropping to 21.2 for the UCL_{95}. Although ground water from this area did not show potential risk to terrestrial wildlife receptors from its use as drinking water, it did show potential risk to wetland wildlife from exposures through the food chain to cadmium, chromium, selenium, vanadium, and zinc at both the maximum and UCL_{95} concentrations (risk from exposure to uranium was also indicated at its maximum measured concentration). Several of these HQs were greater than 10, and two (maximums for cadmium and vanadium) were greater than 100. Because of the potential for risk to ecological receptors in both the aquatic and wetland communities, ground water from this area should not be used as a source for surface ponds or wetlands accessible to wildlife.

Table 6–25. Hazard Quotients for Terrestrial Wildlife from Drinking Water Pumped from Ground Water at the Durango Site

E-COPC	Deer Mouse		Red Fox		Mule Deer		Northern Harrier	
	Maximum	UCL_{95}	Maximum	UCL_{95}	Maximum	UCL_{95}	Maximum	UCL_{95}
Mill Tailings Area								
Arsenic	0.000398	0.0000999	0.000323	0.0000810	0.000290	0.0000728	0.0000427	0.0000107
Cadmium	0.00537	0.000863	0.00435	0.000700	0.00391	0.000629	0.00537	0.000726
Chloride	--	--	--	--	--	--	--	--
Chromium	2.24×10^{-7}	7.74×10^{-8}	1.81×10^{-7}	6.27×10^{-8}	1.63×10^{-7}	5.64×10^{-8}	0.000765	0.000265
Manganese	0.00751	0.00147	0.00609	0.00120	0.00548	0.00107	0.000478	0.0000939
Molybdenum	0.0818	0.0142	0.0664	0.0115	0.0596	0.0103	0.00675	0.00117
Selenium	0.0753	0.0146	0.0610	0.0118	0.0549	0.0106	0.0450	0.00871
Sulfate	--	--	--	--	--	--	--	--
Uranium	0.0984	0.0250	0.0797	0.0202	0.0717	0.0182	0.0203	0.00515
Vanadium	0.266	0.0444	0.216	0.0360	0.194	0.0324	0.00594	0.000993
Zinc	0.00200	0.000390	0.00162	0.000316	0.00146	0.000284	0.0301	0.00588
Raffinate Ponds Area								
Ammonium	--	--	--	--	--	--	--	--
Antimony	0.00250	0.000541	0.00202	0.000439	0.00182	0.000395	--	--
Arsenic	0.00109	0.000164	0.000883	0.000133	0.000794	0.000120	0.000117	0.0000176
Cadmium	0.000457	0.0000635	0.000370	0.0000515	0.000333	0.0000463	0.000384	0.0000534
Chloride	--	--	--	--	--	--	--	--
Chromium	3.04×10^{-7}	7.51×10^{-8}	2.47×10^{-7}	6.09×10^{-8}	2.22×10^{-7}	5.48×10^{-8}	0.00104	0.000257
Copper	0.000509	0.0000418	0.000413	0.0000338	0.000371	0.0000304	0.000142	0.0000117
Iron	--	--	--	--	--	--	--	--
Lead	0.0000312	2.44×10^{-6}	0.0000253	1.98×10^{-6}	0.0000227	1.78×10^{-6}	0.000949	0.0000741
Manganese	0.00984	0.00149	0.00797	0.00121	0.00717	0.00108	0.000626	0.0000947
Molybdenum	0.0491	0.00470	0.0398	0.00381	0.0358	0.00342	0.00404	0.000387
Nitrate	0.0114	0.000533	0.00927	0.000432	0.00834	0.000389	--	--
Selenium	**7.53**	0.521	**6.10**	0.422	**5.49**	0.380	**4.50**	0.311
Sulfate	--	--	--	--	--	--	--	--
Thallium	0.00396	0.00170	0.00321	0.00138	0.00289	0.00124	--	--
Uranium	0.0165	0.00275	0.0134	0.00223	0.0120	0.00201	0.00341	0.000567
Vanadium	0.0139	0.000813	0.0113	0.000659	0.0102	0.000593	0.000311	0.0000182
Zinc	0.000355	0.0000380	0.000288	0.0000308	0.000259	0.0000277	0.00535	0.000573

NOTE:Exposure limited to the ingestion of ground water under the assumption that it is pumped to the surface and made available to wildlife.
-- = No toxicity benchmark available.
Hazard quotient values in **Bold** are greater than 1.

Table 6–26. Hazard Quotients for Wetland Wildlife from Water Pumped from Ground Water at the Durango Site

E-COPC	Muskrat		Raccoon		Mallard		Spotted Sandpiper		Belted Kingfisher	
	Maximum	UCL_{95}	Maximum	UCL_{95}	Maximum	UCL_{95}	Maximum	UCL_{95}	Maximum	UCL_{95}
Mill Tailings Area										
Arsenic	0.00403	0.00177	0.00991	0.00273	0.000332	0.000126	0.00483	0.00121	0.00261	0.000655
Cadmium	0.137	0.0494	**17.5**	**2.82**	0.604	0.109	**23.8**	**3.82**	**159**	**25.5**
Chloride	--	--	--	--	--	--	--	--	--	--
Chromium	0.00000472	0.00000163	0.000167	0.0000576	0.0883	0.0302	**3.49**	**1.21**	0.486	0.168
Manganese	0.880	0.173	0.436	0.0855	0.0305	0.00598	0.0483	0.00947	0.0297	0.00582
Molybdenum	0.851	0.147	0.679	0.118	0.0387	0.00671	0.117	0.0203	0.207	0.0359
Selenium	0.156	0.0274	**6.90**	**1.34**	0.467	0.0895	**18.5**	**3.58**	**18.3**	**3.55**
Sulfate	--	--	--	--	--	--	--	--	--	--
Uranium	0.691	0.175	**1.44**	0.366	0.0925	0.0235	0.879	0.223	**1.65**	0.491
Vanadium	0.271	0.0454	**195**	**32.5**	0.622	0.104	**27.1**	**4.53**	**3.27**	0.547
Zinc	0.0308	0.0121	0.622	0.124	**1.42**	0.326	**51.7**	**10.1**	**19.4**	**3.80**
Raffinate Ponds Area										
Ammonium	--	--	--	--	--	--	--	--	--	--
Antimony	0.0155	0.00337	0.0129	0.00280	--	--	--	--	--	--
Arsenic	0.00743	0.00238	0.0259	0.00432	0.000707	0.000177	0.0132	0.00199	0.00715	0.00108
Cadmium	0.0347	0.0117	**1.50**	0.210	0.0616	0.0116	**2.02**	0.281	**13.5**	**1.88**
Chloride	--	--	--	--	--	--	--	--	--	--
Chromium	0.00000642	0.00000159	0.000226	0.0000560	0.120	0.0297	**4.75**	**1.17**	0.661	0.163
Copper	0.0125	0.00453	0.493	0.0416	0.0202	0.00218	0.805	0.0661	0.207	0.0170
Iron	--	--	--	--	--	--	--	--	--	--
Lead	0.00167	0.000395	0.0392	0.00315	0.194	0.0193	**7.30**	0.570	0.956	0.0747
Manganese	**1.15**	0.174	0.570	0.0863	0.0399	0.00603	0.0632	0.00956	0.0388	0.00588
Molybdenum	0.510	0.0488	0.407	0.0390	0.0232	0.00222	0.0702	0.00672	0.124	0.0119
Nitrate	0.0166	0.000775	0.0164	0.000765	--	--	--	--	--	--
Selenium	**21.3**	**1.22**	**692**	**47.8**	**48.5**	**3.28**	**1,850**	**128**	**1,830**	**127**
Sulfate	--	--	--	--	--	--	--	--	--	--
Thallium	0.00409	0.00176	0.120	0.0513	--	--	--	--	--	--
Uranium	0.116	0.0193	0.242	0.0404	0.0155	0.00259	0.148	0.0246	0.277	0.0462
Vanadium	0.0142	0.000830	**10.2**	0.595	0.0327	0.00190	**1.42**	0.0828	0.172	0.0100
Zinc	0.0115	0.00326	0.113	0.0127	0.300	0.0483	**9.19**	0.985	**3.46**	0.370

NOTE: Exposure based on surface water- and sediment-based pathways, including direct ingestion of water and sediment, and ingestion of plants, invertebrates, and fish (with tissue concentrations estimated from water concentrations) under the assumption that ground water is pumped to the surface and used to create a pond or wetland.
--- = No toxicity benchmark available.

At the raffinate ponds area, maximum ground water concentrations exceeded surface water quality benchmarks for ammonium, cadmium, chloride, copper, iron, lead, manganese, nitrate, selenium, sulfate, vanadium, and zinc. Based on the UCL_{95} values for this plume, only ammonium, chloride, iron, manganese, selenium, and sulfate still show risk to aquatic organisms. Selenium showed the highest HQs at this area, with an HQ of 2,460 for the maximum measured concentration, dropping to 170 for the UCL_{95}. Selenium, at least at the maximum concentration measured at this area, also showed potential risk to terrestrial wildlife receptors if used as drinking water. Among the E-COPCs showing potential risk to wetland wildlife from exposures through the food chain were cadmium, chromium, lead, manganese, selenium, vanadium, and zinc. Maximum selenium HQs were greater than 1,800 for the spotted sandpiper and kingfisher. Because of the potential for risk to ecological receptors in both the aquatic and wetland communities, ground water from this area should not be used as a source for surface ponds or wetlands that are accessible to wildlife.

6.2.5.3 Potential Risks from Radionuclides

Potential risks from radiological E-COPCs were evaluated using the screening-level benchmarks for aquatic biota (specifically large and small fish) derived for Oak Ridge National Laboratory (Bechtel Jacobs 1998b), as based on the methodology for estimating dose rates for aquatic biota developed by Blaylock and others (1993). In addition to these ecological-based benchmarks, CDPHE has established a water quality standard for radium-226+288 (total) at 5 pCi/L and for uranium (total) at 40 pCi/L (the latter is specific to the Animas River basin).

Radionuclide analyses of surface water and ground water samples from the Durango site have included uranium-238 and four of its daughter isotopes (radium-226, thorium-230, lead-210, and polonium-210), as well as uranium-234, radium-228, gross alpha, and gross beta activity. As shown in Table 6–27, all of these analytes except lead-210 and radium-228 have been identified as E-COPCs in the surface water at this site. Ecological benchmarks were available for all radiological analytes except gross alpha and gross beta. All of the HQs that can be determined for these radiological E-COPCs in the surface water are well below 1. Further, the sum of the maximum concentrations of radium-226 (0.21 pCi/L) and radium-228 (<1 pCi/L) is well below the CDPHE standard for these isotopes. Similarly, total uranium (uranium-234 plus uranium-238) for the surface water at this site is 10.2 pCi/L, which is also well below the CDPHE water quality standard of 40 pCi/L.

Table 6–27. Hazard Quotients for Radiological E-COPCs in Surface Water Based on Maximum Measured Activities

E-COPC	Ecological Benchmark Value[a] (pCi/L)[b]	Durango Site	
		Maximum Measured Activity (pCi/L)	Hazard Quotient
Gross Alpha	---	17.9	ND
Gross Beta	---	16.7	ND
Polonium-210	725	0.08	0.000110
Radium-226	160	0.21	0.00250
Thorium-230	413	4.1	0.00993
Uranium-234	4,040	5.6	0.00139
Uranium-238	4,550	4.6	0.00101

[a]Benchmark is the minimum for large and small fish (from Bechtel Jacobs 1998b).
[b]Picocuries per liter.
--- = No benchmark available.
ND = Not determined.

In the ground water at the mill tailings area, gross alpha and beta, polonium-210, radium-226 and -228, and uranium-234 and -238 were identified as E-COPCs. At the raffiante ponds area, all of these except radium-226 were identified as E-COPCs. Table 6–28 presents the comparison (as HQs) of the maximum concentrations of these radionuclides to their ecological screening benchmark values. Although no benchmark was available for radium-228, the HQs for the other radionuclides were less than unity. Therefore, potential doses to aquatic biota (particularly to fish) from ground water pumped to a surface pond should not pose a risk to these receptors. The total of the maximum concentrations of radium-226 and -228 at these areas (1.16 pCi/L at the mill tailings area and 1.53 pCi/L at the raffiante ponds area) were below the CDPHE standard for these isotopes. However, the total uranium concentration in ground water at both areas significantly exceeded the CDPHE standards for surface water. Therefore, these waters should not be used as a source of surface water.

Table 6–28. Hazard Quotients for Radiological E-COPCs in Ground Water Based on Maximum Measured Activities

E-COPC	Ecological Benchmark Value[a] (pCi/L)[b]	Mill Tailings Area		Raffinate Ponds Area	
		Maximum Measured Activity (pCi/L)	Hazard Quotient	Maximum Measured Activity (pCi/L)	Hazard Quotient
Gross Alpha	---	1,655	ND	261	ND
Gross Beta	---	666	ND	161	ND
Polonium-210	725	0.1	0.000138	1.12	0.00154
Radium-226	160	0.46	0.00288	Not an E-COPC in this area	
Radium-228	---	0.7	ND	0.99	ND
Uranium-234	4,040	732	0.181	105	0.0260
Uranium-238	4,550	766	0.168	111	0.0244

[a]Benchmark is the minimum for large and small fish (from Bechtel Jacobs 1998b).
[b]Picocuries per liter.
--- = No benchmark available.
ND = Not determined.

6.2.5.4 Potential Risks to Sensitive Species

As stated in Section 6.2.2, the southwestern willow flycatcher is an endangered species that has the potential for occurring in the riparian habitat along the Animas River at or near the Durango site. The diet of the southwestern willow flycatcher principally consists of flying insects, at least some of which possibly having been exposed to water or sediment of the site during their development. The spotted sandpiper, which was modeled as having a diet consisting entirely of invertebrates exposed to E-COPCs in the surface water of the site, and with additional exposure through direct ingestion of sediments from the site, conservatively represents potential exposure and risk to the southwestern willow flycatcher individuals that may occur at the site (the southwestern willow flycatcher, for example, is not expected to have as high a sediment ingestion rate as the sandpiper). For the spotted sandpiper, some potential risk was indicated from exposure to lead and zinc as indicated by HQs exceeding unity. However, as described in Section 6.2.5.1, the exposures to lead and zinc in the spotted sandpiper at this site are within the range of background for the area. Therefore, the potential for risk to the southwestern willow flycatcher is also expected to be within background ranges.

6.2.6 Recent Data

The results described above were based on monitoring data collected between June 1999 and June 2001 (with the exception of the sediment data, which were from a single sampling round conducted in 1993). Subsequent to the completion of the risk analyses described in this section, the ground water and surface water monitoring data for the August 2001 sampling round were received and validated. In addition, data from January 2001 sediment samples (from each of the surface water sampling locations) were also received. These most recent data are described in the following paragraphs qualitatively with regard to their potential implications to the risk results and conclusions.

For the mill tailings area ground water plume, the August 2001 sampling data showed a large increase in the maximum measured lead concentration, from 0.00043 mg/L to 0.0023 mg/L; however, because the new maximum equaled but did not exceed the maximum background concentration, lead would still not be considered an E-COPC for this plume. Smaller increases in the maximum site concentrations from the August 2001 data were also seen for sulfate (a 2 percent increase to 3,510 mg/L) and zinc (a 3 percent increase to 2.68 mg/L). Neither of these increases will significantly affect the risk results for this plume. Other analytes were within the ranges of the June 1999 through June 2001 data. Chromium and radium-228, identified as E COPCs for this plume, were not detected in the August 2001 samples.

For the raffinate ponds area ground water plume, the August 2001 sampling data showed significant increases in the maximum measured concentrations for selenium (from 12.3 to 19.4 mg/L) and thorium-230 (from less than 3.2 to 9.8 pCi/L). Therefore, the potential for risk to aquatic organisms and wetland wildlife from exposure to selenium (from ground water pumped to the surface from this ground water plume) continues to be considered very high, and for deep-rooted plants will probably remain medium-low; however, the potential for risk to terrestrial wildlife receptors would be increased from very low to low based on this higher maximum. Section 6.4 discusses the categories of potential risk. Although the new maximum for thorium-230 would identify this radionuclide as an E-COPC for this plume based on the comparison to the background maximum, it is still well below the risk benchmark of 413 pCi/L, indicating no risk. Smaller increases in the maximum site concentrations from the August 2001 data were also seen for cadmium (an 11 percent increase to 0.0041 mg/L) and chloride (a 9 percent increase to 1,520 mg/L). Neither of these increases will significantly affect the risk results for this plume. The other analytes were within the ranges of the June 1999 through June 2001 data. Antimony, arsenic, chromium molybdenum, thallium, and radium-228, identified as E-COPCs for this plume, were found to be within the range of background in the August 2001 samples. Of these, antimony, molybdenum, and thallium were not detected. In the case of radium-228, although the August 2001 maximum (1.02 pCi/L) was slightly greater than the previous maximum, the background maximum increased to 1.56 pCi/L based on the new data.

In the case of surface water, concentrations of all nonradiological E-COPCs identified from the June 1999 through June 2001 data were found to be within background ranges in the August 2001 data. Therefore, potential risks from exposures to these E-COPCs in surface water will be within the range of background risk. For the radiological analytes, only radium-226 and thorium-230 were detected. (uranium-234 and uranium-238 were not evaluated in the August 2001 samples.) Gross-alpha and gross-beta activities were within background ranges. The maximum background concentration for radium-226 increased to 0.27 pCi/L, which put all previous site

data within the range of background. Although the maximum background for thorium-230 also increased (to 3.3 pCi/L), the new site maximum (6.5 pCi/L) still exceeded background; however, this new maximum is still much less than the risk benchmark of 413 pCi/L. Therefore, based on the August 2001 surface water results, no risks to ecological receptors are predicted.

The 2001 sediment sampling included ten site locations and five background (upgradient) locations. The sediment samples were analyzed for the same suite of metals used in the 1993 analyses (arsenic, cadmium, iron, lead, manganese, mercury, molybdenum, selenium, uranium, and zinc), as well as for nitrate and sulfate. These analyses were performed on "wet" samples (as received by the laboratory); however, corresponding moisture content measurements were not taken. Therefore, the reported concentration values are expected to be less than those that would be based on the dry weight of the sediment, and for this reason are not exactly comparable to the 1993 sediment sampling results or to dry-weight-based benchmark concentrations. However, some general patterns of concentration distributions were observed in these data that shed light on the possible sources of metal concentrations along the Animas River at the Durango site.

For example, concentrations of all of the metals exceeded their respective maximum background (upgradient) concentration in at least one sample; however, nitrate and sulfate, which are E-COPCs in one or both ground water plumes and are expected to be mobile in ground water and migrate with the plumes, were detected at levels within the range of the background samples. Further, for all metals except mercury, the maximum measured concentration came from a single sample, 0691, which is located on the Animas River adjacent to the downstream end of the old smelter site. In all of these cases except zinc, all other samples were within the background range or very close to the maximum background value (for zinc, only one other sample [location 0584] exceeded the background range by a significant degree). In several cases (cadmium, iron, lead, manganese, molybdenum, uranium, and zinc), the concentration measured in the sample from location 0691 exceeded to maximum background by at least twofold (to about 100-fold for cadmium). These data indicate a hot spot of high metal concentrations in the sediment at location 0691, which is likely to be associated with the historical use of the adjacent area as a smelter.

For mercury, three samples had concentrations that exceeded the background data range (concentrations of all background samples were less than the detection limit of 0.02 mg/kg). These were locations 0583 (0.039 mg/kg), 0691 (0.053 mg/kg), and 0587 (0.063 mg/kg). Although mercury was not detected on the 1993 sediment samples, the higher detection limit of that analytical method (0.1 mg/kg dry weight) might not have detected mercury at the levels found in the 2001 samples. Mercury has not been considered a COPC in ground water at the mill tailings area or the raffinate ponds area or the surface water of the site. The 1997 EPA study concluded that the locally elevated mercury levels in sediment were not attributable to past milling operations (see Section 4.7.2). Although mercury was not evaluated in this risk assessment, the concentrations, albeit based on the wet weight of sediment, are well below the sediment quality benchmark of 0.174 mg/kg dry weight, as presented by Buchman (1999).

6.2.7 Ecological Risk Summary

For the purpose of summarization, the receptors are categorized into six groups: aquatic organisms, benthic organisms, deep-rooted plants, wetland plants, terrestrial wildlife, and wetland wildlife. One or more of these groups may be exposed to the different media evaluated in this assessment at each of the two sites. These media include surface water, sediment, food (exposed to E-COPCs in

water or sediment), and ground water. Further, the potential risk to each group based on the HQs presented earlier in this section was categorized as follows:

- None: HQs less than or equal to 1 for both the maximum and UCL_{95} concentrations
- Very low: Maximum HQs less than 10 but greater than 1; UCL_{95}-based HQs less than 1
- Low: Both maximum and UCL_{95}-based HQs less than 10, but greater than 1
- Medium-Low: Maximum HQ greater than or equal to 10 but less than 100; UCL_{95}-based HQs less than 10
- Medium: Both maximum and UCL_{95}-based HQs greater than or equal to 10 but less than 100
- High: Maximum HQ greater than or equal to 100 but less than 1,000; UCL_{95}-based HQs greater than 10
- Very high: Maximum HQs greater than or equal to 1,000.

Table 6–29 presents the results of this categorization of potential risk. In the cases where multiple receptors are included in the receptor group (i.e., the terrestrial and wetland wildlife groups), the risk is based on the highest (worst-case) risk result among the receptors. Because many conservatisms were incorporated in the calculation of these HQs, including the use of maximum and UCL_{95} values as exposure point concentrations, the use of conservative toxicity benchmarks, such as water quality criteria and NOAELs, and the assumption of 100 percent area and seasonal use, the HQs are expected to overestimate actual risk to most individual receptors, and therefore, risks categorized as medium-low to none are not expected to represent significant potential risks to populations of nonsensitive species. Although for those receptor groups that may include sensitive species, risk categorizations of medium-low to low might still be considered to be of concern; as discussed in Section 6.2.5.4, the indicated low risks for wetland receptors (including the southwestern willow flycatcher) from exposure to lead and zinc along the Animas River are expected to be within the range of background.

Table 6–30 summarizes the E-COPCs that remain at each of the evaluated areas. These constituents are considered to be of potential concern because their concentrations in environmental media indicate a potential for adverse toxicological effects to ecological receptors. Ammonium was the only E-COPC identified as a potential risk driver in surface water. Ammonium concentrations have been found sporadically at concentrations exceeding the CDPHE standard for the Animas River. Because of the sporadic nature of these exceedences, the rapid dilution by the river, and the ability of organisms to use ammonium as a nutrient, this E-COPC does not pose a significant hazard to the aquatic systems below the site. No E-COPCs were identified for the sediments at this site, in part due to the relatively high natural concentrations that exist in the area. Although low and medium-low were indicated for some receptors exposed to E-COPCs in sediment from the site, similar levels of risk were also indicated from exposure to background levels of these constituents.

Table 6–29. Summary of Potential Ecological Risks at the Durango Site

E-COPC	Aquatic Organisms	Benthic Organisms	Wetland Plants	Wetland Wildlife	Terrestrial Wildlife	Deep-Rooted Plants
(principal exposure media)	Surface water	Sediment	Sediment	Surface water Sediment Food	Surface water	Ground water
Surface Water (Animas River and Lightner Creek)						
Ammonium	Medium-low	NA	NA	--	--	NA
Arsenic	NA	Low	low	none	NA	NA
Iron	NA	None	--	--	NA	NA
Lead	None	Low	low	low	none	NA
Nitrate	NA	None	--	none[a]	NA	NA
Selenium	None	None	low	none	none	NA
Sulfate	Very low	NA	NA	--	--	NA
Zinc	NA	Low	medium-low	low	NA	NA
Mill Tailings Area Ground Water Plume[b]						
Arsenic	None	NA	NA	none	none	very low
Cadmium	Medium-low	NA	NA	high	none	None
Chloride	Very low	NA	NA	--	--	--
Chromium	None	NA	NA	low	none	None
Manganese	High	NA	NA	none	none	very low
Molybdenum	None	NA	NA	none	none	None
Selenium	Medium-low	NA	NA	medium-low	none	None
Sulfate	Medium-low	NA	NA	--	--	--
Uranium	Very low	NA	NA	very low	none	None
Vanadium	Medium-low	NA	NA	high	none	very low
Zinc	Medium-low	NA	NA	medium	none	Low
Raffinate Ponds Area Ground Water Plume[b]						
Ammonium	High	NA	NA	--	--	--
Antimony	None	NA	NA	none[a]	none[a]	--
Arsenic	None	NA	NA	none	none	very low
Cadmium	Very low	NA	NA	medium-low	none	None
Chloride	Low	NA	NA	--	--	--
Chromium	None	NA	NA	low	none	None
Copper	Very low	NA	NA	none	none	None
Iron	Low	NA	NA	--	--	None
Lead	Very low	NA	NA	low	none	None
Manganese	High	NA	NA	very low	none	very low
Molybdenum	None	NA	NA	none	none	None
Nitrate	Very low	NA	NA	none[a]	none[a]	--
Selenium	Very high	NA	NA	very high	very low	Medium-low
Sulfate	Medium	NA	NA	--	--	--
Thallium	None	NA	NA	none[a]	none[a]	None
Uranium	None	NA	NA	none	none	None
Vanadium	Very low	NA	NA	very low	none	None
Zinc	Very low	NA	NA	very low	none	very low

[a]Avian benchmark not available. Risk based on mammalian receptors only.
[b]Exposures to aquatic organisms and wildlife based on the hypothetical scenario that ground water is pumped to a surface pond or wetland.
-- = No hazard quotients available.
NA = Not applicable to this area.

Table 6–30. Summary of E-COPC at the Durango Site Based on the Ecological Risk Screening Results

Animas River and Lightner Creek		**Ground Water Plume[a]**	
Surface water	Sediment	Mill Tailings Area	Raffinate Ponds Area
Ammonium	(none)	Cadmium	Ammonium
		Manganese	Cadmium
		Selenium	Manganese
		Sulfate	Selenium
		Vanadium	Sulfate
		Zinc	Uranium-234
		Uranium-234	Uranium-238
		Uranium-238	

[a]Potential risk to deep-rooted plants from exposure to ground water is limited to selenium at the raffinate ponds area.

For the surface waters and sediments of Lightner Creek and the Animas River, the potential for ecological risk was generally low. Medium-low potentials for risk to aquatic organisms and wetland plants were associated with ammonium and zinc, respectively. For ground water, high potentials for risks to ecological receptors were found at the mill tailings area plume for cadmium, manganese, and vanadium, and very high potentials for risk were found at the raffinate ponds area plume for selenium; high potentials were also indicated for ammonium and manganese. The concentrations of uranium in the ground water at both of these sites exceed the CDPHE surface water quality standard (see Section 6.2.5.3). For these reasons, ground water in these plumes is considered unsuitable for use in surface ponds or wetlands. However, the ground water at these sites does not appear to pose a significant risk to either deep-rooted plants or terrestrial wildlife (if hypothetically used as a drinking water source).

End of current text

7.0 Ground Water Compliance Strategy

The framework defined in the final PEIS for the UMTRA Ground Water Project (DOE 1996) governs selection of the final strategy to achieve compliance with the EPA ground water protection standards. Stakeholder review and acceptance of the final PEIS is documented and supported by the Record of Decision. Presented below is a discussion of how the selection process was used to determine the final ground water compliance strategy at the Durango site and a proposed future ground water sampling and analysis plan to monitor compliance and the effectiveness of the selected remedy.

7.1 Compliance Strategy Selection Process

The PEIS framework used to determine the appropriate ground water compliance strategy for the Durango site is summarized in the flowchart in Figure 7–1. The framework takes into consideration human health and environmental risk, stakeholder input, and cost. A step-by-step approach is followed until one or a combination of three general compliance strategies is selected. The three compliance strategies are:

- ***No remediation***—Compliance with the EPA ground water protection standards would be met without altering the ground water or cleaning it up in any way. This strategy could be applied for those contaminants at or below MCLs or background levels or for those contaminants above MCLs or background levels that qualify for supplemental standards or ACLs as defined in Section 2.1.2.

- ***Natural flushing***—Allows natural ground water movement and geochemical processes to decrease contaminant concentrations to regulatory limits. The natural flushing strategy could be applied at a site if ground water compliance can be achieved within 100 years, where effective monitoring and institutional controls can be maintained, and where the ground water is not and is not projected to be a source for a public water system.

- ***Active ground water remediation***—Requires application of engineered ground water remediation methods such as gradient manipulation, ground water extraction and treatment, and in situ ground water treatment to achieve compliance with the standards.

7.2 Mill Tailings Area Compliance Strategy

To achieve compliance with Subpart B of 40 CFR 192 at the mill tailings area, DOE's proposed action is natural flushing in conjunction with institutional controls (ICs) and continued monitoring. Ground water flow and transport modeling has predicted that site-related concentrations of uranium and molybdenum in the alluvial ground water will decrease to levels below the MCL; manganese and sulfate concentrations will be reduced below risk-based and background concentrations, respectively (Section 5.5). Selenium concentrations exceed the MCL in background wells; therefore, DOE defers to an ACL value of 0.05 mg/L from the EPA's Safe Drinking Water Act. Modeling indicates selenium will decrease below the 0.05 mg/L ACL level within 60 years. Cadmium concentrations will not be reduced to levels below the MCL based on model predictions using concentrations from the one well (0612) where cadmium is elevated. However, cadmium concentrations have been decreasing in well 0612 since surface remediation and the downward trend indicates natural flushing greater than indicated by the ground water model. Concentrations in this well will be monitored during the next 10 years and reevaluated

after additional data are collected. Because ICs will be maintained during the flushing period, this compliance strategy protects human health by eliminating the potential for ground water use. This compliance strategy is also protective of the environment as documented by sampling results from the Animas River, which receives contaminated ground water. This proposed action has been determined by applying the compliance strategy selection framework from the PEIS, consisting of several evaluation steps discussed below (Figure 7–1).

7.2.1 Assessment of Environmental Data

The first step in the decision process was an assessment of both historical and new environmental data collected to characterize hydrogeochemical conditions and the extent of ground water contamination related to uranium-ore processing at the site. Ground water is unconfined in the alluvial aquifer; depth to the water table ranges from 10 to 40 ft. Along the base of Smelter Mountain, the Mancos Shale Bedrock is overlain by up to 25 ft of colluvium. The colluvium consists of poorly sorted, silty soil from Smelter Mountain. Closer to Lightner Creek and the Animas River, deposits of river-laid sand and gravel up to 15 ft thick occur over the shale bedrock. A layer of vitreous lead smelter slag as much as 25 ft thick remains along the Animas River near the southeast corner of the mill tailings area.

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 RRM beneath the piles were cleaned up to meet the EPA standards for radium in soil. Supplemental standards were applied to some areas of the slopes of Smelter Mountain and 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.

Ground water in the alluvial aquifer generally flows to the southeast with an average gradient of approximately 0.02 ft/ft. Hydraulic conductivity ranges from 10 to 66 ft/day. Ground water in the colluvium near the base of Smelter Mountain is recharged primarily by runoff from the mountain and by 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 back into the Animas River.

7.2.2 Ground Water Contaminants

The second step in the decision process was to compare the list of ground water contaminants to MCLs or to concentrations in background ground water. The list of COPCs identified in the 1995 BLRA was reevaluated using data collected since November 2000. Potential risks calculated using the recent data for a residential scenario indicate that the major risk contributors are cadmium, lead, manganese, selenium, sodium, sulfate, and uranium. Uranium poses the greatest risk and is the COPC with concentrations that exceed the MCL in ground water in the greatest number of wells. Concentrations of selenium also exceed the MCL in several locations, and cadmium and molybdenum concentrations exceed their MCL in only one location each. All lead concentrations have been less than the MCL since November 2000 (four sampling events). A discussion of COPCs is presented in Section 6.1.

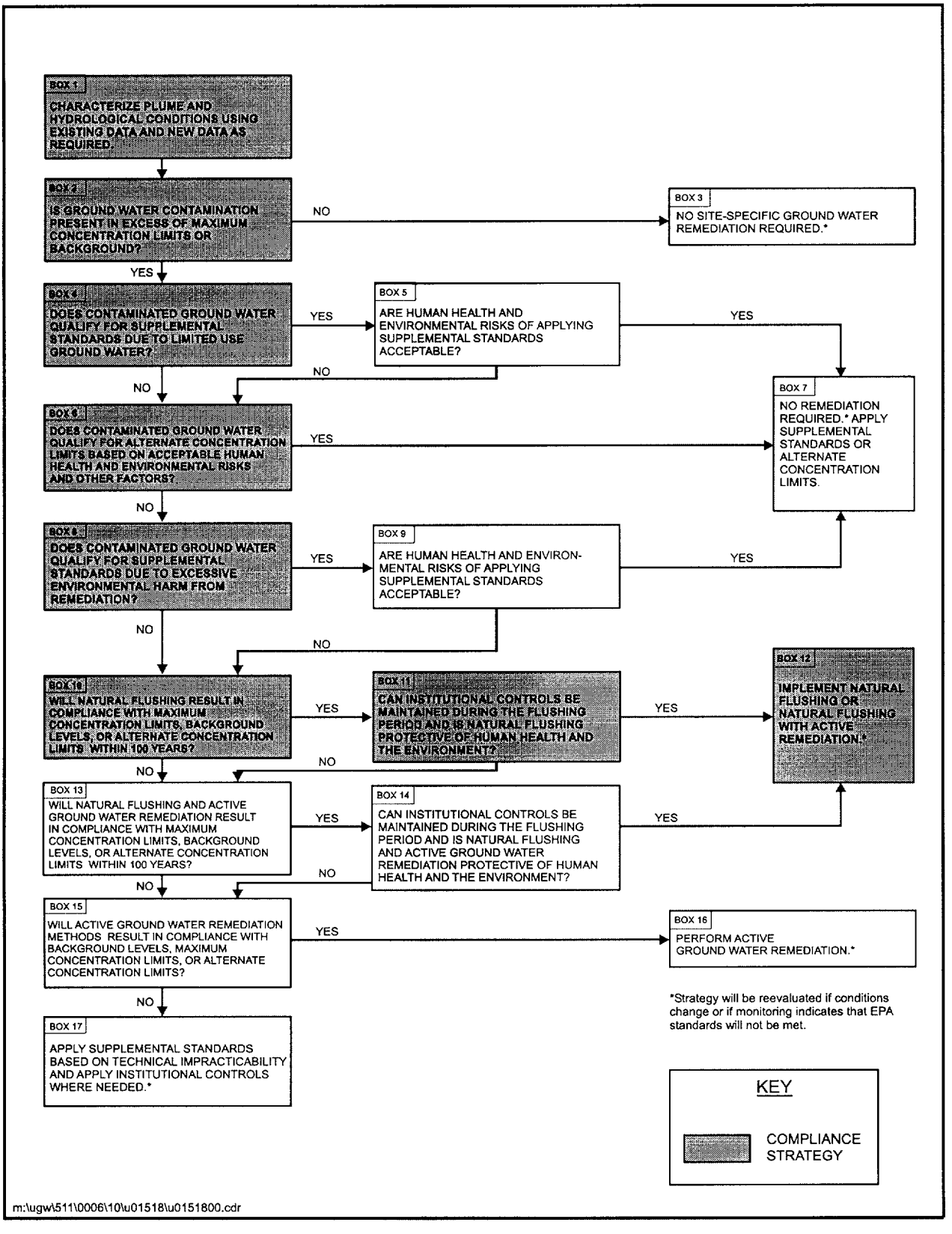


Figure 7–1. Summary of the Mill Tailings Area Ground Water Compliance Selection Framework

7.2.3 Applicability of Natural Flushing

Results of ground water contaminant transport modeling are presented in Section 5.5 and Appendix G. Predicted concentrations of cadmium, manganese, molybdenum, selenium, sulfate, and uranium after 100 years of natural flushing are provided. Of these contaminants, molybdenum and uranium maximum average concentrations are predicted by the ground water model to decrease below UMTRA Project standards. Molybdenum concentration is predicted to decrease below the UMTRA Project standard within 5 years and uranium concentration is predicted to decrease to levels below the UMTRA Project standard after a period of 80 years. Modeling results also predict that concentrations of manganese and sulfate will decrease below their risk-based and background levels, respectively (there are no UMTRA Project standards for manganese and sulfate). Manganese concentration will decrease below the risk-based level prior to 70 years. Sulfate concentrations will decrease below background levels prior to 100 years. Results of selenium and cadmium modeling warrant further discussion.

Selenium

Ground water samples collected from background wells have selenium in concentrations up to 0.0148 mg/L, which is above the MCL of 0.01 mg/L. On-site, maximum selenium concentrations over the past four sampling periods (from November 2000 to August 2001) have averaged 0.078 mg/L. Ground water modeling of selenium was completed to determine if concentrations will naturally flush below the MCL of 0.01 mg/L on site.

Based on stochastic modeling results, maximum average selenium concentrations after 100 years are expected to decrease from 0.078 to 0.025 mg/L. Although the initial concentrations are not exceedingly high, the rather high K_d range associated with this contaminant (from 6.3 to 50.6 mL/g) prevents selenium from naturally flushing below the MCL. Therefore, the compliance standard for selenium will be the ACL of 0.05 mg/L from the EPA's Safe Drinking Water Act.

Cadmium

Based on the ground water modeling all contaminants except cadmium will flush naturally to the MCL, ACL or risk-based level. Cadmium concentration exceeds the MCL in only one well (0612); concentrations in all other onsite wells (0617, 0622, 0630, 0631, 0633, 0634, 0635, and 0859) are at or near the detection limit. As part of the natural flushing compliance strategy, monitoring of cadmium in well 0612 will continue, and the risks associated with cadmium at this one location will be reevaluated after 10 years.

Stochastic model simulations indicate that the concentration will not flush naturally below the MCL (0.01 mg/L) or the risk-based standard of 0.018 mg/L. Ground water modeling results estimate the cadmium concentrations will decrease only 0.0039 mg/L (from an initial concentration of 0.0369 mg/L to 0.033 mg/L) after 100 years of natural flushing. As with selenium, a high K_d influences the limited transport of this contaminant. The measured K_d range for cadmium is from 17 to 418mL/g, with an average of 60.4 mL/g.

The modeling was completed using conservative input parameter estimates. Two of the key input parameters regarding modeling are the K_d and initial concentration values.

The published literature indicates the K_d for cadmium is much lower compared to the range of values measured on site. Reported cadmium K_d values range from 1.3 to 27 mL/g, and average 1.9 mL/g (Baes and Sharp 1983). Stochastic modeling of cadmium using this different K_d range with the same initial concentration distribution indicates the average maximum cadmium concentration will decrease below the 0.018 mg/L risk-based standard between 90 and 100 years of natural flushing. The maximum average concentration does not drop below the 0.01 MCL until after 150 years.

The procedure used to determine the initial concentration distribution for the stochastic modeling is presented in Appendix G. As described in this appendix, the initial concentration for the modeled contaminant was based on the average concentration detected in samples collected from the monitor wells over the past four sampling events (from November 2000 through August 2001).

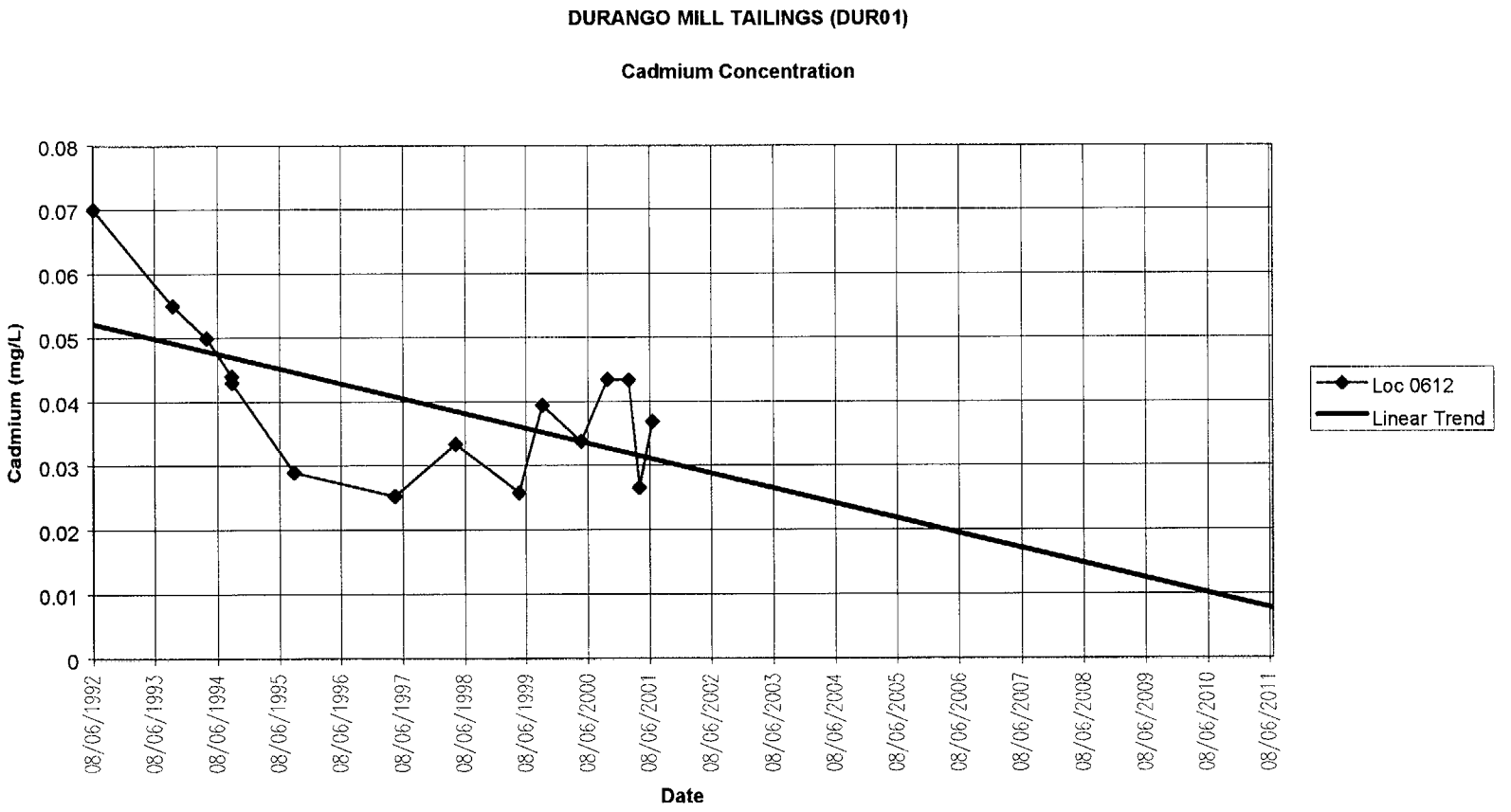
There is considerable variability in the cadmium results from well 0612. A review of historical data for the past 10 years (surface remediation was completed in 1991) suggests a lower initial concentration compared to the value used for the modeling. Historical data also indicate a downward trend that is greater than would be predicted by the model using average estimated site-specific K_ds. A regression line plotted through the data (Figure 7–2) indicates the initial concentration associated with well 0612 is approximately 0.032 mg/L (as opposed to 0.0369 mg/L, which is the maximum initial concentration assigned to the model). Extending this regression line out another 10 years, this initial concentration is expected to be low enough to allow natural flushing of cadmium within 100 years below the 0.01 mg/L UMTRA standard.

Because of the variability in the cadmium results from this one well, additional time to observe the trend in this well will be useful. No unacceptable human health or ecological risks are expected to be posed by the cadmium concentrations in the ground water during the next 10 years for the following reasons:

- Using the worst-case residential scenario for this site, cadmium only accounts for 6 percent of the total site risks, and the hazard quotient is less than 1. The UCL_{95}, based on the current plume, is less than the MCL. If the point of exposure were to occur at any on-site wells other than well 0612, the contribution to total risks drops below 1 percent.

- The most likely scenario for this site is that no ground water exposures will occur (i.e., no risks to human health) because of the existing institutional controls and the availability of municipal water as a drinking water source and river water for other potential uses such as irrigation. However, if a less conservative exposure scenario was assumed, such as occupational exposure to contaminated ground water, risks associated with the current cadmium concentrations in well 0612 would be protective of human health within the 100-year natural flushing time frame.

- The volume of plume water exceeding the MCL is considered to be so small that ground water is not expected to increase ecological risks. Cadmium values in the closest Animas River surface water sampling location (0691) have not exceeded the maximum observed background value (0.00053 mg/L) since the completion of surface remediation; the vast majority of samples had concentrations below the detection limit.



7–2. Durango Mill Tailings Area Cadmium Concentration in Well 0612

7.2.4 Institutional Controls

ICs are restrictions that effectively protect public health and the environment by limiting access to a contaminated medium, such as the alluvial ground water at the Durango Mill Tailings site. ICs typically depend on an administrative legal action, such as zoning, ordinances, and laws to ensure that protection is effective and enforceable. For the UMTRA Ground Water Project, ICs reduce exposure to or reduce health risks by (1) preventing intrusion into contaminated ground water, or (2) restricting access to or use of contaminated ground water for unacceptable purposes. The EPA standards permit the use of ICs at sites where natural flushing will return the ground water to regulatory levels within 100 years.

The EPA standards require that ICs have a high degree of permanence, protect human health and the environment, satisfy beneficial uses of ground water, are enforceable by administrative or judicial branches of government entities, and can be effectively maintained and verified.

The need for, and duration of, ICs depends on the compliance strategy selected for a site, the level of risk to humans and the environment, and existing site conditions. Movement of contaminated ground water may require restrictions over an extended period of time. As risks decrease over time, so should the restrictiveness of ICs. Therefore, to ensure protection of human health and the environment, and beneficial uses the water could have satisfied, it is important the effectiveness of ICs be verified and modified as necessary.

ICs are mandated to be effective for a period of 100 years during which the ground water contaminant levels will reach EPA standards. Current data indicate that contamination on the former mill tailings area property will naturally flush in that time frame. The ground water contamination created by past ore-processing activities is contained within the former millsite boundaries. Therefore, any ICs deemed necessary need only apply to that parcel of property.

In January 2000, the Durango millsite was conveyed to the City of Durango by quitclaim deed. The deed contains the following language:

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

This language is recorded with the deed and ensures that any future landowner is subject to the same restrictions. This language fulfills the requirements for degree of permanence and enforceability by government entities.

7.2.5 Monitoring Compliance Strategy

The monitoring strategy for the alluvial aquifer is designed to determine progress of the natural flushing process in meeting compliance standards for site COPCs. Standards for molybdenum and uranium are their UMTRA MCLs of 0.1 mg/L and 0.044 mg/L, respectively. The cleanup goal for selenium is the ACL of 0.05 mg/L. Monitoring for these three contaminants will continue annually to verify modeling results, that is, that concentrations are decreasing. Monitoring for cadmium will continue on an annual basis and focus on observing trends in well 0612 and establishing a larger database to support future modeling efforts. Cadmium will be

analyzed in samples on a site wide basis to ensure concentrations are not detected in any locations other than well 0612 and that human health risks remain minimal. Cadmium will also 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.

Wells 0612, 0617, 0630, 0631, 0633, 0634, and 0635 have been established as appropriate for monitoring progress of natural flushing in the alluvial aquifer. Concentrations of cadmium, molybdenum, selenium, and uranium were detected above MCLs in these wells during the most recent sampling. In addition, wells 0859 and 0863 will be sampled because these locations are downgradient of the plume and should be adequate for tracking the progress of natural flushing. Well 0633 (downgradient of the former small tailings pile) and well 0612 (downgradient of the former large tailings pile) had the highest concentrations of uranium detected in samples collected in the most recent sampling event, suggesting that the center of this plume has already migrated downgradient. Well 0612 sample results will also be used to verify that cadmium concentrations continue to decrease as expected. Background wells 0857 and 0866 will also continue to be sampled to establish a larger database of background ground water concentrations for statistical analysis, should future modeling for cadmium be necessary. The proposed monitoring locations are shown on Figure 7–3.

Surface water locations 0650 and 0651 along Lightner Creek, and locations along 0515, 0652, 0690, 0583, 0584, 0691, and 0586 along the Animas River will be monitored to verify the natural flushing strategy is protective of the environment.

Monitoring will take place on an annual basis for the first 10 years. At that time the monitoring strategy will be reevaluated and adjusted as appropriate based on current results. To accommodate the specification of observing concentrations of COPCs at or below the compliance standards for 3 consecutive years before discontinuing monitoring for that constituent, a different monitoring frequency will be determined after the first 10 years. Monitoring requirements are summarized in Table 7–1.

Table 7–1. Summary of Ground Water and Surface Water Monitoring Requirements at the Mill Tailings Area

Sampling Location	Monitoring Purpose	Analytes	Location
0612, 0617, 0630, 0631, 0633, 0634, 0635	Monitor plume migration on site for molybdenum, selenium, and uranium. Verify decrease in concentrations of cadmium in well 0612.	Cadmium Molybdenum Selenium Uranium	On site - Downgradient
0859, 0863	Downgradient concentrations; leading edge of plume	Cadmium Moylbdenum Selenium Uranium	On site - Downgradient
0857, 0866	Background for the mill tailings area	Cadmium Moylbdenum Selenium Uranium	Off site - Upgradient
0515, 0650, 0652	Surface water background	Cadmium Moylbdenum Selenium Uranium	Off site - Upgradient
0583, 0584, 0586, 0651, 0690, 0691	Downgradient surface water concentrations	Cadmium Moylbdenum Selenium Uranium	Off site - Downgradient

All other monitor wells at the mill tailings area no longer needed for compliance monitoring will be abandoned in the near future in accordance with UMTRA Project procedures and applicable State of Colorado regulations.

7.3 Raffinate Ponds Area Compliance Strategy

To achieve compliance with Subpart B of 40 CFR 192 at the raffinate ponds area, DOE's proposed action is no remediation and application of supplemental standards based on the criteria for limited use ground water (40 CFR 192.21 [g]). For ground water to be classified as limited use, at least one of three criteria must be met:

- TDS concentrations are at least 10,000 mg/L.
- Widespread ambient contamination not due to ore-processing activities exists that cannot be cleaned up using treatment methods reasonably employed in public water systems.
- The quantity of water reasonably available for sustained continuous use is less than 150 gallons per day.

The TDS concentrations in the background ground water locations at the raffinate ponds area are all less than 10,000 mg/L, and therefore the first criterion would not apply to the raffinate ponds area.

The quantity of ground water available from wells completed in the Point Lookout and Menefee Formations at the site meets the criteria for limited use, with the exception of wells completed in the Bodo fault and fractured coal beds (there is no alluvial ground water at the raffinate ponds area; it occurs in only one small, isolated spot). However, ground water flow at the raffinate ponds area is predominantly through joints, open bedding planes, and fractures; wells completed across these specific features can sustain greater than 150 gallons per day.

The second criterion applies to bedrock ground water at the Durango raffinate ponds area and is the basis for the classification of limited use (Figure 7–4). The raffinate ponds area bedrock ground water has elevated selenium concentrations that are not due to the former mill processing activities. Ground water in bedrock formations at the raffinate ponds area is not a current or potential source of drinking water.

7.3.1 Assessment of Environmental Data

Two bedrock units, both members of the Mesaverde Group, underlie the raffinate ponds area separated by a fault dissecting the site (Plate 2). The Point Lookout Sandstone is the basal formation of the Mesaverde Group and is divided into two members: a lower transitional member consisting of interbedded lenticular sandstones and shales, and an upper massive sandstone member. The Menefee Formation consists of massive sandstone and shale, with beds of carbonaceous shale and coal. The Bodo Fault (a normal fault) juxtaposes the Point Lookout Sandstone and the Menefee Formation and has down dropped the Point Lookout Sandstone approximately 200 ft. The Bodo fault trends northeast and dips to the southeast at approximately 55 degrees.

Ground water in the raffinate ponds area is assumed to be unconfined. It is recharged by infiltration of precipitation and runoff and by horizontal inflow from Smelter Mountain. Water enters the flow system at the intersection of the Bodo Fault with South Creek. This influx is intermittent because South Creek is an ephemeral stream. Hydraulic conductivity data indicate the Point Lookout Sandstone is the least conductive material. In addition, the lower member (predominantly shale and siltstone) of the Point Lookout Sandstone is apparently an aquitard. The Menefee Formation consists of mostly low-conductivity sandstone, but is relatively permeable where fractures or lenticular coal beds are present. The greatest hydraulic conductivity at the raffinate ponds area is found in the Bodo Fault and in the coal beds.

7.3.2 Ground Water Contaminants

The list of COPCs identified in the 1995 BLRA was reevaluated using data collected since November 2000. Potential risks calculated using the recent data for a residential scenario indicated the major risk contributors were chloride, lead, manganese, selenium, sodium, sulfate, and uranium. At the raffinate ponds area, risks are dominated by selenium with quantifiable contributions from manganese and uranium. Selenium and uranium are the only COPCs with concentrations that exceed MCLs. Although there is no consensus as to what concentration of sulfate is acceptable in drinking water, concentrations detected in the raffinate ponds area ground water are sufficiently high to be of probable concern. A discussion of COPCs is presented in Section 6.1.

Concentrations of some constituents are elevated in the background monitor wells. Background selenium values for the raffinate ponds area average 0.0136 mg/L (the MCL is 0.01 mg/L). Selenium concentrations are high in background well 0599 and are not detected in others. The population is bimodal; if the nondetect values are assumed to be the detection limits, the average of 0.0136 mg/L is above the MCL of 0.01 mg/L. The ORP is oxidizing in well 0599; in other background wells the ORP is negative (reducing conditions), preventing selenium from being mobilized into the ground water.

Ground water in some of the background wells (and many of the on-site wells) has a black discoloration and a strong odor of hydrogen sulfide gas. Samples were not routinely collected for sulfide analysis from on site wells, but a limited number were collected from the background well locations. Sulfide at or above the risk-based default value in drinking water of 0.11 mg/L was detected in several background wells. In background well 0592 the concentrations were extremely elevated at 45 mg/L.

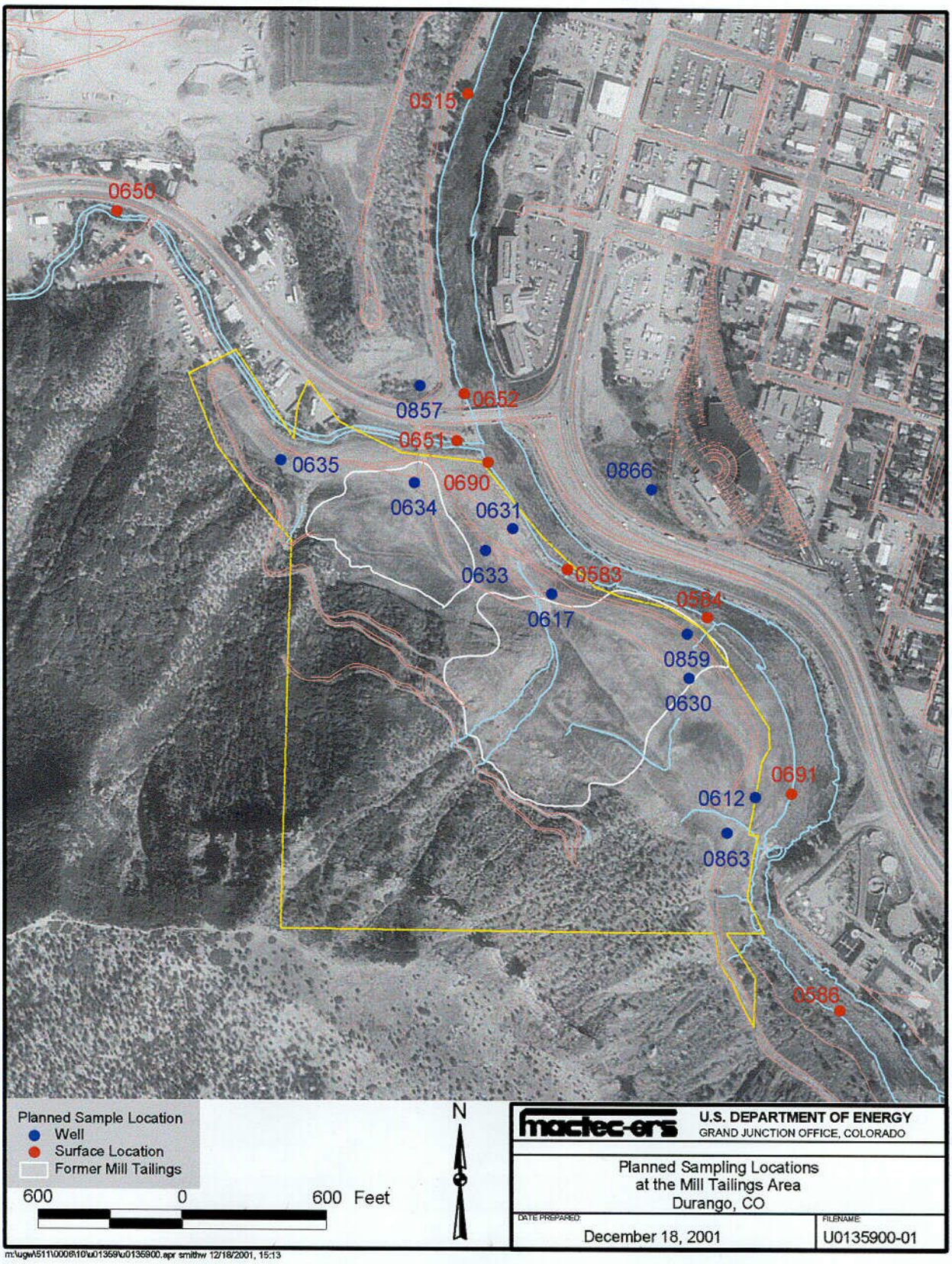


Figure 7–3. Proposed Monitoring Locations for the Mill Tailings Area

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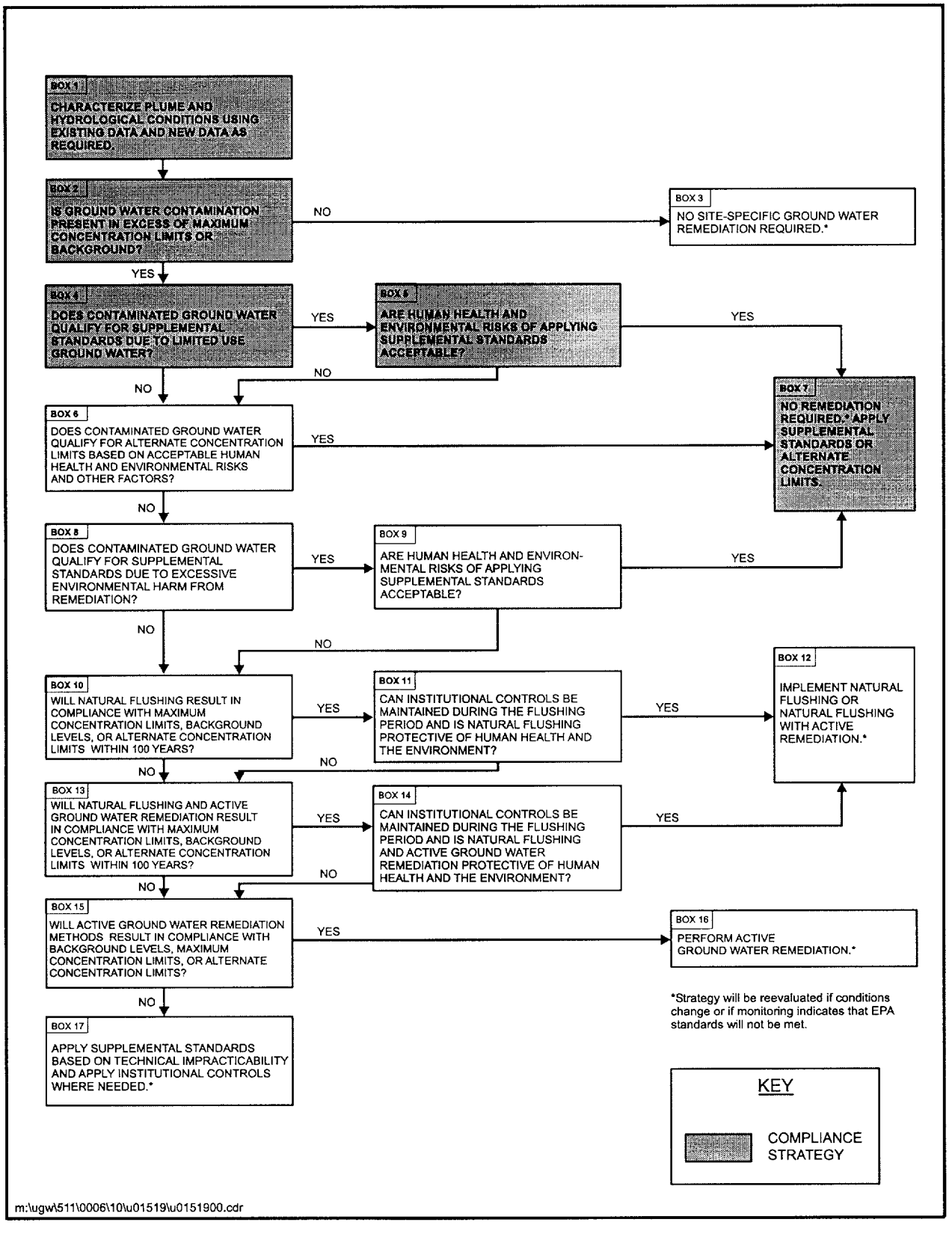

Figure 7–4. Summary of the Raffinate Ponds Area Ground Water Compliance Selection Framework

7.3.3 Applicability of Supplemental Standards

Bedrock ground water at the raffinate ponds area qualifies for supplemental standards on the basis of limited use ground water. Ground water in the bedrock is of limited use because of widespread, elevated concentrations of naturally occurring selenium.

- Selenium concentrations exceeds the MCL at background monitor well 0599. In the August 2001 sampling event, the selenium concentration in this well exceeded the MCL by a factor of nearly nine.

- Historical data indicate high concentrations of selenium were not released from the processing operations at the raffinate ponds area. Tsivoglou and others (1960) reported that less than 0.01 mg/L of selenium was detected in the raffinate produced from the solvent extraction process. This process was used until the operations at the raffinate area ceased in 1963. Prior to that time, raffinate was discharged directly to the Animas River and could not have been as a source of ground water contamination. Therefore, it appears the milling operations were not a source of selenium in ground water.

- Selenium occurs naturally in the western United States and in the Durango area in sufficient concentrations to be a source of ground water contamination under certain conditions. Coals, which occur throughout the raffinate ponds area, can also have elevated selenium concentrations. For example, Naftz and Rice (1989) reported total selenium values of 0.5 to 2 mg/kg for early Tertiary sandstones associated with coal seams from the Powder River Basin in Wyoming. Valkovic (1983) also noted selenium may be the most enriched trace element in coal. Coleman and Delevaux (1957) found selenium to occur naturally in galena, chalcopyrite, arsenopyrite, sphalerite, pyrite, and pyrrhotite within the Colorado Plateau. Pyrite is commonly found in the bedrock units under the raffinate ponds area. The widespread distribution of potential natural sources of selenium at the raffinate site could account, in part, for the high variable selenium concentrations in ground water. Moreover, high selenium in isolated wells such as 0884 and the lack of a clear selenium plume implies that selenium sources are variable and isolated.

- Selenium is released to ground water under oxidizing conditions (Masscheleyn and others 1990). The variability in the historical well data for selenium indicate changing redox conditions at the site (see Section 5.4). One indication of changing redox conditions is the change in iron concentrations that occurred in the 1980s at well 0607 (Figure 5–21). The surface remediation completed in 1991 also may have increased the oxidizing conditions at the site by the removal of 20 to 30 ft of overburden. Figure 5–24 shows the increase in selenium concentrations since remediation in monitor well 0607. Site-specific factors that could influence the rates of release and transport of selenium were not fully determined by the field investigation. The travel time of selenium in the ground water, the weathering rates of host rock, and how selenium is bound up in the various bedrock units and surface soils influence selenium concentrations in the ground water. The inherent variability is expected to continue with changes in water levels, precipitation events, and other influences on the redox conditions.

- Several contaminants are known to be site related. Uranium is the best example of a contaminant linked to past millsite activities. As expected, uranium concentrations have decreased across the site since surface remediation was completed. In contrast, selenium concentrations have increased in several wells (Figure 7–5 shows concentration changes over time for selenium and uranium for well 0607, which was in place before remediation), implying influences from other sources and processes.

- Selenium concentrations in ground water increased after surface disturbances at other locations, which allowed for changes in redox conditions when natural selenium has been available. At the former uranium-ore processing mill in Monticello, Utah, (under the CERCLA program) selenium levels began to increase dramatically in downgradient wells following remediation; where contaminated soil was removed above the Mancos Shale and Dakota Sandstone. Like the Point Lookout Sandstone and Menefee Formation, the Dakota Sandstone has an abundance of coal, carbonaceous shale, and pyrite. However, it has also been shown that disturbance of surface material is not required for mobilizing naturally occurring selenium. The National Irrigation Water Quality Program (NIWQP) has extensively surveyed naturally occurring selenium in the western United States. The USGS analyzed data collected by the NIWQP and concluded that areas having local geologic sources of selenium, application of water to the soil mobilizes the selenium; the degree of contamination resulting from mobilization of selenium by irrigation water depends greatly on the aridity and hydrology of the area; and selenium concentrations in water are elevated in all but 1 of the12 NIWQP study areas where irrigated areas are on or adjacent to Upper Cretaceous marine sedimentary rocks (USGS 1999).

- The highest concentrations of selenium in ground water have occurred in monitor well 0628. The August 2001 results from this well are almost 10 times higher than the concentrations in any other well. As noted in Section 5.4, this well is screened to within 2 ft of the surface (enhanced oxidizing conditions), and it is screened directly below a coal seam (likely source of natural selenium). In addition, concentrations in nearby wells are much lower indicating the high value in monitor well 0628 is isolated. If the analytical results for selenium in well 0628 are excluded from the statistical calculations, the on-site selenium concentrations are closer to concentrations in the wells designated as background for the site (Table 7–2).

Table 7–2. Selenium Concentrations at the Raffinate Ponds Area

	Background Selenium Concentrations	On-site Selenium Concentrations Including Well 0628	On-site Selenium Concentrations Excluding Well 0628
Maximum	0.087	19.4	3.08
Mean	<0.0136	<1.1	0.36
95 Percent UCL	NA	2.17	0.62

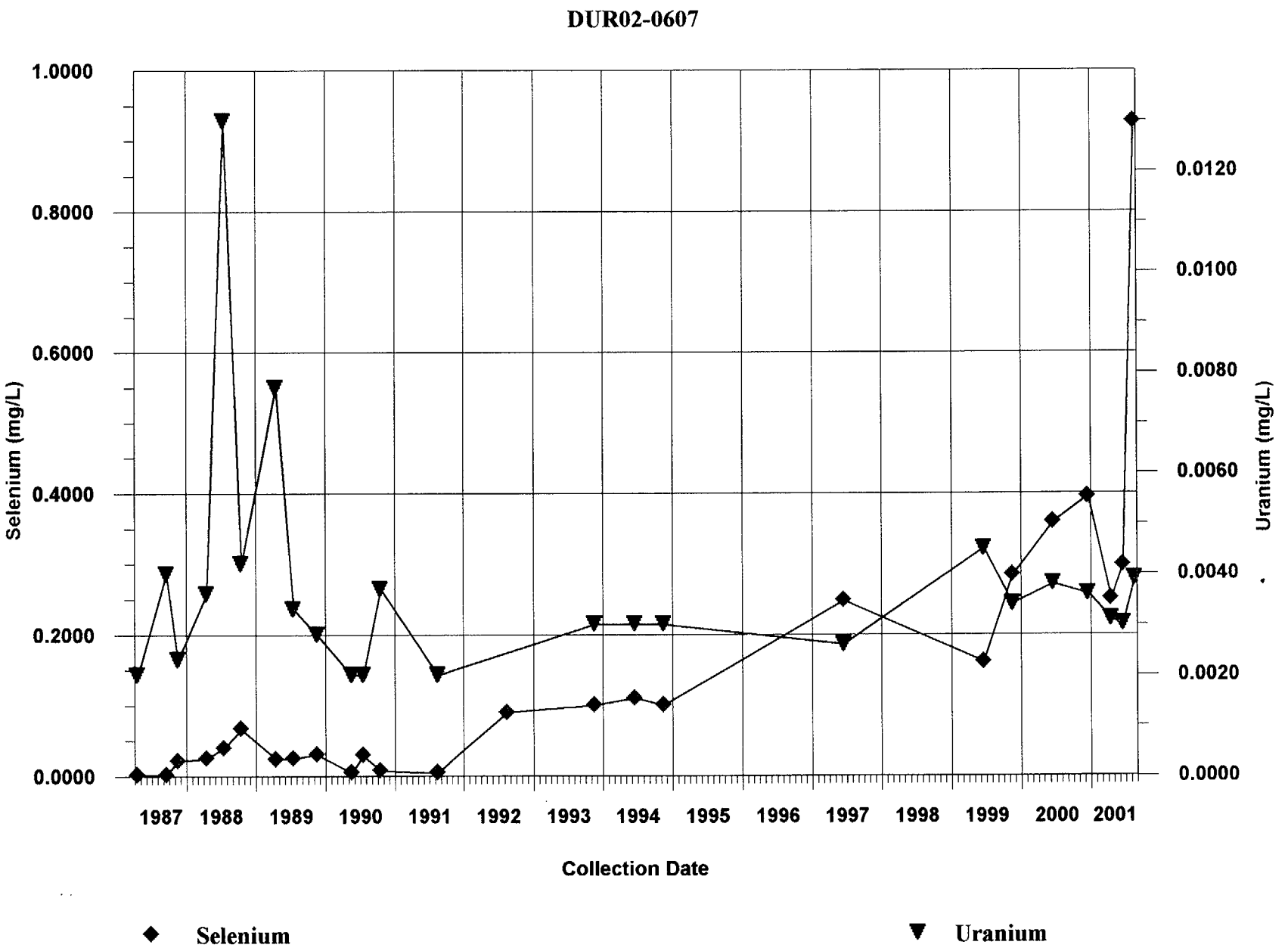

Figure 7–5. Concentrations of Selenium and Uranium in Well 0607 at the Raffinate Ponds Area

7.3.4 Reasonableness of Ground Water Treatment

Ground water from the bedrock formations beneath the raffinate ponds area is not a current or potential source of drinking water. Potable water is readily available from the municipal water system in the vicinity of the site. Based on historical records from the Colorado Division of Water Resources, the nearest known downgradient well is across U.S. Highway 550, approximately 0.2 mile southeast of the site, on the west side of the Animas River. However, this well is located under a building and has never been used because of a black discoloration of the water (DOE 1995a). Future use of ground water from the bedrock aquifer is unlikely based on the planned future development of a pumping plant at the raffinate ponds area. Therefore, the current and reasonably projected uses of site-affected ground water would be preserved with the application of supplemental standards.

However, should the future development plans for the site change, ground water would still not be considered as a source for the municipal water supply. The City of Durango does not consider that ground water could be reasonably treated for drinking water purposes because the bedrock aquifer does not produce water in usable quantities (Rogers 2001). Additionally, water in the area is considered of poor quality with high hardness, iron, and manganese levels (DOE 1995a), as well as black discoloration and the strong odor associated with hydrogen sulfide gas. Prior to any development on the site, the property would be annexed by the City of Durango and the city would not allow use of the ground water for drinking water purposes (Rogers 2001).

7.3.5 Public Involvement Plan

In 1992, DOE began preparation of a Programmatic Environmental Impact Statement (PEIS) for the UMTRA Ground Water Project (DOE 1996). The PEIS presents analyses of the potential effects of four alternatives for implementing the entire UMTRA Ground Water Project: no action, the proposed action, active remediation to regulatory levels, and passive remediation. A public meeting was held at the Durango City Hall on June 8, 1995. Comments and responses from the Durango meeting are listed in Volume II of the PEIS. Nine public hearings and a 120-day comment period followed the issuance of the draft PEIS in April 1995. The final document was distributed to the public in October 1996.

Regulations governing implementation of supplemental standards codified at 40 CFR 192.22 (c) state that when remediation is proposed for supplemental standards "..the Department of Energy shall inform any private owners and occupants of the affected location and solicit their comments." DOE will use the UMTRA Ground Water Public Participation Plan (DOE 2000d) to select the appropriate mechanisms to distribute information to affected parties. In addition, DOE will distribute all documents defining and proposing remedial decisions and actions to the owners of affected properties and will actively solicit their input.

7.3.6 Monitoring Compliance Strategy

Limited monitoring of ground water in the bedrock at the raffinate ponds area is proposed for uranium and selenium as a best management practice. The proposed monitoring locations are shown on Figure 7–6. On-site wells 0879 and 0880 have been established as appropriate for monitoring concentrations of selenium and uranium in the upper portions of the bedrock. In addition, wells 0598, 0887, and 0888 will be sampled to continue monitoring the concentrations of selenium and uranium associated with water within the Bodo Fault zone.

Downgradient wells 0882, 0884, 0889, and 0902 will be sampled to monitor off-site migration and upgradient well 0607 will be sampled to provide an indication of the quality of water coming into the site. Background wells 0592 and 0903 will also continue to be sampled to establish a larger database of background ground water concentrations for statistical comparison.

Surface water location 0588, on South Creek upgradient of the site, will also be sampled to assess the quality of water entering the site. In addition, surface water locations 0654, 0656, and 0657, along the Animas River will continue to be monitored to verify that the supplemental standards strategy is protective of the environment.

Monitoring will take place on an annual basis for the first 5 years. After that time, the monitoring strategy will be reevaluated and adjusted as appropriate based on current results. The monitoring requirements are summarized in Table 7–3.

Table 7–3. Summary of Monitoring Requirements at the Raffinate Ponds Area

Sampling Location	Monitoring Purpose	Analytes	Location
0879, 0880	Monitor concentrations in ground water in the shallow bedrock	Selenium Uranium	On site
0598, 0887, 0888	Monitor concentrations in ground water in the deep bedrock and Bodo Fault zone	Selenium Uranium	On site
0882, 0884, 0889, 0902	Monitor off-site downgradient concentrations and migration	Selenium Uranium	Off site - Downgradient
0607	Water quality entering the raffinate ponds area	Selenium Uranium	On site - Upgradient
0592, 0599, 0903	Background ground water quality	Selenium Uranium	Off site - Upgradient
0588	Surface water quality entering the site	Selenium Uranium	Off site - Upgradient
0654, 0656, 0657	Downgradient surface water concentrations	Selenium Uranium	Off site - Downgradient

All other monitor wells at the Durango raffinate ponds area no longer needed for monitoring will be abandoned in the near future in accordance with UMTRA Project procedures and applicable State of Colorado regulations.

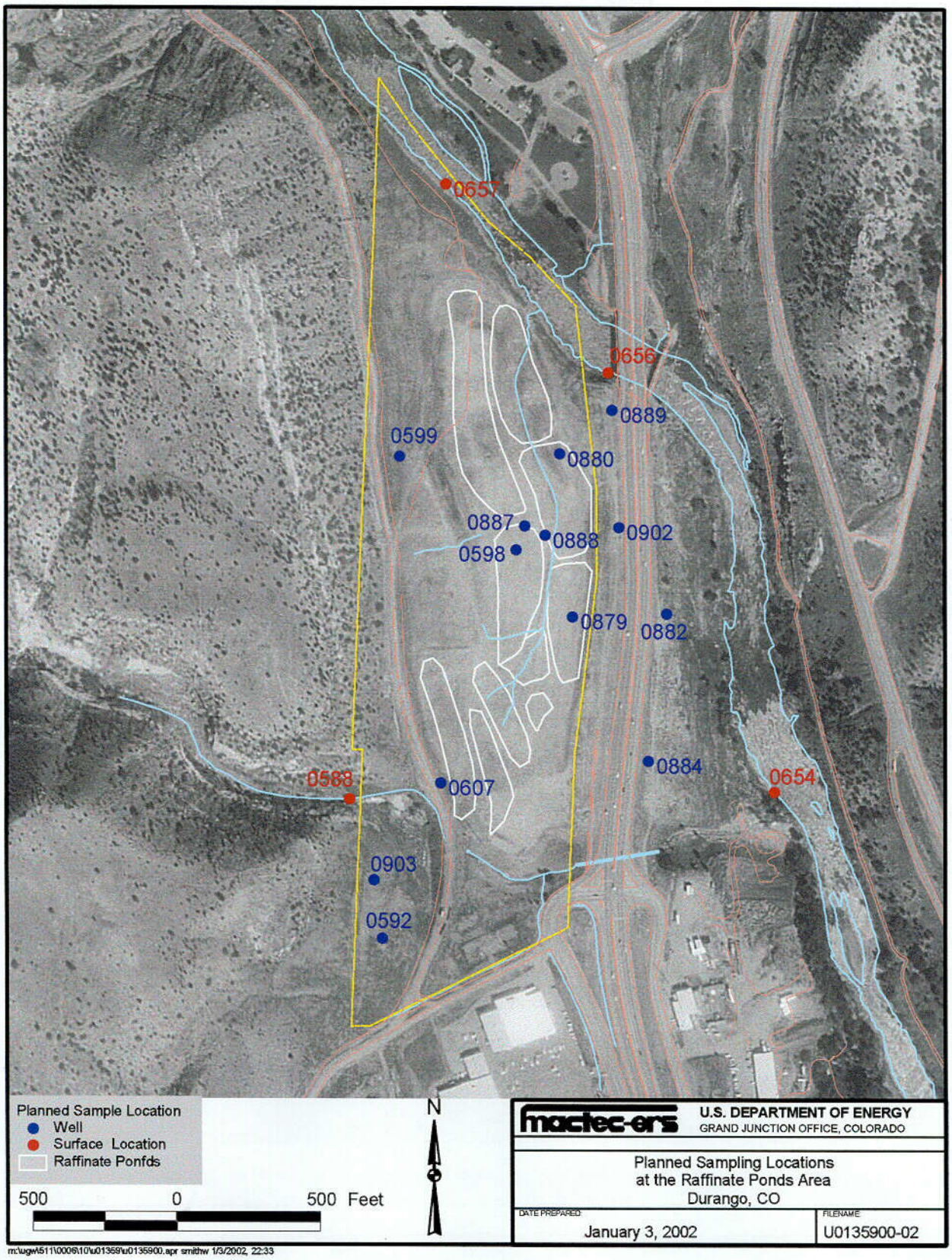

Figure 7–6. Proposed Monitoring Locations for the Raffinate Ponds Area

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8.0 References

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Appendix A

Monitor Well Logs

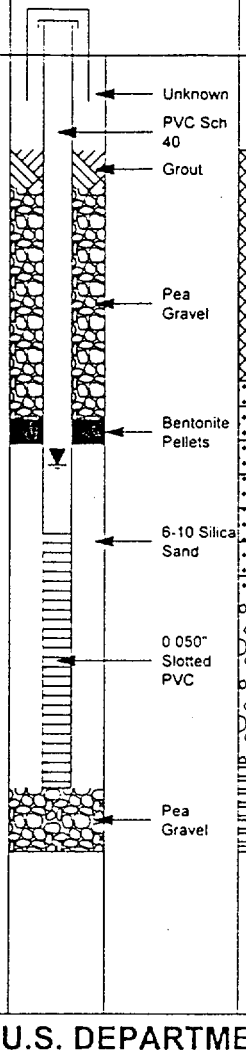
MONITORING WELL COMPLETION LOG DUR01-0612

PROJECT	UMTRA GROUND WATER	NORTH COORD. (FT)	1226429.30	DATE DRILLED	04/18/1983
LOCATION	DURANGO, CO	EAST COORD. (FT)	2306866.69	SURFACE ELEV. (FT NGVD)	6499.21
SITE	DURANGO MILL TAILINGS	HOLE DEPTH (FT)	62.41	TOP OF CASING (FT)	6500.94
WELL NUMBER	0612	WELL DEPTH (FT)	57.41	MEAS. PT. ELEV. (FT)	6500.94
				SLOT SIZE (IN)	0.050
				BIT SIZE(S) (IN)	6.25

WELL INSTALLATION		INTERVAL (FT)		
SURFACE CASING:				
BLANK CASING:	4 in. PVC Sch 40	-1.73	to	37.41
WELL SCREEN:	4 in. Slotted PVC	37.41	to	57.41
SUMP/END CAP:				
SURFACE SEAL:	Grout	7.41	to	10.41
GROUT:	Pea Gravel	10.41	to	28.41
SEAL:	Bentonite Pellets	28.41	to	30.41
UPPER PACK:				
LOWER PACK:	6-10 Silica Sand	30.41	to	57.41

DRILLING METHOD
SAMPLING METHOD
DATE DEVELOPED
WATER LEVEL (FT BGS) 32.0 on 04/18/1983
LOGGED BY
REMARKS Well was modified sometime after 11/14/89. calculated depths based on new survey

DEPTH (FT BGL)	ELEV. (FT NGVD)	BLOW COUNTS	SAMPLE ID.	EXTENT	WELL DIAGRAM	GRAPHIC LOG	LITHOLOGIC DESCRIPTION
							0.00-7.41 ft. UNKNOWN. Well was modified ~1/1/90.
10	6490						7.41-25.41 ft. SMELTER SLAG
20	6480						
30	6470						25.41-42.41 ft. ALLUVIUM (SM), undifferentiated.
40	6460						
50	6450						42.41-55.41 ft. ALLUVIUM, GRAVEL (GP)
60	6440						55.41-62.41 ft. MANCOS SHALE
70	6430						Total Depth 62.41 ft.



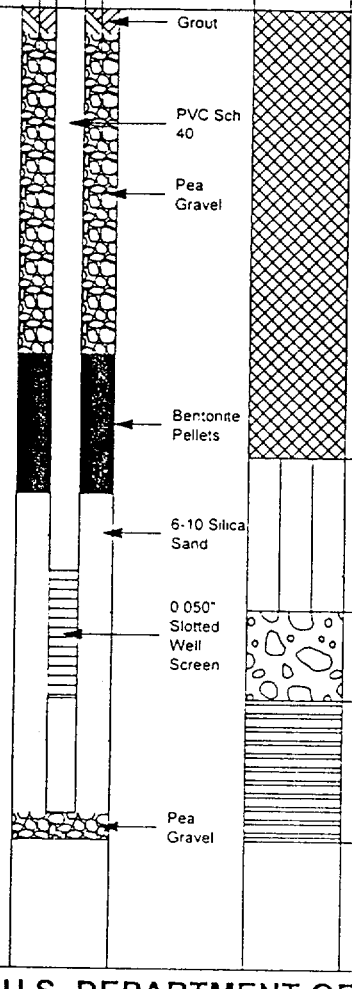
MONITORING WELL COMPLETION LOG DUR01-0614

PROJECT	UMTRA GROUND WATER	NORTH COORD. (FT)	1226612.34	DATE DRILLED	04/18/1983
LOCATION	DURANGO, CO	EAST COORD. (FT)	2306764.21	SURFACE ELEV. (FT NGVD)	6507.90
SITE	DURANGO MILL TAILINGS	HOLE DEPTH (FT)	65.00	TOP OF CASING (FT)	6508.80
WELL NUMBER	0614	WELL DEPTH (FT)	62.90	MEAS. PT. ELEV. (FT)	6508.80
				SLOT SIZE (IN)	0.050
				BIT SIZE(S) (IN)	6.25

	WELL INSTALLATION	INTERVAL (FT)		
SURFACE CASING:				
BLANK CASING:	4 in. PVC Sch 40	-0.9	to	44.0
WELL SCREEN:	4 in. Slotted PVC	44.0	to	54.0
SUMP/END CAP:	4 in. PVC Sch 40	54.0	to	62.9
SURFACE SEAL:	Grout	0.0	to	2.0
GROUT:	Pea Gravel	2.0	to	27.0
SEAL:	Bentonite Pellets	27.0	to	38.0
UPPER PACK:				
LOWER PACK:	6-10 Silica Sand	38.0	to	62.9

DRILLING METHOD
SAMPLING METHOD
DATE DEVELOPED
WATER LEVEL (FT BGS)
LOGGED BY
REMARKS

DEPTH (FT BGL)	ELEV. (FT NGVD)	BLOW COUNTS	SAMPLE ID.	EXTENT	WELL DIAGRAM	GRAPHIC LOG	LITHOLOGIC DESCRIPTION
10, 20, 30, 40, 50, 60, 70	6500, 6490, 6480, 6470, 6460, 6450, 6440						



0-35 ft. FILL MATERIAL

35-47 ft. ALLUVIUM (SM)

47-54 ft. GRAVEL (GP)

54-65 ft. MANCOS SHALE

Total Depth 65 ft

MONITORING WELL COMPLETION LOG DUR01-0615

PROJECT	UMTRA GROUND WATER	NORTH COORD. (FT)	1226862.73	DATE DRILLED	04/18/1983
LOCATION	DURANGO, CO	EAST COORD. (FT)	2306786.91	SURFACE ELEV. (FT NGVD)	6495.20
SITE	DURANGO MILL TAILINGS	HOLE DEPTH (FT)	50.00	TOP OF CASING (FT)	6495.60
WELL NUMBER	0615	WELL DEPTH (FT)	48.00	MEAS. PT. ELEV. (FT)	6495.60
				SLOT SIZE (IN)	0.050
				BIT SIZE(S) (IN)	6.25

WELL INSTALLATION		INTERVAL (FT)		
SURFACE CASING:				
BLANK CASING:	4 in. PVC Sch 40	-0.4	to	33.0
WELL SCREEN:	4 in. Slotted PVC	33.0	to	48.0
SUMP/END CAP:				
SURFACE SEAL:				
GROUT:		0.0	to	29.0
SEAL:		29.0	to	31.0
UPPER PACK:				
LOWER PACK:		31.0	to	48.0

DRILLING METHOD
SAMPLING METHOD
DATE DEVELOPED
WATER LEVEL (FT BGS)
LOGGED BY
REMARKS Well construction data is incomplete

DEPTH (FT BGL)	ELEV. (FT NGVD)	BLOW COUNTS	SAMPLE ID	EXTENT	WELL DIAGRAM	GRAPHIC LOG	LITHOLOGIC DESCRIPTION
							0-25 ft. SMELTER SLAG
10	6490						
	6480				Not Available		
20							
	6470						25-37 ft. FILL MATERIAL
30					Not Available		
	6460				Not Available		
40					Slotted PVC		37-42 ft. GRAVEL (GP)
	6450						42-50 ft. MANCOS SHALE
50							Total Depth 50 ft
	6440						
60							
	6430						
70							

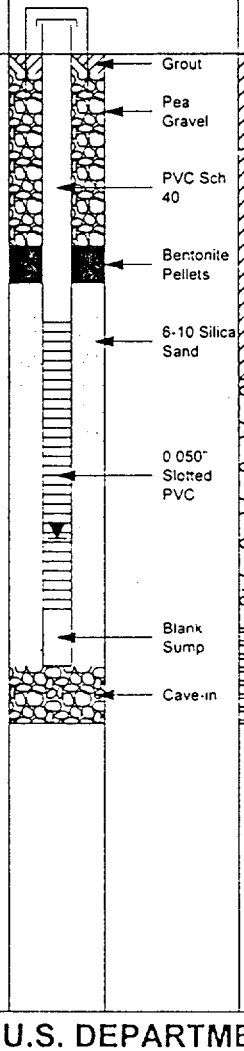
MONITORING WELL COMPLETION LOG DUR01-0617

PROJECT	UMTRA GROUND WATER	NORTH COORD. (FT)	1227262.02	DATE DRILLED	04/18/1983
LOCATION	DURANGO, CO	EAST COORD. (FT)	2306023.82	SURFACE ELEV. (FT NGVD)	6496.20
SITE	DURANGO MILL TAILINGS	HOLE DEPTH (FT)	35.00	TOP OF CASING (FT)	6497 40
WELL NUMBER	0617	WELL DEPTH (FT)	32.00	MEAS. PT. ELEV. (FT)	6497 40
				SLOT SIZE (IN)	0.050
				BIT SIZE(S) (IN)	6 75

	WELL INSTALLATION	INTERVAL (FT)		
SURFACE CASING:				
BLANK CASING:	4 in. PVC Sch 40	-1.2	to	14.0
WELL SCREEN:	4 in. Slotted PVC	14.0	to	29.0
SUMP/END CAP:	4 in. PVC Sch 40	29.0	to	32.0
SURFACE SEAL:	Grout	0.0	to	1.0
GROUT:	Pea Gravel	1.0	to	10.0
SEAL:	Bentonite Pellets	10.0	to	12.0
UPPER PACK:				
LOWER PACK:	6-10 Silica Sand	12.0	to	32.0

DRILLING METHOD
SAMPLING METHOD
DATE DEVELOPED
WATER LEVEL (FT BGS) 25 3 on 04/18/1983
LOGGED BY
REMARKS

DEPTH (FT BGL)	ELEV (FT NGVD)	BLOW COUNTS	SAMPLE ID.	EXTENT	WELL DIAGRAM	GRAPHIC LOG	LITHOLOGIC DESCRIPTION
							0-5 ft. ROAD FILL (SC)
	6490						5-17 ft. SMELTER SLAG (SC)
10							
	6480						
							17-28 ft. ALLUVIUM & COLLUVIUM (GM). Sand and gravel.
20							
	6470						28-30 ft. ALLUVIUM. GRAVEL (GP)
30							30-35 ft. MANCOS SHALE
	6460						Total Depth 35 ft
40							
	6450						



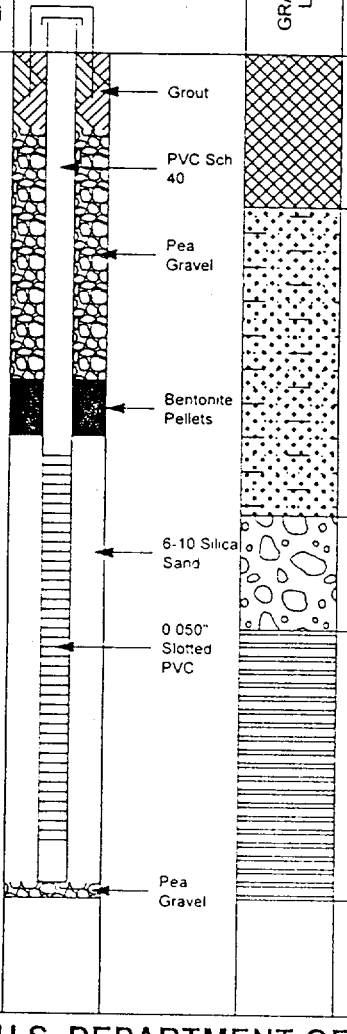
MONITORING WELL COMPLETION LOG DUR01-0618

PROJECT	UMTRA GROUND WATER	NORTH COORD. (FT)	1227423.54	DATE DRILLED	04/18/1983
LOCATION	DURANGO, CO	EAST COORD. (FT)	2305752.61	SURFACE ELEV. (FT NGVD)	6489.80
SITE	DURANGO MILL TAILINGS	HOLE DEPTH (FT)	22.00	TOP OF CASING (FT)	6490.90
WELL NUMBER	0618	WELL DEPTH (FT)	21.60	MEAS. PT. ELEV. (FT)	6490.90
				SLOT SIZE (IN)	0.050
				BIT SIZE(S) (IN)	6.75

	WELL INSTALLATION	INTERVAL (FT)		
SURFACE CASING:				
BLANK CASING:	4 in. PVC Sch 40	-1.1	to	10.5
WELL SCREEN:	4 in. Slotted PVC	10.5	to	20.5
SUMP/END CAP:	4 in. PVC Sch 40	20.5	to	21.6
SURFACE SEAL:	Grout	0.0	to	2.0
GROUT:	Pea Gravel	2.0	to	8.5
SEAL:	Bentonite Pellets	8.5	to	10.0
UPPER PACK:				
LOWER PACK:	6-10 Silica Sand	10.0	to	21.6

DRILLING METHOD
SAMPLING METHOD
DATE DEVELOPED
WATER LEVEL (FT BGS)
LOGGED BY
REMARKS

DEPTH (FT BGL)	ELEV. (FT NGVD)	BLOW COUNTS	SAMPLE ID.	EXTENT	WELL DIAGRAM	GRAPHIC LOG	LITHOLOGIC DESCRIPTION
							0-4 ft. MILL TAILINGS AND SOIL
5	6485						4-12 ft. SOIL AND ALLUVIUM (SM)
10	6480						
							12-15 ft. GRAVEL (GP)
15	6475						15-22 ft. MANCOS SHALE
20	6470						
	6465						Total Depth 22 ft.



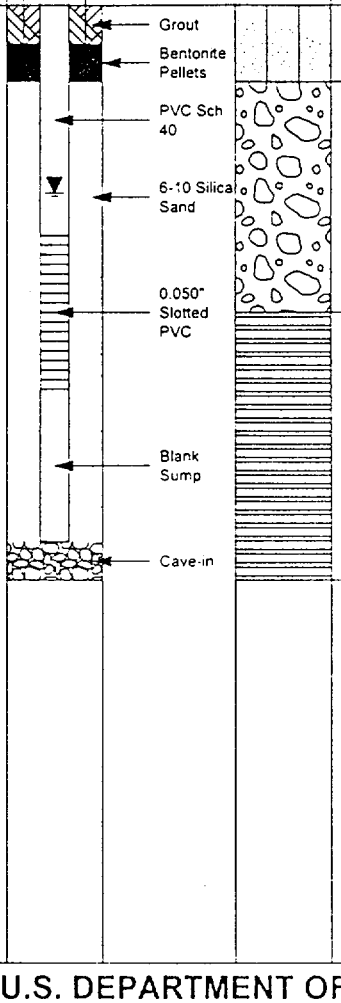
MONITORING WELL COMPLETION LOG DUR01-0619

PROJECT	UMTRA GROUND WATER	NORTH COORD. (FT)	1227637.53	DATE DRILLED	04/18/1983
LOCATION	DURANGO, CO	EAST COORD. (FT)	2305782.45	SURFACE ELEV. (FT NGVD)	6474.50
SITE	DURANGO MILL TAILINGS	HOLE DEPTH (FT)	15.00	TOP OF CASING (FT)	6474.90
WELL NUMBER	0619	WELL DEPTH (FT)	14.00	MEAS. PT. ELEV. (FT)	6474.90
				SLOT SIZE (IN)	0.050
				BIT SIZE(S) (IN)	6.25

	WELL INSTALLATION	INTERVAL (FT)		
SURFACE CASING:				
BLANK CASING:	4 in. PVC Sch 40	-0.4	to	6.0
WELL SCREEN:	4 in. Slotted PVC	6.0	to	10.0
SUMP/END CAP:	4 in. PVC Sch 40	10.0	to	14.0
SURFACE SEAL:	Grout	0.0	to	1.0
GROUT:				
SEAL:	Bentonite Pellets	1.0	to	2.0
UPPER PACK:				
LOWER PACK:	6-10 Silica Sand	2.0	to	14.0

DRILLING METHOD
SAMPLING METHOD
DATE DEVELOPED
WATER LEVEL (FT BGS) 4.9 on 04/18/1983
LOGGED BY
REMARKS

DEPTH (FT BGL)	ELEV. (FT NGVD)	BLOW COUNTS	SAMPLE ID.	EXTENT	WELL DIAGRAM	GRAPHIC LOG	LITHOLOGIC DESCRIPTION
							0-2 ft. SANDY SOIL (SM)
							2-8 ft. GRAVEL (GP)
5	6470						
							8-15 ft. MANCOS SHALE
10	6465						
15	6460						Total Depth 15 ft
20	6455						
	6450						



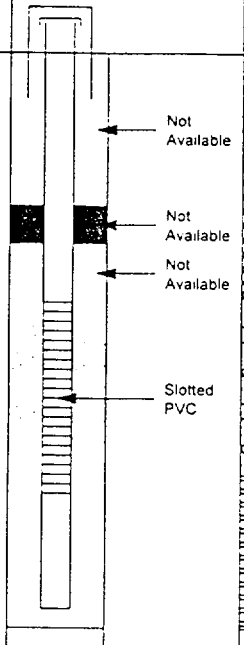
MONITORING WELL COMPLETION LOG DUR01-0620

PROJECT	UMTRA GROUND WATER	NORTH COORD. (FT)	1227827.65	DATE DRILLED	04/18/1983
LOCATION	DURANGO, CO	EAST COORD. (FT)	2305198.95	SURFACE ELEV. (FT NGVD)	6489.00
SITE	DURANGO MILL TAILINGS	HOLE DEPTH (FT)	15.00	TOP OF CASING (FT)	6490.50
WELL NUMBER	0620	WELL DEPTH (FT)	14.50	MEAS. PT. ELEV. (FT)	6490.50
				SLOT SIZE (IN)	0.050
				BIT SIZE(S) (IN)	7.88

	WELL INSTALLATION	INTERVAL (FT)		
SURFACE CASING:				
BLANK CASING:	4 in. PVC Sch 40	-1.5	to	6.5
WELL SCREEN:	4 in. Slotted PVC	6.5	to	11.5
SUMP/END CAP:	4 in. PVC Sch 40	11.5	to	14.5
SURFACE SEAL:				
GROUT:		0.0	to	4.0
SEAL:		4.0	to	5.0
UPPER PACK:				
LOWER PACK:		5.0	to	14.5

DRILLING METHOD
SAMPLING METHOD
DATE DEVELOPED
WATER LEVEL (FT BGS)
LOGGED BY
REMARKS Well construction data is incomplete

DEPTH (FT BGL)	ELEV. (FT NGVD)	BLOW COUNTS	SAMPLE ID.	EXTENT	WELL DIAGRAM	GRAPHIC LOG	LITHOLOGIC DESCRIPTION
							0-6 ft. SOIL AND FILL MATERIAL
5	6485				Not Available; Not Available; Not Available		
							6-11 ft. GRAVEL (GP)
10	6480				Slotted PVC		
							11-15 ft. MANCOS SHALE
15	6475						
							Total Depth 15ft
20	6470						
	6465						

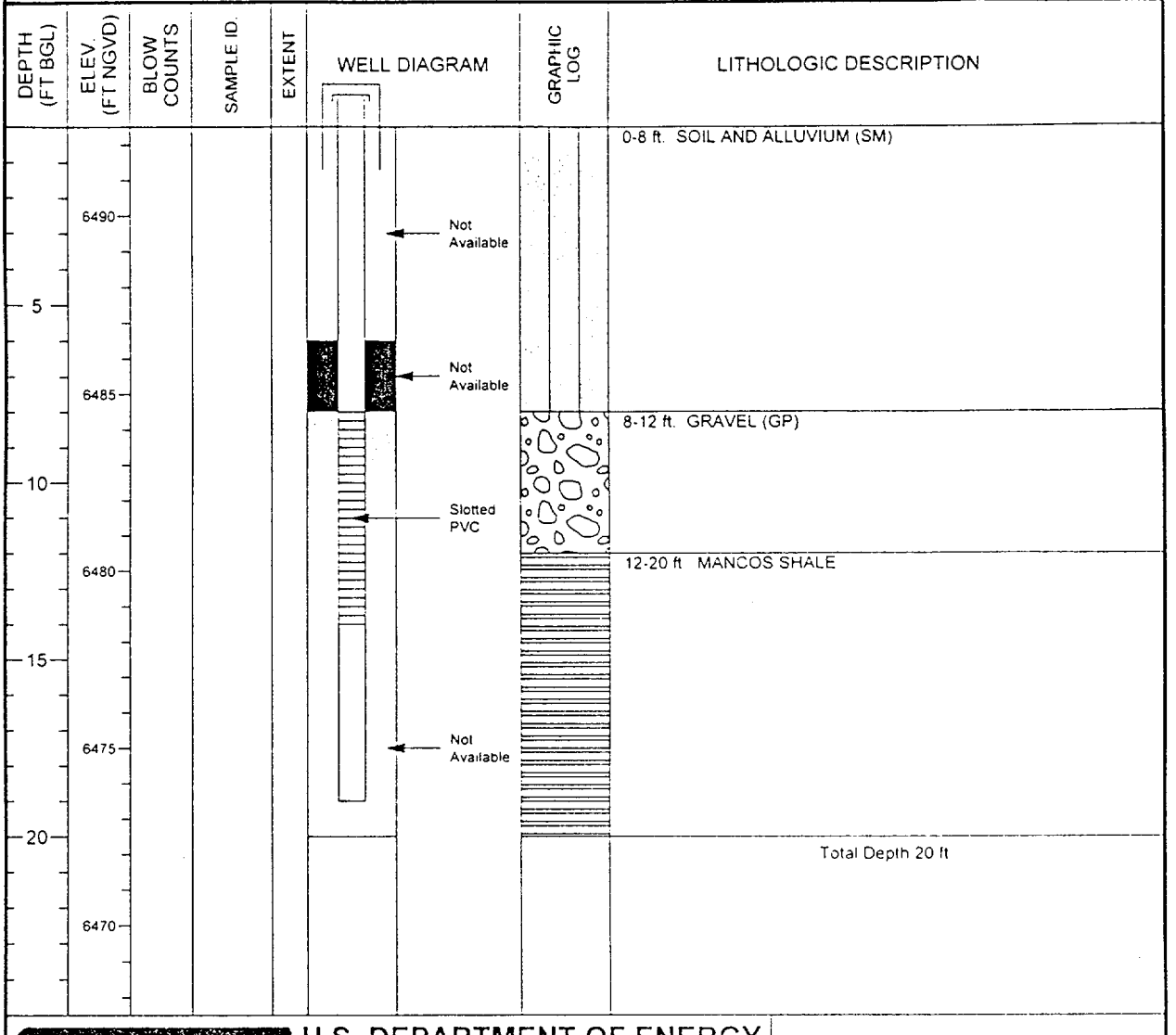


MONITORING WELL COMPLETION LOG DUR01-0621

PROJECT	UMTRA GROUND WATER	NORTH COORD. (FT)	1227831 08	DATE DRILLED	04/18/1983
LOCATION	DURANGO, CO	EAST COORD. (FT)	2305034 49	SURFACE ELEV. (FT NGVD)	6492.50
SITE	DURANGO MILL TAILINGS	HOLE DEPTH (FT)	20.00	TOP OF CASING (FT)	6493 60
WELL NUMBER	0621	WELL DEPTH (FT)	19 00	MEAS. PT. ELEV. (FT)	6493 60
				SLOT SIZE (IN)	0 050
				BIT SIZE(S) (IN)	7 88

	WELL INSTALLATION	INTERVAL (FT)		
SURFACE CASING:				
BLANK CASING:	4 in. PVC Sch 40	-1.1	to	8.0
WELL SCREEN:	4 in. Slotted PVC	8.0	to	14 0
SUMP/END CAP:	4 in. PVC Sch 40	14.0	to	19.0
SURFACE SEAL:				
GROUT:		0.0	to	6 0
SEAL:		6.0	to	10.0
UPPER PACK:				
LOWER PACK:		10.0	to	20.0

DRILLING METHOD
SAMPLING METHOD
DATE DEVELOPED
WATER LEVEL (FT BGS)
LOGGED BY
REMARKS Well construction data is incomplete



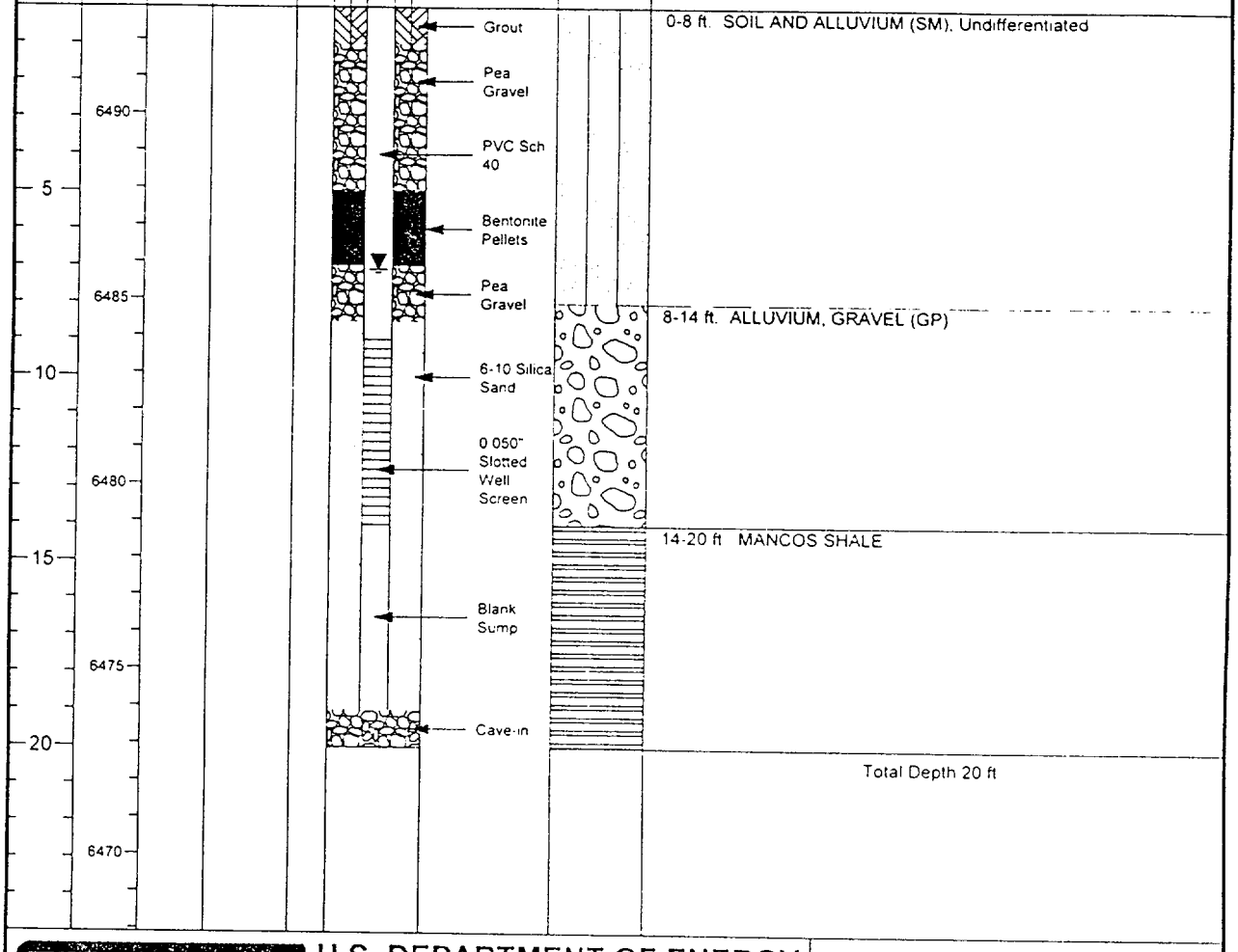
MONITORING WELL COMPLETION LOG DUR01-0622

PROJECT	UMTRA GROUND WATER	NORTH COORD. (FT)	1227884.27	DATE DRILLED	04/18/1983
LOCATION	DURANGO, CO	EAST COORD. (FT)	2304949.79	SURFACE ELEV. (FT NGVD)	6492.90
SITE	DURANGO MILL TAILINGS	HOLE DEPTH (FT)	20.00	TOP OF CASING (FT)	6493.90
WELL NUMBER	0622	WELL DEPTH (FT)	19.00	MEAS. PT. ELEV. (FT)	6493.90
				SLOT SIZE (IN)	0.050
				BIT SIZE(S) (IN)	7.88

	WELL INSTALLATION	INTERVAL (FT)		
SURFACE CASING:				
BLANK CASING:	4 in. PVC Sch 40	-1.0	to	9.0
WELL SCREEN:	4 in. Slotted PVC	9.0	to	14.0
SUMP/END CAP:	4 in. PVC Sch 40	14.0	to	20.0
SURFACE SEAL:	Grout	0.0	to	1.0
GROUT:	Pea Gravel	1.0	to	5.0
SEAL:	Bentonite Pellets	5.0	to	7.0
UPPER PACK:	Pea Gravel	7.0	to	8.5
LOWER PACK:	6-10 Silica Sand	8.5	to	19.0

DRILLING METHOD
SAMPLING METHOD
DATE DEVELOPED
WATER LEVEL (FT BGS) 7.1 on 04/18/1983
LOGGED BY
REMARKS

DEPTH (FT BGL)	ELEV. (FT NGVD)	BLOW COUNTS	SAMPLE ID.	EXTENT	WELL DIAGRAM	GRAPHIC LOG	LITHOLOGIC DESCRIPTION



mactec-ers U.S. DEPARTMENT OF ENERGY
GRAND JUNCTION OFFICE, COLORADO

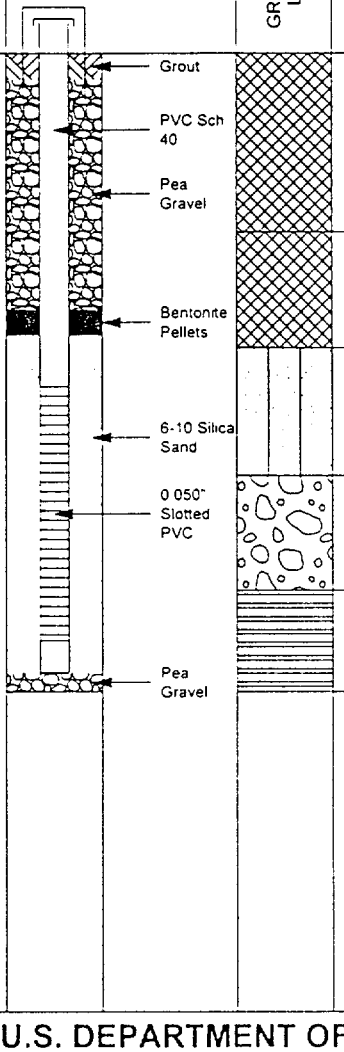
MONITORING WELL COMPLETION LOG DUR01-0626

PROJECT	UMTRA GROUND WATER	NORTH COORD. (FT)	1226832.27	DATE DRILLED	04/18/1983
LOCATION	DURANGO, CO	EAST COORD. (FT)	2306674.77	SURFACE ELEV. (FT NGVD)	6498.60
SITE	DURANGO MILL TAILINGS	HOLE DEPTH (FT)	50.00	TOP OF CASING (FT)	6499.10
WELL NUMBER	0626	WELL DEPTH (FT)	48.50	MEAS. PT. ELEV. (FT)	6499.10
				SLOT SIZE (IN)	0.050
				BIT SIZE(S) (IN)	7.88

	WELL INSTALLATION	INTERVAL (FT)		
SURFACE CASING:				
BLANK CASING:	4 in. PVC Sch 40	-0.5	to	26.0
WELL SCREEN:	4 in. Slotted PVC	26.0	to	46.0
SUMP/END CAP:	4 in. PVC Sch 40	46.0	to	48.5
SURFACE SEAL:	Grout	0.0	to	2.0
GROUT:	Pea Gravel	2.0	to	20.0
SEAL:	Bentonite Pellets	20.0	to	22.0
UPPER PACK:				
LOWER PACK:	6-10 Silica Sand	22.0	to	48.5

DRILLING METHOD
SAMPLING METHOD
DATE DEVELOPED
WATER LEVEL (FT BGS)
LOGGED BY
REMARKS

DEPTH (FT BGL)	ELEV (FT NGVD)	BLOW COUNTS	SAMPLE ID	EXTENT	WELL DIAGRAM	GRAPHIC LOG	LITHOLOGIC DESCRIPTION
							0-14 ft. FILL MATERIAL
10	6490						
							14-23 ft. SMELTER SLAG
20	6480						
							23-33 ft. ALUVIUM (SM)
30	6470						
							33-42 ft. GRAVEL (GP)
40	6460						
							42-50 ft. MANCOS SHALE
50	6450						
							Total Depth 50 ft
60	6440						
70	6430						



MONITORING WELL COMPLETION LOG DUR01-0627

PROJECT	UMTRA GROUND WATER	NORTH COORD. (FT)	1226679.51	DATE DRILLED	04/18/1983
LOCATION	DURANGO, CO	EAST COORD. (FT)	2306903.13	SURFACE ELEV. (FT NGVD)	6495.90
SITE	DURANGO MILL TAILINGS	HOLE DEPTH (FT)	51.00	TOP OF CASING (FT)	6496.90
WELL NUMBER	0627	WELL DEPTH (FT)	46.00	MEAS. PT. ELEV. (FT)	6496.90
				SLOT SIZE (IN)	0.050
				BIT SIZE(S) (IN)	6.75

	WELL INSTALLATION	INTERVAL (FT)		
SURFACE CASING:				
BLANK CASING:	4 in. PVC Sch 40	-1.0	to	33.0
WELL SCREEN:	4 in. Slotted PVC	33.0	to	43.0
SUMP/END CAP:	4 in. PVC Sch 40	43.0	to	46.0
SURFACE SEAL:				
GROUT:		0.0	to	28.0
SEAL:		28.0	to	29.0
UPPER PACK:				
LOWER PACK:		29.0	to	46.0

DRILLING METHOD
SAMPLING METHOD
DATE DEVELOPED
WATER LEVEL (FT BGS)
LOGGED BY
REMARKS Well construction data is incomplete

DEPTH (FT BGL)	ELEV. (FT NGVD)	BLOW COUNTS	SAMPLE ID.	EXTENT	WELL DIAGRAM	GRAPHIC LOG	LITHOLOGIC DESCRIPTION
							0-5 ft. ROAD FILL AND SMELTER SLAG
	6490						5-35 ft. SMELTER SLAG
10							
	6480				Not Available		
20							
	6470						
30					Not Available		
	6460						35-39 ft. ALLUVIUM (SM)
					Slotted PVC		
40							39-46 ft. GRAVEL (GP)
	6450						46-51 ft. MANCOS SHALE
50							
							Total Depth 51 ft
	6440						
60							
	6430						
70							

MONITORING WELL COMPLETION LOG DUR01-0629

PROJECT	UMTRA GROUND WATER	NORTH COORD. (FT)	1228142.57	DATE DRILLED	10/12/1993
LOCATION	DURANGO, CO	EAST COORD. (FT)	2304611.69	SURFACE ELEV. (FT NGVD)	6506.00
SITE	DURANGO MILL TAILINGS	HOLE DEPTH (FT)	21.00	TOP OF CASING (FT)	6507.97
WELL NUMBER	0629	WELL DEPTH (FT)	21.00	MEAS. PT. ELEV. (FT)	6507.97
				SLOT SIZE (IN)	0.020
				BIT SIZE(S) (IN)	6.5

	WELL INSTALLATION	INTERVAL (FT)		
SURFACE CASING:				
BLANK CASING:	2 in. PVC Sch 40	-1.97	to	9.0
WELL SCREEN:	2 in. Slotted PVC	9.0	to	19.0
SUMP/END CAP:	2 in. PVC Sch 40	19.0	to	21.0
SURFACE SEAL:				
GROUT:		0.0	to	2.5
SEAL:	Bentonite Chips	2.5	to	7.0
UPPER PACK:				
LOWER PACK:		7.0	to	21.0

DRILLING METHOD: HOLLOW STEM AUGER
SAMPLING METHOD: SPLIT SPOON
DATE DEVELOPED:
WATER LEVEL (FT BGS): 13.5 on 10/12/1993
LOGGED BY: W. Wood
REMARKS:

DEPTH (FT BGL)	ELEV. (FT NGVD)	BLOW COUNTS	SAMPLE ID	EXTENT	WELL DIAGRAM	GRAPHIC LOG	LITHOLOGIC DESCRIPTION
	6505				Cement - Bentonite		0-2 ft. ALLUVIUM, SILTY CLAY (CL), Trace fine gravel, medium plasticity, reddish brown.
					Bentonite Chips		2-6 ft. ALLUVIUM, GRAVELLY CLAY (CL), considerable gravel, medium plasticity, light brown.
					PVC Sch 40		
5							
	6500				Bentonite Pellets		6-14 ft. ALLUVIUM, SILTY CLAY (CL), trace fine gravel, brown.
10					16-30 Silica Sand		
	6495				0.020" Slotted PVC		
15							14-21 ft. MANCOS SHALE, moderately hard to soft, black
	6490						
20					Blank Sump		
	6485						Total Depth 21 ft

MONITORING WELL COMPLETION LOG DUR01-0630

PROJECT	UMTRA GROUND WATER	NORTH COORD. (FT)	1226916.09	DATE DRILLED	10/08/1993
LOCATION	DURANGO, CO	EAST COORD. (FT)	2306592.09	SURFACE ELEV. (FT NGVD)	6493.10
SITE	DURANGO MILL TAILINGS	HOLE DEPTH (FT)	40.00	TOP OF CASING (FT)	6494.70
WELL NUMBER	0630	WELL DEPTH (FT)	38.30	MEAS. PT. ELEV. (FT)	6494.70
				SLOT SIZE (IN)	0.020
				BIT SIZE(S) (IN)	6.5

	WELL INSTALLATION	INTERVAL (FT)		
SURFACE CASING:				
BLANK CASING:	2 in. PVC Sch 40	-1.6	to	28.3
WELL SCREEN:	2 in. Slotted PVC	28.3	to	38.3
SUMP/END CAP:				
SURFACE SEAL:	Grout	0.0	to	4.0
GROUT:	Bentonite Chips	4.0	to	23.5
SEAL:	Bentonite Pellets	23.5	to	25.5
UPPER PACK:				
LOWER PACK:	16-30 Silica Sand	25.5	to	38.3

DRILLING METHOD HOLLOW STEM AUGER
SAMPLING METHOD SPLIT SPOON
DATE DEVELOPED
WATER LEVEL (FT BGS) 31.8 on 10/08/1993
LOGGED BY W. Wood
REMARKS

DEPTH (FT BGL)	ELEV. (FT NGVD)	BLOW COUNTS	SAMPLE ID.	EXTENT	WELL DIAGRAM	GRAPHIC LOG	LITHOLOGIC DESCRIPTION
	6490				Cement - Bentonite		0-2 ft. FILL, SANDY SILT (ML), some clay, trace fine gravel, low plasticity, dark brown. 2-5 ft. FILL, SILTY CLAY (CL), trace fine gravel, with clasts of shale fragments, medium plasticity, brown to dark brown
10					PVC Sch 40		5-11.5 ft. MILL SLAG, black to dark grey, very hard from 9 to 10.5 ft.
	6480				Bentonite Chips		11.5-17.5 ALLUVIUM, SANDY SILT (ML), some clay, low plasticity, black.
20							17.5-28 ft. ALLUVIUM, SANDY CLAY (CL), with clasts of shale and sandstone fragments, medium plasticity, light yellow brown
	6470				Bentonite Pellets		Very moist at 25.5 to 26.5 ft
					16-30 Silica Sand		28-34 ft ALLUVIUM, CLAYEY SAND (CL), fine grained with clasts of shale and sandstone fragments, low plasticity, light yellow brown
30	6460				0.020" Slotted PVC		34-40 ft MANCOS SHALE, soft to moderately hard, grey to dark brown
40	6450						Total Depth 40 ft

MONITORING WELL COMPLETION LOG DUR01-0631

PROJECT	UMTRA GROUND WATER	NORTH COORD. (FT)	1227530.56	DATE DRILLED	10/09/1993
LOCATION	DURANGO, CO	EAST COORD. (FT)	2305863.70	SURFACE ELEV. (FT NGVD)	6476.00
SITE	DURANGO MILL TAILINGS	HOLE DEPTH (FT)	16.00	TOP OF CASING (FT)	6478.05
WELL NUMBER	0631	WELL DEPTH (FT)	16.00	MEAS. PT. ELEV. (FT)	6478.05
				SLOT SIZE (IN)	0.020
				BIT SIZE(S) (IN)	6.5

	WELL INSTALLATION	INTERVAL (FT)		
SURFACE CASING:				
BLANK CASING:	2 in. PVC Sch 40	-2.05	to	3.0
WELL SCREEN:	2 in. Slotted PVC	6.0	to	16.0
SUMP/END CAP:				
SURFACE SEAL:				
GROUT:	Cement - Bentonite	0.0	to	2.0
SEAL:	Bentonite Pellets	2.0	to	4.0
UPPER PACK:				
LOWER PACK:	16-30 Silica Sand	4.0	to	16.0

DRILLING METHOD: HOLLOW STEM AUGER
SAMPLING METHOD: SPLIT SPOON
DATE DEVELOPED:
WATER LEVEL (FT BGS): 8.5 on 10/09/1993
LOGGED BY: W. Wood
REMARKS:

DEPTH (FT BGL)	ELEV. (FT NGVD)	BLOW COUNTS	SAMPLE ID	EXTENT	WELL DIAGRAM	GRAPHIC LOG	LITHOLOGIC DESCRIPTION
	6475				Cement - Bentonite; Bentonite Pellets		0-4 ft. ALLUVIUM, SANDY CLAY (CL), some fine gravel, low to medium plasticity, brown.
5							4-5.5 ft. ALLUVIUM, SILTY CLAY (CL), medium plasticity, brown.
	6470				16-30 Silica Sand		5.5-10.5 ft. ALLUVIUM, SILTY SAND AND GRAVEL (GM), poorly graded to 1.0 inch, nonplastic, brown. Note, occasional seams of sandy clay.
10	6465				0.020" Slotted PVC		10.5-16 ft. MANCOS SHALE, soft to moderately hard, black
15	6460						Total Depth 16 ft
20	6455						

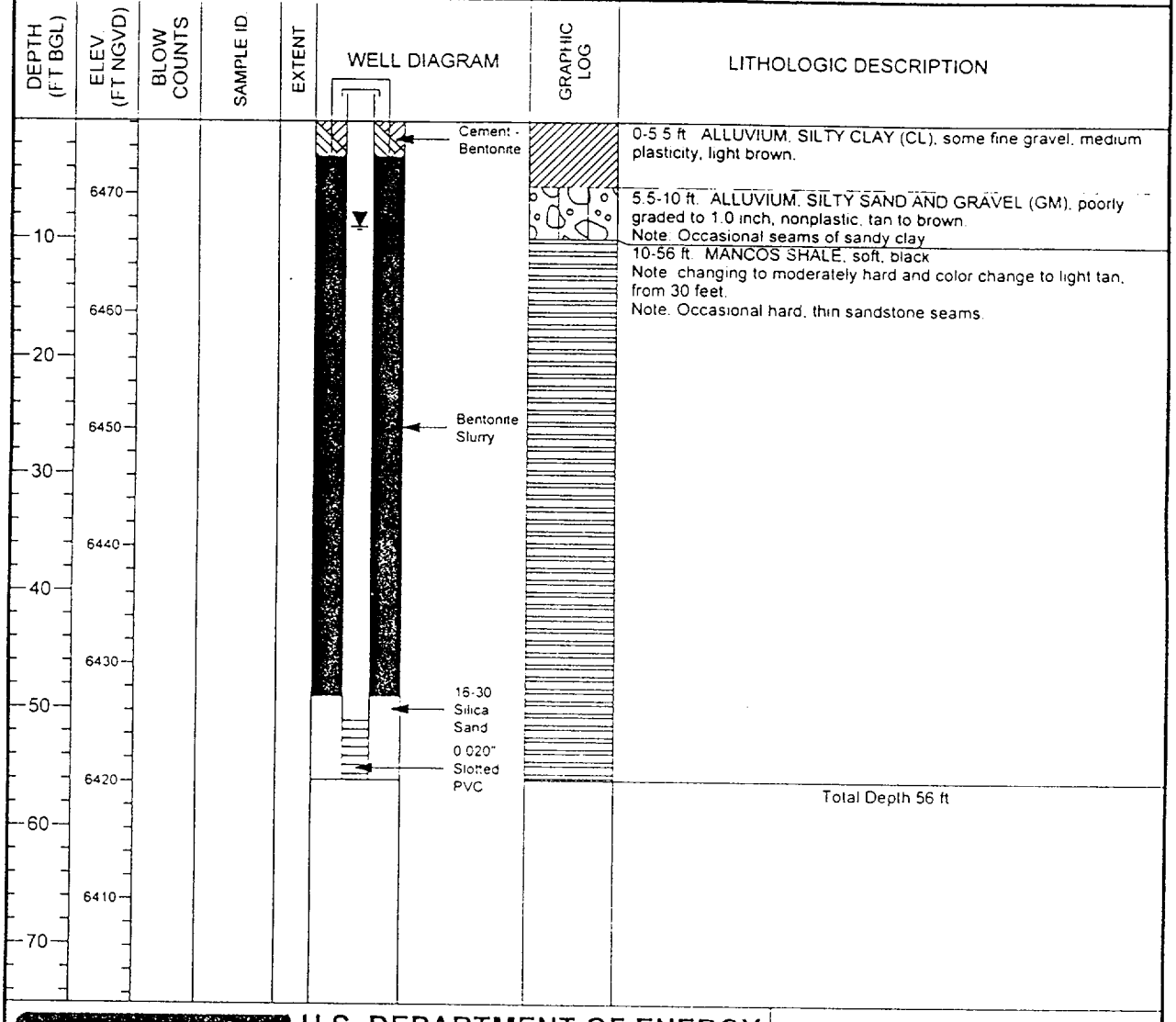
MONITORING WELL COMPLETION LOG DUR01-0632

PROJECT	UMTRA GROUND WATER	NORTH COORD. (FT)	1227523 44	DATE DRILLED	10/12/1993 to 10/15/1993
LOCATION	DURANGO, CO	EAST COORD. (FT)	2305860.81	SURFACE ELEV. (FT NGVD)	6476 20
SITE	DURANGO MILL TAILINGS	HOLE DEPTH (FT)	56.00	TOP OF CASING (FT)	6478 13
WELL NUMBER	0632	WELL DEPTH (FT)	56.00	MEAS. PT. ELEV. (FT)	6478 13
				SLOT SIZE (IN)	0.020
				BIT SIZE(S) (IN)	6 5

	WELL INSTALLATION	INTERVAL (FT)		
SURFACE CASING:				
BLANK CASING:	2 in. PVC Sch 40	-1.93	to	51.0
WELL SCREEN:	2 in. Slotted PVC	51.0	to	56.0
SUMP/END CAP:				
SURFACE SEAL:				
GROUT:	Cement - Bentonite	0.0	to	3.0
SEAL:	Bentonite Slurry	3.0	to	49.0
UPPER PACK:				
LOWER PACK:	16-30 Silica Sand	49.0	to	56 0

DRILLING METHOD HOLLOW STEM AUGER
SAMPLING METHOD SPLIT SPOON
DATE DEVELOPED
WATER LEVEL (FT BGS) 9 0 on 10/09/993
LOGGED BY W Wood
REMARKS

DEPTH (FT BGL)	ELEV. (FT NGVD)	BLOW COUNTS	SAMPLE ID	EXTENT	WELL DIAGRAM	GRAPHIC LOG	LITHOLOGIC DESCRIPTION
							0-5 5 ft ALLUVIUM. SILTY CLAY (CL), some fine gravel, medium plasticity, light brown.
							5.5-10 ft. ALLUVIUM. SILTY SAND AND GRAVEL (GM), poorly graded to 1.0 inch, nonplastic, tan to brown. Note. Occasional seams of sandy clay
							10-56 ft. MANCOS SHALE, soft, black Note changing to moderately hard and color change to light tan, from 30 feet. Note. Occasional hard, thin sandstone seams.
							Total Depth 56 ft



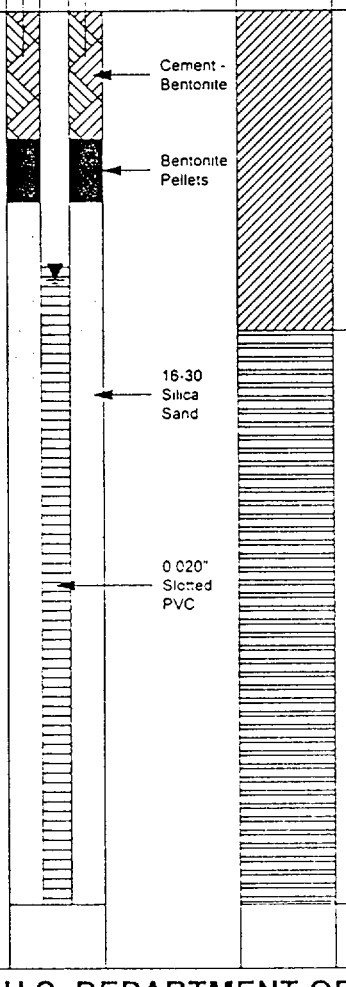
MONITORING WELL COMPLETION LOG DUR01-0633

PROJECT	UMTRA GROUND WATER	NORTH COORD. (FT)	1227438.88	DATE DRILLED	10/13/1993
LOCATION	DURANGO, CO	EAST COORD. (FT)	2305749.60	SURFACE ELEV. (FT NGVD)	6479 00
SITE	DURANGO MILL TAILINGS	HOLE DEPTH (FT)	14 00	TOP OF CASING (FT)	6482 02
WELL NUMBER	0633	WELL DEPTH (FT)	14.00	MEAS. PT. ELEV. (FT)	6482 02
				SLOT SIZE (IN)	0.020
				BIT SIZE(S) (IN)	6 5

	WELL INSTALLATION	INTERVAL (FT)		
SURFACE CASING:				
BLANK CASING:	2 in. PVC Sch 40	-3.02	to	4.0
WELL SCREEN:	2 in. Slotted PVC	4.0	to	14.0
SUMP/END CAP:				
SURFACE SEAL:				
GROUT:	Cement - Bentonite	0.0	to	2 0
SEAL:	Bentonite Pellets	2.0	to	3.0
UPPER PACK:				
LOWER PACK:	16-30 Silica Sand	3.0	to	14.0

DRILLING METHOD	HOLLOW STEM AUGER
SAMPLING METHOD	SPLIT SPOON
DATE DEVELOPED	
WATER LEVEL (FT BGS)	4 2 on 10/13/1993
LOGGED BY	W Wood
REMARKS	

DEPTH (FT BGL)	ELEV. (FT NGVD)	BLOW COUNTS	SAMPLE ID	EXTENT	WELL DIAGRAM	GRAPHIC LOG	LITHOLOGIC DESCRIPTION
							0-5 ft. ALLUVIUM, SANDY CLAY (CL), considerable gravel, low to medium plasticity, brown.
	6475						
5							5-14 ft. MANCOS SHALE, soft, dark grey.
	6470						
10							
	6465						Total Depth 14 ft



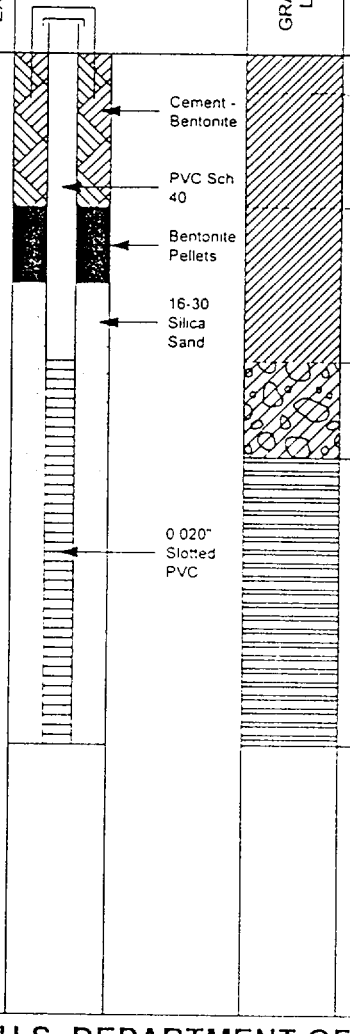
MONITORING WELL COMPLETION LOG DUR01-0634

PROJECT	UMTRA GROUND WATER	NORTH COORD. (FT)	1227718 79	DATE DRILLED	10/10/1993 to 10/15/1993
LOCATION	DURANGO, CO	EAST COORD. (FT)	2305456 62	SURFACE ELEV. (FT NGVD)	6489 90
SITE	DURANGO MILL TAILINGS	HOLE DEPTH (FT)	18.00	TOP OF CASING (FT)	6491 89
WELL NUMBER	0634	WELL DEPTH (FT)	18 00	MEAS. PT. ELEV. (FT)	6491 89
				SLOT SIZE (IN)	0 020
				BIT SIZE(S) (IN)	6.5

	WELL INSTALLATION	INTERVAL (FT)		
SURFACE CASING:				
BLANK CASING:	2 in. PVC Sch 40	-1.99	to	8.0
WELL SCREEN:	2 in. Slotted PVC	8 0	to	18.0
SUMP/END CAP:				
SURFACE SEAL:				
GROUT:	Cement - Bentonite	0.0	to	4 0
SEAL:	Bentonite Pellets	4.0	to	6.0
UPPER PACK:				
LOWER PACK:	16-30 Silica Sand	6.0	to	18 0

DRILLING METHOD HOLLOW STEM AUGER
SAMPLING METHOD SPLIT SPOON
DATE DEVELOPED
WATER LEVEL (FT BGS)
LOGGED BY W Wood
REMARKS Hole was dry at time of well installation

DEPTH (FT BGL)	ELEV. (FT NGVD)	BLOW COUNTS	SAMPLE ID	EXTENT	WELL DIAGRAM	GRAPHIC LOG	LITHOLOGIC DESCRIPTION
							0-1 ft. ALLUVIUM, SANDY CLAY (CL), considerable gravel and cobbles, low to medium plasticity, brown. 1-4 ft. ALLUVIUM, SILTY CLAY (CL), some fine gravel, medium plasticity, dark brown.
5	6485						4-8 ft. ALLUVIUM, SANDY CLAY (CL), considerable gravel, low to medium plasticity, brown. Note. occasional cobbles
10	6480						8-10 5 ft. ALLUVIUM, CLAYEY SAND AND GRAVEL (GC), with cobbles, poorly graded to 5 inch maximum, medium plasticity, brown.
							10 5-18 ft. MANCOS SHALE, soft to moderately hard, dark grey
15	6475						
							Total Depth 18 ft
20	6470						



MONITORING WELL COMPLETION LOG DUR01-0635

PROJECT	UMTRA GROUND WATER	NORTH COORD. (FT)	1227808 13	DATE DRILLED	10/13/1993
LOCATION	DURANGO, CO	EAST COORD. (FT)	2304902.06	SURFACE ELEV. (FT NGVD)	6495 80
SITE	DURANGO MILL TAILINGS	HOLE DEPTH (FT)	15.50	TOP OF CASING (FT)	6497 90
WELL NUMBER	0635	WELL DEPTH (FT)	15.50	MEAS. PT. ELEV. (FT)	6497.90
				SLOT SIZE (IN)	0.020
				BIT SIZE(S) (IN)	6.5

	WELL INSTALLATION	INTERVAL (FT)		
SURFACE CASING:				
BLANK CASING:	2 in. PVC Sch 40	-2.1	to	5 5
WELL SCREEN:	2 in. Slotted PVC	5.5	to	15 5
SUMP/END CAP:				
SURFACE SEAL:				
GROUT:	Cement - Bentonite	0.0	to	2.0
SEAL:	Bentonite Pellets	2.0	to	4.0
UPPER PACK:				
LOWER PACK:	16-30 Silica Sand	4.0	to	15 5

DRILLING METHOD	HOLLOW STEM AUGER
SAMPLING METHOD	SPLIT SPOON
DATE DEVELOPED	
WATER LEVEL (FT BGS)	10 5 on 10/13/1993
LOGGED BY	W Wood
REMARKS	

DEPTH (FT BGL)	ELEV. (FT NGVD)	BLOW COUNTS	SAMPLE ID	EXTENT	WELL DIAGRAM	GRAPHIC LOG	LITHOLOGIC DESCRIPTION
	6495				Cement - Bentonite; PVC Sch 40; Bentonite Pellets		0-5.5 ft ALLUVIUM, SILTY CLAY (CL), little fine gravel, medium plasticity, brown.
5	6490				16-30 Silica Sand		5.5-10.5 ft. ALLUVIUM, SANDY CLAY (CL), some clasts of shale and sandstone fragments, low to medium plasticity, brown Note: becoming moist at 9 ft., with occasional thin seam of silty sand with free water.
10	6485				0.020" Slotted PVC		10 5-12 ft ALLUVIUM, CLAYEY SAND AND GRAVEL (GC), poorly graded to 2 5 inch, low to medium plasticity, brown 12-15 5 ft ALLUVIUM, SILTY SAND AND GRAVEL (GM), poorly graded, with occasional cobbles and boulders, nonplastic, brown
15	6480						Total Depth 15 5 ft
20	6475						

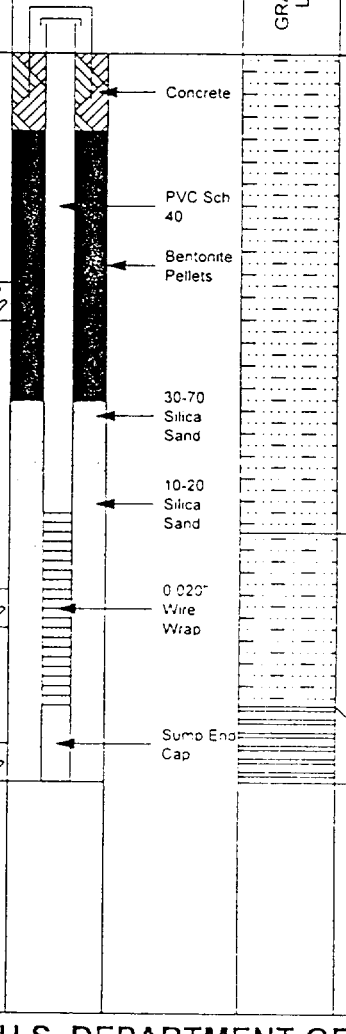
MONITORING WELL COMPLETION LOG DUR01-0857

PROJECT	UMTRA GROUND WATER	NORTH COORD. (FT)	1228116.93	DATE DRILLED	10/18/2000
LOCATION	DURANGO, CO	EAST COORD. (FT)	2305477.03	SURFACE ELEV. (FT NGVD)	6487 47
SITE	DURANGO MILL TAILINGS	HOLE DEPTH (FT)	19.00	TOP OF CASING (FT)	6490.08
WELL NUMBER	0857	WELL DEPTH (FT)	19.00	MEAS. PT. ELEV. (FT)	6490.08
				SLOT SIZE (IN)	0.020
				BIT SIZE(S) (IN)	6.0

	WELL INSTALLATION	INTERVAL (FT)		
SURFACE CASING:				
BLANK CASING:	2 in. PVC Sch 40	-2.61	to	12.0
WELL SCREEN:	2 in. Vee Wire Wrapped	12.0	to	17.0
SUMP/END CAP:	2 in. PVC Sch 40	17.0	to	19.0
SURFACE SEAL:	Concrete	0.0	to	2.0
GROUT:				
SEAL:	Bentonite Pellets	2.0	to	9.08
UPPER PACK:	30-70 Silica Sand	9.08	to	9.83
LOWER PACK:	10-20 Silica Sand	9.83	to	19.0

DRILLING METHOD	ROTASONIC
SAMPLING METHOD	GRAB
DATE DEVELOPED	
WATER LEVEL (FT BGS)	
LOGGED BY	Kautsky, M
REMARKS	

DEPTH (FT BGL)	ELEV. (FT NGVD)	BLOW COUNTS	SAMPLE ID	EXTENT	WELL DIAGRAM	GRAPHIC LOG	LITHOLOGIC DESCRIPTION
							0-12.5 ft. COLLUVIUM (Qc). SANDY SILT (ML), very dark gray (5YR 3/1), with low plasticity, moist, medium dense, contains red brown (5YR 5/3) sand grains to 3 mm diameter, residual soil material.
5	6485						
			6-7 ft.				
	6480						
10							
	6475						12.5-17 ft. ALLUVIUM (Qal). GRAVELLY SILT (ML), very dark gray (2.5YN 3/0), wet, with strong petroleum odor, silt ~ 60%, gravel ~ 40%, gravel up to 4 inch diameter, gravel consists of plutonic and metamorphic rock types (river alluvium). 15-17 ft. mottled very dark gray (5YR 3/1) and olive (5YR 5/3), moist, contains rounded pebbles of yellow sandstone and flat rounded shale pebbles, wet at contact with shale, no petroleum odor.
15			14-15 ft				
	6470						17-19 ft. MANCOS SHALE (Km). grayish black (N/2), hard, dry.
			18-19 ft				
20							Total Depth 19.0 ft.
	6465						



BOREHOLE LOG DUR01-0860

PROJECT	UMTRA GROUND WATER	SURFACE ELEV. (FT NGVD)	6505.23
LOCATION	DURANGO, CO	BIT SIZE(S) (IN)	6.0
SITE	DURANGO MILL TAILINGS	DRILLING METHOD	ROTASONIC
WELL NUMBER	0860	SAMPLING METHOD	GRAB
NORTH COORD. (FT)	1227511.39	WATER LEVEL (FT BGS)	
EAST COORD. (FT)	2305489.35	LOGGED BY	Kautsky, M.
HOLE DEPTH (FT)	37.00	REMARKS	
DATE DRILLED	09/22/2000		

DEPTH (FT BGL)	ELEV. (FT NGVD)	BLOW COUNTS	SAMPLE ID.	EXTENT	GRAPHIC LOG	LITHOLOGIC DESCRIPTION
	6505					0-24 ft. COLLUVIUM (Qc) SANDY SILT (ML), dark gray brown (2.5YR 4/2), moist, dense with 20% angular sandstone rock fragments to 1 inch diameter, sandstone clasts are yellow brown (10YR 5/4), and deeply weathered.
			3-5 ft			
5	6500					
10	6495					
15	6490		15-17 ft			
20	6485					
25	6480		25-27 ft			24-28 ft. ALLUVIUM (Qal) GRAVEL (GW), coarse yellowish brown (10YR 5/4) dense, dry, and moist, gravel clasts are rounded and consists of crystalline lithologies.
			28-30 ft			28-37 ft. MANCOS SHALE (Km) SHALE, dark gray (N4/0), hard, dry
30	6475					
35	6470					
						Total Depth 37.0 ft.

BOREHOLE LOG DUR01-0861

PROJECT	UMTRA GROUND WATER	**SURFACE ELEV. (FT NGVD)**	6521.55
LOCATION	DURANGO, CO	**BIT SIZE(S) (IN)**	6.0
SITE	DURANGO MILL TAILINGS	**DRILLING METHOD**	ROTASONIC
WELL NUMBER	0861	**SAMPLING METHOD**	GRAB
NORTH COORD. (FT)	1226984.26	**WATER LEVEL (FT BGS)**	
EAST COORD. (FT)	2306193.58	**LOGGED BY**	Kautsky, M.
HOLE DEPTH (FT)	67.00	**REMARKS**	
DATE DRILLED	09/21/2000		

DEPTH (FT BGL)	ELEV. (FT NGVD)	BLOW COUNTS	SAMPLE ID	EXTENT	GRAPHIC LOG	LITHOLOGIC DESCRIPTION
	6520					0-20 ft. COLLUVIUM (Qc) SANDY SILT (ML): mottled, very dark brown (10YR 2/2) and dark yellow brown (10YR 4/4), moist, medium dense, contains ~30% angular sandstone clasts olive gray (5Y 4/2), soft and weathered, derived from Point Lookout Sandstone
5			4-6 ft.			
	6515					
10						
	6510					
15			14-17 ft.			
	6505					
20						20-30 ft. SANDY SILT (ML), dark brown (10 YR 3/3), moist, medium dense below 20 ft., the material is uniformly dark brown (10 YR 3/3) and gravel/rock fragments are absent.
	6500					
25			22-27 ft.			
	6495					
30						30-59 ft. COLLUVIUM (Qc)/TERACE ALLUVIUM (Qt) SANDY GRAVEL (GW), mottled, red yellow (5 YR 6/6), dark yellow brown (10 YR 4/4), and subrounded, dark brown (10 YR 3/3) moist dense, subrounded, contains rock fragments of granodiorite, all sizes up to boulder, colluvium (Qt) <10% fines terrace alluvium (Qt).
	6490					
35			34-37 ft.			
	6485					

BOREHOLE LOG DUR01-0861

PROJECT UMTRA GROUND WATER **BOREHOLE NUMBER** 0861

SITE DURANGO MILL TAILINGS **DATES DRILLED** 09/21/2000

Continued from Previous Page

DEPTH (FT BGL)	ELEV. (FT NGVD)	BLOW COUNTS	SAMPLE ID.	EXTENT	GRAPHIC LOG	LITHOLOGIC DESCRIPTION
	6480					
45			42-47 ft.			45 ft. increasing moisture and fines below.
	6475					
50						
	6470		50-53 ft.			50-53 ft. clean, coarse gravel (GW), no fines, composed of various Precambrian lithologies up to 1.0 ft. diameter.
55						
	6465					
60						59-67 ft. MANCOS SHALE (Km). SHALE, gray (5Y 5/1), hard, dry.
	6460		60-67 ft.			
65						
	6455					
						Total Depth 67.0 ft.
70						
	6450					
75						
	6445					
80						
	6440					

BOREHOLE LOG DUR01-0862

PROJECT	UMTRA GROUND WATER	**SURFACE ELEV. (FT NGVD)**	6514.75
LOCATION	DURANGO, CO	**BIT SIZE(S) (IN)**	6.0
SITE	DURANGO MILL TAILINGS	**DRILLING METHOD**	ROTASONIC
WELL NUMBER	0862	**SAMPLING METHOD**	GRAB
NORTH COORD. (FT)	1226517.42	**WATER LEVEL (FT BGS)**	
EAST COORD. (FT)	2306598.61	**LOGGED BY**	Kautsky, M.
HOLE DEPTH (FT)	57.00	**REMARKS**	
DATE DRILLED	09/20/2000		

DEPTH (FT BGL)	ELEV. (FT NGVD)	BLOW COUNTS	SAMPLE ID.	EXTENT	GRAPHIC LOG	LITHOLOGIC DESCRIPTION
						0-50 ft. COLLUVIUM (Qc) SANDY SILT (ML), dark brown (7.5YR 3/2), fine, compacted, moist, dense
5	6510		4-6 ft.			5 ft. contains light olive brown (2.5YR 5/4) coated clasts, angular rock fragments up to 2 inch diameter.
10	6505					
15	6500		14-16 ft.			15 ft. grading to very dark gray (2.5YR 3/0).
20	6495					
25	6490		24-26 ft.			25 ft. grading to mottled very dark gray brown (2.5Y 3/2), yellowish red (5YR 5/8) with medium plasticity, moist, medium dense
30	6485					
35	6480		34-36 ft			35 ft mottled very dark gray brown (10YR 3/2) and yellow brown (10YR 5/6) with gravel, slight plasticity-gravel fragments are angular, fine grained sandstone
	6475					

BOREHOLE LOG DUR01-0862

PROJECT UMTRA GROUND WATER **BOREHOLE NUMBER** 0862

SITE DURANGO MILL TAILINGS **DATES DRILLED** 09/20/2000

Continued from Previous Page

DEPTH (FT BGL)	ELEV. (FT NGVD)	BLOW COUNTS	SAMPLE ID.	EXTENT	GRAPHIC LOG	LITHOLOGIC DESCRIPTION
45	6470		45-46 ft.			44 ft. drilling becomes harder.
50	6465					48 ft. encountered a large ~2.0 ft. diameter clast of yellow (10YR 7/6) fine grained, deeply weathered sandstone, slightly moist, light brownish gray (10YR 6/2), dry.
						50-57 ft. MANCOS SHALE (Km) SHALE, gray (10YR 5/1), dry, hard.
55	6460		52-56 ft.			
						Total Depth 57.0 ft.
60	6455					
65	6450					
70	6445					
75	6440					
80	6435					

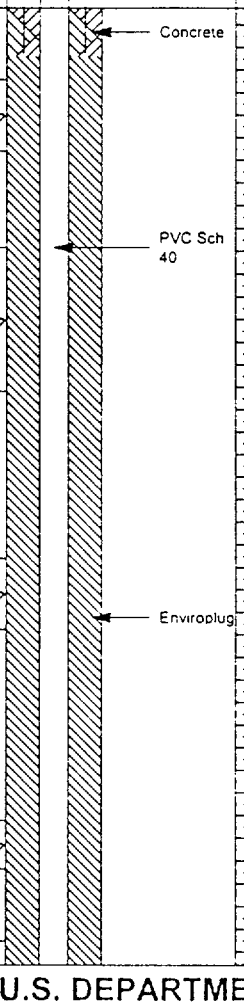
MONITORING WELL COMPLETION LOG DUR01-0863

PROJECT	UMTRA GROUND WATER	NORTH COORD. (FT)	1226282.04	DATE DRILLED	09/21/2000
LOCATION	DURANGO, CO	EAST COORD. (FT)	2306750.05	SURFACE ELEV. (FT NGVD)	6513.56
SITE	DURANGO MILL TAILINGS	HOLE DEPTH (FT)	74.50	TOP OF CASING (FT)	6513.32
WELL NUMBER	0863	WELL DEPTH (FT)	68.00	MEAS. PT. ELEV. (FT)	6513.32
				SLOT SIZE (IN)	0.020
				BIT SIZE(S) (IN)	6.0

	WELL INSTALLATION	INTERVAL (FT)		
SURFACE CASING:				
BLANK CASING:	2 in. PVC Sch 40	0.24	to	58.0
WELL SCREEN:	2 in. Vee Wire Wrapped	58.0	to	67.5
SUMP/END CAP:	2 in. PVC Sch 40	67.5	to	68.0
SURFACE SEAL:	Concrete	0.0	to	2.0
GROUT:	Enviroplug	2.0	to	49.0
SEAL:	Bentonite Pellets	50.5	to	54.1
UPPER PACK:	30-70 Silica Sand	54.1	to	56.2
LOWER PACK:	10-20 Silica Sand	56.2	to	68.0

DRILLING METHOD ROTASONIC
SAMPLING METHOD GRAB
DATE DEVELOPED
WATER LEVEL (FT BTOC) 60.0 on 09/21/2000
LOGGED BY Kautsky, M.
REMARKS 30 -70 sand pack from 49 0 to 50 5 ft

DEPTH (FT BGL)	ELEV. (FT NGVD)	BLOW COUNTS	SAMPLE ID.	EXTENT	WELL DIAGRAM	GRAPHIC LOG	LITHOLOGIC DESCRIPTION
							0-67 ft. COLLUVIUM (Qc). SANDY SILT (ML), mottled dark gray brown (10YR 4/2) and yellow brown (10YR 5/6) with angular sandstone rock fragments, moist, dense colluvial deposits. Contains hard, angular, pale olive (5Y 6/3) sandstone fragments derived from the Point Lookout Sandstone formation.
5	6510		3-6 ft.				
10	6505						
15	6500		10-16 ft.				
20	6495						
25	6490		23-26 ft				
30	6485						
35	6480		34-36 ft				
	6475						



MONITORING WELL COMPLETION LOG DUR01-0863

PROJECT UMTRA GROUND WATER **WELL NUMBER** 0863
SITE DURANGO MILL TAILINGS **DATES DRILLED** 09/21/2000

Continued from Previous Page

DEPTH (FT BGL)	ELEV. (FT NGVD)	BLOW COUNTS	SAMPLE ID.	EXTENT	WELL DIAGRAM	GRAPHIC LOG	LITHOLOGIC DESCRIPTION
45	6470		39-45 ft.				
50	6465				30-70 Silica Sand; Bentonite Pellets		
55	6460		54-57 ft.		30-70 Silica Sand		
60	6455				10-20 Silica Sand; 0.020" Wire Wrap		60 ft. increasing clay or plastic silt content.
65	6450		63-67 ft.				65-67 ft. colluvial deposit is wet.
70	6445				Native soil/fill		67-74.5 ft. MANCOS SHALE (Km) SHALE, gray (N 5/0), deeply weathered, moist, weathered zone extends to 70.0 ft. Bedrock is dry, hard.
75	6440		71-74 ft.				Total Depth 74.5 ft.
80	6435						
85	6430						
90	6425						

BOREHOLE LOG DUR01-0864

PROJECT	UMTRA GROUND WATER	**SURFACE ELEV. (FT NGVD)**	
LOCATION	DURANGO, CO	**BIT SIZE(S) (IN)**	6.0
SITE	DURANGO MILL TAILINGS	**DRILLING METHOD**	ROTASONIC
WELL NUMBER	0864	**SAMPLING METHOD**	GRAB
NORTH COORD. (FT)	1226520.00	**WATER LEVEL (FT BGS)**	
EAST COORD. (FT)	2307643.00	**LOGGED BY**	Kautsky, M.
HOLE DEPTH (FT)	27.00	**REMARKS**	
DATE DRILLED			

DEPTH (FT BGL)	ELEV. (FT NGVD)	BLOW COUNTS	SAMPLE ID.	EXTENT	GRAPHIC LOG	LITHOLOGIC DESCRIPTION
						0-2 ft. SANDY SILT (ML), brown (7.5YR 4/2), slightly moist, loose
						2-3 ft. SILTY SAND (SM), light yellow brown (10YR 6/4)
5			6-8 ft.			3-10 ft. TERRACE GRAVEL (Qt) SANDY GRAVEL (GW), red brown (5YR 4/4), loose, dry, 30% sand, gravel consists of hard, Precambrian rounded clasts
10			10-16 ft.			10-27 ft. MANCOS SHALE (Km). SHALE, gray (5Y 5/1) hard, dry. Sample of Mancos from cutting bit collected at 27.0 ft. Abandoned the hole.
15						
20						
25			26-27 ft.			
						Total Depth 27.0 ft
30						
35						

BOREHOLE LOG DUR01-0865

PROJECT	UMTRA GROUND WATER	**SURFACE ELEV. (FT NGVD)**	6500.63
LOCATION	DURANGO, CO	**BIT SIZE(S) (IN)**	6.0
SITE	DURANGO MILL TAILINGS	**DRILLING METHOD**	ROTASONIC
WELL NUMBER	0865	**SAMPLING METHOD**	
NORTH COORD. (FT)	1227299.69	**WATER LEVEL (FT BGS)**	
EAST COORD. (FT)	2307100.83	**LOGGED BY**	Miller, D.
HOLE DEPTH (FT)	17.00	**REMARKS**	
DATE DRILLED	10/17/2000		

DEPTH (FT BGL)	ELEV. (FT NGVD)	BLOW COUNTS	SAMPLE ID.	EXTENT	GRAPHIC LOG	LITHOLOGIC DESCRIPTION
	6500					0-3 ft. TOPSOIL, brown to dark brown with organic debris, mixed with some gravel
						3-4 ft. FILL, roadbase.
5	6495					4-7.5 ft. FILL, sandy, silty, topsoil, clean, brown, dry.
10	6490					7.5-17 ft. MANCOS SHALE (Km). SHALE, gray (N 5/0) deeply weathered and fractured shale, dry. 11-17 ft. becomes gray (10YR 5/1) dry, hard.
15	6485					
						Total Depth 17.0 ft
20	6480					

MONITORING WELL COMPLETION LOG DUR01-0866

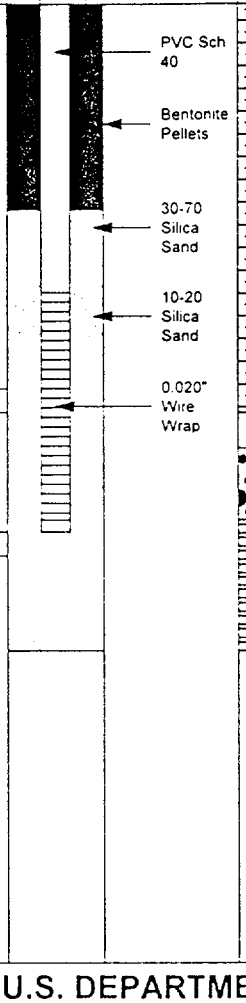
PROJECT	UMTRA GROUND WATER	NORTH COORD. (FT)	1227694.25	DATE DRILLED	10/17/2000
LOCATION	DURANGO, CO	EAST COORD. (FT)	2306437.87	SURFACE ELEV. (FT NGVD)	6481.15
SITE	DURANGO MILL TAILINGS	HOLE DEPTH (FT)	27.00	TOP OF CASING (FT)	6483.32
WELL NUMBER	0866	WELL DEPTH (FT)	22.00	MEAS. PT. ELEV. (FT)	6483.32
				SLOT SIZE (IN)	0.020
				BIT SIZE(S) (IN)	6.0

	WELL INSTALLATION	INTERVAL (FT)		
SURFACE CASING:				
BLANK CASING:	2 in. PVC Sch 40	-2.17	to	12.0
WELL SCREEN:	2 in. Vee Wire Wrapped	12.0	to	21.5
SUMP/END CAP:	2 in. PVC Sch 40	21.5	to	22.0
SURFACE SEAL:				
GROUT:				
SEAL:	Bentonite Pellets	0.0	to	8.6
UPPER PACK:	30-70 Silica Sand	8.6	to	10.0
LOWER PACK:	10-20 Silica Sand	10.0	to	27.0

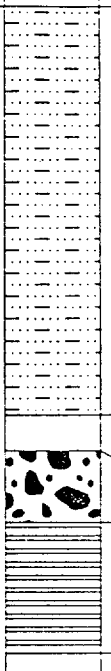
DRILLING METHOD ROTASONIC
SAMPLING METHOD GRAB
DATE DEVELOPED
WATER LEVEL (FT BGS)
LOGGED BY Miller, D.
REMARKS

DEPTH (FT BGL)	ELEV. (FT NGVD)	BLOW COUNTS	SAMPLE ID.	EXTENT
	6480			
5	6475			
10	6470			
15	6465		16-17 ft	
20	6460			
			22-23 ft	
25	6455			
30	6450			
35	6445			

WELL DIAGRAM



GRAPHIC LOG



LITHOLOGIC DESCRIPTION

0-17 ft. SANDY SILT (ML), light brown (7.5YR 6/6) loose, poorly sorted with ~25% large gravel fragments to 2 inches, dry, possibly fill.

17-18.5 ft SAND (SP), well sorted, <5% gravel, mottled coloring, fines ~ 20% fine to medium grained

18.5-21.5 ft ALLUVIUM (Qal)
GRAVEL (GW), brown (7YR 6/6) rounded to well rounded gravels to 2 inches with ~ 50% sands and <5% silt, very poorly sorted

21.5-27 ft MANCOS SHALE (Km)
SHALE, weathered, wet.
22-27 ft layer becomes gray, hard, dry

Total Depth 27.0 ft

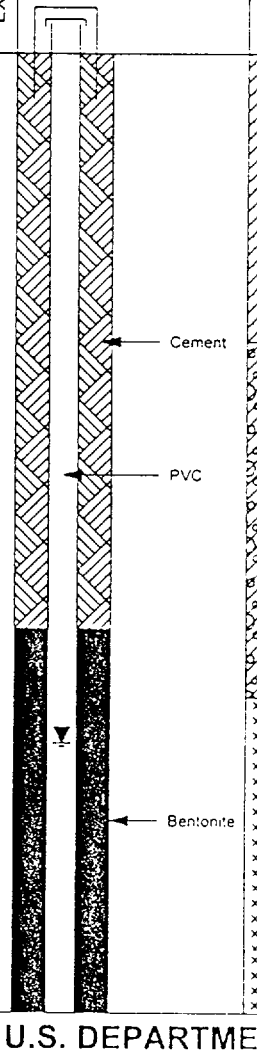
MONITORING WELL COMPLETION LOG DUR02-0592

PROJECT	UMTRA GROUND WATER	NORTH COORD. (FT)	1222224 64	DATE DRILLED	05/09/1990 to 05/22/1990
LOCATION	DURANGO, CO	EAST COORD. (FT)	2307502.64	SURFACE ELEV. (FT NGVD)	6542 90
SITE	DURANGO RAFFINATE PONDS	HOLE DEPTH (FT)	198.00	TOP OF CASING (FT)	6544.90
WELL NUMBER	0592	WELL DEPTH (FT)	140.00	MEAS. PT. ELEV. (FT)	6544 90
				SLOT SIZE (IN)	0 050
				BIT SIZE(S) (IN)	

	WELL INSTALLATION	INTERVAL (FT)		
SURFACE CASING:				
BLANK CASING:	2 in. PVC	-2.0	to	80 0
WELL SCREEN:	2 in. Slotted PVC	80.0	to	140.0
SUMP/END CAP:				
SURFACE SEAL:				
GROUT:	Cement Grout	0.0	to	30.0
SEAL:	Bentonite	30.0	to	70.0
UPPER PACK:				
LOWER PACK:	8-12 Silica Sand	70.0	to	198.0

DRILLING METHOD	
SAMPLING METHOD	
DATE DEVELOPED	
WATER LEVEL (FT BGS)	36 0 on 05/18/1990
LOGGED BY	T Jackson
REMARKS	BOR # DH-118

DEPTH (FT BGL)	ELEV. (FT NGVD)	BLOW COUNTS	SAMPLE ID.	EXTENT	WELL DIAGRAM	GRAPHIC LOG	LITHOLOGIC DESCRIPTION
	6540						0-15 ft QUATERNARY ALLUVIUM (SC). Clayey sand with gravel and cobbles. About 55% coarse to fine, angular to sub-angular sand, about 25% fines with low to medium plasticity About 20% coarse to fine, angular to subangular gravel, trace of cobbles, maximum size 75 mm.
10	6530				Cement		
20	6520				PVC		15-33.6 ft. QUATERNARY TERRACE, GRAVEL WITH COBBLES (GC). Poor recovery consists of about 70% coarse to fine, hard, subangular to subrounded gravel.
30	6510						33-131 9 ft CRETACEOUS MENEFEE FORMATION. Interval consists of approximately 90% siltstone with 10% sandstone interbeds
40	6500				Bentonite		46 7-46 8 ft. SILT AND CLAY INTERBED 46 8-113 1 ft SILT AND CLAY INTERBED



MONITORING WELL COMPLETION LOG DUR02-0592

PROJECT UMTRA GROUND WATER **WELL NUMBER** 0592

SITE DURANGO RAFFINATE PONDS **DATES DRILLED** 05/09/1990 to 05/22/1990

Continued from Previous Page

DEPTH (FT BGL)	ELEV. (FT NGVD)	BLOW COUNTS	SAMPLE ID.	EXTENT	WELL DIAGRAM	GRAPHIC LOG	LITHOLOGIC DESCRIPTION
	6490						
60							
	6480						
70							
	6470				8-12 Silica Sand		
80							
	6460						
90					0.050" Slotted PVC		
	6450						
100							
	6440						
110							
	6430						

MONITORING WELL COMPLETION LOG DUR02-0592

PROJECT UMTRA GROUND WATER **WELL NUMBER** 0592
SITE DURANGO RAFFINATE PONDS **DATES DRILLED** 05/09/1990 to 05/22/1990

Continued from Previous Page

DEPTH (FT BGL)	ELEV. (FT NGVD)	BLOW COUNTS	SAMPLE ID.	EXTENT	WELL DIAGRAM	GRAPHIC LOG	LITHOLOGIC DESCRIPTION
							113.1-113.3 ft. SILT INTERBED 113.1-115.8 ft. COAL 115.8-121.9 ft. CARBONACEOUS SANDSTONE
120							
	6420						121.9-122.7 ft. TERTIARY ANDESITE DIKE 122.7-123.7 ft. CARBONACEOUS SANDSTONE 123.7-126.3 ft. TERTIARY ANDESITE DIKE
							126.3-126.5 ft. COAL 126.5-129.3 ft. CARBONACEOUS SANDTONE
130							129.3-132 ft. TERTIARY ANDESITE DIKE
	6410						131.9-132 ft. CLAY FAULT 132-138.7 ft. CRETACEOUS POINT LOOKOUT SANDSTONE. Sandstone with siltstone interbeds, sandstone with approximately 90% sandstone and 10% siltstone.
140							138.7-141.2 ft. CLAYSTONE
	6400						141.2-198 ft CRETACEOUS POINT LOOKOUT SANDSTONE. Sandstone with siltstone interbeds, sandstone with approximately 90% sandstone and 10% siltstone.
150							
	6390						
160							
	6380						
170							
	6370						

MONITORING WELL COMPLETION LOG DUR02-0592

PROJECT UMTRA GROUND WATER **WELL NUMBER** 0592
SITE DURANGO RAFFINATE PONDS **DATES DRILLED** 05/09/1990 to 05/22/1990

Continued from Previous Page

DEPTH (FT BGL)	ELEV. (FT NGVD)	BLOW COUNTS	SAMPLE ID.	EXTENT	WELL DIAGRAM	GRAPHIC LOG	LITHOLOGIC DESCRIPTION
180							
	6360						
190							
	6350						
200							Total Depth 198 ft
	6340						
210							
	6330						
220							
	6320						
230							
	6310						
240							

MONITORING WELL COMPLETION LOG DUR02-0593

PROJECT	UMTRA GROUND WATER	NORTH COORD. (FT)	1223398 61	DATE DRILLED	03/09/1990 to 03/14/1990
LOCATION	DURANGO, CO	EAST COORD. (FT)	2308351 43	SURFACE ELEV. (FT NGVD)	6473 70
SITE	DURANGO RAFFINATE PONDS	HOLE DEPTH (FT)	38 80	TOP OF CASING (FT)	6473 80
WELL NUMBER	0593	WELL DEPTH (FT)	38.80	MEAS. PT. ELEV. (FT)	6473 80
				SLOT SIZE (IN)	0 050
				BIT SIZE(S) (IN)	

	WELL INSTALLATION	INTERVAL (FT)		
SURFACE CASING:				
BLANK CASING:	2 in. PVC	-0.1	to	18.8
WELL SCREEN:	2 in. Slotted PVC	18.8	to	38.8
SUMP/END CAP:				
SURFACE SEAL:				
GROUT:	Cement Grout	0 0	to	5.0
SEAL:	Bentonite	5 0	to	10.0
UPPER PACK:				
LOWER PACK:	8-12 Silica Sand	10 0	to	38.8

DRILLING METHOD
SAMPLING METHOD
DATE DEVELOPED
WATER LEVEL (FT BGS) 21.0 on 04/06/1990
LOGGED BY T. Jackson
REMARKS BOR # DH-117

DEPTH (FT BGL)	ELEV. (FT NGVD)	BLOW COUNTS	SAMPLE ID	EXTENT	WELL DIAGRAM	GRAPHIC LOG	LITHOLOGIC DESCRIPTION
							0-3 5 ft. FILL (CL-CH). Gravelly lean to fat clay with sand.
	6470				Cement; PVC		3 5-7 7 ft. QUATERNARY TERRACE (GC). Cobbles with clayey gravel and sand.
10					Bentonite		7.7-20.2 ft. CRETACEOUS MENEFEE FORMATION. Sandstone with approximately 35% siltstone interbeds. Contacts are gradational.
	6460				8-12 Silica Sand		
20							20 2-21 4 ft. COAL
	6450						21 4-26 6 ft. SANDSTONE, with approximately 35% siltstone. Contacts are gradational.
30					0 050" Slotted PVC		26 6-38 8 SANDSTONE
	6440						
40							Total Depth 38 8 ft
	6430						

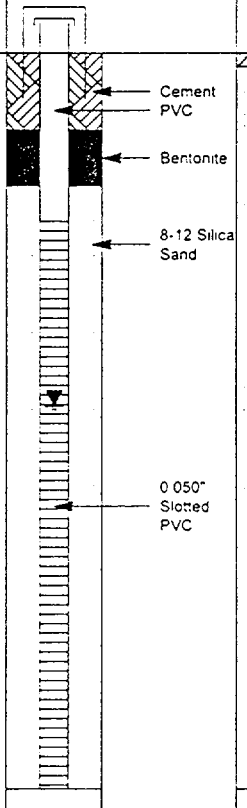
MONITORING WELL COMPLETION LOG DUR02-0594

PROJECT	UMTRA GROUND WATER	NORTH COORD. (FT)	1223821.11	DATE DRILLED	03/07/1990 to 03/08/1990
LOCATION	DURANGO, CO	EAST COORD. (FT)	2308320.14	SURFACE ELEV. (FT NGVD)	6472.70
SITE	DURANGO RAFFINATE PONDS	HOLE DEPTH (FT)	38.50	TOP OF CASING (FT)	6472.80
WELL NUMBER	0594	WELL DEPTH (FT)	38.50	MEAS. PT. ELEV. (FT)	6472.80
				SLOT SIZE (IN)	0.050
				BIT SIZE(S) (IN)	

	WELL INSTALLATION	INTERVAL (FT)		
SURFACE CASING:				
BLANK CASING:	2 in. PVC	-0.1	to	8.5
WELL SCREEN:	2 in. Slotted PVC	8.5	to	38.5
SUMP/END CAP:				
SURFACE SEAL:				
GROUT:	Cement Grout	0.0	to	4.0
SEAL:	Bentonite	4.0	to	7.0
UPPER PACK:				
LOWER PACK:	8-12 Silica Sand	7.0	to	38.5

DRILLING METHOD	
SAMPLING METHOD	
DATE DEVELOPED	
WATER LEVEL (FT BGS)	18.4 on 03/07/1990
LOGGED BY	T. Jackson
REMARKS	BOR # DH-116

DEPTH (FT BGL)	ELEV. (FT NGVD)	BLOW COUNTS	SAMPLE ID	EXTENT	WELL DIAGRAM	GRAPHIC LOG	LITHOLOGIC DESCRIPTION
	6470						0-0.07 ft. QUATERNARY ALLUVIUM (SC). No core recovery. interpreted from surrounding surficial deposits consisting of clayey sand with gravel.
							0.7-38.5 ft. CRETACEOUS MENEFEE FORMATION. Sandstone with approximately 10% siltstone interbeds, contacts are gradational.
10	6460						
20	6450						
30	6440						
40	6430						Total Depth 38.5 ft



MONITORING WELL COMPLETION LOG DUR02-0595

PROJECT	UMTRA GROUND WATER	NORTH COORD. (FT)	1224569.40	DATE DRILLED	02/13/1990 to 02/15/1990
LOCATION	DURANGO, CO	EAST COORD. (FT)	2307937.60	SURFACE ELEV. (FT NGVD)	6453.74
SITE	DURANGO RAFFINATE PONDS	HOLE DEPTH (FT)	61.00	TOP OF CASING (FT)	6455.74
WELL NUMBER	0595	WELL DEPTH (FT)	53.00	MEAS. PT. ELEV. (FT)	6455.74
				SLOT SIZE (IN)	0.050
				BIT SIZE(S) (IN)	

	WELL INSTALLATION	INTERVAL (FT)		
SURFACE CASING:				
BLANK CASING:	2 in. PVC	-2.0	to	21.0
WELL SCREEN:	2 in. Slotted PVC	21.0	to	51.0
SUMP/END CAP:				
SURFACE SEAL:				
GROUT:	Cement Grout	0.0	to	13.0
SEAL:	Bentonite	13.0	to	16.2
UPPER PACK:				
LOWER PACK:	8-12 Silica Sand	16.2	to	51.0

DRILLING METHOD
SAMPLING METHOD
DATE DEVELOPED
WATER LEVEL (FT BGS) 13.6 on 03/05/1990
LOGGED BY T. Jackson
REMARKS BOR # DH-113

DEPTH (FT BGL)	ELEV (FT NGVD)	BLOW COUNTS	SAMPLE ID	EXTENT	WELL DIAGRAM	GRAPHIC LOG	LITHOLOGIC DESCRIPTION
	6450						0-3 ft. FILL (GC). A dozer scraped quaternary alluvium consisting of clayey gravel with sand, cobbles, and boulders forming a drill pad for the drill rig. Poor recovery
10					Cement; PVC		3-14.3 ft. QUATERNARY/RECENT STREAM FILL AND MAN-MADE FILL (GC). Undifferentiated, clayey gravel with sand and cobbles, poor recovery during drilling
	6440				Bentonite		14.3-61 ft. CRETACEOUS POINT LOOKOUT SANDSTONE. Siltstone with approximately 10% sandstone interbeds
20							
	6430				8-12 Silica Sand		
30							
	6420				0.050" Slotted PVC		
40							
	6410						
50							
	6400						
60							Total Depth 61 ft
	6390						
70							
	6380						

MONITORING WELL COMPLETION LOG DUR02-0596

PROJECT	UMTRA GROUND WATER	NORTH COORD. (FT)	1223864 00	DATE DRILLED	02/07/1990 to 02/09/1990
LOCATION	DURANGO, CO	EAST COORD. (FT)	2307954 00	SURFACE ELEV. (FT NGVD)	6466 70
SITE	DURANGO RAFFINATE PONDS	HOLE DEPTH (FT)	78.60	TOP OF CASING (FT)	6468 50
WELL NUMBER	0596	WELL DEPTH (FT)	60.40	MEAS. PT. ELEV. (FT)	6468 50
				SLOT SIZE (IN)	0 050
				BIT SIZE(S) (IN)	

	WELL INSTALLATION	INTERVAL (FT)		
SURFACE CASING:				
BLANK CASING:	2 in. PVC	-1.8	to	18.6
WELL SCREEN:	2 in. Slotted PVC	18 6	to	58.6
SUMP/END CAP:				
SURFACE SEAL:				
GROUT:	Cement Grout	0 0	to	5.0
SEAL:	Bentonite	5.0	to	8.6
UPPER PACK:	8-12 Silica Sand	8.6	to	64.0
LOWER PACK:	Bentonite	64 0	to	69.0

DRILLING METHOD
SAMPLING METHOD
DATE DEVELOPED
WATER LEVEL (FT BGS) 7 0 on 02/09/1990
LOGGED BY T Jackson
REMARKS BOR # DH-112

DEPTH (FT BGL)	ELEV. (FT NGVD)	BLOW COUNTS	SAMPLE ID	EXTENT	WELL DIAGRAM	GRAPHIC LOG	LITHOLOGIC DESCRIPTION
							0-0 8 ft QUATERNARY TERRACE (GC). Clayey gravel and cobbles from nearby exposures.
							0 8-78.6 ft. CRETACEOUS POINT LOOKOUT SANDSTONE. Siltstone with interbedded sandstone and shale
10	6460				Cement; Bentonite		
					PVC		
20	6450				8-12 Silica Sand		
30	6440				0 050" Slotted PVC		
40	6430						
50	6420						
60	6410						
70	6400				Bentonite; 8-12 Silica Sand		
80	6390						Total Depth 78 6 ft
90	6380						
	6370						

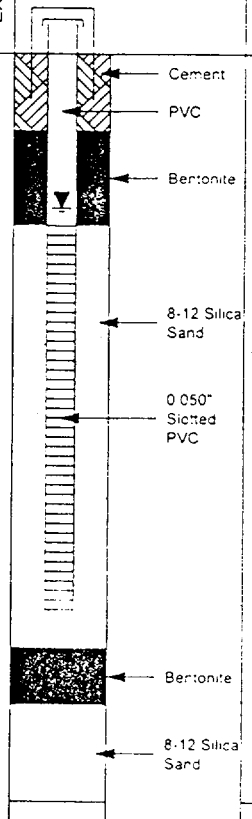
MONITORING WELL COMPLETION LOG DUR02-0597

PROJECT	UMTRA GROUND WATER	NORTH COORD. (FT)	1224315 19	DATE DRILLED	02/02/1990 to 02/05/1990
LOCATION	DURANGO, CO	EAST COORD. (FT)	2307956.36	SURFACE ELEV. (FT NGVD)	6465 33
SITE	DURANGO RAFFINATE PONDS	HOLE DEPTH (FT)	78.00	TOP OF CASING (FT)	6469.25
WELL NUMBER	0597	WELL DEPTH (FT)	64 60	MEAS. PT. ELEV. (FT)	6469 25
				SLOT SIZE (IN)	0 050
				BIT SIZE(S) (IN)	

	WELL INSTALLATION	INTERVAL (FT)		
SURFACE CASING:				
BLANK CASING:	2 in. PVC	-3.92	to	18 0
WELL SCREEN:	2 in. Slotted PVC	18.0	to	58.0
SUMP/END CAP:				
SURFACE SEAL:				
GROUT:	Cement Grout	0.0	to	8.0
SEAL:	Bentonite	8 0	to	18 0
UPPER PACK:	8-12 Silica Sand	18.0	to	62.0
LOWER PACK:	Bentonite	62.0	to	68.0

DRILLING METHOD
SAMPLING METHOD
DATE DEVELOPED
WATER LEVEL (FT BGS) 16 2 on 02/07/1990
LOGGED BY T Jackson
REMARKS BOR # DH-111

DEPTH (FT BGL)	ELEV. (FT NGVD)	BLOW COUNTS	SAMPLE ID	EXTENT	WELL DIAGRAM	GRAPHIC LOG	LITHOLOGIC DESCRIPTION
							0-78 ft. CRETACEOUS POINT LOOKOUT SANDSTONE. Siltstone with interbedded sandstone and shale.
10	6460						
20	6450						
30	6440						
40	6430						
50	6420						
60	6410						
70	6400						
80	6390						Total Depth 78 ft
90	6380						
	6370						



MONITORING WELL COMPLETION LOG DUR02-0598

PROJECT	UMTRA GROUND WATER	NORTH COORD. (FT)	1223450 90	DATE DRILLED	01/23/1990 to 02/01/1990
LOCATION	DURANGO, CO	EAST COORD. (FT)	2308010 79	SURFACE ELEV. (FT NGVD)	6475 00
SITE	DURANGO RAFFINATE PONDS	HOLE DEPTH (FT)	128 50	TOP OF CASING (FT)	6479 00
WELL NUMBER	0598	WELL DEPTH (FT)	102 30	MEAS. PT. ELEV. (FT)	6479 00
				SLOT SIZE (IN)	0 050
				BIT SIZE(S) (IN)	

	WELL INSTALLATION	INTERVAL (FT)		
SURFACE CASING:				
BLANK CASING:	2 in. PVC	-4.0	to	66 2
WELL SCREEN:	2 in. Slotted PVC	66.2	to	96 2
SUMP/END CAP:				
SURFACE SEAL:				
GROUT:	Cement Grout	0.0	to	44.0
SEAL:	Bentonite	44.0	to	53.0
UPPER PACK:	8-12 Silica Sand	53.0	to	99 5
LOWER PACK:	Bentonite	99 5	to	104.0

DRILLING METHOD
SAMPLING METHOD
DATE DEVELOPED
WATER LEVEL (FT BGS) 16 4 on 01/31/1990
LOGGED BY T. Jackson
REMARKS BOR # DH-110; Well has 2 Bentonite seals from 44-53 ft. and 99 5-104 ft

DEPTH (FT BGL)	ELEV. (FT NGVD)	BLOW COUNTS	SAMPLE ID	EXTENT	WELL DIAGRAM	GRAPHIC LOG	LITHOLOGIC DESCRIPTION
							0-11 3 ft QUATERNARY TERRACE (GC) Predominantly clayey gravel with cobbles and boulders.
10	6470				Cement		
					PVC		11 3-71 3 ft CRETACEOUS MENEFEE FORMATION 11 3-17 4 ft. SILTSTONE, with minor sandstone.
	6460						
							17.4-19.3 ft. COAL
20							19 3-21 7 ft SILTSTONE, with minor sandstone
							21 7-71 3 ft SANDSTONE, with siltstone interbeds
	6450						
30							
	6440						
40							
	6430				Bentonite		

MONITORING WELL COMPLETION LOG DUR02-0598

PROJECT UMTRA GROUND WATER **WELL NUMBER** 0598
SITE DURANGO RAFFINATE PONDS **DATES DRILLED** 01/23/1990 to 02/01/1990

Continued from Previous Page

DEPTH (FT BGL)	ELEV. (FT NGVD)	BLOW COUNTS	SAMPLE ID	EXTENT	WELL DIAGRAM	GRAPHIC LOG	LITHOLOGIC DESCRIPTION
	6420						
60					8-12 Silica Sand		
	6410						
70							71.3-84.7 ft. TERTIARY DIKE AND FAULT 71.3-74.8 ft. ANDESITE DIKE
	6400						74.8-81.4 ft. CORE LOSS ZONE
80					0.050" Slotted PVC		
							81.4-81.8 ft. GOUGE ZONE 81.8-83.8 ft. SILTSTONE
	6390						83.8-84.7 ft. GOUGE ZONE 84.7-128.5 ft. CRETACECUS POINT LOOKOUT SANDSTONE, Interbedded sandstone and siltstone
90							
	6380						
100					Bentonite		
	6370						
110					8-12 Silica Sand		

MONITORING WELL COMPLETION LOG DUR02-0598

PROJECT UMTRA GROUND WATER **WELL NUMBER** 0598
SITE DURANGO RAFFINATE PONDS **DATES DRILLED** 01/23/1990 to 02/01/1990

Continued from Previous Page

DEPTH (FT BGL)	ELEV. (FT NGVD)	BLOW COUNTS	SAMPLE ID.	EXTENT	WELL DIAGRAM	GRAPHIC LOG	LITHOLOGIC DESCRIPTION
	6360						
120							
	6350						
130							Total Depth 128 5 ft.
	6340						
140							
	6330						
150							
	6320						
160							
	6310						
170							
	6300						

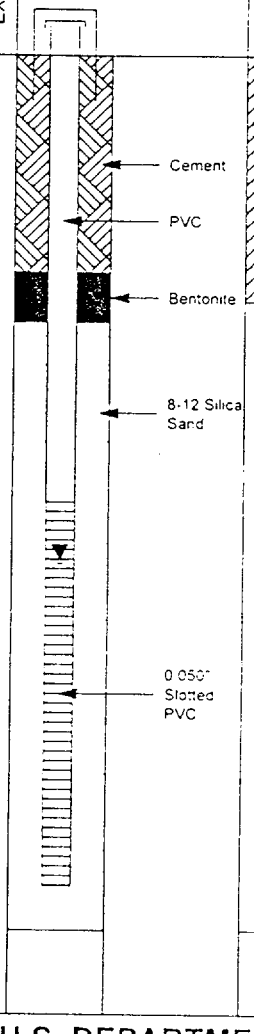
MONITORING WELL COMPLETION LOG DUR02-0599

PROJECT	UMTRA GROUND WATER	NORTH COORD. (FT)	1223868.34	DATE DRILLED	02/21/1990 to 02/27/1990
LOCATION	DURANGO, CO	EAST COORD. (FT)	2307628.31	SURFACE ELEV. (FT NGVD)	6510.20
SITE	DURANGO RAFFINATE PONDS	HOLE DEPTH (FT)	68.50	TOP OF CASING (FT)	6514.08
WELL NUMBER	0599	WELL DEPTH (FT)	65.00	MEAS. PT. ELEV. (FT)	6514.08
				SLOT SIZE (IN)	0.050
				BIT SIZE(S) (IN)	

	WELL INSTALLATION	INTERVAL (FT)		
SURFACE CASING:				
BLANK CASING:	2 in. PVC	-3.88	to	35.0
WELL SCREEN:	2 in. Slotted PVC	35.0	to	65.0
SUMP/END CAP:				
SURFACE SEAL:				
GROUT:	Cement Grout	0.0	to	17.0
SEAL:	Bentonite	17.0	to	21.0
UPPER PACK:				
LOWER PACK:	8-12 Silica Sand	21.0	to	68.5

DRILLING METHOD	
SAMPLING METHOD	
DATE DEVELOPED	
WATER LEVEL (FT BGS)	39.6 on 03/07/1990
LOGGED BY	T. Jackson
REMARKS	BOR # DH-114

DEPTH (FT BGL)	ELEV. (FT NGVD)	BLOW COUNTS	SAMPLE ID	EXTENT	WELL DIAGRAM	GRAPHIC LOG	LITHOLOGIC DESCRIPTION
10	6500						0-19.3 ft QUATERNARY SLOPEWASH/FILL (SC) Clayey sand with gravel and cobbles. Poor recovery consists of about 50% coarse to fine, hard, subrounded to subangular sand
20	6490						19.3-68.5 ft CRETACEOUS POINT LOOKOUT SANDSTONE. Approximately 60% interbedded siltstone and approximately 40% sandstone.
30	6480						
40	6470						
50	6460						
60	6450						
70	6440						Total Depth 68.5 ft



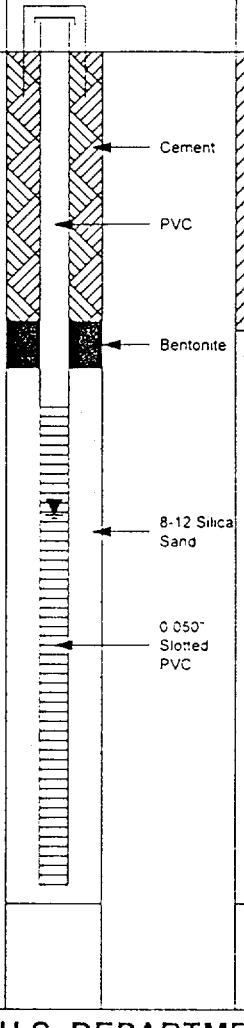
MONITORING WELL COMPLETION LOG DUR02-0600

PROJECT	UMTRA GROUND WATER	NORTH COORD. (FT)	1223422.53	DATE DRILLED	03/01/1990 to 03/06/1990
LOCATION	DURANGO, CO	EAST COORD. (FT)	2307707.91	SURFACE ELEV. (FT NGVD)	6516.57
SITE	DURANGO RAFFINATE PONDS	HOLE DEPTH (FT)	89.00	TOP OF CASING (FT)	6519.88
WELL NUMBER	0600	WELL DEPTH (FT)	87.00	MEAS. PT. ELEV. (FT)	6519.88
				SLOT SIZE (IN)	0.050
				BIT SIZE(S) (IN)	

	WELL INSTALLATION	INTERVAL (FT)		
SURFACE CASING:				
BLANK CASING:	2 in. PVC	-3.31	to	37.0
WELL SCREEN:	2 in. Slotted PVC	37.0	to	87.0
SUMP/END CAP:				
SURFACE SEAL:				
GROUT:	Cement Grout	0.0	to	28.0
SEAL:	Bentonite	28.0	to	33.0
UPPER PACK:				
LOWER PACK:	8-12 Silica Sand	33.0	to	87.0

DRILLING METHOD	
SAMPLING METHOD	
DATE DEVELOPED	
WATER LEVEL (FT BGS)	48.3 on 03/07/1990
LOGGED BY	T. Jackson
REMARKS	BOR # DH-115

DEPTH (FT BGL)	ELEV. (FT NGVD)	BLOW COUNTS	SAMPLE ID.	EXTENT	WELL DIAGRAM	GRAPHIC LOG	LITHOLOGIC DESCRIPTION
							0-29 ft. QUATERNARY SLOPEWASH/FILL (SC). Undifferentiated. Clayey sand with gravel, cobbles, and boulders
10	6510				Cement		
20	6500				PVC		
30	6490				Bentonite		29-89 ft. CRETACEOUS POINT LOOKOUT SANDSTONE. Siltstone with approximately 30% sandstone interbeds
40	6480						
50	6470				8-12 Silica Sand		
60	6460				0.050" Slotted PVC		
70	6450						
80	6440						
90	6430						Total Depth 89 ft
	6420						



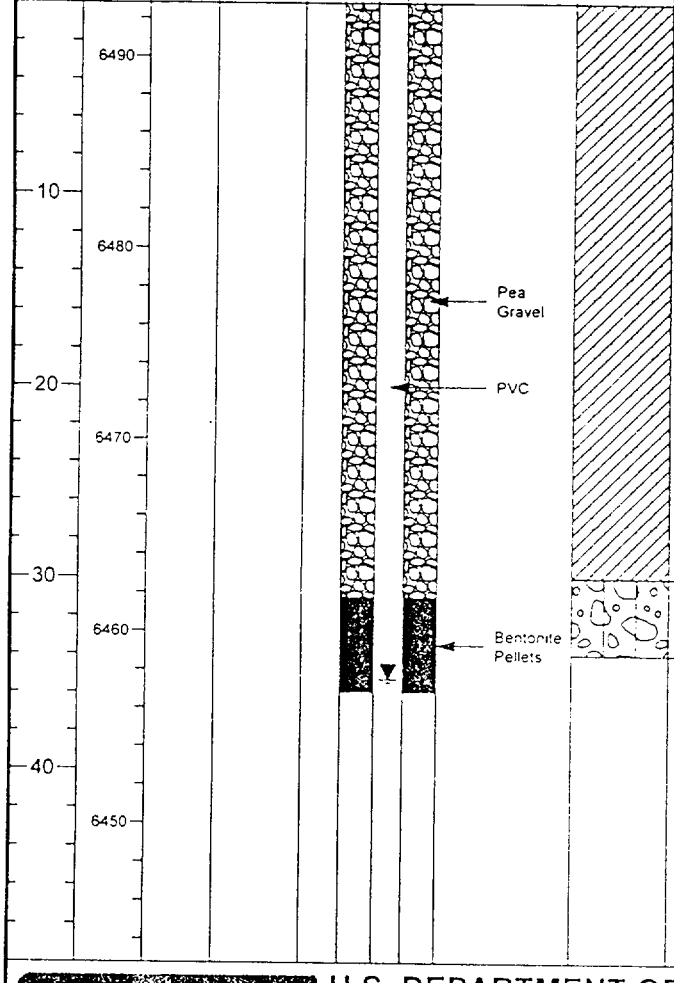
MONITORING WELL COMPLETION LOG DUR02-0601

PROJECT	UMTRA GROUND WATER	NORTH COORD. (FT)	1222756.26	DATE DRILLED	10/10/1982
LOCATION	DURANGO, CO	EAST COORD. (FT)	2308191.03	SURFACE ELEV. (FT NGVD)	6492.80
SITE	DURANGO RAFFINATE PONDS	HOLE DEPTH (FT)	183.00	TOP OF CASING (FT)	6493.10
WELL NUMBER	0601	WELL DEPTH (FT)	82.00	MEAS. PT. ELEV. (FT)	6493.10
				SLOT SIZE (IN)	0.050
				BIT SIZE(S) (IN)	5.63

	WELL INSTALLATION	INTERVAL (FT)		
SURFACE CASING:				
BLANK CASING:	4 in. PVC Sch 40	-0.3	to	51.0
WELL SCREEN:	4 in. Slotted PVC	51.0	to	81.0
SUMP/END CAP:	4 in. PVC Sch 40	81.0	to	82.0
SURFACE SEAL:				
GROUT:	Pea Gravel	0.0	to	31.0
SEAL:	Bentonite Pellets	31.0	to	36.0
UPPER PACK:				
LOWER PACK:	6-10 Silica Sand	36.0	to	82.0

DRILLING METHOD	CORE/ROTARY
SAMPLING METHOD	
DATE DEVELOPED	
WATER LEVEL (FT BGS)	35.3 on 04/18/1983
LOGGED BY	
REMARKS	

DEPTH (FT BGL)	ELEV. (FT NGVD)	BLOW COUNTS	SAMPLE ID	EXTENT	WELL DIAGRAM	GRAPHIC LOG	LITHOLOGIC DESCRIPTION
	6490						0-30 FT ALLUVIUM (SC), Undifferentiated deposit, to 30 feet (assume clayey sand).
10	6480				Pea Gravel		
20	6470				PVC		
30	6460				Bentonite Pellets		30-34 ft GRAVEL (GM), Undifferentiated
							34-61 ft CRETACEOUS MENEFEE FORMATION Sandstone medium grained massive with scattered thin carbonaceous lenses.
40	6450						



MONITORING WELL COMPLETION LOG DUR02-0601

PROJECT UMTRA GROUND WATER **WELL NUMBER** 0601
SITE DURANGO RAFFINATE PONDS **DATES DRILLED** 10/10/1982

Continued from Previous Page

DEPTH (FT BGL)	ELEV. (FT NGVD)	BLOW COUNTS	SAMPLE ID	EXTENT	WELL DIAGRAM	GRAPHIC LOG	LITHOLOGIC DESCRIPTION
	6440				6-10 Silica Sand		
60							61-65 ft. SILTY SHALE
	6430				0.050" Slotted PVC		65-66 ft. COAL TO COALY SHALE 66-68 ft. COALY SHALE
70							68-71 ft. COAL 71-73 ft. SHALE
	6420						73-74 ft. COAL 74-84.4 ft. SHALE, carbonaceous, coaly
80					Blank Sump		
	6410						84.4-85.4 ft. COAL 85.4-98.4 ft. SHALE, sandy, carbonaceous
90							
	6400						
100					Grout		98.4-99.4 ft. COAL 99.4-100 ft. SHALE 100-135 ft. SANDSTONE, medium grained, crossbedded Note becoming massive bedded at 110 ft
	6390						
110							
	6380						

MONITORING WELL COMPLETION LOG DUR02-0601

PROJECT	UMTRA GROUND WATER	WELL NUMBER	0601
SITE	DURANGO RAFFINATE PONDS	DATES DRILLED	10/10/1982

Continued from Previous Page

DEPTH (FT BGL)	ELEV. (FT NGVD)	BLOW COUNTS	SAMPLE ID.	EXTENT	WELL DIAGRAM	GRAPHIC LOG	LITHOLOGIC DESCRIPTION
120							
	6370						
130							
	6360						
							135-136 4 ft. SHALE, carbonaceous
							136 4-137 4 ft COAL
							137.4-141 ft. SHALE, carbonaceous, coaly
140							
							141-145 ft. SANDSTONE, silty.
	6350						
							145-148 ft. SANDSTONE, crossbedded.
							148-153 ft SANDSTONE/SHALE, interbedded
150							
	6340						
							153-172 ft SANDSTONE, medium to coarse, sandstone
160							
	6330						
170							
	6320						172-183 ft SANDSTONE, cross bedded

MONITORING WELL COMPLETION LOG DUR02-0601

PROJECT UMTRA GROUND WATER **WELL NUMBER** 0601
SITE DURANGO RAFFINATE PONDS **DATES DRILLED** 10/10/1982

Continued from Previous Page

DEPTH (FT BGL)	ELEV. (FT NGVD)	BLOW COUNTS	SAMPLE ID.	EXTENT	WELL DIAGRAM	GRAPHIC LOG	LITHOLOGIC DESCRIPTION
180							
	6310						Total Depth 183 ft.
190							
	6300						
200							
	6290						
210							
	6280						
220							
	6270						
230							
	6260						
240							

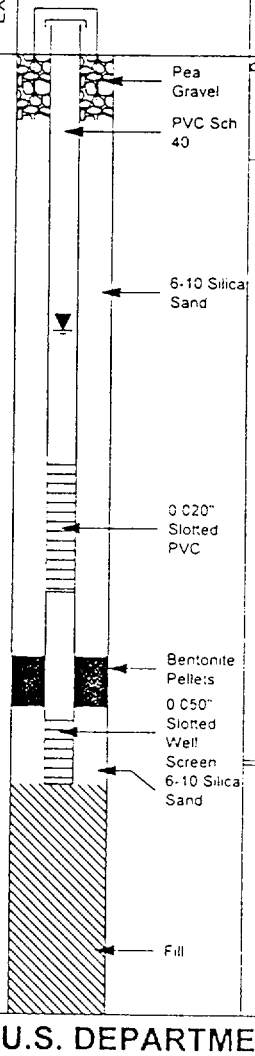
MONITORING WELL COMPLETION LOG DUR02-0602

PROJECT	UMTRA GROUND WATER	NORTH COORD. (FT)	1223649.25	DATE DRILLED	04/18/1983 to 04/18/1993
LOCATION	DURANGO, CO	EAST COORD. (FT)	2308269.47	SURFACE ELEV. (FT NGVD)	6469.51
SITE	DURANGO RAFFINATE PONDS	HOLE DEPTH (FT)	147.11	TOP OF CASING (FT)	6471.68
WELL NUMBER	0602	WELL DEPTH (FT)	57.11	MEAS. PT. ELEV. (FT)	6471.68
				SLOT SIZE (IN)	0.020
				BIT SIZE(S) (IN)	5.63

	WELL INSTALLATION	INTERVAL (FT)		
SURFACE CASING:				
BLANK CASING:	4 in. PVC Sch 40	-2.17	to	32.11
WELL SCREEN:	4 in. Slotted PVC	32.11	to	57.11
SUMP/END CAP:				
SURFACE SEAL:				
GROUT:	Pea Gravel	0.0	to	5.11
SEAL:	Bentonite Pellets	47.11	to	51.11
UPPER PACK:				
LOWER PACK:	6-10 Silica Sand	51.11	to	57.11

DRILLING METHOD
SAMPLING METHOD
DATE DEVELOPED
WATER LEVEL (FT BGS) 21.6 on 04/18/1983
LOGGED BY
REMARKS Well has 2 types of screens from 32.11-42.11 ft. (0.020") and 52.11-62.11 ft (0.050"). Well Modified ~ 8/1/1989.

DEPTH (FT BGL)	ELEV. (FT NGVD)	BLOW COUNTS	SAMPLE ID	EXTENT	WELL DIAGRAM	GRAPHIC LOG	LITHOLOGIC DESCRIPTION
							0.00 - 1.11 ft. GRAVEL (GM). Undifferentiated
							1.11 - 8.11 ft. CRETACEOUS MENEFFE FORMATION. Sandstone, medium grained, massive, with interbedded shale seams.
10	6460						8.11 - 55.11 ft. SANDSTONE, medium grained, massive.
20	6450						
30	6440						
40	6430						
50	6420						
							55.11 - 56.11 ft. COAL with coaly shale
							56.11 - 67.11 ft. SANDSTONE, silty with shale seams
60	6410						
							67.11 - 81.11 ft. SANDSTONE, medium, cross bedded
70	6400						



MONITORING WELL COMPLETION LOG DUR02-0602

PROJECT UMTRA GROUND WATER **WELL NUMBER** 0602
SITE DURANGO RAFFINATE PONDS **DATES DRILLED** 04/18/1983 to 04/18/1993

Continued from Previous Page

DEPTH (FT BGL)	ELEV. (FT NGVD)	BLOW COUNTS	SAMPLE ID.	EXTENT	WELL DIAGRAM	GRAPHIC LOG	LITHOLOGIC DESCRIPTION
80	6390						81.11 - 95.11 ft. SANDSTONE, massive, medium grained, cross bedded.
90	6380						
							95.11 - 101.11 ft. SHALE, with interbedded sandstone.
100	6370						101.11 - 106.11 ft. SANDSTONE, medium grained, massive.
							106.11 - 111.11 ft. SANDSTONE, cross bedded.
110	6360						111.11 - 112.11 ft. SHALE, with interbedded sandy shale
							112.11 - 127.11 ft. SANDSTONE, medium grained, massive.
120	6350						
							127.11 - 129.61 ft. SHALE, with sandy shale
130	6340						129.61 - 147.11 ft. SANDSTONE, medium grained, massive.
140	6330						
							Total Depth 147.11 ft.
150	6320						
160	6310						
170	6300						

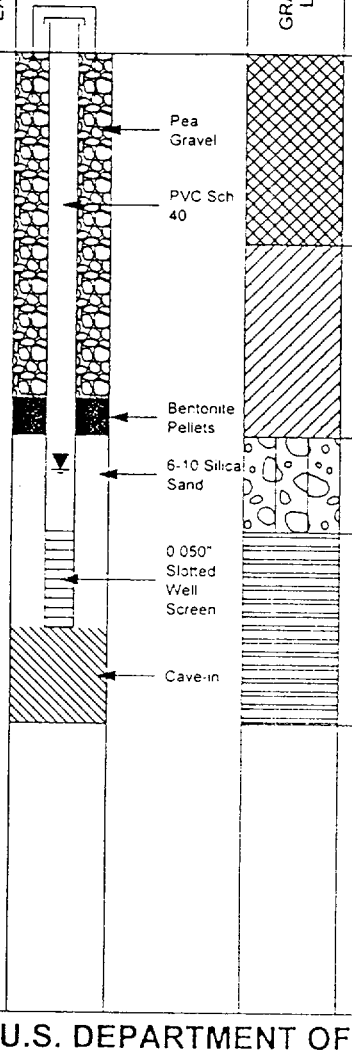
MONITORING WELL COMPLETION LOG DUR02-0606

PROJECT	UMTRA GROUND WATER	NORTH COORD. (FT)	1223143.57	DATE DRILLED	10/10/1982
LOCATION	DURANGO, CO	EAST COORD. (FT)	2308210.83	SURFACE ELEV. (FT NGVD)	6487.80
SITE	DURANGO RAFFINATE PONDS	HOLE DEPTH (FT)	35.00	TOP OF CASING (FT)	6488.10
WELL NUMBER	0606	WELL DEPTH (FT)	30.00	MEAS. PT. ELEV. (FT)	6488.10
				SLOT SIZE (IN)	0.050
				BIT SIZE(S) (IN)	6.25

	WELL INSTALLATION	INTERVAL (FT)		
SURFACE CASING:				
BLANK CASING:	4 in. PVC Sch 40	-0.3	to	25.0
WELL SCREEN:	4 in. Slotted PVC	25.0	to	30.0
SUMP/END CAP:				
SURFACE SEAL:				
GROUT:	Pea Gravel	0.0	to	18.0
SEAL:	Bentonite Pellets	18.0	to	20.0
UPPER PACK:				
LOWER PACK:	6-10 Silica Sand	20.0	to	30.0

DRILLING METHOD	CORE/ROTARY
SAMPLING METHOD	
DATE DEVELOPED	
WATER LEVEL (FT BGS)	21.8 on 04/18/1983
LOGGED BY	
REMARKS	

DEPTH (FT BGL)	ELEV (FT NGVD)	BLOW COUNTS	SAMPLE ID	EXTENT	WELL DIAGRAM	GRAPHIC LOG	LITHOLOGIC DESCRIPTION
							0-10 ft. FILL, Unspecified.
10	6480						
							10-20 ft. ALLUVIUM (SC), Undifferentiated, clayey sand assumed for this log.
20	6470						
							20-25 ft GRAVEL (GM), Undifferentiated
30	6460						25-35 ft. CRETACEOUS MENEFEE FORMATION, Shale, with shaley sandstone seams
							Total Depth 35 ft
40	6450						
	6440						



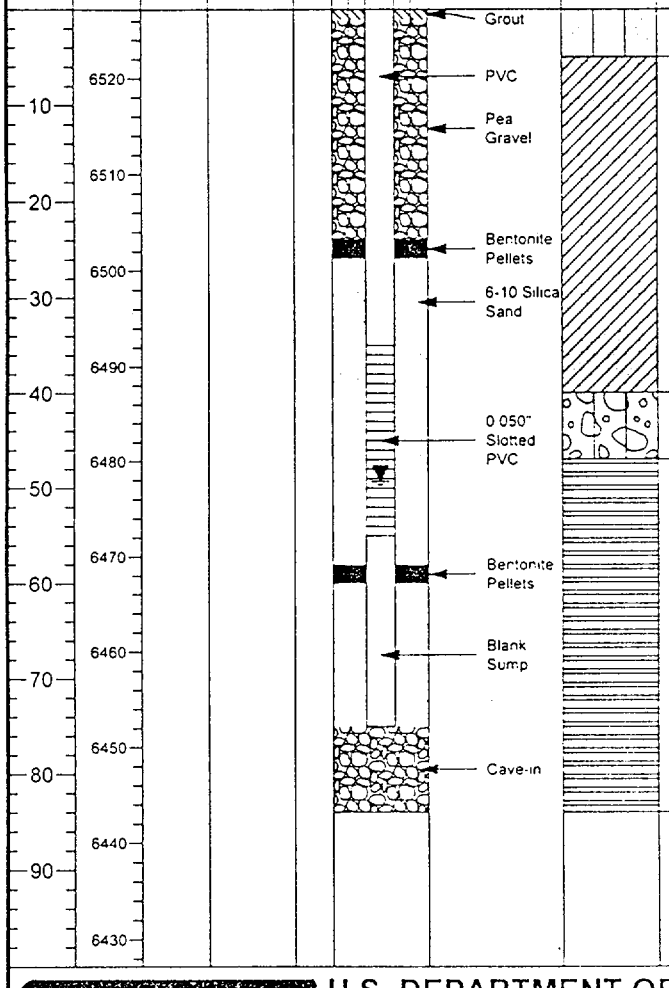
MONITORING WELL COMPLETION LOG DUR02-0607

PROJECT	UMTRA GROUND WATER	NORTH COORD. (FT)	1222747.28	DATE DRILLED	04/18/1983
LOCATION	DURANGO, CO	EAST COORD. (FT)	2307768.71	SURFACE ELEV. (FT NGVD)	6527.20
SITE	DURANGO RAFFINATE PONDS	HOLE DEPTH (FT)	84.00	TOP OF CASING (FT)	6528.20
WELL NUMBER	0607	WELL DEPTH (FT)	75.00	MEAS. PT. ELEV. (FT)	6528.20
				SLOT SIZE (IN)	0.050
				BIT SIZE(S) (IN)	6.75

	WELL INSTALLATION	INTERVAL (FT)		
SURFACE CASING:				
BLANK CASING:	4 in. PVC Sch 40	-1.0	to	35.0
WELL SCREEN:	4 in. Slotted PVC	35.0	to	55.0
SUMP/END CAP:	4 in. PVC Sch 40	55.0	to	75.0
SURFACE SEAL:	Grout	0.0	to	1.0
GROUT:	Pea Gravel	1.0	to	24.0
SEAL:	Bentonite Pellets	24.0	to	26.0
UPPER PACK:	6-10 Silica Sand	26.0	to	58.0
LOWER PACK:	Bentonite	58.0	to	60.0

DRILLING METHOD CORE/ROTARY
SAMPLING METHOD
DATE DEVELOPED
WATER LEVEL (FT BGS) 49.3 on 04/18/1983
LOGGED BY
REMARKS Well has 2 Bentonite seals at 24-26 ft and 58-60 ft.

DEPTH (FT BGL)	ELEV. (FT NGVD)	BLOW COUNTS	SAMPLE ID	EXTENT	WELL DIAGRAM	GRAPHIC LOG	LITHOLOGIC DESCRIPTION
							0-5 ft. UNDIFFERENTIATED FILL (SM)
							5-40 ft. ALLUVIUM/COLLUVIUM (SC). Undifferentiated sands, silts, and clays.
							40-47 ft. GRAVEL (GM)
							47-84 ft. CRETACEOUS MENEFEE FORMATION. Shale, carbonaceous, with thin coal seams.
							Total Depth 84 ft



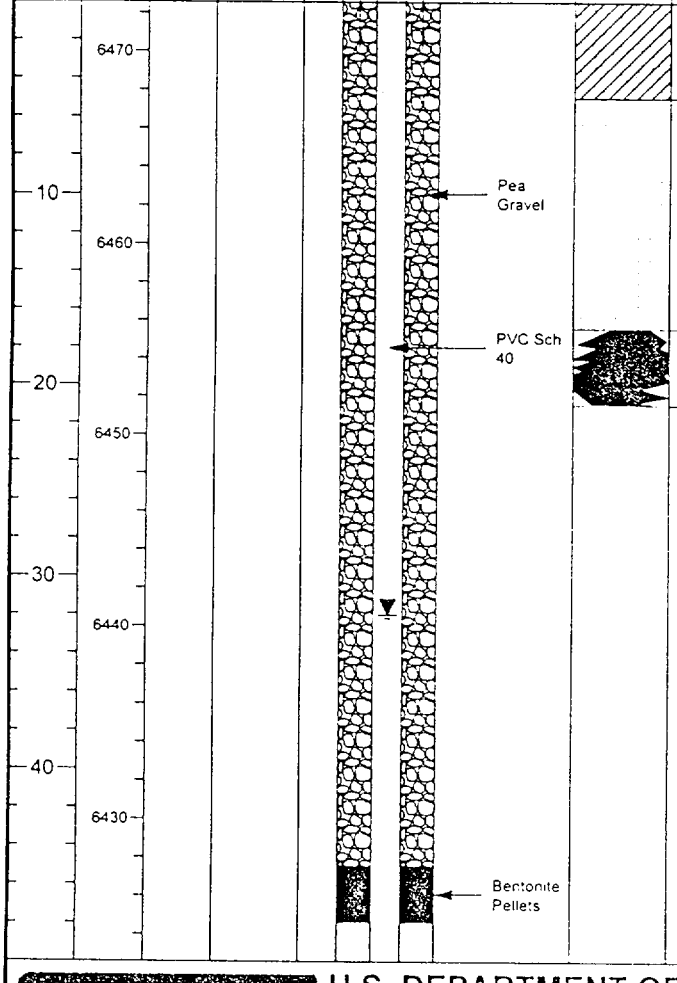
MONITORING WELL COMPLETION LOG DUR02-0610

PROJECT	UMTRA GROUND WATER	NORTH COORD. (FT)	1224076.50	DATE DRILLED	10/10/1982
LOCATION	DURANGO, CO	EAST COORD. (FT)	2308320.82	SURFACE ELEV. (FT NGVD)	6472.60
SITE	DURANGO RAFFINATE PONDS	HOLE DEPTH (FT)	101.00	TOP OF CASING (FT)	6472.80
WELL NUMBER	0610	WELL DEPTH (FT)	81.00	MEAS. PT. ELEV. (FT)	6472.80
				SLOT SIZE (IN)	0.050
				BIT SIZE(S) (IN)	5.63

	WELL INSTALLATION	INTERVAL (FT)		
SURFACE CASING:				
BLANK CASING:	4 in. PVC Sch 40	-0.2	to	65.0
WELL SCREEN:	4 in. Slotted PVC	65.0	to	80.0
SUMP/END CAP:				
SURFACE SEAL:				
GROUT:	Pea Gravel	0.0	to	45.0
SEAL:	Bentonite Pellets	45.0	to	48.0
UPPER PACK:				
LOWER PACK:	6-10 Silica Sand	48.0	to	81.0

DRILLING METHOD CORE/ROTARY
SAMPLING METHOD
DATE DEVELOPED
WATER LEVEL (FT BGS) 32.0 on 04/18/1983
LOGGED BY
REMARKS

DEPTH (FT BGL)	ELEV. (FT NGVD)	BLOW COUNTS	SAMPLE ID	EXTENT	WELL DIAGRAM	GRAPHIC LOG	LITHOLOGIC DESCRIPTION
	6470						0-5 ft. ALLUVIUM (SC). Undifferentiated, assume clayey sand.
10	6460				Pea Gravel		5-17 ft. CRETACEOUS MENEFEE FORMATION. Sandstone, medium grained, massive bedded, becoming shaley in bottom half of bed.
20	6450				PVC Sch 40		17-21 ft. COAL 21-74 ft. SANDSTONE, medium grained, massive bedded with minor cross bedding, occasional thin shale interbeds
30	6440						
40	6430				Bentonite Pellets		



MONITORING WELL COMPLETION LOG DUR02-0623

PROJECT	UMTRA GROUND WATER	NORTH COORD. (FT)	1223823.26	DATE DRILLED	10/10/1982
LOCATION	DURANGO, CO	EAST COORD. (FT)	2308060.46	SURFACE ELEV. (FT NGVD)	6483.50
SITE	DURANGO RAFFINATE PONDS	HOLE DEPTH (FT)	30.00	TOP OF CASING (FT)	6484.00
WELL NUMBER	0623	WELL DEPTH (FT)	29.00	MEAS. PT. ELEV. (FT)	6484.00
				SLOT SIZE (IN)	0.050
				BIT SIZE(S) (IN)	7.75

	WELL INSTALLATION	INTERVAL (FT)		
SURFACE CASING:				
BLANK CASING:	4 in. PVC Sch 40	-0.5	to	21.0
WELL SCREEN:	4 in. Slotted PVC	21.0	to	26.0
SUMP/END CAP:	4 in. PVC Sch 40	26.0	to	29.0
SURFACE SEAL:				
GROUT:	Pea Gravel	0.0	to	18.0
SEAL:	Bentonite Pellets	18.0	to	19.5
UPPER PACK:				
LOWER PACK:	6-10 Silica Sand	19.5	to	29.0

DRILLING METHOD CORE/ROTARY
SAMPLING METHOD
DATE DEVELOPED
WATER LEVEL (FT BGS) 15.9 on 04/18/1983
LOGGED BY
REMARKS

DEPTH (FT BGL)	ELEV (FT NGVD)	BLOW COUNTS	SAMPLE ID	EXTENT	WELL DIAGRAM	GRAPHIC LOG	LITHOLOGIC DESCRIPTION
							0-2 ft. FILL, Undifferentiated
	6480				Pea Gravel		2-8 ft. ALLUVIUM (CL), Soil, undifferentiated. Assume as silty clay for this log.
10							8-24 ft. ALLUVIUM (SC), Undifferentiated, assume as clayey sand for this log.
	6470				PVC Sch 40		
20					Bentonite Pellets; 6-10 Silica Sand		
	6460				0.050" Slotted Well Screen		24-26 ft. GRAVEL (GM)
							26-30 ft. CRETACEOUS MENEFEE FORMATION, Shale grey
30					Cuttings from reaming		Total Depth 30 ft
	6450						
40							
	6440						

MONITORING WELL COMPLETION LOG DUR02-0624

PROJECT	UMTRA GROUND WATER	NORTH COORD. (FT)	1223631.06	DATE DRILLED	10/10/1982
LOCATION	DURANGO, CO	EAST COORD. (FT)	2308107.22	SURFACE ELEV. (FT NGVD)	6487.30
SITE	DURANGO RAFFINATE PONDS	HOLE DEPTH (FT)	138.00	TOP OF CASING (FT)	6487.80
WELL NUMBER	0624	WELL DEPTH (FT)	138.00	MEAS. PT. ELEV. (FT)	6487.80
				SLOT SIZE (IN)	0.050
				BIT SIZE(S) (IN)	5.63

	WELL INSTALLATION	INTERVAL (FT)			
SURFACE CASING:					
BLANK CASING:	4 in. PVC Sch 40	-0.5	to	123.0	
WELL SCREEN:	4 in. Slotted PVC	123.0	to	138.0	
SUMP/END CAP:					
SURFACE SEAL:					
GROUT:	Pea Gravel	0.0	to	116.0	
SEAL:	Bentonite Pellets	116.0	to	118.0	
UPPER PACK:					
LOWER PACK:	6-10 Silica Sand	118.0	to	138.0	

DRILLING METHOD CORE/ROTARY
SAMPLING METHOD
DATE DEVELOPED
WATER LEVEL (FT BGS) 22.2 on 04/18/1983
LOGGED BY
REMARKS

DEPTH (FT BGL)	ELEV. (FT NGVD)	BLOW COUNTS	SAMPLE ID	EXTENT	WELL DIAGRAM	GRAPHIC LOG	LITHOLOGIC DESCRIPTION
							0-19 ft ALLUVIUM/COLLUVIUM (SC), Undifferentiated, assume as clayey sand for this log.
10	6480						
	6470						
20							19-21 ft. GRAVEL (GM)
					PVC Sch 40		21-138 ft. CRETACEOUS MENEFEE FORMATION, Shale, sandy, grey.
30	6460						
40	6450						37-60 ft SANDSTONE, fine to medium grained, massive bedded, grey.
50	6440						
60	6430				Pea Gravel		60-75 ft SHALE, carbonaceous
70	6420						

MONITORING WELL COMPLETION LOG DUR02-0624

PROJECT UMTRA GROUND WATER **WELL NUMBER** 0624
SITE DURANGO RAFFINATE PONDS **DATES DRILLED** 10/10/1982

Continued from Previous Page

DEPTH (FT BGL)	ELEV. (FT NGVD)	BLOW COUNTS	SAMPLE ID	EXTENT	WELL DIAGRAM	GRAPHIC LOG	LITHOLOGIC DESCRIPTION
	6410						75-79 ft SANDSTONE, cross bedded
80							79-88 ft. INTERBEDDED SANDSTONE, Shale, Coal, Coaly Shales.
	6400						88-91 ft. SANDSTONE, fine to medium, massive
90							91-101 ft BASALT, dike intrusion along fault, altered, faulted
	6390						
100							101-123 ft. SANDSTONE, medium grained, dark grey
	6380						
110							
	6370				Bentonite Pellets		
120					6-10 Silica Sand		123-130 ft. BASALT, dike intrusion, faulted, with clay gouge, altered.
	6360						
130					0.050" Slotted PVC		130-138 ft. SHALE, sandy
	6350						
140							Total Depth 138 ft.
	6340						
150							
	6330						
160							
	6320						
170							

MONITORING WELL COMPLETION LOG DUR02-0625

PROJECT	UMTRA GROUND WATER	NORTH COORD. (FT)	1223752.33	DATE DRILLED	10/10/1982
LOCATION	DURANGO, CO	EAST COORD. (FT)	2308125.42	SURFACE ELEV. (FT NGVD)	6482.60
SITE	DURANGO RAFFINATE PONDS	HOLE DEPTH (FT)	30.00	TOP OF CASING (FT)	6483.30
WELL NUMBER	0625	WELL DEPTH (FT)	29.00	MEAS. PT. ELEV. (FT)	6483.30
				SLOT SIZE (IN)	0.050
				BIT SIZE(S) (IN)	7.75

	WELL INSTALLATION	INTERVAL (FT)		
SURFACE CASING:				
BLANK CASING:	4 in. PVC Sch 40	-0.7	to	19.0
WELL SCREEN:	4 in. Slotted PVC	19.0	to	24.0
SUMP/END CAP:				
SURFACE SEAL:				
GROUT:	Pea Gravel	0.0	to	14.0
SEAL:	Bentonite Pellets	14.0	to	15.0
UPPER PACK:	Pea Gravel	15.0	to	18.0
LOWER PACK:	6-10 Silica Sand	18.0	to	29.0

DRILLING METHOD CORE/ROTARY
SAMPLING METHOD
DATE DEVELOPED
WATER LEVEL (FT BGS) 14.6 on 04/18/1983
LOGGED BY
REMARKS

DEPTH (FT BGL)	ELEV. (FT NGVD)	BLOW COUNTS	SAMPLE ID.	EXTENT	WELL DIAGRAM	GRAPHIC LOG	LITHOLOGIC DESCRIPTION
	6480				Pea Gravel		0-19 FT. ALLUVIUM/COLLUVIUM (SC), Undifferentiated, assume as clayey sand.
10					PVC Sch 40		
	6470				Bentonite Pellets; Pea Gravel		
20					6-10 Silica Sand; 0.050" Slotted Well Screen		19-25 ft. GRAVEL (GM)
	6460						25-28 ft. CRETACEOUS MENEFEE FORMATION SANDSTONE, Medium grained, grey
30					Cave-in		Total Depth 30 ft
	6450						
40							
	6440						

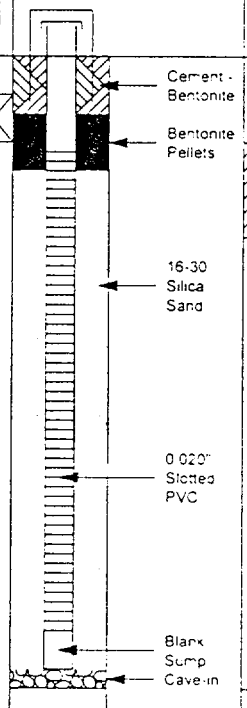
MONITORING WELL COMPLETION LOG DUR02-0628

PROJECT	UMTRA GROUND WATER	NORTH COORD. (FT)	1223642.19	DATE DRILLED	10/05/1993 to 10/07/1993
LOCATION	DURANGO, CO	EAST COORD. (FT)	2308266.93	SURFACE ELEV. (FT NGVD)	6470.30
SITE	DURANGO RAFFINATE PONDS	HOLE DEPTH (FT)	33.00	TOP OF CASING (FT)	6472.27
WELL NUMBER	0628	WELL DEPTH (FT)	32.00	MEAS. PT. ELEV. (FT)	6472.27
				SLOT SIZE (IN)	0.020
				BIT SIZE(S) (IN)	8.0

	WELL INSTALLATION	INTERVAL (FT)		
SURFACE CASING:				
BLANK CASING:	4 in. PVC Sch 40	-1.97	to	7.0
WELL SCREEN:	4 in. Slotted PVC	7.0	to	30.0
SUMP/END CAP:	4 in. PVC Sch 40	30.0	to	32.0
SURFACE SEAL:				
GROUT:	Cement - Bentonite	0.0	to	3.0
SEAL:	Bentonite Pellets	3.0	to	6.0
UPPER PACK:				
LOWER PACK:	16-30 Silica Sand	6.0	to	32.0

DRILLING METHOD: H.S.A./ROTARY/AIR
SAMPLING METHOD: SPLIT SPOON
DATE DEVELOPED:
WATER LEVEL (FT BGS):
LOGGED BY: D. Tarbox
REMARKS:

DEPTH (FT BGL)	ELEV (FT NGVD)	BLOW COUNTS	SAMPLE ID	EXTENT	WELL DIAGRAM	GRAPHIC LOG	LITHOLOGIC DESCRIPTION
							0-4.5 ft. ALLUVIUM, SILT (ML), little fine sand, occasional fine gravel, roots near surface, dense, light brown
							4.5-9.5 ft. ALLUVIUM, CLAYEY SAND (SC), coarse to fine, little coarse to fine gravel from 4.5 to 5.5 feet, low plasticity, light brown
10	6460						9.5-33 ft. CLIFF HOUSE SANDSTONE FORMATION (SP), fine, quartzose, moderate hard to hard, orange brown staining on partings, grey. Note: Becoming moderate hard to moderate soft from 20 feet.
20	6450						Damp at 24.5 feet. Groundwater flow into well 26.3 to 27.3 at 0.48 gpm, from 26.3 to 24.15 flow is 0.89 gpm
30	6440						
40	6430						Total Depth 33 ft



MONITORING WELL COMPLETION LOG DUR02-0875

PROJECT	UMTRA GROUND WATER	NORTH.COORD. (FT)	1222397.72	DATE DRILLED	10/03/2000 to 10/04/2000
LOCATION	DURANGO, CO	EAST COORD. (FT)	2307536.15	SURFACE ELEV. (FT NGVD)	6549.65
SITE	DURANGO RAFFINATE PONDS	HOLE DEPTH (FT)	126.00	TOP OF CASING (FT)	6551.26
WELL NUMBER	0875	WELL DEPTH (FT)	122.50	MEAS. PT. ELEV. (FT)	6551.26
				SLOT SIZE (IN)	0.020
				BIT SIZE(S) (IN)	6.0

	WELL INSTALLATION	INTERVAL (FT)		
SURFACE CASING:				
BLANK CASING:	2 in. PVC Sch 40	-1.61	to	82.0
WELL SCREEN:	2 in. Vee Wire Wrapped	82.0	to	122.0
SUMP/END CAP:	2 in. PVC Sch 40	122.0	to	122.5
SURFACE SEAL:				
GROUT:	Enviroplug	0.0	to	71.9
SEAL:	Bentonite Pellets	74.2	to	78.0
UPPER PACK:	30-70 Silica Sand	78.0	to	80.3
LOWER PACK:	10-20 Silica Sand	80.3	to	126.0

DRILLING METHOD ROTASONIC
SAMPLING METHOD GRAB
DATE DEVELOPED
WATER LEVEL (FT BGS)
LOGGED BY Goodknight, C.
REMARKS This will be background well for Point Lookout SS formation. Centralizers at top and bottom of screen. Filter Pack (30-70 Sand) from 71.9 to 74.2 ft.

DEPTH (FT BGL)	ELEV. (FT NGVD)	BLOW COUNTS	SAMPLE ID.	EXTENT	WELL DIAGRAM	GRAPHIC LOG	LITHOLOGIC DESCRIPTION
5	6545						0-12 ft. COLLUVIUM (Qc): SILTY SAND (SM), mottled, very pale brown (10YR 7/4) and red yellow (7.5YR 6/6), dry, some clasts of deeply weathered sandstone and black carbonaceous shale.
10	6540						
15	6535						12-16 ft. FILL black, coaly, sooty material, former ground surface during milling, and mottled yellow, red, tan, and black sand and silt.
20	6530				PVC Sch 40		16-32 ft TERRACE ALLUVIUM (Qt) GRAVEL (GW), approximately 70% gravel and cobbles up to 6 inches diameter and 30% medium grained sand.
25	6525		24-26 ft.				25-26 ft a Sandstone boulder of Menefee Formation, fine grained, weathered, dark yellowish orange (10YR 6/6)
30	6520						
35	6515				Enviroplug		32-65.5 ft MENEFEE FORMATION 32-35 ft SANDSTONE, weathered bedrock, appears to be Menefee Formation, but was mostly lost. 35-39 ft IGNEOUS Diorite porphyry dike, very hard at 37.0-39.0 ft. Some limonitic alteration and fracturing, medium dark gray (N4) in fresh rock, high specific gravity.
	6510		36-38 ft				39-42 ft SANDSTONE, medium grained altered, soft, limonite

MONITORING WELL COMPLETION LOG DUR02-0875

PROJECT UMTRA GROUND WATER **WELL NUMBER** 0875
SITE DURANGO RAFFINATE PONDS **DATES DRILLED** 10/03/2000 to 10/04/2000

Continued from Previous Page

DEPTH (FT BGL)	ELEV. (FT NGVD)	BLOW COUNTS	SAMPLE ID.	EXTENT	WELL DIAGRAM	GRAPHIC LOG	LITHOLOGIC DESCRIPTION
			39-41 ft.				along fractures. 20 degree fracture. pale yellowish brown (10 YR 6/2). crossbedded.
			42-44 ft.				42-50 ft. SHALE. carbonaceous. soft. medium dark gray (N4). some limonite alteration along fractures. much of this interval was lost.
45	6505						
50	6500						50-53 ft. SHALE. dark gray to black. medium dark gray (N4). near vertical fractures coated with limonite. baked nearly to hornfels.
			53-54 ft.				53-61 ft. SANDSTONE. fine grained. altered to hornfels. vertical fractures with limonitic coatings. blocky structures of recovered material. some carbonaceous material along bedding. medium light gray (N6).
55	6495		54-56 ft.				55-61 ft. layer becomes fine-medium grained carbonaceous sandstone. crossbedded.
60	6490						
							61-63 ft. SILTSTONE; dark gray to black carbonaceous siltstone and shale with some coal.
65	6485		64-65 ft.				63-65.5 ft. COAL; black. Core recovered is powdery, dry.
			67-69 ft.				65.5-126 ft. POINT LOOKOUT SANDSTONE. massive. fine grained. pale brown (5YR 5/2). some horizontal bedding and some inclined bedding. Steep fractures at 71.0 ft. and 74.0 ft (about 80 degrees). but they are tight (no alteration)
70	6480						
					30-70 Silica Sand		
75	6475				Bentonite Pellets		
					30-70 Silica Sand		78 ft. layer is mostly fine grained sandstone (some medium grained also). crossbedded. medium light gray (N6)
80	6470						
			81-82 ft.				
					10-20 Silica Sand		
85	6465				0.020" Wire Wrap		
90	6460						

MONITORING WELL COMPLETION LOG DUR02-0875

PROJECT UMTRA GROUND WATER **WELL NUMBER** 0875
SITE DURANGO RAFFINATE PONDS **DATES DRILLED** 10/03/2000 to 10/04/2000

Continued from Previous Page

DEPTH (FT BGL)	ELEV. (FT NGVD)	BLOW COUNTS	SAMPLE ID.	EXTENT	WELL DIAGRAM	GRAPHIC LOG	LITHOLOGIC DESCRIPTION
95	6455		93-94 ft.				
							96 ft. woody coal fragment. 97 ft. 50 degree inclined joint. Crossbeds inclined up to 30-35 degrees. Sandstone is medium gray (N5), wet color.
100	6450						
			102-103 ft				
105	6445						105 ft. dry color of sandstone is light gray (N7) to medium light gray (N6).
110	6440						
115	6435						
			117-118 ft.				117 ft. bedding becomes more nearly horizontal. Trace carbonaceous material along bedding ~117.0-119.0 ft.
120	6430						
			122-123 ft				122-122.5 ft. layer is fine grained sandstone to siltstone that contains carbonaceous material, medium gray (N5) 122.5-126 ft. SHALE total depth of core was 126 ft., but 122.5 to 126 ft. was not recovered, it is believed to be a shaley sequence because facies change that was starting at 122.0 ft and the sequence at South Creek below the massive sandstone of the upper Point Lookout Sandstone.
125	6425						
							Total Depth 126.0 ft
130	6420						
135	6415						
140	6410						

MONITORING WELL COMPLETION LOG DUR02-0876

PROJECT	UMTRA GROUND WATER	NORTH COORD. (FT)	1223013.65	DATE DRILLED	11/02/2000 to 11/07/2000
LOCATION	DURANGO, CO	EAST COORD. (FT)	2307874.30	SURFACE ELEV. (FT NGVD)	6490.70
SITE	DURANGO RAFFINATE PONDS	HOLE DEPTH (FT)	115.00	TOP OF CASING (FT)	6490.62
WELL NUMBER	0876	WELL DEPTH (FT)	75.00	MEAS. PT. ELEV. (FT)	6490.62
				SLOT SIZE (IN)	0.020
				BIT SIZE(S) (IN)	6.0

	WELL INSTALLATION	INTERVAL (FT)		
SURFACE CASING:				
BLANK CASING:	2 in. PVC Sch 40	0.08	to	54.5
WELL SCREEN:	2 in. Vee Wire Wrapped	54.5	to	74.5
SUMP/END CAP:	2 in. PVC Sch 40	74.5	to	75.0
SURFACE SEAL:				
GROUT:	Enviroplug	0.0	to	44.3
SEAL:	Bentonite Pellets	46.0	to	51.0
UPPER PACK:	30-70 Silica Sand	51.0	to	52.9
LOWER PACK:	10-20 Silica Sand	52.9	to	115.0

DRILLING METHOD ROTASONIC
SAMPLING METHOD GRAB
DATE DEVELOPED
WATER LEVEL (FT BGS)
LOGGED BY Goodknight, C
REMARKS Centralizers at both ends of screen
Bodo Fault was indistinct in hole, but was ~60 ft. below which was in Point Lookout SS fm. no igneous dike material found. Filter Pack (30-70 Sand) from 44.3 to 46.0 ft.

DEPTH (FT BGL)	ELEV. (FT NGVD)	BLOW COUNTS	SAMPLE ID	EXTENT	WELL DIAGRAM	GRAPHIC LOG	LITHOLOGIC DESCRIPTION
	6490						0-1 ft. SILT (ML), brown (7.5YR 4/4), a few small pebbles and rock fragments.
							1-6 ft. FILL, some sand, mainly silty sand, yellowish brown (10YR 5/4), with some reddish brick material ~5.0 to 6.0 ft.
5	6485						
							6-17 ft. FILL GRAVEL (GW), cobble to boulder gravel with sand matrix, large cobbles of granite, some reddish material (probably brick fragments), mostly fill.
10	6480				PVC Sch 40		9-17 ft. fill contains pebbles and cobbles in gravel with sand matrix, some reddish fragments of brick material, and black coal or ash fragments.
15	6475						
							17-20 ft. SANDY GRAVEL (GP), brown (10YR 5/3), thin veneer of former terrace gravel deposit.
20	6470				Enviroplug		20-60 ft. MENEFEE FORMATION 20-29 ft. SANDSTONE, fine grained weathered, moderate yellowish brown (10YR 5/4), limonitic stain (tan-orange) along fractures, calcareous 22 ft. layer below 22.0 ft is hard, medium gray (N5) High angle limonitic coloration, moderate brown (5YR 4/4) at 24.0 to 25.0 ft 25-27 ft. layer has 70 degree fracture, coated with limonite with some slickensides, slightly calcareous
			23-24 ft				
25	6465		26-27 ft				
30	6460						29-30 ft. SHALE, alternating beds of siltstone and shale (medium dark gray (N4)) 30-31 ft. SANDSTONE fine grained with 70 degree fracture. 31-34 ft. SILTSTONE, horizontally fractured, carbonaceous, medium gray (N5).
35	6455		34-35 ft				34-38.5 ft. SHALE, alternating fine grained sandstone, carbonaceous, and carbonaceous siltstone and shale, dark gray (N3) for shale portion.
			39-40 ft				38.5-60 ft. SANDSTONE, fine grained with trace of carbonaceous

MONITORING WELL COMPLETION LOG DUR02-0876

PROJECT UMTRA GROUND WATER **WELL NUMBER** 0876
SITE DURANGO RAFFINATE PONDS **DATES DRILLED** 11/02/2000 to 11/07/2000

Continued from Previous Page

DEPTH (FT BGL)	ELEV. (FT NGVD)	BLOW COUNTS	SAMPLE ID	EXTENT	WELL DIAGRAM	GRAPHIC LOG	LITHOLOGIC DESCRIPTION
	6450						clasts. 90 degree fracture at 39-40 ft coated with pyrite 40-60 ft. fine grained sandstone of Menefee Formation medium light gray (N6). 70 degree fracture with pyrite coating at 41.0 ft and 42.0 ft.
45	6445		45-46 ft		30-70 Silica Sand		45 ft. 45 degree fracture. 46-47 ft. 70 degree fracture with pyrite. sandstone is baked and brittle.
					Bentonite Pellets		46 ft. 60 degree fracture. 48 ft. 30 degree fracture.
50	6440				30-70 Silica Sand		48-49 ft. Interval has several fractures coated with pyrite and one hackly vertical fracture. 52-53 ft. 60 degree fracture.
55	6435		56-57 ft.		10-20 Silica Sand		56 ft. 60 degree fracture with pyrite. 58 ft. 60 degree fracture with pyrite. Position of main Bodo Fault estimated at about 60 ft.
60	6430		61-62 ft		0.020" Wire Wrap		60-115 ft. POINT LOOKOUT SANDSTONE 60-91 ft. SANDSTONE, fine to very fine grained, and some silty shale. 60-62 ft. layer has alternating thin beds of fine grained sandstone and silty shales (with bioturbation) abundant pyrite in horizontal and high angle fractures.
65	6425						62-63 ft. sandstone layer is fine grained. 63-67 ft. layer becomes alternating thin beds of fine grained sandstone and darker medium dark gray (N4) silty shale, wavy bedding. 65-66 ft. 60 degree fracture with pyrite.
70	6420						67-77 ft. ~ 8 ft. recovered in more horizontal fractured interval, mainly alternating thin beds of fine grained sandstone and carbonaceous silty shale, abundant rip up clasts of silty shale in the sandstone beds 70.0 and 74.0 ft. 60 degree fractures, trace pyrite along fractures.
75	6415		76-77 ft				77-87 ft. ~ 8 ft. recovered, lost in 77.0 to 80.0 ft. interval in horizontal fractured thin beds of fine grained sandstone and silty shale, bioturbated.
80	6410						80-80.5 ft. thin fine grained sandstone bed. 81-83 ft. layer becomes soft sediment deformation, carbonaceous material throughout along bedding surfaces in alternating thin beds of sandstone and silty shale.
85	6405		84-85 ft				
90	6400						88.5-91 ft. layer becomes massive very fine grained sandstone, medium dark gray (N4).

MONITORING WELL COMPLETION LOG DUR02-0876

PROJECT UMTRA GROUND WATER **WELL NUMBER** 0876

SITE DURANGO RAFFINATE PONDS **DATES DRILLED** 11/02/2000 to 11/07/2000

Continued from Previous Page

DEPTH (FT BGL)	ELEV. (FT NGVD)	BLOW COUNTS	SAMPLE ID.	EXTENT	WELL DIAGRAM	GRAPHIC LOG	LITHOLOGIC DESCRIPTION
							91-93 ft. SHALE. horizontally fractured silty shale. dark gray (N3).
			93-94 ft.				93-97 ft. SANDSTONE, massive. fine grained medium dark gray (N4). trace of carbonaceous material and pyrite. rough. hackly. near vertical fracture at 93.0 ft.
95	6395						
							97-115 ft. SHALE. approximately 7.5 ft. recovered. in run to 107.0 ft. mostly silty shale. medium gray (N5). horizontal fracturing common at 98.0 ft. and 100.0 ft.. 100.5 ft. high angle fracture. 103-104 ft. rough. hackly fracture.
100	6390						
			103-104 ft.				
105	6385						
							107-115 ft. approximately 5 ft. recovered. 108-109 ft. thin sandstone layer. very fine grained. calcareous. trace of pyrite. medium gray (N5) 109-115 ft. mostly alternating thin beds of bioturbated silty shale and shale. 110-112 ft. horizontal and high angle fractures. 114 ft. bioturbated. 115 ft. in silty shale of middle part of Point Lookout Sandstone formation.
110	6380		109-110 ft.				
115	6375						Total Depth 115.0 ft.
120	6370						
125	6365						
130	6360						
135	6355						
140	6350						

MONITORING WELL COMPLETION LOG DUR02-0878

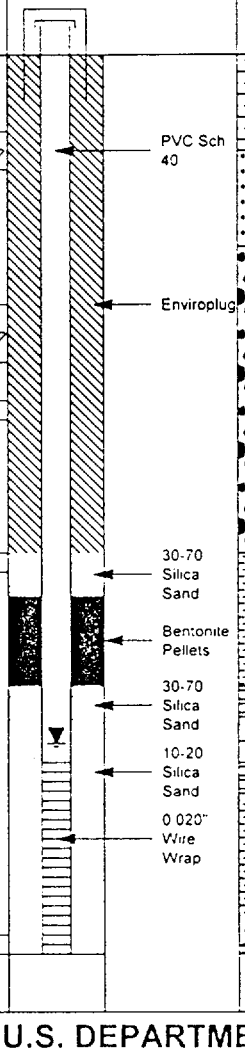
PROJECT	UMTRA GROUND WATER	NORTH COORD. (FT)	1222910.07	DATE DRILLED	09/24/2000
LOCATION	DURANGO, CO	EAST COORD. (FT)	2308065.51	SURFACE ELEV. (FT NGVD)	6486.51
SITE	DURANGO RAFFINATE PONDS	HOLE DEPTH (FT)	47.00	TOP OF CASING (FT)	6486.50
WELL NUMBER	0878	WELL DEPTH (FT)	47.00	MEAS. PT. ELEV. (FT)	6486.50
				SLOT SIZE (IN)	0.020
				BIT SIZE(S) (IN)	6.0

	WELL INSTALLATION	INTERVAL (FT)		
SURFACE CASING:				
BLANK CASING:	2 in. PVC Sch 40	0.01	to	37.0
WELL SCREEN:	2 in. Vee Wire Wrapped	37.0	to	46.5
SUMP/END CAP:	2 in. PVC Sch 40	46.5	to	47.0
SURFACE SEAL:				
GROUT:	Enviroplug	0.0	to	26.0
SEAL:	Bentonite Pellets	28.25	to	33.0
UPPER PACK:	30-70 Silica Sand	33.0	to	35.0
LOWER PACK:	10-20 Silica Sand	35.0	to	47.0

DRILLING METHOD ROTASONIC
SAMPLING METHOD GRAB
DATE DEVELOPED
WATER LEVEL (FT BTOC) 36.0 on 09/24/2000
LOGGED BY Kautsky, M
REMARKS 30-70 sand pack from 26.0 to 28.25 ft.

DEPTH (FT BGL)	ELEV. (FT NGVD)	BLOW COUNTS	SAMPLE ID	EXTENT
	6480		4-6 ft.	
10				
	6470		13-16 ft.	
			18-19 ft	
20				
	6460		26-27 ft	
30				
	6450			
40				
	6440		46-47 ft	

WELL DIAGRAM



GRAPHIC LOG

LITHOLOGIC DESCRIPTION

0-5 ft. SANDY SILT (ML), dark gray (10YR 4/2) medium stiff, moist, with yellow (10YR 8/6), deeply weathered sandstone clasts.

5-10 ft. GRAVELLY SAND (SW), very dark gray brown (10YR 3/2) moist, medium dense.

10-26 ft. SANDY GRAVEL (GW), brown (7.5YR 4/4), moist, medium dense, ~10% fines

17-26 ft. more coarse with no fines.

26-47 ft MENEFEE FORMATION
26-33 ft SILTSTONE, gray (7.5YR, N 7/0 to N 6/0), fine sandy siltstone with silty shale interbeds, individual siltstone beds are strong, fresh with wavy laminations individual siltstone beds are 1 to 2 inches thick, siltstone to shale ratio is ~ 10:1.

33-35 ft. SHALE, carbonaceous shale zone.

35-37 ft CLAYSTONE, dark gray (10YR 4/2)

37-39 ft. SHALE, gray (7.5YR N 7/0)

39-45 ft SILTSTONE, gray (7.5YR N 7/0), fine grained sandy siltstone containing thin laminae of dark gray (10YR 4/2) claystone.

45-47 ft COAL, black (2.5YR N 2.5/0).

Total Depth 47.0 ft

MONITORING WELL COMPLETION LOG DUR02-0879

PROJECT	UMTRA GROUND WATER	NORTH COORD. (FT)	1223319.95	DATE DRILLED	10/22/2000
LOCATION	DURANGO, CO	EAST COORD. (FT)	2308225.69	SURFACE ELEV. (FT NGVD)	6473.90
SITE	DURANGO RAFFINATE PONDS	HOLE DEPTH (FT)	37.00	TOP OF CASING (FT)	6473.91
WELL NUMBER	0879	WELL DEPTH (FT)	37.00	MEAS. PT. ELEV. (FT)	6473.91
				SLOT SIZE (IN)	0.020
				BIT SIZE(S) (IN)	6.0

	WELL INSTALLATION	INTERVAL (FT)		
SURFACE CASING:				
BLANK CASING:	2 in. PVC Sch 40	-0.01	to	27.0
WELL SCREEN:	2 in. Vee Wire Wrapped	27.0	to	36.9
SUMP/END CAP:	2 in. PVC Sch 40	36.9	to	37.0
SURFACE SEAL:				
GROUT:	Enviroplug	0.0	to	15.8
SEAL:	Bentonite Pellets	18.0	to	22.6
UPPER PACK:	30-70 Silica Sand	22.6	to	25.2
LOWER PACK:	10-20 Silica Sand	25.2	to	37.0

DRILLING METHOD ROTASONIC
SAMPLING METHOD GRAB
DATE DEVELOPED
WATER LEVEL (FT BTOC) 35.6 on 10/22/2000
LOGGED BY Kautsky, M.
REMARKS 30-70 sand pack from 15.8 to 18.0 ft

DEPTH (FT BGL)	ELEV. (FT NGVD)	BLOW COUNTS	SAMPLE ID	EXTENT	WELL DIAGRAM	GRAPHIC LOG	LITHOLOGIC DESCRIPTION
							0-6 ft. SILTY SAND (SM), dark gray brown (10YR 4/2) with occasional, large cobbles.
5	6470				PVC Sch 40		
10	6465				Enviroplug		6-37 ft. MENEFEE FORMATION. 6-10 ft. SANDSTONE, pale yellow orange (10YR 8/6) deeply weathered. 6.5-7 ft. white (N 9) deeply weathered. 7-10 ft. lost, assumed to be weathered Menefee Formation 10-21 ft. light gray (N 7) medium grained sandstone, medium grained with medium gray (N 5) laminations of carbonaceous material, 2.0 to 3.0 ft. thick beds. 16.5-17 ft. 45 degree fracture with ferric oxyhydroxide staining along fracture surface.
15	6460						
			16.5-17 ft		30-70 Silica Sand		
20	6455				Bentonite Pellets		21-26.5 ft. SILTSTONE, dark gray (N3), hard, well cemented, with fractured zone at 24.0 ft., contains contorted bedding zones
			23-24 ft		30-70 Silica Sand		
25	6450				10-20 Silica Sand		26.5-30 ft. SANDSTONE, light gray (N 7) medium grained hard, laminated with carbonaceous material, wavy bedding
30	6445				0.020" Wire Wrap		30-37 ft. COAL, Black (N 0), lost approximately 5.0 ft. of interval, suspect it to be largely coal and carbonaceous shale, coal seam apparently producing water.
			33-34 ft				
35	6440						
	6435						Total Depth 37.0 ft.

MONITORING WELL COMPLETION LOG DUR02-0880

PROJECT	UMTRA GROUND WATER	NORTH COORD. (FT)	1223879.37	DATE DRILLED	10/21/2000
LOCATION	DURANGO, CO	EAST COORD. (FT)	2308181.65	SURFACE ELEV. (FT NGVD)	6469.67
SITE	DURANGO RAFFINATE PONDS	HOLE DEPTH (FT)	37.00	TOP OF CASING (FT)	6469.50
WELL NUMBER	0880	WELL DEPTH (FT)	37.00	MEAS. PT. ELEV. (FT)	6469.50
				SLOT SIZE (IN)	0.020
				BIT SIZE(S) (IN)	6.0

	WELL INSTALLATION	INTERVAL (FT)		
SURFACE CASING:				
BLANK CASING:	2 in. PVC Sch 40	0.17	to	27.0
WELL SCREEN:	2 in. Vee Wire Wrapped	27.0	to	36.9
SUMP/END CAP:	2 in. PVC Sch 40	36.9	to	37.0
SURFACE SEAL:				
GROUT:	Enviroplug	0.0	to	16.5
SEAL:	Bentonite Pellets	18.1	to	23.4
UPPER PACK:	30-70 Silica Sand	23.4	to	25.2
LOWER PACK:	10-20 Silica Sand	25.2	to	37.0

DRILLING METHOD	ROTASONIC
SAMPLING METHOD	GRAB
DATE DEVELOPED	
WATER LEVEL (FT BGS)	
LOGGED BY	Kautsky M.
REMARKS	30-70 sand pack from 16.5 to 18.1 ft.

DEPTH (FT BGL)	ELEV. (FT NGVD)	BLOW COUNTS	SAMPLE ID.	EXTENT	WELL DIAGRAM	GRAPHIC LOG	LITHOLOGIC DESCRIPTION
							0-2 ft. SILTY SAND (SM), brown (7.5 YR 3/4) moist, loose.
5	6465				PVC Sch 40		2-37 ft. MENEFEE FORMATION. SANDSTONE, very light gray (N 8) bedded 1 inch to 12 inch thick, contains medium gray (N 5) lamination and occasional carbonaceous material, deeply weathered to dark yellow orange (10YR 6/6) in some beds with 45 degree fractures at 5.0 to 6.0 ft. 9.0 ft. ferric oxyhydroxide staining.
					Enviroplug		
10	6460						9-14 ft. becomes very light gray (N8) to light gray (N7) medium grained massive bedded sandstone, well cemented, with occasional ripup clasts of dark gray carbonaceous shale.
15	6455		14-16 ft.				14-17 ft. has several 45 degree fractures.
					30-70 Silica Sand		17-25 ft. becomes light gray (N7) medium grained sandstone well cemented, with 45 degree fractures at 22.0 ft and 25.0 ft. Fractures are stained with ferric oxyhydroxide.
20	6450		19-20 ft		Bentonite Pellets		
25	6445				30-70 Silica Sand		25-37 ft well cemented, with occasional ripup clasts of carbonaceous shale 29-30 ft vertical fracture 32 ft vertical fracture 33-34 ft 45 degree fractures 37 ft vertical fracture Bedding breaks at 4-12 inch intervals, limonite stains absent, zone is making water
					10-20 Silica Sand		
30	6440				0.020" Wire Wrap		
35	6435		36-37 ft				
	6430						Total Depth 37.0 ft

MONITORING WELL COMPLETION LOG DUR02-0881

PROJECT	UMTRA GROUND WATER	NORTH COORD. (FT)	1224138.45	DATE DRILLED	10/21/2000
LOCATION	DURANGO, CO	EAST COORD. (FT)	2308059.84	SURFACE ELEV. (FT NGVD)	6466.48
SITE	DURANGO RAFFINATE PONDS	HOLE DEPTH (FT)	37.00	TOP OF CASING (FT)	6466.22
WELL NUMBER	0881	WELL DEPTH (FT)	37.00	MEAS. PT. ELEV. (FT)	6466.22
				SLOT SIZE (IN)	0.020
				BIT SIZE(S) (IN)	6.0

	WELL INSTALLATION	INTERVAL (FT)		
SURFACE CASING:				
BLANK CASING:	2 in. PVC Sch 40	0.26	to	27.0
WELL SCREEN:	2 in. Vee Wire Wrapped	27.0	to	36.9
SUMP/END CAP:	2 in. PVC Sch 40	36.9	to	37.0
SURFACE SEAL:				
GROUT:	Enviroplug	0.0	to	17.0
SEAL:	Bentonite Pellets	19.0	to	23.0
UPPER PACK:	30-70 Silica Sand	23.0	to	25.0
LOWER PACK:	10-20 Silica Sand	25.0	to	37.0

DRILLING METHOD ROTASONIC
SAMPLING METHOD GRAB
DATE DEVELOPED
WATER LEVEL (FT BGS)
LOGGED BY Kautsky, M
REMARKS Filter Pack (30-70 Sand) from 17.0 to 19.0 ft.

DEPTH (FT BGL)	ELEV. (FT NGVD)	BLOW COUNTS	SAMPLE ID.	EXTENT	WELL DIAGRAM	GRAPHIC LOG	LITHOLOGIC DESCRIPTION
							0-3 ft. SILTY SAND (SM), dark brown (7.5 YR 3/4) moist loose.
5	6465				PVC Sch 40		3-37 ft. POINT LOOKOUT SANDSTONE (Kpl) 3-17 ft. SILTSTONE, alternating thinly bedded light gray (N 7) calcareous siltstone and medium gray siltstone with individual beds from 1/2 cm to 2-3 cm each, deeply weathered to depth of 5 ft. subhorizontal fractures prevalent to depth of ~12 ft., then absent below that.
10	6460				Enviroplug		
15	6455						
20	6450				30-70 Silica Sand		17-17.25 ft. CLAYSTONE, 3 inch thick bed 17.25-37 ft SILTSTONE, bedding is wavy below 18.0 ft., assumed to be bioturbated.
25	6445				Bentonite Pellets		22-24 ft. Few vertical fractures some filled with calcareous cement, others open.
30	6440				30-70 Silica Sand		
35	6435				10-20 Silica Sand		
	6430				0.020" Wire Wrap		33-37 ft Subvertical fractures
							Total Depth 37.0 ft.

MONITORING WELL COMPLETION LOG DUR02-0882

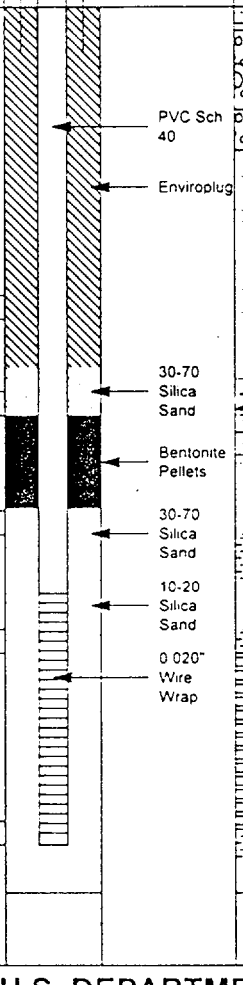
PROJECT	UMTRA GROUND WATER	NORTH COORD. (FT)	1223330.73	DATE DRILLED	11/08/2000
LOCATION	DURANGO, CO	EAST COORD. (FT)	2308551.33	SURFACE ELEV. (FT NGVD)	6469.20
SITE	DURANGO RAFFINATE PONDS	HOLE DEPTH (FT)	37.00	TOP OF CASING (FT)	6471.10
WELL NUMBER	0882	WELL DEPTH (FT)	35.00	MEAS. PT. ELEV. (FT)	6471.10
				SLOT SIZE (IN)	0.020
				BIT SIZE(S) (IN)	6.0

	WELL INSTALLATION	INTERVAL (FT)		
SURFACE CASING:				
BLANK CASING:	2 in. PVC Sch 40	-1.9	to	24.5
WELL SCREEN:	2 in. Vee Wire Wrapped	24.5	to	34.5
SUMP/END CAP:	2 in. PVC Sch 40	34.5	to	35.0
SURFACE SEAL:				
GROUT:	Enviroplug	0.0	to	15.0
SEAL:	Bentonite Pellets	17.0	to	20.9
UPPER PACK:	30-70 Silica Sand	20.9	to	23.0
LOWER PACK:	10-20 Silica Sand	23.0	to	35.0

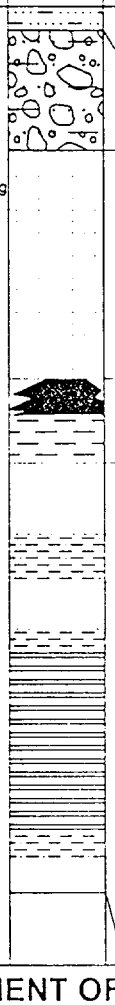
DRILLING METHOD: ROTASONIC
SAMPLING METHOD: GRAB
DATE DEVELOPED:
WATER LEVEL (FT BGS):
LOGGED BY: Goodknight, C.
REMARKS: Centralizers at top and bottom of screen. Filter pack (30-70 sand) from 15.0 to 17.0 ft

DEPTH (FT BGL)	ELEV. (FT NGVD)	BLOW COUNTS	SAMPLE ID.	EXTENT
5	6465			
10	6460			
			12-13 ft.	
15	6455			
			16-17 ft.	
20	6450			
			21-22 ft.	
25	6445			
			26-27 ft.	
30	6440			
35	6435		34-35 ft.	
	6430			

WELL DIAGRAM



GRAPHIC LOG



LITHOLOGIC DESCRIPTION

0-1 ft. SILTY SOIL (ML), dark brown (7.5YR 3/4) some brick fragments.

1-6 ft. SILTY GRAVEL (GM), light yellowish brown (10YR 6/4) some cobbles up to 1.0 ft. diameter, corresponds to (Qt_1), from CGS mapping and to "t7u" from Gillam (1998).

6-37 ft. MENEFEE FORMATION.
6-15 ft. SANDSTONE, at 6.0 to 8.0 ft. is weathered fine grained sandstone, brownish yellow (10YR 6/6), some carbonaceous material, soft.
8-15.5 ft. fine grained sandstone, yellowish gray (5Y 7/2), with mats of black carbonaceous material, some crossbedding, weathered slightly down to ~11.0 ft., some void space and some bioturbated bedding.

15.5-17 ft. COAL, coal and carbonaceous shale, grayish black (N2).

17-19 ft. CLAYSTONE, medium dark gray (N4) grading downward to siltstone.

19-22 ft. SANDSTONE, fine grained with trace carbonaceous material and pyrite, numerous fractures with hematite/limonite, and trace pyrite coating, medium gray (N5).

22-24 ft. SILTSTONE, yellowish gray (5Y 7/2) to light olive gray (5Y 5/2), noncalcareous.

24-26 ft. SANDSTONE, fine grained, medium light gray (N6), trace carbonaceous material, high angle limonitic alteration.

26-27 ft. SILTSTONE, medium dark gray (N4), trace pyrite, 60 degree fracture at 26.5 with limonite coating.
27-34.5 ft. Interval not recovered, believed to be carbonaceous shale and coaly interval because of ease of drilling and black drill returns.

34.5-35.5 ft. SILTSTONE, medium gray (N5), abundant carbonaceous fragments.
35.5-37 ft. SANDSTONE, fine grained, medium light gray (N6) high angle limonite coated fracture, moderate carbonaceous material. At TD, in middle part of Menefee Formation.

Total Depth 37.0 ft

MONITORING WELL COMPLETION LOG DUR02-0883

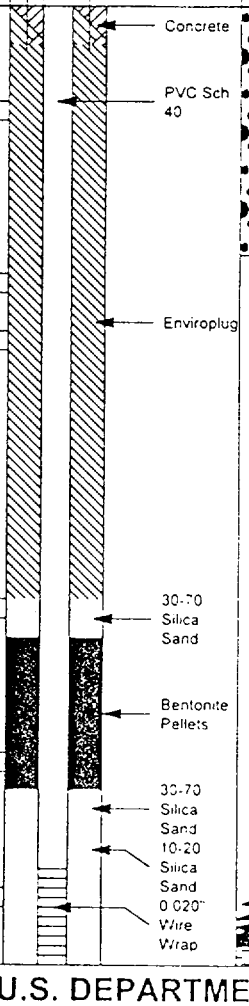
PROJECT	UMTRA GROUND WATER	NORTH COORD. (FT)	1223123.74	DATE DRILLED	10/20/2000
LOCATION	DURANGO, CO	EAST COORD. (FT)	2308348.38	SURFACE ELEV. (FT NGVD)	6477.72
SITE	DURANGO RAFFINATE PONDS	HOLE DEPTH (FT)	57.00	TOP OF CASING (FT)	6480.11
WELL NUMBER	0883	WELL DEPTH (FT)	55.00	MEAS. PT. ELEV. (FT)	6480.11
				SLOT SIZE (IN)	0.020
				BIT SIZE(S) (IN)	6.0

WELL INSTALLATION		INTERVAL (FT)		
SURFACE CASING:				
BLANK CASING:	2 in. PVC Sch 40	-2.39	to	45.0
WELL SCREEN:	2 in. Vee Wire Wrapped	45.0	to	55.0
SUMP/END CAP:	2 in. PVC Sch 40	55.0	to	55.25
SURFACE SEAL:	Concrete	0.0	to	2.0
GROUT:	Enviroplug	2.0	to	31.0
SEAL:	Bentonite Pellets	33.0	to	40.92
UPPER PACK:	30-70 Silica Sand	40.92	to	42.83
LOWER PACK:	10-20 Silica Sand	42.83	to	55.0

DRILLING METHOD: ROTASONIC
SAMPLING METHOD: GRAB
DATE DEVELOPED:
WATER LEVEL (FT BGS):
LOGGED BY: Kautsky, M.
REMARKS: 30-70 sand pack from 31.0 to 33.0 ft

DEPTH (FT BGL)	ELEV. (FT NGVD)	BLOW COUNTS	SAMPLE ID	EXTENT
	6470		5-6 ft.	
10				
			14-15 ft	
	6460		17-18 ft.	
20				
	6450			
30			31-32 ft.	
	6440			
40			39-40 ft.	
	6430		46-47 ft.	

WELL DIAGRAM



GRAPHIC LOG

LITHOLOGIC DESCRIPTION

0-13 ft. SILTY SANDY GRAVEL (GW), brown (7.5YR 4/2) loose, moist.

10-12 ft. soil becomes pink, dry, loose.

12-13 ft. soil becomes brown (7.5YR 4/2) loose, moist.

13-57 ft. MENEFEE FORMATION.
13-46 ft. SANDSTONE, medium gray (N5) silty sandstone, deeply weathered and fractured to 17.0 ft., contains interbeds of claystone.

17-23 ft. medium light gray (N6) medium grained sandstone with dark gray (N2) ripup clasts of organic debris, thickly bedded and cross laminated occasionaly with medium gray (N5) organic enriched zones.

23-32 ft. alternating beds of medium gray (N5) sandstone and gray (N4) shale/claystone with 45 degree fracture at 30 ft and 32 ft., with occasional black ripup clasts

32-37 ft. zone is well cemented, hard, medium gray

37-46 ft. becomes medium light gray (N6) medium grained sandstone in beds 2 inches to 3 ft in thickness, cross laminated with organic debris and containing black ripup clasts occasionally.

46-49 ft. COAL, black (N0), lost interval to ~49 ft. estimated to be comprised of coal

MONITORING WELL COMPLETION LOG DUR02-0883

PROJECT UMTRA GROUND WATER **WELL NUMBER** 0883
SITE DURANGO RAFFINATE PONDS **DATES DRILLED** 10/20/2000

Continued from Previous Page

DEPTH (FT BGL)	ELEV. (FT NGVD)	BLOW COUNTS	SAMPLE ID.	EXTENT	WELL DIAGRAM	GRAPHIC LOG	LITHOLOGIC DESCRIPTION
			53-54 ft.				49-57 ft. SILTSTONE, dark gray (N3), carbonaceous with wavy bedding. 54-57 ft becomes interbedded medium gray (N5) siltstone and claystone.
	6420						Total Depth 57.0 ft.
60							
	6410						
70							
	6400						
80							
	6390						
90							
	6380						
100							
	6370						
110							

MONITORING WELL COMPLETION LOG DUR02-0884

PROJECT	UMTRA GROUND WATER	NORTH COORD. (FT)	1222824.23	DATE DRILLED	11/09/2000
LOCATION	DURANGO, CO	EAST COORD. (FT)	2308488.43	SURFACE ELEV. (FT NGVD)	6476.31
SITE	DURANGO RAFFINATE PONDS	HOLE DEPTH (FT)	47.00	TOP OF CASING (FT)	6476.37
WELL NUMBER	0884	WELL DEPTH (FT)	47.00	MEAS. PT. ELEV. (FT)	6476.37
				SLOT SIZE (IN)	0.020
				BIT SIZE(S) (IN)	6.0

	WELL INSTALLATION	INTERVAL (FT)		
SURFACE CASING:				
BLANK CASING:	2 in. PVC Sch 40	-0.06	to	36.5
WELL SCREEN:	2 in. Vee Wire Wrapped	36.5	to	46.5
SUMP/END CAP:	2 in. PVC Sch 40	46.5	to	47.0
SURFACE SEAL:				
GROUT:	Enviroplug	0.0	to	27.0
SEAL:	Bentonite Pellets	29.0	to	33.4
UPPER PACK:	30-70 Silica Sand	33.4	to	35.0
LOWER PACK:	10-20 Silica Sand	35.0	to	47.0

DRILLING METHOD ROTASONIC
SAMPLING METHOD GRAB
DATE DEVELOPED
WATER LEVEL (FT BGS)
LOGGED BY Goodknight, C
REMARKS Filter Pack (30-70 Sand) from 27.0 to 29.0 ft.

DEPTH (FT BGL)	ELEV. (FT NGVD)	BLOW COUNTS	SAMPLE ID	EXTENT	WELL DIAGRAM	GRAPHIC LOG	LITHOLOGIC DESCRIPTION
							0-3 ft. SILTY SOIL (ML), brown (10YR 5/3), some organic debris and fill. 2-3 ft. compacted base of soil material.
	6470				PVC Sch 40		3-7 ft. FILL. SILTY GRAVEL (GM), light yellowish grown (10YR 6/4), pebbles and cobbles up to 1.0 ft. diameter.
10							7-12 ft. FILL. SILTSTONE, weathered siltstone fragments, olive brown (2.5Y 4/3) with more gravelly material and brick fragments at 10.0 ft to 12.0 ft. marking base of fill material.
					Enviroplug		12-14 ft. SILTY GRAVEL (GM), light gray (10YR 7/2). Corresponds to Qt. from CGS maps and to t7u from Gillam (1998)
							14-16 ft. SANDY GRAVEL (GP), yellowish brown (10 YR 5/6).
	6460						16-47 ft. MENEFEE FORMATION.
			18-19 ft.				16-39 ft. SANDSTONE, weathered fine grained, light gray (N6), some carbonaceous material, trace pyrite, slightly calcareous, limonite stained fractures in weathered zone at 18.0 to19.0 ft 20 degree fracture at 18.5 ft, several thin <1 inch shaley beds, some crossbedding and bioturbation at ~21.0 ft. some shale/clay ripup clasts, becomes massive and unweathered below ~19.0 ft.
20							
	6450				30-70 Silica Sand		27-30 ft color change to medium light gray (N6)
30			30-31 ft		Bentonite Pellets		30-33 ft carbonaceous mats form partings, more abundant pyrite is common along these partings.
					30-70 Silica Sand		33-35.5 ft. more carbonaceous material and some limonitic alteration
	6440		36-37 ft		10-20 Silica Sand		35.5-39 ft fine grained sandstone cuts into silty sandstone interval below medium gray (N5).
40			39-40 ft.		0.020" Wire Wrap		39-41 ft. SILTSTONE, medium dark gray (N4) noncalcareous.
							41-47 ft COAL, small amount of coal recovered, lost interval is believed to be soft, fractured coal and carbonaceous shale in upper part of Menefee Formation
	6430						47 ft in carbonaceous shale and coal of upper part of Menefee Formation
							Total Depth 47.0 ft.

MONITORING WELL COMPLETION LOG DUR02-0886

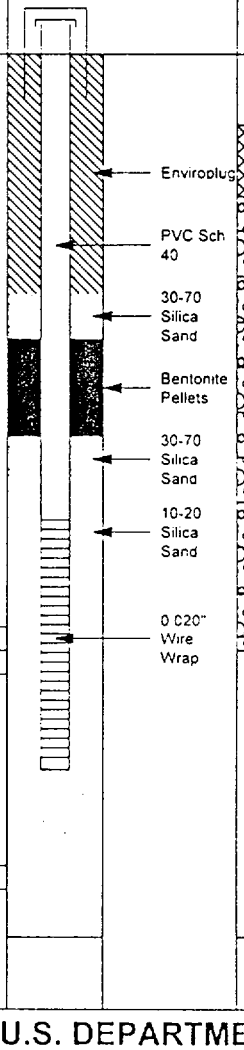
PROJECT	UMTRA GROUND WATER	NORTH COORD. (FT)	1222253.79	DATE DRILLED	11/07/2000 to 11/08/2000
LOCATION	DURANGO, CO	EAST COORD. (FT)	2308266.33	SURFACE ELEV. (FT NGVD)	6483.66
SITE	DURANGO RAFFINATE PONDS	HOLE DEPTH (FT)	37.00	TOP OF CASING (FT)	6485.16
WELL NUMBER	0886	WELL DEPTH (FT)	30.00	MEAS. PT. ELEV. (FT)	6485.16
				SLOT SIZE (IN)	0.020
				BIT SIZE(S) (IN)	6.0

	WELL INSTALLATION	INTERVAL (FT)		
SURFACE CASING:				
BLANK CASING:	2 in. PVC Sch 40	-1.5	to	19.5
WELL SCREEN:	2 in. Vee Wire Wrapped	19.5	to	29.5
SUMP/END CAP:	2 in. PVC Sch 40	29.5	to	30.0
SURFACE SEAL:				
GROUT:	Enviroplug	0.0	to	10.0
SEAL:	Bentonite Pellets	11.9	to	16.0
UPPER PACK:	30-70 Silica Sand	16.0	to	17.9
LOWER PACK:	10-20 Silica Sand	17.9	to	37.0

DRILLING METHOD ROTASONIC
SAMPLING METHOD GRAB
DATE DEVELOPED
WATER LEVEL (FT BGS)
LOGGED BY Goodknight, C
REMARKS Drilled to 37.0 ft. on 11/7. Completed on 11/8. Centralizers both ends of screen. Filter Pack (30-70 Sand) placed from 10.0 to 11.9 ft

DEPTH (FT BGL)	ELEV. (FT NGVD)	BLOW COUNTS	SAMPLE ID	EXTENT
5	6480			
10	6475			
15	6470			
20	6465			
25	6460		24-25 ft 25-26 ft	
30	6455			
35	6450		34-35 ft	
	6445			

WELL DIAGRAM



GRAPHIC LOG

LITHOLOGIC DESCRIPTION

0-3 ft. TOP SOIL.
SILT (MH), soil material, dark yellowish brown (10YR 4/4), mottled, some rock fragments.

3-6 ft. FILL, some red brick fragments, coarse sand matrix with some silt.

6-25 ft. SILTY GRAVEL (GM), cobbles up to 1.0 ft. diameter of sedimentary, igneous, and metamorphic rocks, brown (10YR 4/3), ~60% cobbles and pebbles. Terrace deposit that corresponds to "l7u" as mapped by Gillian (1998) and is late Pleistocene in age.

15-25 ft. layer is mainly large cobbles.

25-37 ft. CLIFF HOUSE SANDSTONE
SANDSTONE, very fine grained with some alternating silty beds, bioturbated, medium-gray (N5) to medium dark gray (N4). Trace of pyrite and some carbonaceous material. Darker beds are finer grained, slightly calcareous, and silty with trace of carbonaceous material where more horizontal fracturing occurs. Some horizontal fracturing at 30.0 ft. and from 33.0-35.0 ft.

Total Depth 37.0 ft.

MONITORING WELL COMPLETION LOG DUR02-0887

PROJECT	UMTRA GROUND WATER	NORTH COORD. (FT)	1223632.22	DATE DRILLED	10/09/2000 to 10/10/2000
LOCATION	DURANGO, CO	EAST COORD. (FT)	2308060.36	SURFACE ELEV. (FT NGVD)	6472.38
SITE	DURANGO RAFFINATE PONDS	HOLE DEPTH (FT)	96.00	TOP OF CASING (FT)	6472.14
WELL NUMBER	0887	WELL DEPTH (FT)	93.20	MEAS. PT. ELEV. (FT)	6472.14
				SLOT SIZE (IN)	0.020
				BIT SIZE(S) (IN)	6.0

	WELL INSTALLATION	INTERVAL (FT)		
SURFACE CASING:				
BLANK CASING:	2 in. PVC Sch 40	0.24	to	82.7
WELL SCREEN:	2 in. Vee Wire Wrapped	82.7	to	92.7
SUMP/END CAP:	2 in. PVC Sch 40	92.7	to	93.2
SURFACE SEAL:				
GROUT:	Enviroplug	0.0	to	72.5
SEAL:	Bentonite Pellets	74.0	to	78.9
UPPER PACK:	30-70 Silica Sand	78.9	to	81.5
LOWER PACK:	10-20 Silica Sand	81.5	to	96.0

DRILLING METHOD ROTASONIC
SAMPLING METHOD GRAB
DATE DEVELOPED
WATER LEVEL (FT BGS)
LOGGED BY Goodknight C.
REMARKS Drilled to 45.5 ft. on 10/9. Set well on 10/10. Screened at lower Bodo Fault (diorite porphyry, fractured, altered silty shales) in lower Point Lookout SS Fm. Centralizers at top and bottom of screen.

DEPTH (FT BGL)	ELEV. (FT NGVD)	BLOW COUNTS	SAMPLE ID.	EXTENT	WELL DIAGRAM	GRAPHIC LOG	LITHOLOGIC DESCRIPTION
	6470						0-2 ft. TOP SOIL. SILT (MH), dark yellowish brown (10YR 4/4).
							2-9 ft. SANDY GRAVEL (GW), some cobbles-up to 8 inch diameter-mostly granite and metamorphic rocks. Corresponds to late Pleistocene terrace gravel ($t7_2$) as mapped by Gillam (1998). Large granite boulder cored for ~ 3.0 ft.
10	6460						9-64 ft. MENEFEE FORMATION. 9-17 ft. SILTSTONE, weathered, medium gray (N5), bioturbated bedding, trace of carbonaceous material. Layer becomes less weathered below 15.0 ft. Low angle (10 degree) fracture with limonite at 16.0 ft.
20	6450		20-21 ft 23-24 ft 25-26 ft				17-23 ft. SANDSTONE, fine grained, crossbedded, medium gray (N5), 80 degree fracture and coated with limonite at 20-21 ft.. 21-23 ft. layer becomes highly fractured with black material on surfaces and some void space along fractures-indicative of baking. Layer becomes metamorphosed at 22.0 ft. and is contact zone of baked sandstone and dike. 23-28 ft. IGNEOUS, layer is a dike composed of diorite porphyry, medium light gray (N6), some light grayish yellow green (5GY 7/2) propylitic alteration (this may be hornblende altering to chlorite), white phenocrysts
30	6440		29-30 ft		Enviroplug		28-30 ft. SANDSTONE, fine grained, crossbedded, high angle fractures with black coatings, baked, some void spaces along fracture. 30-32 ft. Lost. Probable highly fractured interval. 32-39 ft. SANDSTONE, near vertical, limonite-coated fractures at 32.0 ft., some pyrite in vugs and nodules, sandstone is baked and crossbedded
40	6430		39-40 ft 41-42 ft				38-39 ft. 45 degree fracture and altered with limonite. 40-40.3 ft. SHALE, thin carbonaceous shale bed, medium dark gray (N4). 40.3-64 ft. SANDSTONE, medium light gray (N6), mainly horizontal bedded with trace to ~1% carbonaceous material along bedding. Sandstone appears not to be altered or baked. Sandstone is mainly medium gray (N5) with horizontal bedding that has numerous light fractures. 46 ft. 45 degree fracture

MONITORING WELL COMPLETION LOG DUR02-0887

PROJECT UMTRA GROUND WATER **WELL NUMBER** 0887
SITE DURANGO RAFFINATE PONDS **DATES DRILLED** 10/09/2000 to 10/10/2000

Continued from Previous Page

DEPTH (FT BGL)	ELEV. (FT NGVD)	BLOW COUNTS	SAMPLE ID.	EXTENT	WELL DIAGRAM	GRAPHIC LOG	LITHOLOGIC DESCRIPTION
	6420		52-53 ft.				49 ft. 20 degree fracture. 51 ft. 45 degree fracture. 53 ft. thin (1-2 inch) zone of rip-up clasts of shale in the sandstone
60					PVC Sch 40		57 ft. sandstone becomes more fractured and crossbedded. trace of carbonaceous material along bedding.
	6410		61-62 ft.				61-62 ft. sandstone has a hackly 60 degree fracture coated with black sooty material.
			64-65 ft. 65-66 ft.				62-63 ft. fracturing common-appears to be Bodo fault zone. 64-96 ft. POINT LOOKOUT SANDSTONE 64-72 ft. SILTSTONE, dense, medium light gray (N6) siltstone that has been altered to hornfels, some fracturing with calcite. This is Lower part of Point Lookout Sandstone formation. 65-66 ft. 60 degree fracture with some void space
70			70-71 ft.				67-72 ft. some core loss, interbedded siltstone, medium light gray (N6) and shale, dark gray (N3), both brittle lithologies.
	6400				30-70 Silica Sand		72-85 ft. SANDSTONE, layer mainly fine grained sandstone, medium gray (N5), crossbedded, trace carbonaceous material, some contorted bedding in darker gray thin shaley layers.
			76-77 ft.		Bentonite Pellets		72.50-74.00 ft. Centralizer. Filter Pack 30-70 Sand 75 ft. 60 degree fracture.
			78-79 ft.				77 ft. (some core loss down to ~85 ft.). Layer becomes medium gray (N5) and dark gray (N3) silty shale layers in a bioturbated mixture.
80					30-70 Silica Sand		
	6390				10-20 Silica Sand		83 ft. some void space– core loss indicates some fracturing becomes more shaley below ~83 ft
			85-86 ft.				85-87 ft. SILTSTONE, dark shale and siltstone with pyrite nodules along vertical fracture, medium gray (N5), and white calcite also along vertical fractures.
			87-88 ft.		0.020" Wire Wrap		87-89 ft. IGNEOUS, Diorite porphyry. Color ranges from medium gray (N5) in porpyritic parts to light brownish gray (5YR6/1) in fine grained part of dike near margin. Some prophylitic alteration
90							
	6380		93-94 ft.				89-96 ft. SHALE, silty shale, dark gray (N3), baked to hornfels, well fractured (lost about 3 ft of core through this 89-96 ft. interval), white coating along fractures (vertical) are gypsum and calcite. Pyrite fairly common in this interval. Baked silty shale (hornfels) of lower part of Point Lookout Sandstone formation
							Total Depth 96.0 ft
100							
	6370						
110							
	6360						

MONITORING WELL COMPLETION LOG DUR02-0888

PROJECT	UMTRA GROUND WATER	NORTH COORD. (FT)	1223599.49	DATE DRILLED	10/10/2000 to 10/12/2000
LOCATION	DURANGO, CO	EAST COORD. (FT)	2308130.37	SURFACE ELEV. (FT NGVD)	6471.07
SITE	DURANGO RAFFINATE PONDS	HOLE DEPTH (FT)	148.00	TOP OF CASING (FT)	6471.04
WELL NUMBER	0888	WELL DEPTH (FT)	148.00	MEAS. PT. ELEV. (FT)	6471.04
				SLOT SIZE (IN)	0.020
				BIT SIZE(S) (IN)	6.0

	WELL INSTALLATION	INTERVAL (FT)		
SURFACE CASING:				
BLANK CASING:	2 in. PVC Sch 40	0.03	to	133.0
WELL SCREEN:	2 in. Vee Wire Wrapped	133.0	to	147.5
SUMP/END CAP:	2 in. PVC Sch 40	147.5	to	148.0
SURFACE SEAL:				
GROUT:	Enviroplug	0.0	to	123.0
SEAL:	Bentonite Pellets	125.0	to	129.0
UPPER PACK:	30-70 Silica Sand	129.0	to	131.0
LOWER PACK:	10-20 Silica Sand	131.0	to	148.0

DRILLING METHOD ROTASONIC
SAMPLING METHOD GRAB
DATE DEVELOPED
WATER LEVEL (FT BGS)
LOGGED BY Goodknight, C.
REMARKS Drilled to 23 ft. on 10/10, 123 ft. on 10/11; 148 ft on 10/12 and, set on 10/17. Screen set in Bodo fault zone in Menefee FM (fine grained SS Siltstone, fractured). Centralizers at both ends of screen.

DEPTH (FT BGL)	ELEV. (FT NGVD)	BLOW COUNTS	SAMPLE ID	EXTENT	WELL DIAGRAM	GRAPHIC LOG	LITHOLOGIC DESCRIPTION
	6470						0-1 ft. SILT (ML), dark yellowish brown (10YR 4/4)
							1-2.5 ft. SILTY GRAVEL (GM)
							2.5-8 ft. FILL: assorted fill material consisting of gravel, old brick, sandstone pieces, sand and silt, generally brown to brick red.
10	6460						8-148 ft. MENEFEE FORMATION 8-19 ft. SILTSTONE, some shale, carbonaceous, medium gray (N5) to medium dark gray (N4), weathered from 8.0 ft. to ~12 ft. Wavy bedding, well cemented from 12.0 ft. to 17 ft.
							17-19 ft. gradually coarsens to fine grained sandstone, 80 degree fracture at 18.0 ft.
20	6450		22-23 ft.				19-52 ft. SANDSTONE, fine grained, medium gray (N5), trace of carbonaceous material, mostly horizontal bedding, few thin shaley layers. Crossbedding in some places.
30	6440						27-37 ft. layer is essentially the same as above-poor recovery (only ~5.0 ft.)
40	6430						37-52 ft. layer has sporadic thin (<1") carbonaceous partings. Trace of carbonaceous material along bedding.

MONITORING WELL COMPLETION LOG DUR02-0888

PROJECT	UMTRA GROUND WATER	WELL NUMBER	0888
SITE	DURANGO RAFFINATE PONDS	DATES DRILLED	10/10/2000 to 10/12/2000

Continued from Previous Page

DEPTH (FT BGL)	ELEV. (FT NGVD)	BLOW COUNTS	SAMPLE ID.	EXTENT	WELL DIAGRAM	GRAPHIC LOG	LITHOLOGIC DESCRIPTION
	6420						52-53 ft. SHALE, some silt, dark gray, wavy bedding, rip up clasts 53-65 ft. SANDSTONE, fine grained, trace of carbonaceous material along bedding and in thin partings
60	6410				Enviroplug		
							63-65 ft. layer has abundant shale clasts and some gray chert pebbles. 65-66 ft. CLAYSTONE, high specific gravity (possibly some sulfides), light brownish gray (5YR 6/1). 66-126 ft. SANDSTONE, fine grained, trace of carbonaceous material. 68-69 ft. uneven fractured with some void space.
70	6400						72-74 ft. lost-believed to be soft shale interval.
			74-75 ft.				74-75 ft. layer becomes dark gray (N3) in color (wet) with some siltstone. 75-82 ft. fine grained sandstone becomes darker-medium dark gray (N4). 77-78 ft. uneven hackly fracture with void spaces. 79-80 ft. 75 degree fracture with more uneven fractures scattered throughout.
80	6390						82-87 ft. more even bedded, medium gray (N5), few to no fractures.
							87-97 ft. even bedded and crossbedded.
90	6380				PVC Sch 40		
			92-93 ft.				91-92 ft. 80 degree fracture 92-93 ft. 80 degree fracture with white gypsum or calcite on surface with trace of pyrite. No open fractures.
100	6370						99.5 ft. some horizontal fractures. 102 ft. 45 degree fracture 103.5 ft. some horizontal fractures and filled burrows. Sandstone layer becoming medium dark gray (N4). 106.5-107 ft. 75 degree fracture.
110	6360						112.5 ft. 60 degree fracture

MONITORING WELL COMPLETION LOG DUR02-0888

PROJECT UMTRA GROUND WATER **WELL NUMBER** 0888
SITE DURANGO RAFFINATE PONDS **DATES DRILLED** 10/10/2000 to 10/12/2000

Continued from Previous Page

DEPTH (FT BGL)	ELEV. (FT NGVD)	BLOW COUNTS	SAMPLE ID.	EXTENT	WELL DIAGRAM	GRAPHIC LOG	LITHOLOGIC DESCRIPTION
120	6350						115-115.5 ft. 60 degree and 30 degree fractures, respectively. 117 ft. some clay pellets. 117.5 ft. 60 degree fracture. 119 ft. 45 degree fracture. 120 ft. becomes lighter in color below 120 ft. to medium light gray (N6).
					30-70 Silica Sand		123-125 ft. Centralizer: Filter Pack 30-70 Sand
			125-126 ft 127-1278 ft 128-129 ft		Bentonite Pellets		125-126 ft. altered and black to dark gray (N3) and 50-60 degree fractures with white fillings of calcite or gypsum 126-127 ft. IGNEOUS, diorite porphyry dike, medium dark gray (N4) and medium light gray (N6) along margins.
130	6340				30-70 Silica Sand		127-148 ft. SANDSTONE, fine grained, trace of carbonaceous material. At 127.0 to 127.5, layer is altered black to dark gray (N3) and fractured. Below 127.5 ft. sandstone is lighter in color - medium gray (N5) to medium dark gray (N4). Hackly uneven fracture at 129.0 ft. Sandstone fractures vertical at 131.0 ft. and has a 45 degree fracture at 134.0 ft. 135.5-136 ft. thin shale or claystone layer, dark gray (N3). 136-137 ft. fractured interval.
					10-20 Silica Sand		
140	6330				0.020" Wire Wrap		139 ft. 45 degree fracture. 141-143 ft. near vertical fracture. 143 ft. 45 degree fracture and altered. 143-147 ft. poor recovery, soft zone. Believed to be alternating thin beds of dark gray very fine grained sandstone and siltstone of Menefee Formation.
			145-146 ft 147-148 ft				147-148 ft. becomes fine grained sandstone, medium dark gray (N4) in Menefee Formation.
150	6320						Total Depth 148.0 ft
160	6310						
170	6300						

MONITORING WELL COMPLETION LOG DUR02-0889

PROJECT	UMTRA GROUND WATER	NORTH COORD. (FT)	1224029.93	DATE DRILLED	10/22/2000 to 10/24/2000
LOCATION	DURANGO, CO	EAST COORD. (FT)	2308362.20	SURFACE ELEV. (FT NGVD)	6470.25
SITE	DURANGO RAFFINATE PONDS	HOLE DEPTH (FT)	97.00	TOP OF CASING (FT)	6472.00
WELL NUMBER	0889	WELL DEPTH (FT)	90.50	MEAS. PT. ELEV. (FT)	6472.00
				SLOT SIZE (IN)	0.020
				BIT SIZE(S) (IN)	6.0

	WELL INSTALLATION	INTERVAL (FT)		
SURFACE CASING:				
BLANK CASING:	2 in. PVC Sch 40	-1.75	to	80.0
WELL SCREEN:	2 in. Vee Wire Wrapped	80.0	to	90.0
SUMP/END CAP:	2 in. PVC Sch 40	90.0	to	90.5
SURFACE SEAL:				
GROUT:	Enviroplug	0.0	to	70.9
SEAL:	Bentonite Pellets	72.4	to	76.0
UPPER PACK:	30-70 Silica Sand	76.0	to	78.3
LOWER PACK:	10-20 Silica Sand	78.3	to	97.0

DRILLING METHOD ROTASONIC
SAMPLING METHOD GRAB
DATE DEVELOPED
WATER LEVEL (FT BGS)
LOGGED BY Goodknight, C.
REMARKS Drilled to 65 ft. on 10/22. Rig repairs on 10/23. Centralizers at both ends of screen. Filter Pack (30-70 Sand) from 70.9 to 72.4 ft

DEPTH (FT BGL)	ELEV. (FT NGVD)	BLOW COUNTS	SAMPLE ID.	EXTENT	WELL DIAGRAM	GRAPHIC LOG	LITHOLOGIC DESCRIPTION
							0-3 ft. SILT (ML), silty soil, dark brown (10YR 3/3), some fine grained sand.
							3-15 ft. MENEFEE FORMATION: 3-4 ft. COAL, weathered coal material, grayish black (N2) 4-9 ft. SANDSTONE, very weathered, moderate yellowish brown (10YR 5/4). 5-5.9 ft. layer is fine grained sandstone, dark yellowish brown (10YR 4/2). A 30 degree limonite stained fracture at 7.0 ft. Some weathering present with limonite staining on fractures, vertical fracture at 8.0 ft. 9-12 ft. SHALE, brownish gray (5YR 4/1) to dark gray (N3), soft, some may be claystone, trace of very fine grained sandstone. 12-15 ft. COAL, grayish black (N2).
10	6460						
			14-15 ft.				
			16-17 ft.				15-97 ft. POINT LOOKOUT SANDSTONE. 15-79 ft. SANDSTONE, fine grained with some fractures (mostly healed) medium dark gray (N4), trace of carbonaceous material. At 16-18 ft., there is a 70 degree fracture with apparent slicken sides. 18-79 ft. sandstone becomes massive, but with highly inclined healed fractures common. Medium gray (N5), trace of carbonaceous material defining bedding. Fractures numerous, but healed (no void space or alteration evident).
20	6450						
			25-26 ft.				
30	6440						
					Enviroplug		
			37-38 ft.				
40	6430						39 ft. two 60 degree fractures, one with void space 40 ft. medium dark gray (N4), trace of carbonaceous material on bedding surfaces and as stems or woody material
							46 ft., 60 degree fracture and coated with white calcite and trace of pyrite 48-51 ft. massively bedded.

MONITORING WELL COMPLETION LOG DUR02-0889

PROJECT UMTRA GROUND WATER **WELL NUMBER** 0889
SITE DURANGO RAFFINATE PONDS **DATES DRILLED** 10/22/2000 to 10/24/2000

Continued from Previous Page

DEPTH (FT BGL)	ELEV. (FT NGVD)	BLOW COUNTS	SAMPLE ID.	EXTENT	WELL DIAGRAM	GRAPHIC LOG	LITHOLOGIC DESCRIPTION
			52-53 ft.				51-52 ft. high angle (~60 degree) fracture with void space trace of carbonaceous material along bedding.
60	6410				PVC Sch 40		56 ft. thin shale (~6"), medium gray (N5), some siltstone also in this bed, noncalcareous. 57-64 ft. sandstone layer becomes fine grained with carbonaceous material.
							64 ft. horizontal fracturing. 65-69 ft. sandstone layer is mainly cross laminated.
70	6400		69-70 ft		30-70 Silica Sand Bentonite Pellets 30-70 Silica Sand		69-70 ft. near vertical fractures (uneven and hackly) with blebs of pyrite coating and some void space. 73-74 ft. layer has some carbonaceous material along inclined beds, medium dark gray (N4), bleb of pyrite at 73.8 ft., abrupt change at 74 ft.-layer becomes lighter colored sandstone, medium light gray, (N6).
80	6390		81-82 ft. 83-85 ft		10-20 Silica Sand 0.020" Wire Wrap		78 ft. high angle fracture (70 degree). 79-86 ft. SHALE, soft shaley material, light gray (N7) to medium light gray (N6). Loss of core (4 to 5 ft) in 79.0-86.0 ft interval. At 83.0 to 85.0 ft. layer is hard, porcelaneous, hornfels-like shale, medium gray (N5) to light gray (N6), horizontal fractures. Trace of carbonaceous material and pyrite.
90	6380						86-88 ft. SANDSTONE, medium light gray (N6) with trace of carbonaceous material and pyrite. 88-89 ft. SILTSTONE, dense, medium dark gray (N4), horizontal fractures, some void space 89-90 ft. SANDSTONE fine grained 90-91 ft. SILTSTONE, dense, medium dark gray (N4), horizontal fractures, some void space 91-97 ft SANDSTONE, fine grained medium gray (N5), trace of carbonaceous material and stems along bedding planes, even bedded, less carbonaceous material from 94.0 to 97.0 ft. Lower massive sandstone unit of Point Lookout Sandstone formation
			96-97 ft.				Total Depth 97.0 ft
100	6370						
110	6360						

MONITORING WELL COMPLETION LOG DUR02-0890

PROJECT	UMTRA GROUND WATER	NORTH COORD. (FT)	1222876.39	DATE DRILLED	09/24/2000
LOCATION	DURANGO, CO	EAST COORD. (FT)	2308073.33	SURFACE ELEV. (FT NGVD)	6487.40
SITE	DURANGO RAFFINATE PONDS	HOLE DEPTH (FT)	77.00	TOP OF CASING (FT)	6487.33
WELL NUMBER	0890	WELL DEPTH (FT)	73.00	MEAS. PT. ELEV. (FT)	6487.33
				SLOT SIZE (IN)	0.020
				BIT SIZE(S) (IN)	6.0

	WELL INSTALLATION	INTERVAL (FT)		
SURFACE CASING:				
BLANK CASING:	2 in. PVC Sch 40	0.07	to	63.0
WELL SCREEN:	2 in. Vee Wire Wrapped	63.0	to	72.5
SUMP/END CAP:	2 in. PVC Sch 40	72.5	to	73.0
SURFACE SEAL:				
GROUT:	Enviroplug	0.0	to	48.0
SEAL:	Bentonite Pellets	50.0	to	58.0
UPPER PACK:	30-70 Silica Sand	58.0	to	60.0
LOWER PACK:	10-20 Silica Sand	60.0	to	77.0

DRILLING METHOD	ROTASONIC
SAMPLING METHOD	GRAB
DATE DEVELOPED	
WATER LEVEL (FT BGS)	
LOGGED BY	Kautsky, M.
REMARKS	30-70 sand pack from 48.0 to 50.0 ft

DEPTH (FT BGL)	ELEV. (FT NGVD)	BLOW COUNTS	SAMPLE ID.	EXTENT	WELL DIAGRAM	GRAPHIC LOG	LITHOLOGIC DESCRIPTION
	6485						0-6 ft. FILL; contains sandy silt, dark gray brown (10YR 4/2) to yellow (10YR 8/6), medium stiff, moist sandy silt. Deeply weathered sandstone clasts to gravel size and black plastic and red brick fragments..
5							
	6480						6-10 ft. SILTY SAND (SM), very dark gray brown (10YR 3/2) with gravel, medium, dense, moist.
10							10-13 ft. GRAVEL (GW), boulders, dense, dry terrace gravel.
	6475						
			13-15 ft.				13-15 ft. GRAVELLY SAND (SW), red (10R 4/6), moist, medium dense.
15			15-17 ft.				15-77 ft. MENEFEE FORMATION. 15-16 ft. SHALE, dark gray (N 4/6) with silt 16-17 ft. SANDSTONE, fine grained, light gray (5YR 7/2) with strong brown (7.5 YR 5/8) specks to 1mm diameter in size. Weak to medium strong. 17-37 ft. SHALE, very dark gray (7.5YR 3/0) with silt, strong, dry, remains intact when drilled with water, crumbles otherwise Bedding is up to 2.0 ft thick.
	6470						
20							
	6465						
					Enviroplug		
25							
	6460						
30							
	6455						
					PVC Sch 40		
35							
	6450						37-42 ft. COAL, black, with sulfurous odor, very little recovery in this zone.

MONITORING WELL COMPLETION LOG DUR02-0891

PROJECT	UMTRA GROUND WATER	NORTH COORD. (FT)	1223321.81	DATE DRILLED	10/05/2000 to 10/07/2000
LOCATION	DURANGO, CO	EAST COORD. (FT)	2308211.58	SURFACE ELEV. (FT NGVD)	6473.49
SITE	DURANGO RAFFINATE PONDS	HOLE DEPTH (FT)	77.00	TOP OF CASING (FT)	6473.27
WELL NUMBER	0891	WELL DEPTH (FT)	75.00	MEAS. PT. ELEV. (FT)	6473.27
				SLOT SIZE (IN)	0.020
				BIT SIZE(S) (IN)	6.0

	WELL INSTALLATION	INTERVAL (FT)		
SURFACE CASING:				
BLANK CASING:	2 in. PVC Sch 40	0.22	to	64.5
WELL SCREEN:	2 in. Vee Wire Wrapped	64.5	to	74.5
SUMP/END CAP:	2 in. PVC Sch 40	74.5	to	75.0
SURFACE SEAL:				
GROUT:	Enviroplug	0.0	to	55.0
SEAL:	Bentonite Pellets	57.0	to	61.0
UPPER PACK:	30-70 Silica Sand	61.0	to	63.2
LOWER PACK:	10-20 Silica Sand	63.2	to	77.0

DRILLING METHOD ROTASONIC
SAMPLING METHOD GRAB
DATE DEVELOPED
WATER LEVEL (FT BGS)
LOGGED BY Goodknight, C
REMARKS Drilled to 67 ft. on 10/5. Completed Drilling to 77 ft on 10/7. Centralizers at top and bottom of screen.

DEPTH (FT BGL)	ELEV. (FT NGVD)	BLOW COUNTS	SAMPLE ID	EXTENT	WELL DIAGRAM	GRAPHIC LOG	LITHOLOGIC DESCRIPTION
							0-6 ft. FILL, soil, dark brown (10YR 3/3) with sandy silt (ML), wet/moist to 4.0 ft. Gravel at 1.0 to 3.0 ft. Dark yellowish brown (10YR 4/4) at 3.0 to 4.0 ft. Dark brown (10YR 3/3) at 5.0 to 6.0 ft.
5	6470						
							6-7 ft. SILTY GRAVEL (GM), mottled gray, brown, red, tan, pebbles up to 3" diameter.
							7-77 ft. MENEFEE FORMATION. 7-32 ft. SANDSTONE, weathered medium to fine grained with carbonaceous material, dark yellowish orange (10YR 6/6). Below 11.0 ft., sandstone becomes firm and unweathered, light gray (N7).
10	6465		11-12 ft.				
15	6460						
							17 ft. carbonaceous parting. 17.5 ft. near horizontal fractures. 18 ft. carbonaceous sandstone, fine grained, medium gray (N5) to medium dark gray (N4) with some coal fragments. 20-26 ft. bioturbated, very fine grained sandstone and carbonaceous siltstone, medium dark gray (N4) to dark gray (N5), some coal material.
20	6455		20-21 ft.				
25	6450						
					Enviroplug		26-27 ft. fine grained sandstone. 27-32 ft. contains carbonaceous shale, medium dark gray (N4). Low angle fracture (5 to 10 degrees) at 29.0 and 30.0 ft.
30	6445		29-30 ft.				
							32-37.5 ft. SHALE, black, carbonaceous and impure coal, grayish black (N2)
35	6440						
							37.5-77 ft. SANDSTONE, fine to very fine grained, olive gray (5Y 4/1).
	6435						

MONITORING WELL COMPLETION LOG DUR02-0891

PROJECT UMTRA GROUND WATER **WELL NUMBER** 0891
SITE DURANGO RAFFINATE PONDS **DATES DRILLED** 10/05/2000 to 10/07/2000

Continued from Previous Page

DEPTH (FT BGL)	ELEV. (FT NGVD)	BLOW COUNTS	SAMPLE ID.	EXTENT	WELL DIAGRAM	GRAPHIC LOG	LITHOLOGIC DESCRIPTION
			41-42 ft.				38.5-40.5 sandstone has carbonaceous material along bedding planes. 40.5 ft. thin shale parting. 41 ft. layer below this depth is massive sandstone with carbonaceous material along bedding as scattered flecks. color is light gray (N7) to medium light gray (N6) and the carbonaceous bedding planes are medium dark gray (N4). Predominantly planar bedding with only trace of carbonaceous material long core segments intact. well cemented. Trace of gray chert pieces up to 1/4" long at ~63.0 ft.
45	6430				PVC Sch 40		
50	6425						
55	6420						
			56-57 ft		30-70 Silica Sand		55-59 ft. Centralizer: Filter Pack 30-70 Sand.
60	6415				Bentonite Pellets		
					30-70 Silica Sand		
65	6410				10-20 Silica Sand		
							66-68 ft. layer becomes darker with 10% carbonaceous coal material. medium light gray (N6). Contorted bedding.
70	6405				0.020" Wire Wrap		68-71.5 ft. fine grained sand. medium light gray (N6) with trace of carbonaceous material. massive. mostly horizontal bedding
			72-73 ft				72-73 ft. massive fine grained sandstone with bedding inclined ~20 degrees.
75	6400						74.2-75.5 ft massive fine grained sandstone with chaotic bedding defined by carbonaceous shale clasts. 75.5-76.6 ft massive fine grained sandstone with trace of carbonaceous material. 76.6-76.7 dark gray shaley bed 76.7-77 massive fine grained sandstone with trace of carbonaceous material in lower part of Menefee Formation
80	6395						Total Depth 77.0 ft
85	6390						
90	6385						

MONITORING WELL COMPLETION LOG DUR02-0892

PROJECT	UMTRA GROUND WATER	NORTH COORD. (FT)	1223878.06	DATE DRILLED	10/07/2000 to 10/08/2000
LOCATION	DURANGO, CO	EAST COORD. (FT)	2308170.06	SURFACE ELEV. (FT NGVD)	6469.71
SITE	DURANGO RAFFINATE PONDS	HOLE DEPTH (FT)	85.00	TOP OF CASING (FT)	6469.49
WELL NUMBER	0892	WELL DEPTH (FT)	80.00	MEAS. PT. ELEV. (FT)	6469.49
				SLOT SIZE (IN)	0.020
				BIT SIZE(S) (IN)	6.0

	WELL INSTALLATION	INTERVAL (FT)		
SURFACE CASING:				
BLANK CASING:	2 in. PVC Sch 40	0.22	to	69.5
WELL SCREEN:	2 in. Vee Wire Wrapped	69.5	to	79.5
SUMP/END CAP:	2 in. PVC Sch 40	79.5	to	80.0
SURFACE SEAL:				
GROUT:	Enviroplug	0.0	to	59.8
SEAL:	Bentonite Pellets	61.3	to	66.5
UPPER PACK:	30-70 Silica Sand	66.5	to	68.0
LOWER PACK:	10-20 Silica Sand	68.0	to	85.0

DRILLING METHOD: ROTASONIC
SAMPLING METHOD: GRAB
DATE DEVELOPED:
WATER LEVEL (FT BGS):
LOGGED BY: Goodknight, C
REMARKS: Drilled to 59 ft on 10/7, set well on 10/8. Screened in Menefee Fm in lower part of Bodo fault zone. Centralizers at both ends of screen

DEPTH (FT BGL)	ELEV. (FT NGVD)	BLOW COUNTS	SAMPLE ID.	EXTENT	WELL DIAGRAM	GRAPHIC LOG	LITHOLOGIC DESCRIPTION
							0-2 ft. SANDY SILT (ML), dark yellowish brown (10YR 4/4).
							2-4 ft. SILTY GRAVEL (GM), brown (10YR 5/3), pebbles up to 3" diameter.
							4-80 ft. MENEFEE FORMATION.
			6-7 ft.				4-44.5 ft. SANDSTONE, weathered, fine grained, pale brown (10YR 6/3). Unweathered sandstone is medium light gray (N6).
			7-8 ft.				4.5 ft. 45 degree fracture.
10	6460						6.5-8 ft. fracture inclined 75-80 degrees with light gray (N7) gouge about 3/4 in thick and coaly shale ~1/2 in thick.
			13-14 ft.				12-13 ft. inclined fracture (~75 degrees), with just hematite and limonite staining. Round chert pebbles up to 1.5" diameter found in trace amounts from 12.0-15.0 ft. Trace carbonaceous material along bedding. Sandstone is medium light gray (N6).
							15.5 -16 ft. Thin carbonaceous shale partings. Sandstone, fine grained, damp color is medium dark gray (N4) to medium gray (N5). Trace of carbonaceous material.
20	6450						18.0 and 20.5 ft. 45 degree inclined fractures, both are limonite coated.
			22-23 ft.				23-25 ft. Some inclined bedding (~20 degrees)
							27.5 ft. sandstone becomes darker colored to medium dark gray (N4) from disseminated carbonaceous material
30	6440		29-30 ft.				32.5 ft. trace of chert pebbles.
							36.5 ft. grades to carbonaceous sandstone, fine grained to very fine grained, damp color is medium dark gray (N4) to dark gray (N3)
40	6430		39-40 ft.		0.020" Wire Wrap Enviroplug		38 ft. an inclined fracture (80 degrees) with no alteration along it.
							40.0 ft. carbonaceous, fine grained sandstone, medium dark gray (N4) to dark gray (N3), some inclined bedding (~20 degrees) Hackly fracture at 42.0 ft.
							43.5 to 44.5 ft. Gradual change to coal.
							44.5-46.5 ft. COAL
			47-48 ft.				46.5-56 ft. SANDSTONE, abrupt change to fine grained sandstone, carbonaceous, with coal material in streaks and along bedding, medium dark gray (N4)

MONITORING WELL COMPLETION LOG DUR02-0892

PROJECT UMTRA GROUND WATER **WELL NUMBER** 0892

SITE DURANGO RAFFINATE PONDS **DATES DRILLED** 10/07/2000 to 10/08/2000

Continued from Previous Page

DEPTH (FT BGL)	ELEV (FT NGVD)	BLOW COUNTS	SAMPLE ID.	EXTENT	WELL DIAGRAM	GRAPHIC LOG	LITHOLOGIC DESCRIPTION
			52-53 ft.		PVC Sch 40		48-56 ft. sandstone becomes less carbonaceous and lighter medium light gray (N6),. Some healed fractures. 45 degree at 48-48.5 ft. At 50 ft., sandstone is darker, medium gray (N5) and appears to be baked. A 45 degree fracture at 52.0 ft and a 65 degree fracture at 55 ft..
			56-57 ft				56-57 ft. IGNEOUS. Diorite porphyry dike.
			57-58 ft				57-59 ft. SANDSTONE. baked sandstone with 65 degree fracture and some baked shale.
			58-59 ft				
60	6410		59-60 ft		30-70 Silica Sand		59-60 ft. IGNEOUS. Diorite porphyry dike, very dense, medium gray (N5), some light green propylitic alteration.
					Bentonite Pellets		59.8-61.3 ft. Centralizer. Filter Pack 30-70 Sand. 60-68 ft. SANDSTONE, trace of carbonaceous material appears dense and baked, medium gray (N5) to medium dark gray (N4). A 60 degree fracture with black, sooty material along it from 61.0 to 61.5 ft., a 65 degree fracture from 63.0 to 64.0 ft., and a 45 degree fracture at 66.5 ft. Some inclined bedding at ~ 20 degrees.
					30-70 Silica Sand		
			68-69 ft		10-20 Silica Sand		68-69 ft. IGNEOUS, altered diorite dike, light gray (N7), some light green propylitic alteration.
70	6400						69-80 ft. SANDSTONE, fine grained of the Menefee Formation, medium gray (N5), appears baked and brittle. Black sooty material adjacent to dike. Fractured from 71.0-72.0 ft. A 45 degree fracture at 73.5 ft. Sandstone generally has inclined bedding at ~20 degrees and trace of carbonaceous material.
			72-73 ft				
			78-79 ft.				78.5-80 ft. sandstone layer is medium gray (N5) with 60 degree fracture and more intense fracturing from 79.0 to 80.0 ft.
80	6390						80-85 ft. POINT LOOKOUT SANDSTONE. SHALE and SILTSTONE, medium gray (N5) to medium light gray (N6). Abrupt lithology change at ~80.0 ft. This is the main Bodo Fault. Intense fracturing from 80.0 to 81.0 ft. Dry from 82.0 to 85.0 ft. This is in the lower part of the Point Lookout Sandstone formation.
			82-84 ft				Total Depth 85.0 ft
90	6380						
100	6370						
110	6360						

MONITORING WELL COMPLETION LOG DUR02-0893

PROJECT	UMTRA GROUND WATER	NORTH COORD. (FT)	1224136.19	DATE DRILLED	10/08/2000 to 10/09/2000
LOCATION	DURANGO, CO	EAST COORD. (FT)	2308046.25	SURFACE ELEV. (FT NGVD)	6466.58
SITE	DURANGO RAFFINATE PONDS	HOLE DEPTH (FT)	76.50	TOP OF CASING (FT)	6466.41
WELL NUMBER	0893	WELL DEPTH (FT)	75.00	MEAS. PT. ELEV. (FT)	6466.41
				SLOT SIZE (IN)	0.020
				BIT SIZE(S) (IN)	6.0

	WELL INSTALLATION	INTERVAL (FT)		
SURFACE CASING:				
BLANK CASING:	2 in. PVC Sch 40	0.17	to	64.5
WELL SCREEN:	2 in. Vee Wire Wrapped	64.5	to	74.5
SUMP/END CAP:	2 in. PVC Sch 40	74.5	to	75.0
SURFACE SEAL:				
GROUT:	Enviroplug	0.0	to	55.0
SEAL:	Bentonite Pellets	57.0	to	61.0
UPPER PACK:	30-70 Silica Sand	61.0	to	63.3
LOWER PACK:	10-20 Silica Sand	63.3	to	76.5

DRILLING METHOD ROTASONIC
SAMPLING METHOD GRAB
DATE DEVELOPED
WATER LEVEL (FT BGS)
LOGGED BY Goodknight, C
REMARKS Drilled 47 ft. on 10/8. Set well on 10/9. Screened in Point Lookout SS Fm near the transition to the underlying Mancos Shale. Centralizers at both ends of screen.

DEPTH (FT BGL)	ELEV. (FT NGVD)	BLOW COUNTS	SAMPLE ID.	EXTENT	WELL DIAGRAM	GRAPHIC LOG	LITHOLOGIC DESCRIPTION
							0-2 ft. SILT (ML), dark yellowish brown (10YR 3/4) damp color
	6460						2-76.5 ft. POINT LOOKOUT SANDSTONE 2-3 ft. SILTSTONE, brown (7.5YR 4/4) with weathered shale, thinly bedded with shale--lower part of the Point Lookout Sandstone. Siltstone is medium light gray (N6) and shale is medium dark gray (N4). Bedding is bioturbated, particularly in the siltstone. Material is well fractured (horizontal) along bedding as a result of weathering down to about 12.0 ft. Unweathered interbedded siltstone and shale in thin beds below 12.0 ft. Shale is predominant at 60-70% and is medium dark gray (N4).
10			9-10 ft.				
	6450						18 ft. thin resistant siltstone bed (~4"), medium light gray (N6), and a low angle fracture (~20 degrees). Trace to several percent carbonaceous material along bedding throughout layer below 19.0 ft to about 40.0 ft.
20			23-24 ft.				
	6440				Enviroplug		
30							
	6430						
40					PVC Sch 40		40 ft. below this depth, layer has more interbeds of shale and silty shale--lower part of Point Lookout Sandstone formation. Beds are mostly bioturbated. Shale is medium dark gray (N4) and silty material is medium light gray (N6). Throughout section, layer has scattered thin beds (2-3") of well cemented calcarenite, medium gray (N5).
	6420						

MONITORING WELL COMPLETION LOG DUR02-0893

PROJECT UMTRA GROUND WATER **WELL NUMBER** 0893

SITE DURANGO RAFFINATE PONDS **DATES DRILLED** 10/08/2000 to 10/09/2000

Continued from Previous Page

DEPTH (FT BGL)	ELEV. (FT NGVD)	BLOW COUNTS	SAMPLE ID.	EXTENT	WELL DIAGRAM	GRAPHIC LOG	LITHOLOGIC DESCRIPTION
	6410		54-55 ft.		30-70 Silica Sand		55-57 ft. Centralizer. Filter Pack 30-70 Sand
60					Bentonite Pellets		
					30-70 Silica Sand		60 ft. below this depth shale beds become more common. Only a trace of carbonaceous material finely disseminated along bedding. Description of shale and silty shale as above with this being in the lower Point Lookout Sandstone formation and near the uppermost Mancos Shale transition zone.
	6400				10-20 Silica Sand		
70					0.020" Wire Wrap		
			72-73 ft.				
	6390						Total Depth 76.5 ft.
80							
	6380						
90							
	6370						
100							
	6360						
110							

MONITORING WELL COMPLETION LOG DUR02-0902

PROJECT	UMTRA GROUND WATER	NORTH COORD. (FT)	1223627.50	DATE DRILLED	10/18/2000
LOCATION	DURANGO, CO	EAST COORD. (FT)	2308386.50	SURFACE ELEV. (FT NGVD)	6470.29
SITE	DURANGO RAFFINATE PONDS	HOLE DEPTH (FT)	148.50	TOP OF CASING (FT)	6472.28
WELL NUMBER	0902	WELL DEPTH (FT)	148.00	MEAS. PT. ELEV. (FT)	6472.28
				SLOT SIZE (IN)	0.020
				BIT SIZE(S) (IN)	6.0

	WELL INSTALLATION	INTERVAL (FT)		
SURFACE CASING:				
BLANK CASING:	2 in. PVC Sch 40	-1.99	to	128.0
WELL SCREEN:	2 in. Vee Wire Wrapped	128.0	to	148.0
SUMP/END CAP:	2 in. PVC Sch 40	148.0	to	148.5
SURFACE SEAL:	Concrete	0.0	to	2.0
GROUT:	Enviroplug	2.0	to	111.0
SEAL:	Bentonite Pellets	113.2	to	121.0
UPPER PACK:	30-70 Silica Sand	121.0	to	122.83
LOWER PACK:	10-20 Silica Sand	122.83	to	148.5

DRILLING METHOD	ROTASONIC
SAMPLING METHOD	GRAB
DATE DEVELOPED	
WATER LEVEL (FT BGS)	
LOGGED BY	Kautsky, M
REMARKS	30-70 sand pack from 111.0 to 113.2 ft

DEPTH (FT BGL)	ELEV. (FT NGVD)	BLOW COUNTS	SAMPLE ID.	EXTENT	WELL DIAGRAM	GRAPHIC LOG	LITHOLOGIC DESCRIPTION
					Concrete		0-1 ft. FILL, silty gravel loose fill cover 1-7 ft. CLAY (CL), silt and sand, brown (10YR 4/3) some sand, medium stiff, dry to mostly moist, medium plasticity
			5-6 ft.				
			7-9 ft.				7-9 ft. SANDY GRAVEL (GP), contains ~20 % clayey sand matrix and 80% medium gravel, rounded, various Precambrian-crystalline type lithologies, up to 1.0 ft diameter clasts
10	6460		10-11 ft.				7-148.5 ft. MENEFEE FORMATION 7-42 ft. SANDSTONE; contains black flecks of carbonaceous matter, wavy bedding that contains moderate yellow brown ferric oxyhydroxide staining. Occasional vugs. Individual beds are 7.0 ft or more in thickness. 0-5% carbonaceous material along bedding throughout. Massive light gray (N7) sandstone with trace of carbonaceous material.
20	6450						
			24-25 ft.				
30	6440						
			36-37 ft.				
40	6430						42-43 ft. SHALE, lost zone, lots of small angular rock in interval 43-54 ft. SANDSTONE, light gray sandstone (N7) with dark gray blebs (N3) of carbonaceous shale material. Parting along bedding every 2-3 inches 45-48 ft. bedding becomes 6-12 inches thick. 48-54 ft. massive medium grained sand, with increasing
			44-45 ft.		PVC Sch 40		

MONITORING WELL COMPLETION LOG DUR02-0902

PROJECT UMTRA GROUND WATER **WELL NUMBER** 0902
SITE DURANGO RAFFINATE PONDS **DATES DRILLED** 10/18/2000

Continued from Previous Page

DEPTH (FT BGL)	ELEV. (FT NGVD)	BLOW COUNTS	SAMPLE ID.	EXTENT	WELL DIAGRAM	GRAPHIC LOG	LITHOLOGIC DESCRIPTION
							carbonaceous material at depth and grading to darker gray (N3)
			54-55 ft		Bentonite Grout		54-57.5 ft. COAL, black impure coal and carbonaceous shale
60	6410						57.5-131 ft. SANDSTONE, medium grained, containing 25 % carbonaceous material along bedding, massive 7 ft. thick bedding section.
							63-66 ft. sandstone becomes light gray (N7) to medium gray with carbonaceous laminae. Shale parting along bedding.
							66-67 ft. zone contains two shale partings. 67-87 ft. zone becomes medium light gray (N6) to medium gray in color with carbonaceous laminae of medium dark gray (N4) to medium gray (N5) carbonaceous material. Note Sections of continuous core are up to 3.0 ft. long The bedding thickness varies from 2 inches to 3.0 ft.
70	6400		70-71 ft.				
80	6390		80-83 ft.		PVC Sch 40		
							87-89 ft. zone contains 8 interbeds of presumed carbonaceous shale, cross laminated sandstone.
90	6380						90-97 ft sandstone contains 3 interbeds. The medium grained sandstone is cross laminated with medium dark gray (N4) to medium gray (N5) carbonaceous material
			95-96 ft.				
							97-99 ft zone becomes medium dark gray (N4) with some contorted bedding-cross laminated with carbonaceous material and 2 inch thick interbed of siltstone 99-105.5 ft. zone color changes to medium gray (N5) layer is massive, with laminations of dark gray carbonaceous flecks parallel to bedding.
100	6370		100-101 ft				
			105-106 ft				105.5-115 ft contains a very thin shale bed 2 inches thick at 105.5 ft and is dark gray black (N2) Sandstone layer below this bed is cross laminated with carbonaceous material
110	6360				30-70 Silica Sand		

MONITORING WELL COMPLETION LOG DUR02-0902

PROJECT UMTRA GROUND WATER **WELL NUMBER** 0902
SITE DURANGO RAFFINATE PONDS **DATES DRILLED** 10/18/2000

Continued from Previous Page

DEPTH (FT BGL)	ELEV. (FT NGVD)	BLOW COUNTS	SAMPLE ID.	EXTENT	WELL DIAGRAM	GRAPHIC LOG	LITHOLOGIC DESCRIPTION
			115-116 ft.		Bentonite Pellets		115-118 ft sandstone becomes medium light to light gray (N6 to N7) with finer sand zones and occasional contorted bedding
120	6350		121-122 ft.		30-70 Silica Sand		121-127 ft. zone decreasing in carbonaceous lamination and is massive bedding, very hard and finer grained.
			126-127 ft.				
					10-20 Silica Sand		127-131 ft. Note Lost most of this interval. Fragments from this zone are calcareous shale with occasional carbonaceous laminae.
130	6340						131-133 ft. SILTSTONE, calcareous.
							133-135 ft. SANDSTONE, medium grained, hard, thick bedded.
			135-136 ft.				135-135.5 ft. SILTSTONE, calcareous.
			137-138 ft.		0.020" Wire Wrap		135.5-137 ft. SANDSTONE, medium grained with ripple bedding and organic material in places, medium gray color (N5).. 137-138 ft. SHALE, lost interval but presumed shale 138-148.5 SANDSTONE, mostly light gray (N7), medium grained, hard, massive beds, contains probable shale breaks @ 143.0 to 145.0 ft. and @147.
140	6330						
			144-145 ft.				
150	6320						Total Depth 148.5 ft.
160	6310						
170	6300						

MONITORING WELL COMPLETION LOG DUR02-0903

PROJECT	UMTRA GROUND WATER	NORTH COORD. (FT)	1222414.33	DATE DRILLED	09/25/2000
LOCATION	DURANGO, CO	EAST COORD. (FT)	2307535.29	SURFACE ELEV. (FT NGVD)	6549.97
SITE	DURANGO RAFFINATE PONDS	HOLE DEPTH (FT)	66.00	TOP OF CASING (FT)	6552.13
WELL NUMBER	0903	WELL DEPTH (FT)	65.40	MEAS. PT. ELEV. (FT)	6552.13
				SLOT SIZE (IN)	0.020
				BIT SIZE(S) (IN)	6.0

	WELL INSTALLATION	INTERVAL (FT)		
SURFACE CASING:				
BLANK CASING:	2 in. PVC Sch 40	-2.16	to	34.9
WELL SCREEN:	2 in. Vee Wire Wrapped	34.9	to	64.9
SUMP/END CAP:	2 in. PVC Sch 40	64.9	to	65.4
SURFACE SEAL:				
GROUT:	Enviroplug	0.0	to	25.0
SEAL:	Bentonite Pellets	27.0	to	31.2
UPPER PACK:	30-70 Silica Sand	31.2	to	33.4
LOWER PACK:	10-20 Silica Sand	33.4	to	66.0

DRILLING METHOD ROTASONIC
SAMPLING METHOD GRAB
DATE DEVELOPED
WATER LEVEL (FT BGS)
LOGGED BY Kautsky, M.
REMARKS Well installed on 10/3. Background well for Menefee FM. TD is believed to be in coal near base of Menefee. Centralizers at top and bottom of screen.

DEPTH (FT BGL)	ELEV. (FT NGVD)	BLOW COUNTS	SAMPLE ID.	EXTENT	WELL DIAGRAM	GRAPHIC LOG	LITHOLOGIC DESCRIPTION
			4-5 ft.				0-16 ft. SILTY SAND (SM), dry, medium dense, mottled very pale brown (10YR 7/4) and red yellow (7.5 YR 6/6), contains clasts of deeply weathered sandstone and flecks of black carbonaceous shale. Sandstone clasts grading to less weathered and more angular with depth below 12.0 ft.
10	6540				Enviroplug		
			14-16 ft.				
							16-30 ft. SANDY GRAVEL (GW), brown (7.5YR 4/2), loose, subrounded clasts of gabro, greenstone, granodiorite to 3-inch diameter. Gravel and 30% medium grained sand, dry to moist, contact zone with overlying colluvium contained 2 inch thick zone of plastic black clay (terrace alluvium (QT_2).
20	6530				PVC Sch 40		
			23-25 ft				
					30-70 Silica Sand		25-27 ft. Centralizer Filter Pack 30-70 Sand
					Bentonite Pellets		
30	6520		29-30 ft				30-66 ft. MENEFEE FORMATION
			31-34 ft		30-70 Silica Sand		30-53 ft. SANDSTONE, massive medium grained, hard, dry, light gray (7.5 YR N7/0).
			34-35 ft		10-20 Silica Sand		34 ft fine sandy silt interbed with slight plasticity and moist (deeply weathered siltstone), light yellow brown (10YR 6/4)
			36-38 ft				36-37 ft four fractures (~60 degrees), with ferric oxyhydroxide staining
40	6510		40-41 ft.				39-40 ft four fractures with ferric oxyhydroxide staining
					0.020" Wire Wrap		42 ft bedding plane fractures at 42.0, 44.0 and 46.0 ft. 1 fracture with 60 degree dip at 46.0 ft. Zone contains gray (10YR 5/1) blebs to 2 inch diameter of chert
			45-46 ft.				48 ft ferric oxyhydroxide stained fracture with ~45 degree dip, fine

MONITORING WELL COMPLETION LOG DUR02-0903

PROJECT UMTRA GROUND WATER **WELL NUMBER** 0903
SITE DURANGO RAFFINATE PONDS **DATES DRILLED** 09/25/2000

Continued from Previous Page

DEPTH (FT BGL)	ELEV. (FT NGVD)	BLOW COUNTS	SAMPLE ID	EXTENT	WELL DIAGRAM	GRAPHIC LOG	LITHOLOGIC DESCRIPTION
			50-51 ft.				black laminae appear below 48 ft.
							53- 55 ft. CLAYSTONE, interbeds very dark gray (10YR 3/1), black coal seam 1 inch thick.
			55-56 ft.				55-59 ft. SANDSTONE, medium grained, hard, dense, massive, light gray (7YR 7/0). Note, water level @ 11.35 ft.
60	6490						59-64 ft. SHALE, black, carbonaceous, with coal seam
			60-63 ft.				
			64-65 ft.				64-65 ft. SANDSTONE, medium grained, dark gray (2.5YN 4/0).
			65-66 ft.				65-66 ft. CLAYSTONE, very dark gray brown (10YR 3/2), very plastic.
							Total Depth 66.0 ft.
70	6480						
80	6470						
90	6460						
100	6450						
110	6440						

MONITORING WELL COMPLETION LOG DUR02-0905

PROJECT	UMTRA GROUND WATER	NORTH COORD. (FT)	1224577.46	DATE DRILLED	10/25/2000 to 10/31/2000
LOCATION	DURANGO, CO	EAST COORD. (FT)	2308640.03	SURFACE ELEV. (FT NGVD)	6468.55
SITE	DURANGO RAFFINATE PONDS	HOLE DEPTH (FT)	187.00	TOP OF CASING (FT)	6470.57
WELL NUMBER	0905	WELL DEPTH (FT)	172.00	MEAS. PT. ELEV. (FT)	6470.57
				SLOT SIZE (IN)	0.020
				BIT SIZE(S) (IN)	6.0

	WELL INSTALLATION	INTERVAL (FT)		
SURFACE CASING:				
BLANK CASING:	2 in. PVC Sch 40	-2.02	to	161.5
WELL SCREEN:	2 in. Vee Wire Wrapped	161.5	to	171.5
SUMP/END CAP:	2 in. PVC Sch 40	171.5	to	172.0
SURFACE SEAL:				
GROUT:	Enviroplug	0.0	to	150.0
SEAL:	Bentonite Pellets	152.2	to	156.0
UPPER PACK:	30-70 Silica Sand	156.0	to	157.9
LOWER PACK:	10-20 Silica Sand	157.9	to	187.0

DRILLING METHOD: ROTASONIC
SAMPLING METHOD: GRAB
DATE DEVELOPED:
WATER LEVEL (FT BGS):
LOGGED BY: Goodknight, C
REMARKS: Drilled to 87 ft on 10/25, 137 ft on 10/26, and competed on 10/13 in lower part of Point Lookout SS fm (in silty shale, fractured). Centralizers at both ends of screen.

DEPTH (FT BGL)	ELEV. (FT NGVD)	BLOW COUNTS	SAMPLE ID.	EXTENT	WELL DIAGRAM	GRAPHIC LOG	LITHOLOGIC DESCRIPTION
							0-6 ft. FILL. silty sand (very fine grained) with 5% small rock fragments, very dark brown (10YR 2/2) slightly plastic. Some brick pieces at 5.0 to 6.0 ft.
10	6460						6-12 ft. SANDY SILT (ML). very fine grained sand, very dark gray (10YR 3/1), slightly to moderate plasticity.
							12-16 ft. SILTY SAND (SM). very dark grayish brown (10YR 3/2), some reddish and tan weathered rock fragments.
							16-18 ft. GRAVEL (GP). little fine material, gravel and cobbles of mainly granite.
20	6450						18-187 ft. POINT LOOKOUT SANDSTONE 18-25 ft. SHALE. mottled, mostly weathered shale and siltstone bedrock, upper part of Point Lookout formation. Colors range from dark yellowish brown (10YR 4/2) to dark yellowish orange (10YR 6/6).
			23-24 ft				
30	6440		29-30 ft				25-33 ft. SILTSTONE. slightly calcareous, medium gray (N5), firm, only slightly weathered. Vertical, limonite-coated fractures at 27.0 to 28.0 ft. From 28.0 to 30.0 ft., fractures are vertical in very fine grained sandstone filled with calcite, some horizontal fractures coated with limonite.
			35-36 ft				33-187 ft. SHALE. some alternating siltstone and very fine grained sandstone beds throughout, wavy beds are due to some bioturbation, some fossils present, trace of carbonaceous material. Very fine grained sandstone is lighter-medium light gray (N6)
40	6430						40-41 ft. shale beds are horizontally fractured
	6420		49-50 ft				45 ft. layer has calcareous siltstone and is medium gray (N5) in color. Some limonite blotches at 46.0 to 47.0 ft. 47-57 ft. siltstone and silty shale beds alternate, siltstone is lighter-medium light gray (N6) to light gray (N7) and silty shale beds

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SITE DURANGO RAFFINATE PONDS **DATES DRILLED** 10/25/2000 to 10/31/2000

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DEPTH (FT BGL)	ELEV. (FT NGVD)	BLOW COUNTS	SAMPLE ID	EXTENT	WELL DIAGRAM	GRAPHIC LOG	LITHOLOGIC DESCRIPTION
							are darker-medium gray (N5). Siltstone layers comprise only ~10-20%. Bedding is uneven and lenticular with some bioturbation slightly calcareous.
60	6410		60-61 ft.				57-67 ft. Only 6.0 ft recovered. Loss occurred probably in 63.0 to 67.0 ft. interval in softer drilling. Shale recovered in bit at 67.0 ft was highly fractured (high angle).
70	6400						67-76 ft. mostly shale or silty shale, medium gray (N5). Fossil burrowing (worms) in places.
			74-75 ft.		Enviroplug		76-77 ft. layer is disrupted (small fault), bedding is possibly soft sediment deformation. Below 77.0 ft., layer becomes mainly shale or silty shale, medium gray (N5)
80	6390		83-84 ft.				82-84 ft. layer has flattened fauna (pelecypod fossil)-preservation of pelecypods by calcareous material (aragonite). 84-92 ft. layer is mostly silty shale.
90	6380						92-93 ft. fracture (70 degrees), healed, no void space. Scattered fossils are present below 93.0 ft.
			96-97 ft				
100	6370				PVC Sch 40		100-107 ft. layer becomes more silty, medium gray (N5) in color, few fossils, and slightly calcareous. Trace of fine pyrite.
			105-106 ft				
110	6360						110-130 ft. horizontal fracturing increases, some thin, lighter colored siltstone layers at ~ 110.0 ft. Fine pyrite becoming more abundant along some bedding planes (as a replacement of trace

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			114-115 ft				carbonaceous material) 115 ft. layer is mainly silty shale.
120	6350						
			125-126 ft				125 ft. layer has trace of pyrite coating along surface of small pelecypod, calcareous.
130	6340						130-135 ft. bioturbation becoming more pervasive. Calcareous replacement of fossils as well as by pyrite, trace carbonaceous material.
			135-136 ft				
140	6330						139 ft. some horizontal fractures and voids. 140-147 ft. layer becomes medium gray (N5), trace of carbonaceous material. Calcareous replacement of fossils. shale only slightly calcareous.
150	6320						147-157 ft. increased horizontal fracturing only 7.0 ft recovered. trace of pyrite, no inclined fractures
					30-70 Silica Sand		150.0-152.2 ft. Centralizer. Filter Pack 30-70 Sand
			153-154 ft		Bentonite Pellets		
					30-70 Silica Sand		157- 167 ft. only 6.0 ft recovered. Horizontal fracturing continues through interval. Continued silty shale with sparse fossils replaced by calcareous material (aragonite).
160	6310						
					10-20 Silica Sand		
					0.020" Wire Wrap		
170	6300		169-170 ft				167-177 ft. only 7.0 ft recovered. Less horizontal fracturing and increased high angle fractures with small amount of void space, high angle fracturing at ~170.0 ft. 45 degree hackly uneven fracture at 169.0 ft. 60 degree fracture at 176.0 ft. Continued silty shale.

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180	6290		179-180 ft				177-187 ft. only 8.0 ft. recovered. Less amount of horizontal fracturing, no high angle fractures noted. Continued silty shale Layer is considered the lower part of the Point Lookout Sandstone formation, near the transition to the upper part of the Mancos Shale.
190	6280						Total Depth 187.0 ft.
200	6270						
210	6260						
220	6250						
230	6240						
240	6230						