The current concentrations for the other COCs were used as indicators of future exposure point concentrations near well 92–09. The impacts on the risk estimates are expected to be minimal because concentrations for all COCs other than uranium have been stable in this area over the last 10 yr.

(2) *Use of soil/sediment data from the original risk assessment*—As noted earlier the 1998 RI was completed with data collected prior to soil and sediment remediation. Although resampling would likely yield lower concentrations in this area, a comprehensive resampling was not done, and this updated risk assessment used concentrations of samples collected before remediation. These values are likely to overestimate risks associated with exposures to contaminated soils and sediments.

The most significant area of uncertainty is whether the residential ground water ingestion pathway (the most significant exposure pathway) will be complete. Institutional controls are in place to prevent the use of contaminated ground water as a drinking water source. In addition; municipal water lines are nearby and could be extended for use in this area.

4.1.7 Human Health Risk Assessment Synopsis

Risk characterization results were presented in Section 4.1.5; the following paragraph presents an overall synopsis of the risk assessment results.

The improbable future use of alluvial ground water as the primary source of drinking water would cause the most significant risks of all exposure pathways evaluated for the HHRA. Use of this water as drinking water is not likely because of the availability of city of Monticello water, the low yield from the alluvial aquifer, and the shallow depth of the water, which could become contaminated from nearby animal feed locations. The current recreational/agricultural scenario does not exceed risk-based concentrations using CT exposure assumptions.

4.2 Ecological Risk Assessment

In preparation of this document, surface water data collected since the 1998 RI were viewed by the ETAG as the only type of data that required aspects of the 1998 ERA to be updated. Receptors, exposure pathways, and toxicity benchmarks used in the 1998 ERA were considered to still be appropriate or viewed as not having changed enough to alter the final conclusion of the 1998 ERA. It was noted that some evaluation of the benthic community might be considered in the future to demonstrate a successful remedy (Hoff 2000).

It was also noted by the ETAG that continued monitoring of selenium concentrations in surface water and ground water was prudent because of the increase in selenium concentrations (that began in 1999) to levels above those evaluated in the 1998 ERA. The ETAG felt that continued surface water and ground water monitoring was the appropriate course of action because it was reasoned that weathering of bedrock and bedrock-derived soil naturally abundant in selenium released selenium to surface water and ground water. These materials are present as carbonaceous marine shale that were freshly exposed during remediation beneath the alluvial aquifer on the east half of the Millsite. Selenium leaching from the bedrock was expected to decrease once the effect of exposing the bedrock and then covering with backfill material and restoration of the Millsite was complete.

DOE, EPA, and UDEQ also made the decision to look for other possible sources of selenium and explanations for the increase in its concentration. This additional investigation led to the identification of seeps on the Millsite with high selenium concentrations. High concentrations of selenium in samples from those seeps are considered the result of weathering of similar, off-site bedrock and bedrock residuum. An example of surface water that contains high selenium concentrations from the weathering of off-site materials is seep 3, which is channeled to Montezuma Creek and provides some recharge and selenium contamination to the alluvial system a short distance upstream of Wetland 3. Therefore, the increase in selenium in Montezuma Creek and the constructed wetlands (primarily Wetland 3) since source removal is currently believed to be the result of (1) the discharge of alluvial ground water on the Millsite that contains selenium at currently observed concentrations and (2) seeps that are not related to the alluvial system (separate sources) but enter the creek and wetlands from the north margin of the Millsite (e.g., seep 3).

During preparation of this ERA update, there was ongoing discussion with the ETAG about the scope of the update. It was decided that a new review of the results of the 1998 ERA (Table 1–6 presents a summary) was necessary given the following changes: (1) the progressing establishment of wetlands on the Millsite and (2) the selenium surface water data which show that selenium concentrations in Millsite surface water have increased more than in surface water downstream of the Millsite (Plate 8).

In 1998, the risk-driving pathways were ingestion of invertebrates, soil/sediment, and grass; COCs were arsenic, copper, vanadium, uranium, and selenium (Table 1–6). The receptors with pathways and COCs exceeding an HQ of 1 were the deer mouse, muskrat, spotted bat, and southwestern willow flycatcher. It was concluded in 1998 that even though some pathways and COCs resulted in HQs greater than 1, the conservative nature of assumptions used in the assessment probably overestimated risks and that actual risks were likely to be lower. It was noted that benthic macroinvertebrates did show some uptake of arsenic, molybdenum, uranium, and vanadium; however, effects of these uptakes were not apparent with respect to the benthic organisms themselves. The concentration range of selenium in benthic macroinvertebrate samples from reference areas (nondetect to 1.78 mg/kg) and from Montezuma Creek (nondetect to 1.72 mg/kg) were similar (see 1998 RI, Volume VII, Appendix C, page C1-7). Surface water exposure point concentrations for benthic macroinvertebrates did not exceed ambient water quality criteria.

After considering that selenium concentrations have increased in surface water and that concentrations are greatest in surface water near Wetland 3 created on the Millsite, the ETAG suggested focusing this update on potential risks to the spotted bat and southwestern willow flycatcher. These receptors are of particular concern because of their status as state and federal endangered species, respectively. They are also the only receptors for which selenium was identified as a risk-driving COC; the risk-driving exposure pathway associated with selenium was invertebrate ingestion. Benthic macroinvertebrates were included because results of the earlier ERA were inconclusive and those organisms are in direct contact with surface water.

During the process of updating the evaluation of risk to the spotted bat, the southwestern willow flycatcher, and benthic macroinvertebrates, it became evident that data gaps existed. Although 238 surface soil samples were collected from the Millsite during verification and 17 samples were collected of wetland subgrade sediments[1], the entire Millsite was covered with 6 inches of loess-derived soil subsequent to sampling and so the prior data are not representative of exposure point concentrations in the future. The loess-derived soil placed on the hillside of the restored Millsite and in the wetlands is not expected to be a current significant source of selenium. Possibly, selenium may accumulate in the loess-derived soils and the subgrade soil/sediment (primarily in the wetlands and in those areas with seeps) because of the elevated concentrations in surface water and ground water passing through those materials.

Besides the lack of current sediment data, no benthic macroinvertebrate samples have been collected for chemical analysis since the 1998 ERA. Macroinvertebrate data are not relevant to the task of updating risk to the spotted bat or southwestern willow flycatcher as they are not a food item in either animal's diet; however, aquatic invertebrates are a pathway of concern as a primary food chain item for new receptors that may frequent the constructed wetlands. Data necessary to fill the data gaps and complete the analysis of risk to new ecological receptors (in particular waterfowl exposure to aquatic vertebrates) cannot be collected until a definitive trend in selenium concentrations has been established and development of the wetlands on the Millsite has progressed to the state where they are a high quality habitat. At the present stage of development, Wetland 3 is relatively small and does not contain any open water or a shrub mid-story component. As such, it does not serve as higher quality habitat for avian species such as waterfowl or shorebirds. However, if Wetland 3 develops as designed, there is a potential risk to waterfowl if high selenium concentrations are present in the wetland. The scope of additional data collection efforts is the subject of continued discussion for the ETAG. A preliminary outline of the types of data that will be collected and the areas where collection efforts will be focused is given in Section 4.2.4. The scope of additional data collection (which will begin in 2004) and routine monitoring will be described in the OU III Proposed Plan and ROD.

4.2.1 Data Review

Consistent with ETAG discussions prior to preparation of this document, no additional analyses of grasses, invertebrates, soil and sediment needed to be performed since completion of the 1998 ERA. In general, decreases of COC concentrations in surface water, ground water, soil, and sediment should also result in concentration decreases for those same constituents in grasses and invertebrates, although for contaminants that bioaccumulate (e.g., selenium), concentrations may have increased.

Surface water and ground water monitoring have been ongoing since completion of the 1998 ERA. As described in Section 2.7.1, cobalt, copper, lead, and zinc were eliminated as COCs for ecological risk; they will not be considered further here. Table 4–14 presents a comparison of recent surface water analyses with concentrations used in the 1998 ERA for the current ecological COCs. Concentrations of all constituents except selenium have decreased. Because the original source of ground water and surface water contamination (mill tailings) has been removed, concentrations of all COC (except, perhaps, selenium in the short term) will continue to decrease from present levels in surface water and ground water as the contaminant plume dissipates.

[1] Soil and subgrade sediment data are sufficient to conclude that COC concentrations in those materials are at background levels and should not be a source of surface water and ground water contamination. The average selenium concentration in surface soil samples was approximately 0.4 mg/kg; the average selenium concentration in subgrade sediment samples was 0.8 mg/kg.

Table 4–14. Montezuma Creek Surface Water Concentrations (µg/L)

Analyte	Upper Montezuma Creek			Upper and Middle	Middle Montezuma Creek		Lower Montezuma Creek		All Sections
	1995	1995 and 1996 Combined	2001 and 2002 Combined; Sorenson and SW00–04	1996	1995 and 1996 Combined	2001 and 2002 Combined; SW92–08	1995	2001 and 2002 Combined; SW94–01	1995 and 1996 Combined
Arsenic	3.21[a]	2.83[a]	1.5[a]	2.69[a]	2.7[b]	1.4[b]	4.6[a]	1.1[b]	3.55[a]
Molybdenum	28.9U	17.2[a]	13.3[a]	18.6[a]	16.3[b]	13.7[b]	28.9U	11.6[b]	16.3[a]
$NO_3 + NO_2$ as N	538[a]	538[a]	517[c]	–	–	325[a]	1,140[b]	61.9[b]	899[a]
Selenium	2.23[a]	2.19[a]	9.9[a]	2.33[a]	2.0[b]	7.5[b]	2.2U	6.3[b]	1.82[a]
Uranium	–	159[a]	120[a]	159	140[b]	139[a]	–	93.7[b]	159[b]
Vanadium	13.6[a]	10.5[a]	9.7[a]	10.9[a]	7.7U	4.3[a]	9.1[b]	3.0[b]	8.42[a]

U = Not detected; value is the sample detection limit.
– = No data.
[a]95 percent upper confidence limit.
[b]Maximum detected.
[c]Average concentration.

For the purposes of characterizing the range of selenium concentrations in surface water at the MMTS, surface water sampling locations can be divided into three groups: (1) Montezuma Creek locations, (2) wetland (pond) locations, and (3) seep locations. In Montezuma Creek, selenium concentrations have increased from about 2 μg/L to about 8 to 10 μg/L (Table 4–14 and Plate 8).

Surface water in Wetlands 1 and 2 has not been sampled directly, but samples collected from the outflow of the wetlands into Montezuma Creek (locations SW01-02 and SW-01-03, respectively) have ranged from nondetect to 2 μg/L. Selenium concentrations in Wetland 3 on the Millsite ranged from 10 to 69.3 μg/L in 2002; the extent of open water was approximately half the design size shown on Plate 8. During a site visit in August 2003, no open water was present at Wetland 3. Downstream of the Millsite surface water, concentrations at the sediment pond that exists where the canyon narrows and the cliffs begin, ranged from 2.5 to 7.4 μg/L as measured at the outflow of the pond (location SW00-04).

On the Millsite, concentrations of selenium at seep 1 ranged from 5.9 to 9.9 μg/L (Appendix C, page C2–21), at seep 2 from 2 to 97.3 μg/L (Appendix C, page C2–25), and at seep 3 from 112 to 129 μg/L (Appendix C, page C2–19). Seeps in the western half of the Millsite ranged from 5.9 to 15.5 μg/L (Plate 8). Selenium concentrations in surface water in 2002 are greater than, or at least representative of, concentrations measured since the 1998 ERA.

Wetland 3 and Montezuma Creek capture most of the ground water flow on the Millsite. Some water captured by the wetlands and creek leaks back into the aquifer at the eastern margin of the Millsite. COC concentrations currently measured in Wetland 3 are similar to ground water concentrations in the area as a result of ground water discharge to the wetland. COC concentrations in Montezuma Creek are less because of mixing of relatively clean upstream surface water with the contaminated ground water that is discharged to the creek near Wetland 3. The interaction between surface water and ground water has been established on the restored Millsite, and the effect of ground water concentrations on surface water is fully accounted for in the surface water quality data, including the effect of any other features such as the riprap channel near Deer Draw and the PRB. Therefore, direct exposure to ground water is still a negligible exposure pathway for OU III receptors of concern.

As weathering of the bedrock on the Millsite progresses, the amount of selenium that is mobilized is expected to decrease because the bedrock will be exposed to less oxidizing conditions. Also, it is believed that the transient nitrate plume, which resulted from fertilization efforts during revegetation of the Millsite, may have enhanced the mobility of selenium. The nitrate plume, which reached concentrations as high as 65 mg/L in some areas of the alluvial ground water on the Millsite, has now dissipated to concentrations less than 10 mg/L and generally to concentrations less than 2 mg/L. Unlike selenium released from Millsite bedrock, off-site sources of selenium that enter the Millsite along the north margin of the Millsite may continue. For further discussion of selenium concentrations see page 2–31 of Section 2.7.3, "Ground Water Results."

4.2.2 Ecological Risk Assessment Update

Although a determination of risk to the environment from increases in selenium concentrations in surface water cannot be completed for the Millsite for the reasons discussed in the introduction to this section, surface water monitoring data are available to complete an update to the evaluation of risk to the receptors identified in 1998 downstream of the Millsite.

For this update, the receptors evaluated are those identified in the previous RI/FS—the spotted bat and willow flycatcher. Effects on changed site conditions relevant to those receptors are discussed. It is important to note, however, that in preparing this addendum, a need was identified to reevaluate relevant site receptors because both the spotted bat and southwestern willow flycatcher prey on terrestrial invertebrates and not the aquatic invertebrates that are expected to be more profoundly affected by increased levels of selenium in surface water. Waterfowl were subsequently identified as the most likely receptors of greatest concern in the future. Data are not presently available to characterize risk to waterfowl. However, appropriate data to assess potential risks to those receptors will be collected as part of the site monitoring for the CERCLA 5-year review process (see Section 4.2.4).

Except for selenium, the decreases in COC concentrations in surface water, ground water, soil, and sediment should result in concentration decreases for those same constituents in grasses and invertebrates. Because selenium tends to bioaccumulate, concentrations may have increased in these media. Therefore, it is assumed that risks to the ecological receptors identified in 1998 associated with all ecological COCs except selenium have been reduced by remedial action and that the conclusions reached in the 1998 ERA remain valid (i.e., no significant current ecological risks are present). The reevaluation of risks to the 1998 ecological receptors of concern presented in the following section focuses on changes in selenium concentrations.

Reevaluation of Risks Associated with Surface Water Ingestion

In the 1998 ERA, the risks calculated for selenium via surface water ingestion by the spotted bat and flycatcher were very low—maximum HQs approached 0.002. Exposure point selenium concentrations used for those calculations were approximately 2.0 µg/L. Recent (2001 and 2002) surface water data show that selenium concentrations in Upper Montezuma Creek average 8.6 µg/L. In Middle and Lower Montezuma Creek, the maximum concentrations detected were 7.5 and 6.3 µg/L, respectively. The Utah Aquatic Wildlife Criteria is 5 µg/L. Data from 2002 are favored for use in this update because (1) they are the most current; (2) Millsite restoration was not completed until August 31, 2001; and (3) concentration trends resulting from Millsite excavation (source removal) and restoration have stabilized (see Section 2.7). Selenium concentrations are greatest in seeps on the Millsite, where the maximum concentration measured in 2002 was 129 µg/L (Plate 8). Concentrations in seeps are not representative of the surface water system downstream of the Millsite where concentrations in 2003 ranged from 0.95 to 10 µg/L. Although the best current habitat for the spotted bat and willow flycatcher is near the sediment pond at the beginning of the narrows, the seeps do represent worst-case concentrations for surface water ingestion. If these worst-case values were used with the same exposure parameters and assumptions as those in the 1998 ERA, the resulting risks for the spotted bat and flycatcher would be two orders of magnitude higher than those in the 1998 ERA—on the order of 0.1 for maximum HQs. These risks are still well below the threshold value of 1.0, which is used to signal a potential for concern.

Because selenium concentrations exceed the Utah Aquatic Wildlife Criteria, concentrations could be of some concern for aquatic organisms, specifically benthic macroinvertebrates. No new data are available for COC concentrations in invertebrates or on the benthic macroinvertebrate community. Data reported by the U.S. Department of Interior (DOI), states that the lowest threshold for chronic toxicity for selenite or selenate occurs at approximately 25 to 100 µg/L and no clear community-level effects were apparent at concentrations of 25 µg/L. Using the DOI data as criteria, risks to the benthic community in Montezuma Creek are probably low because the highest concentration of selenium measured in Montezuma Creek during 2001 and 2002 was 12.1 µg/L. Risks to the benthic community are not likely to be a major concern and these organisms should continue to provide a viable food source for higher level organisms. However, as discussed in the next section, concentrations of selenium in macroinvertebrates, in general, may be of concern for higher trophic level organisms because they are a primary food chain item. The appropriateness of benthic macroinvertebrates, specifically (i.e., aquatic organisms), as assessment endpoints will be discussed with the ETAG and the need for additional sampling will be addressed in the OU III Proposed Plan and ROD.

Reevaluation of Risks to Spotted Bat and Southwestern Willow Flycatcher Associated with Terrestrial Invertebrate Ingestion

Summary of 1998 ERA Results

According to the 1998 ERA, the highest potential risks posed to the flycatcher and spotted bat were due to concentrations of selenium in terrestrial invertebrates that make up the major portions of their diets. Ninety-nine percent and 95 percent of dietary intake for the spotted bat and southwestern willow flycatcher, respectively, were assumed to be terrestrial invertebrates. Selenium concentrations analyzed in samples of terrestrial invertebrates from the site ranged from 0.33 to 2.9 mg/kg and averaged 1.2 mg/kg. Reference area concentrations were as high as 1.5 mg/kg and averaged about 0.5 mg/kg, based on data presented in Appendix H of the 1998 RI (DOE 1998a). Selenium results from the 1998 ERA for the various sampling media are presented in Table 4–15.

A summary of HQs calculated for the flycatcher and bat via terrestrial invertebrate ingestion is presented in Table 4–16 for Upper Montezuma Creek, Upper and Middle Montezuma Creek, and the reference area for the site (Verdure Creek). In selecting numerical benchmarks that were used to calculate HQs, an attempt was made to identify benchmarks representing both the "no observed adverse effects level" (NOAEL) and "lowest observed adverse effects level"(LOAEL).

At the time of the 1998 ERA, site-related HQs calculated for intakes of selenium through ingestion of terrestrial invertebrates were within the range calculated for the Verdure Creek reference area, despite the higher concentrations of selenium in Montezuma Creek surface water. This suggested that terrestrial invertebrate concentrations may not have been directly related to surface water concentrations and that selenium levels in terrestrial invertebrates from OU III did not differ significantly from background.

Table 4–15.1998 RI Co-Located Sample Data for Selenium

Media	Location	Detection Frequency	Minimum[a] Detected	Maximum[a] Detected	Average[b]	Upper Confidence Limit (Spotted Bat)[c]	Upper Confidence Limit (Southwestern Willow Flycatcher)[c]
Surface Water	Reference	0/7	0.85	1.1	0.98	1.1[d] (1995) 0.85[a] (1996)	1.1[d] (1995) 0.85[a] (1996)
	Upper Montezuma Creek	5/8	1.8	2.5	1.8	2.23 (1995)	2.23 (1995)
	Middle Montezuma Creek	1/2	2.0	2.0	1.43		
	Lower Montezuma Creek	0/4	1.1	1.1	1.1		
	Upper/Middle Montezuma Creek					2.33 (1996)	2.33 (1996)
Soil	Reference	12/14	0.29	1.4	0.61	0.491[e] (1995) 1.34 (1996)	0.491[e] (1995) 1.34 (1996)
	Upper Montezuma Creek	16/16	0.39	4.1	1.23	1.21 (1995)	1.21 (1995)
	Middle Montezuma Creek	4/4	1.3	3.6	2.23		
	Lower Montezuma Creek	8/8	0.49	0.86	0.652		
	Upper/Middle Montezuma Creek					3.62 (1996)	3.62 (1996)
Sediment	Reference	10/11	0.22	5.3	1.4		
	Upper Montezuma Creek	26/32	0.28	6.8	1.43		
	Middle Montezuma Creek	4/4	0.5	6.3	1.69		
	Lower Montezuma Creek	2/4	0.15	3.6	0.72		
Cliff Swallow	Reference	3/3	1.1	1.3	1.2		
	Upper Montezuma Creek	3/3	1.3	1.8	1.6		
Terrestrial Invertebrates	Reference	6/7	0.1	1.5	0.65	0.3[e] (1995) 1.5 (1996)	0.3[e] (1995) 1.5 (1996)
	Upper/Middle/Lower Montezuma Creek	15/15	0.33	2.9	1.2		
	Upper Montezuma Creek					1.26 (1995)	1.26 (1995)
	Upper/Middle Montezuma Creek					1.1 (1996)	1.1 (1996)
Shrubs	Reference	3/6	0.27	0.41	0.19		0.41[e] (1995) 0.06 (1996)
	Upper Montezuma Creek	7/8	0.22	0.72	0.37		0.61 (1995)
	Middle Montezuma Creek	2/2	0.25	0.33	0.29		
	Lower Montezuma Creek	4/4	0.27	0.76	0.45		
	Upper/Middle Montezuma Creek						0.33 (1996)

[a]Minimum and maximum detected are actual values detected and not 1/2 the detection limit unless the frequency of detection was zero in which case 1/2 the detection limit is reported.
[b]Averages were calculated assuming 1/2 the detection limit for samples with of non-detect results.
[c]Values are the 95% lognormal upper confidence limit used in the exposure assessment for the identified receptor.
[d]Value is less than minimum detection limit.
[e]Maximum value detected. 95% UCL was greater than maximum.

Table 4–16. Selenium HQs for Terrestrial Invertebrate Ingestion at Monticello OU III—1998 ERA Results

Receptor/Location	$HQ\text{-}CT_{NOAEL}$	$HQ\text{-}RME_{NOAEL}$	$HQ\text{-}CT_{LOAEL}$	$HQ\text{-}RME_{LOAEL}$
Spotted Bat—U	1.28	1.36	0.73	0.78
Spotted Bat—UM	1.12	1.19	0.64	0.68
Reference Area Range	0.30–1.5	0.32–1.62	0.17–0.87	0.19–0.93
Flycatcher—U	1.63	2.92	0.82	1.5
Flycatcher—UM	1.43	2.55	0.71	1.3
Reference Area Range	0.39–1.94	0.70–3.48	0.19–0.97	0.35–1.74

U = Upper Montezuma Creek.
UM = Upper and Middle Montezuma Creek.

Ecotoxicological Effects of Selenium

DOI (1998) summarized potential effects of different levels of selenium in various media based on a review of the ecotoxicological literature. Results of the DOI evaluation pertinent for comparison to OU III are presented in Table 4–17.

Table 4–17. Summary of the Ecotoxicity of Selenium (from DOI 1998)

Medium	Concentration	Effect
Water	1–3 µg/L	LOAELs in fish and wildlife through bioaccumulation
Terrestrial invertebrates	0.1–2.5 mg/kg	Background invertebrate concentrations (typically <1.5 mg/kg)
Aquatic invertebrates	0.4–4.5 mg/kg	Background invertebrate concentrations (typically <2.0 mg/kg)
Aquatic invertebrates	2.5–15 mg/kg	Experimental LOAEL for subacute (growth) effects in invertebrates
Avian dietary intakes (e.g., invertebrates)	3–8 mg/kg	Threshold for reproductive impairment
Bird, whole body	<2 mg/kg	Typical background
Dietary intakes, rats	3 mg/kg (dry wt.)	LOAEL, reproductive selenosis
Dietary intakes, dogs	7 mg/kg	Sublethal effects, LOAEL
Sediment	2.5 mg/kg	EC 10 (effective concentration) for fish and birds

Selenium ecotoxicity summarized in Table 4–17 indicates that concentrations of selenium detected in surface water since the 1998 ERA are within the range reportedly associated with adverse effects to fish and wildlife. Dietary exposure calculations using invertebrate tissue concentrations collected prior to 1998 (thus not affected by the recently increased concentrations in surface water) also suggested a potential risk to avian insectivores and mammals. However, it is also noted that those calculations were performed using conservative assumptions which likely overestimated average exposures.

As indicated by the DOI (1998) report, selenium is much less toxic to most plants and invertebrate animals than to vertebrate animals, and the most notable feature of selenium ecotoxicology is the very narrow margin between nutritionally optimal and potentially toxic dietary exposures for vertebrate animals. Current concentrations of selenium in sediment and terrestrial or benthic macroinvertebrate tissue have not been measured since the increased concentrations in surface water have occurred. Due to the nature of selenium to bioaccumulate, there is a potential for dietary selenium to be within the threshold reported for reproductive impairment in avian receptors.

Selenium ecotoxicity data in Table 4–17 also indicates that concentrations of selenium measured in OU III terrestrial invertebrates (average 1.2 mg/kg) are within the range of measured background terrestrial invertebrate concentrations (0.2 to 1.5 mg/kg), indicating that risks to the terrestrial invertebrate community are probably low. Concentrations of selenium measured in cliff swallow carcasses for OU III (less than 1.8 mg/kg, see Volume VII, Appendix H, page H-67 of the1998 RI) were within the range identified as background for avian whole-body concentrations (Table 4–17). Slightly elevated risks were calculated for ingestion of invertebrates by the spotted bat and southwestern willow flycatcher at OU III (Table 4–16), despite the fact that that selenium concentrations measured in OU III terrestrial invertebrates were within the range of background. However, on the basis of a threshold range of 3 to 8 mg/kg for reproductive impairment in birds and a threshold of 3 mg/kg for mammals (rats; Table 4–17), average OU III terrestrial invertebrate concentrations (1.2 mg/kg) would need to increase by a factor of at least 3 (and perhaps as large as 8) over those observed through previous sampling and analysis to fall within this range. There is no reason to believe that changed site conditions downstream of the Millsite would have produced such changes in terrestrial invertebrate concentrations, so this pathway is probably of little concern for the spotted bat and southwestern willow flycatcher.

Increases in selenium in seeps and surface water since completion of Millsite excavation does raise the issue of potential effects on benthic invertebrate concentrations and implications for corresponding higher trophic level receptors (i.e., waterfowl). Benthic invertebrate concentrations probably are related to surface water concentrations and may be affected by selenium increases at the site. Because wetlands were created at the site to attract waterfowl, which feed on benthic invertebrates, it is possible that these receptors could be at increased risk due to changes in selenium concentration associated with the site. The future monitoring and evaluation planned for the site will address these issues (see Section 4.2.4).

Reevaluation of Exposure Assumptions

Risks associated with dietary exposure to representative insectivorous avian and mammal receptors remain a primary concern for the site. Terrestrial invertebrate tissue account for 99 percent and 95 percent of the dietary intakes of the spotted bat and flycatcher, respectively. Tables 4–18 through 4–21 provide exposure parameters and calculated exposure factors used in the 1998 ERA risk calculations for the spotted bat and southwestern willow flycatcher. The assumptions made regarding intakes of site-related (and presumably contaminated) invertebrates are critical in calculating potential risks; uncertainties in the assumptions must be considered in interpreting resulting calculated risks. As previously noted, no new monitoring data have been obtained for OU III-specific invertebrates during the recovery period since completion of the 1998 ERA, so it is not possible to recalculate those HQs based on current site conditions. However, selenium does tend to bioaccumulate, and the effects increased concentrations in surface water will have on terrestrial invertebrate concentrations are unknown.

Table 4–18. Spotted-Bat Exposure Parameters

Parameter	Units	CT Value[a]	RME Value[b]	Source
DF_{soil}—Diet fraction of soil	percent	1.00	1.00	Assumed
$DF_{invertebrates}$—Det fraction of invertebrates	percent	99.00	99.00	Poche 1981
IR_{solids}—Ingestion rate of solids	g/g-day	0.12	0.13	Poche 1981
IR_{water}—Ingestion rate of water	g/g-day	0.09	0.09	Poche 1981
BW—Body weight	g	13.70	14.50	Poche 1981
HR—Home range	hectares	—	—	Not Available
CA—Contaminated area	hectares	15.10	15.10	Measured
ED—Exposure days	days	365.00	365.00	Assumed

[a]Median value of the reported range.
[b]Maximum value of the reported range.

Table 4–19. Calculated Exposure Factors for the Spotted Bat

Exposure Factor	Units	CT Value[a]	RME Value[b]	Equation
I_{ts}—Ingestion total for solids	g/day	1.69	1.90	$I_{ts} = IR_{solids} \times BW$
I_{soil}—Ingestion of soil	g/day	0.02	0.02	$I_{soil} = I_{ts} \times DF_{soil}/100$
$I_{invertebrates}$—Ingestion of invertebrates	g/day	1.67	1.88	$I_{invertebrates} = I_{ts} \times DF_{invertebrates}/100$
I_{tw}—Ingestion total for water	g/day	1.21	1.35	$I_{tw} = IR_{water} \times BW$
EF—Exposure frequency	unitless	1.00	1.00	EF = ED/365
AUF_{ca}—Area use factor for contaminated area	unitless	1.00	1.00	$AUF_{ca} = CA/HR$

[a]Calculated from CT values, Table 4–17.
[b]Calculated from RME values, Table 4–17.

Table 4–20. Southwestern Willow Flycatcher Exposure Parameters

Parameter	Units	CT Value[a]	RME Value[b]	Source
DF_{soil}—Diet fraction of soil	percent	1.00	1.00	Assumed
DF_{shrubs}—Diet fraction of shrubs	percent	4.00	4.00	Bent 1963
$DF_{invertebrates}$—Diet fraction of invertebrates	percent	95.00	95.00	EPA 1993
IR_{solids}—Ingestion rate of solids	g/g-day	0.83	0.99	EPA 1993
IR_{water}—Ingestion rate of water	g/g-day	0.27	0.28	EPA 1993
BW—Body weight	g	13.80	14.60	King 1955, USFWS 1996
HR—Home range	hectares	0.26	0.06	Bent 1963
CA—Contaminated area	hectares	15.10	15.10	Measured
ED—Exposure days	days	120.00	180.00	Assumed

[a]Median value of the reported range.
[b]Maximum or minimum value of the reported range.

Table 4–21. Calculated Exposure Factors for the Southwestern Willow Flycatcher

Exposure Factor	Units	CT Value[a]	RME Value[b]	Equation
I_{ts}—Ingestion total for solids	g/day	11.45	14.45	$I_{ts} = IR_{solids} \times BW$
I_{soil}—Ingestion of soil	g/day	0.11	0.14	$I_{soil} = I_{ts} \times DF_{soil}/100$
I_{shrubs}—Ingestion of shrubs	g/day	0.46	0.58	$I_{shrubs} = I_{ts} \times DF_{shrubs}/100$
$I_{invertebrates}$—Ingestion of invertebrates	g/day	10.88	13.73	$I_{invertebrates} = I_{ts} \times DF_{invertebrates}/100$
I_{tw}—Ingestion total for water	g/day	3.73	4.09	$I_{tw} = IR_{water} \times BW$
EF—Exposure frequency	unitless	0.33	0.49	EF = ED/365
AUF_{ca}—Area use factor for contaminated area	unitless	1.00	1.00	AUF_{ca} = CA/HR

[a]Calculated from CT values, Table 4–19.
[b]Calculated from RME values, Table 4–19.

The assumptions used in the 1998 ERA were purposely selected to represent a range of conservative estimates to ensure that risks were not underestimated. Effects of elevated selenium concentrations, if any, would probably be localized based on OU III selenium distributions in surface water, sediment, and terrestrial invertebrate tissue. For example, it is conservative to assume that spotted bats will spend 100 percent of their time feeding in the contaminated area, when it is known that they will travel up to 10 kilometers from their roost to forage (University of Michigan website at http://animaldiversity.ummz.umich.edu/accounts/euderma/e.maculatum$narrative.html). The most likely bat roosting habitat is in the narrow portion of the canyon near surface water sampling locations SW92-07/SW00-04, and SW92-08. At SW92-07 and SW00-04, selenium concentrations averaged 3.7 µg/L from November 1992 through December 1996 (Appendix C, page C2–41) and 7.0 µg/L during 2001 and 2002 (Appendix C, page C2–42). At SW92-08, concentrations averaged 2.4 µg/L in November 1992 through December 1996 and 5.1 µg/L during 2001 and 2002 (Appendix C, page C2–47). Feeding habits indicate that spotted bats drink shortly after leaving their roosts and then forage for several hours. It is possible that most of the bats' diet would then consist of terrestrial invertebrates from outside the small fraction of area that is affected by selenium.

As for the southwestern willow flycatcher, it is likely that not all the suitable flycatcher-nesting habitat at OU III has elevated levels of selenium in soil or surface water. Birds selecting nesting locations outside the selenium-contaminated area would not have elevated risks for ingestion of selenium in invertebrates. Also, although flycatchers maintain well-defined territories, which are typically no larger than the size of the area with elevated levels of selenium, flycatchers are known to leave their territories even during the nesting stage to gather food for their nestlings (USFWS 2002). Birds that are not nesting are also known to travel to areas outside their territories (USFWS 2002). As such, the assumption that 100 percent of dietary terrestrial invertebrates is from the contaminated area likely contributes to an overestimation of site-related selenium intake for the southwestern willow flycatcher. For the spotted bat and the southwestern willow flycatcher, it is probable that the exposure assumptions used in the 1998 ERA are conservative and not likely realistic for existing site conditions.

4.2.3 Summary of the ERA Update

Current concentrations of selenium in surface water in the Millsite wetlands reflect, in part, perturbations from remediation activities and are not likely to represent long-term concentrations in those media. While it is anticipated that concentrations in surface water and ground water may decrease as the bedrock surface weathers and less selenium is available for leaching, the tendency for selenium to accumulate in the environment will have the opposite effect on concentrations measured. Also, in their present state (i.e., newly established and in a drought regime), the wetlands on the Millsite are not a long-term representation of their value as habitat or their potential for risks to ecological receptors.

For COCs other than selenium, the decreases in COC concentrations in surface water, ground water, soil, and sediment should result in concentration decreases for those same constituents in biotic media. Therefore, it is assumed that risks to the ecological receptors identified in 1998 associated with all ecological COCs except selenium have been reduced by remedial action and that the conclusions reached in the 1998 ERA remain valid (i.e., no significant ecological risks). However, increased concentrations of selenium detected in surface water at the site may be of potential concern to new ecological receptors (i.e., waterfowl through ingestion of aquatic invertebrates) because of high selenium toxicity and its tendency to bioaccumulate. It is probable that the observed increase in selenium concentrations is partly the result of remediation to and exposure of bedrock.

The best habitat for the spotted bat and southwestern willow flycatcher is in an area where concentrations of selenium in the creek average between 5.1 and 7.0 µg/L and hot-spot remediation of contaminated soil and sediment has occurred. Although the surface water concentrations are above Utah Water Quality standards and in the range for dietary effects to wildlife, it is unlikely that the spotted bat or southwestern willow flycatcher are using the Millsite wetlands as a primary habitat. The data necessary to evaluate effects due to potentially increased dietary ingestion of selenium are not available at this time, though it is unlikely that these receptors are currently at significant risk from selenium. Selenium concentrations in surface water in Montezuma Creek are unlikely to be a significant risk to benthic macroinvertebrates in the short term or the long term. However, bioaccumulation of selenium in benthic macroinvertebrates could be of concern for higher trophic level receptors.

The analysis presented in this update supports the conclusions reached in the 1998 ERA that there is not a current significant risk to the receptors chosen for evaluation in 1998 and that no alternatives need to be developed in the focused feasibility study (Section 5.0) to mitigate environmental risk. However, because current conditions are not an adequate representation of future conditions, especially on the Millsite, a long-term monitoring plan will be developed that includes biomonitoring. Data needs and the scope of potential monitoring are outlined in the following section and will be included in the OU III ROD. If an evaluation of the data collected under the OU III long-term monitoring plan indicates that risks from selenium exposure are a concern, the ETAG will be consulted as to the appropriate steps to take.

4.2.4 Uncertainties and Continued Monitoring and Data Collection

Future risks to ecological receptors from exposure to selenium cannot be addressed at this time and are considered an uncertainty. If Wetland 3 develops as designed, there is a potential risk to ecological receptors, in particular waterfowl, because of the presence of selenium. A post-remediation monitoring plan will be developed to address potential uncertainties with regard to the ecological health of wetlands on the Millsite due to selenium. Results of the data collection effort dictated by the post-remedial monitoring plan will be evaluated as recommended by the ETAG before the next CERCLA 5-year review scheduled to be completed during year 2007.

During preparation and review of this ERA update, the ETAG identified potential data gaps that require resolution. All the potential data gaps relate to the observation that selenium concentrations have increased significantly in Millsite surface water relative to concentrations evaluated in the 1998 ERA. The increase in selenium concentrations was first identified in 1999 and has been the subject of numerous discussions since that time. Possible sources of selenium were evaluated, and it is accepted that the most probably source is the mobilization of selenium from carbonaceous marine shale present in the area during remediation activities and not tailings-related contamination that was not remediated. Concentrations in surface water are expected to attenuate with time, making the current increase temporary or transient. The rate and degree to which they might decrease cannot yet be predicted.

The ETAG has accepted these observations and the decision was made to continue to monitor selenium concentrations in water as the drought eases and the hydrologic conditions designed for the Millsite are established. While the specific sampling goals and design will be in the OU III Proposed Plan, ROD, and LTS&M Plan, ground water monitoring is expected to continue in the vicinity of Wetland 3 and downgradient of the Millsite. Surface water monitoring is expected to continue at

- SW00-02 near the outlet of Wetland 3 at the eastern boundary of the Millsite,
- Seeps along the north side of the Millsite,
- SW01-02 near the outlet of Wetland 1, which is near the western boundary of the Millsite,
- SW01-03 near the outlet of Wetland 2 near the mid-portion of the Millsite, and
- Downstream of the Millsite at locations SW01-01, Sorenson, and SW00-04.

The lack of updated selenium concentration data in sediment prevents the meaningful evaluation of potential exposure and risk associated with current selenium concentrations at the site. Sediment sampling will be conducted in the wetlands and at the pond near surface water location SW00-04, at a minimum, as part of the long-term monitoring.

Before finalizing other components of the long-term monitoring plan, the list of ecological receptors will be reviewed to determine the adequacy of those receptors to reflect potential current and future concerns at the site, given the habitat that is expected to develop on the Millsite. For example, although a site-specific evaluation of the benthic macroinvertebrate community has been suggested, benthic macroinvertebrates are probably more important as a food source to other wildlife. It is well documented that benthic macroinvertebrates may bioaccumulate concentrations of selenium higher than those in the water in which they live. It is anticipated that an aquatic bird species that uses wetland habitats for breeding might be added as a receptor of concern. DOE may request that U.S. Fish and Wildlife Service technical staff perform field surveys of threatened and endangered species within the vicinity of OU III.

Other components of long-term monitoring that are being considered by the ETAG include

- Collection of data necessary to model exposure point concentrations for risk-driving pathway (aquatic invertebrates) or direct measurement of those concentrations in aquatic invertebrates. If the ETAG determines that these data are appropriate, the data will be collected in the near future to establish baseline concentrations in aquatic invertebrates.
- Collection of waterfowl eggs to evaluate impairment of clutch viability.

Additional types of monitoring will be conducted on an as-needed basis if certain "trigger levels" are exceeded. The establishment of these decision points will be done in conjunction with the ETAG. The scope of long-term monitoring will be outlined in the OU III Proposed Plan and ROD and will be explicitly stated in a long-term monitoring plan that will be reviewed by and receive concurrence from EPA, UDEQ, and other members of the ETAG. Prior to the reevaluation of risk to the environment that will be presented in the 2007 CERCLA 5-year review, information on selenium fate and transport and ecological toxicity will be updated to evaluate risk to the receptor(s) of concern.

End of current text