A1−7.0 Analysis for Aquatic Species

A1−7.1 Species Accounts and Status in the Proposed Action Area

The major portions of the upper Colorado and Green rivers, including tributaries, have been designated by USF&WS as critical habitat for the Colorado pikeminnow, razorback sucker, humpback chub, and bonytail (Table A1−3). The segment of the Colorado River near the Moab site is within this designated critical habitat. These fish species are considered endangered by USF&WS. Conservation of these species requires the identification and management of water resources and habitat that are important for their survival and propagation (i.e., spawning areas, nursery grounds, and interactions with predators and competitors) (50 CFR 17.95).

Table A1−3. Status of Aquatic Species

Common Name	Scientific Name	Status
Humpback chub	*Gila cypha*	Endangered
Bonytail	*Gila elegans*	Endangered
Colorado pikeminnow	*Ptychocheilus lucius*	Endangered
Razorback sucker	*Xyrauchen texanus*	Endangered

The Colorado pikeminnow, razorback sucker, humpback chub, and bonytail are included in the Upper Colorado River Endangered Fish Recovery Program (USF&WS 2002a, 2002b, 2002c, 2002d). The program goal is "to recover the endangered fishes while water development proceeds in compliance with State and Federal laws, including the ESA, State water law, interstate compacts, and Federal trust responsibilities to American Indian Tribes" (USF&WS 2002a, 2002b, 2002c, 2002d). Management actions identified as part of the recovery goals for these species include "minimizing the risk of hazardous-materials spills in critical habitats and remediation of water-quality problems." Contaminants of concern, primarily ammonia, pose a threat to the Colorado pikeminnow and razorback sucker. There is also the risk of "catastrophic pile failure that could affect important nursery areas and destroy other fish habitat" (USF&WS 2002a, 2002b). Disposal cell or pile failure is discussed further in Section A1−7.2.

A1−7.1.1 Colorado Pikeminnow

Habitat/Reproduction. Colorado pikeminnow, a large, predatory fish belonging to the minnow family, was once abundant and widely distributed in the Colorado River basin. Wild populations of Colorado pikeminnow currently occupy only about 25 percent of their historical range in the basin, including the upper Colorado River from Palisade, Colorado, to Lake Powell, Utah (USF&WS 2002a). Natural reproduction of Colorado pikeminnow is known to occur in the upper Colorado, Green, Yampa, Gunnison and San Juan Rivers (USF&WS 2002a). Although adult and juvenile fish move intermittently through the reach of the Colorado adjacent to the Moab Site, the entire reach is considered occupied habitat at all times. Exposure of pikeminnow to Moab site-related contamination is related to the presence of suitable habitat and to the presence or absence of contamination in those suitable areas. The areal extent and type of pikeminnow habitat near Moab changes with the time of the year, water temperature, pH, changes in river morphology, water level, and water quality. The interaction and connections

among these habitat characteristics and the exact location of suitable habitat can change over time. These changes can occur over very short periods of less than a day to seasonal, annual, and even decadal periods of time.

Throughout most of the year, juvenile, subadult, and adult pikeminnow use relatively deep, low-velocity eddies, pools, and runs that occur in the nearshore areas of main river channels (USF&WS 2002a). During the spring and early summer, the adults use shorelines, floodplain habitats, flooded tributary mouths, and flooded side canyons that are available only during high flows (Tyus 1990, USF&WS 2002a). These high spring flows provide an important cue to prepare adults for spawning migration (USF&WS 2002a). During the spawning season, adults have been reported to migrate up to 200 miles upstream or downstream to reach spawning areas (Tyus 1990). By late August or September, most adults return to home ranges occupied the previous spring (Muth et al. 2000). Juvenile pikeminnow, which are more commonly collected in the lower reaches of the river, are more wide-ranging in their habitat preference compared to adults. Juveniles feed on small-bodied fishes that spend much of their life in or associated with low velocity habitats. Whereas adult pikeminnow are found in the lower Colorado River, the greatest concentration of adults (spawning population) occurs upstream of the Moab site in Colorado (USF&WS 2004a).

Pikeminnows spawn on cobble bars in the upper reaches of the river, upstream of Westwater Canyon (USF&WS 2004a). Spawning occurs during period of declining flows during June, July, or August (Tyus and Haines 1991, Muth et al. 2000, Tyus 1990). After hatching, larvae passively drift downstream to settle into relatively low-velocity river reaches where they are entrained in backwater nursery habitats. Larvae develop paired fins and are then classified as young-of-the-year. They remain in these backwater habitats throughout most of their first year of life (USF&WS 2002a). Backwater areas are vital to successful recruitment of early life stages of Colorado pikeminnow. The pikeminnow larvae occupy these in-channel backwaters soon after hatching. They tend to occur in backwaters that are large, warm, deep (approximately 1 ft) and turbid (USF&WS 2002a). Larval and juvenile pikeminnow (0 to 1 year) show a preference for secondary channel habitats (Trammell and Chart 1998, Rakowski and Schmidt 1997, Day et al. 1999, USF&WS 2002a), and they are primarily found in low-velocity waters, which include backwaters (Tyus and Haines 1991, Trammell and Chart 1998). During the fall, they utilize backwater habitats that are deeper and more persistent than other habitats (Trammell and Chart 1998, Day et al. 1999). These backwaters are created when a secondary channel is cut off at the upper end but remains connected to the river at the downstream end. These areas are considered crucial for over-winter survival of the larval and juvenile fish (Trammell and Chart 1998). The backwater areas are considered primary, preferred habitat for juveniles; however, both adults and juveniles can occur in a variety of habitats throughout the year. Young Colorado pikeminnow remain near the nursery areas for the first 2 to 4 years of life, then move upstream and establish home ranges (Osmundson et al. 1998).

Aerial observations of the Colorado River were conducted between 1992 and 1996 to estimate backwater habitat from river mile 53.5 to 64.0. In addition, Colorado River flow data (in cubic feet per second) were recorded from the U.S. Geological Survey (USGS) Cisco, Utah, gaging station (Station No. 09180500) for each observation. Flows recorded during the observations ranged from 2,490 to 9,260 cfs. Base river flow typically ranges from 3,000 to 5,000 cfs for most of the year. Between April and July, the river discharge and stage dramatically increase in response to snowmelt runoff. On average, the river stage rises approximately 7 ft during peak flows at the Cisco gaging station (DOE 2003b). The average total backwater area for flows under

5,000 cfs was 2.3 acres (ranging from 0.4 to 4.4 acres). The average total backwater area for flows over 5,000 cfs was 1.2 acres (ranging from 0.9 to 2.0 acres).

Backwater areas were also quantified for areas adjacent to and immediately downstream of the Moab site (river mile 61 to 64). The average total backwater area in river mile 61 to 64 was 1.2 acres (ranging from 0.2 to 2.1 acres) for flows under 5,000 cfs and 0.9 acre (ranging from 0.4 to 1.9 acres) for flows over 5,000 cfs. Fifty to 70 percent of the backwater areas from river mile 53.5 to 64.0 were found in the stretch of the Colorado River in the vicinity of the Moab site (river mile 61 to 64).

A field visit with UDWR on December 19, 2001, identified backwater areas that may be used by larval and juvenile pikeminnows beginning at the mouth of Moab Wash and extending approximately 1,200 ft south. Within this area, three locations extending about 600 to 800 ft south of the wash were tentatively identified as having the greatest potential for suitable nursery habitat at river flows that inundate these areas each year.

Based on multiple studies of young-of-the-year pikeminnow habitat, researchers have established a protocol for sampling backwater areas to monitor pikeminnow recovery efforts (Trammell and Christopherson 1999). The protocol calls for sampling backwaters with a minimum surface area of 322 ft^2 and a minimum depth of 0.98 ft for the Interagency Standardized Monitoring Program (ISMP). The relatively permanent "average" secondary channel backwater areas have mean surface areas of 10,749 ft^2 and mean depths of 1.38 ft (Trammell and Christopherson 1999). Besides area and depth requirements, quality pikeminnow habitat must also be sufficiently turbid to provide adequate cover. Recent studies of pikeminnow in the Green River found a positive correlation of pikeminnow with higher turbidity; it was therefore recommended that a minimum depth for sampling in these turbid areas be reduced to 0.7 to 0.8 ft (Day et al. 1999).

Known Occurrences in the Project Area. There are estimated to be 600 to 900 adult pikeminnows in the upper Colorado River (USF&WS 2002a). The two known spawning areas in this reach of the river are near Grand Junction, Colorado, and in the lower Gunnison River (USF&WS 2002a). Age 0–1 fish and juveniles are found in the upper Colorado River downstream of Palisade to Lake Powell (USF&WS 2002a). The Moab site is located on river mile 64 and is within the habitats documented to contain current populations of Colorado pikeminnow. Both adults and subadults have been collected in Moab Wash and directly downstream from the tailings pile (USGS 2002). Up to 53 young-of-the-year pikeminnow were captured between river mile 48 and 84 (Osmundson et al. 1997). In a mark-recapture study of adult pikeminnow in this reach (river mile 48 to 84), 21 of 51 (41 percent) fish were caught between river mile 57 and 65 (Osmundson et al. 1997). Surveys in 1992 to 1996 by Trammell and Chart (1998) found adult and larval pikeminnow between river mile 55 and 65.

As part of the ISMP, pikeminnow nursery habitat was sampled each fall (1986 to 2002) between river mile 53.5 and 63.5. The purpose of this sampling was to determine relative abundance and distribution of young-of-the-year Colorado pikeminnow. The sampling protocol required sampling two habitats every 5 miles. Sixty backwater locations were sampled between 1986 and 2002, of which 13 were between river mile 61 and 63.5. Five of the 13 backwater areas sampled contained a total of 83 young-of-the-year pikeminnow comprising 24 percent of the total pikeminnow captured between river mile 53.5 and 63.5 during ISMP sampling (UDWR 2003a).

In the spring of 2003, USF&WS captured 8 stocked adult pikeminnow between river miles 60 and 64, 4 between river miles 64 and 70, and 20 between river miles 50 and 60 (USF&WS 2004b).

UDWR sampled three locations within 1,000 ft of the Moab Wash in April 2004. Each site was sampled using seines. Red shiner and plains killifish were collected. However, Colorado pikeminnow were not collected during these sampling events (UDWR 2004).

Diet. Pikeminnow less than 2.0 inches total length prey on small aquatic invertebrates in side channels and backwaters; juveniles between 2.0 and 4.0 inches total length still in the backwater nursery habitat eat invertebrates and other fish; and pikeminnow greater than 4.0 inches total length prey mainly on other fish (Muth and Snyder 1995; USF&WS 2002a).

Threats. Threats to this species include streamflow regulation, habitat modification, competition with and predation by non-native fish species, and pesticides and pollutants (USF&WS 2002a). The Moab site poses two significant threats to the Colorado pikeminnow: "toxic discharges of pollutants, particularly ammonia, through ground water to the Colorado River and the risk of catastrophic pile failure, that could affect important nursery areas and destroy other fish habitat" (USF&WS 2002a).

A1−7.1.2 Razorback Sucker

General Distribution. The endangered razorback sucker is one of the most imperiled fishes in the basin and exists naturally as only a few disjunct populations of scattered individuals (Minckley et al. 1991; Muth et al. 2000). Lack of recruitment sufficient to sustain populations has been mainly attributed to the cumulative effects of habitat loss and modification caused by water and land development and predation on early life stages by non-native fishes (Hamilton 1998; USF&WS 1998a; Muth et al. 2000). Wild populations of razorback sucker were virtually extirpated from the Colorado River system by 1990. Since the mid-1990s, the recovery program has been reintroducing hatchery-reared fish in the Colorado and Gunnison rivers (USF&WS 2004a).

Habitat. Razorback suckers are known to spawn on gravel bars and may also spawn in backwaters (NRC 1999). In the past, they have been observed spawning in early and mid-summer within 2 miles upstream of the tailings pile (NRC 1999). The razorback sucker may be found almost anywhere in the river, including slow runs in the main channel, inundated floodplains and tributaries, eddies and backwaters, sandy bottom riffles, and gravel pits (50 CFR 17.95). Young razorback suckers require nursery habitat with warm, shallow water such as tributary mouths, backwaters, or inundated floodplains (Modde 1996, Muth et al. 2000). Stocked juvenile and adult razorback sucker actively seek out flooded habitat in the Colorado River system and are likely using flooded habitats available at the mouth of Courthouse Wash, Moab Wash, the mouth of Mill Creek and Kane Springs (USF&WS 2004a). During periods of inundations, the lower Moab Wash and the riparian woodland near the toe of the pile potentially provide habitat for pikeminnow and razorback suckers (NRC 1999). The Matheson Wetlands Preserve area is also potential nursery habitat for the razorback sucker (NPS 2003). For purposes of this BA, it is assumed that the razorback sucker may be present in the project area.

Known Occurrences in the Project Area. A limited number of adults have been found in the upper Colorado River since 1974 (USF&WS 2002b). Many of the adults captured during

studies have been found in two abandoned gravel pits in the Grand Valley, near Grand Junction, Colorado, just upstream and downstream of the confluence with the Gunnison River (USF&WS 2002b). Recaptures of stocked individuals have been increasing in recent years throughout the river, including near the Moab site (USF&WS 2004a). In 2003, USF&WS captured 3 stocked adult razorback suckers between river miles 60 and 64, 10 between river miles 64 and 70, and 8 between river miles 50 and 60 (USF&WS 2004b). USF&WS sampled this stretch of river in the spring of 2004 and captured 6 stocked adults between river miles 64 and 70, 2 between river miles 60 and 64, and 3 between river miles 45 and 60 (USF&WS 2004c). No young razorback suckers have been captured anywhere in the upper Colorado River since the mid-1960s (USF&WS 2002b; USGS 2002; NPS 2003). However, in recent years, stocked razorback sucker have reproduced in the Gunnison River, and naturally produced larvae are now in the Colorado River system (USF&WS 2004a).

Diet. The diet of all life stages is varied and includes invertebrates, zooplankton, phytoplankton, algae, and detritus (Behnke and Benson 1980, Muth et al. 1998, Marsh 1987, Muth et al. 2000).

Threats. Threats to this species include streamflow regulation, habitat modification, competition with and predation by non-native fish species, and pesticides and pollutants (USF&WS 2002b). The Moab site poses two significant threats to the razorback sucker: “toxic discharges of pollutants, particularly ammonia, through ground water to the Colorado River and the risk of catastrophic pile failure, that could affect important nursery areas and destroy other fish habitat” (USF&WS 2002b).

A1−7.1.3 Humpback Chub

Habitat/Distribution. The humpback chub, a large cyprinid fish, prefers deep canyons with swift water and rapids (USF&WS 2002c; Muth et al. 2000). Historical abundance of the humpback chub is unknown, and historical distribution is incomplete (Muth et al. 2000; USF&WS 2002c). The species primarily inhabits relatively inaccessible canyons of the Colorado River Basin and was rare in early collections (USF&WS 2002c). Adults require eddies and sheltered shoreline habitats maintained by high spring flows. These high spring flows maintain channel and habitat diversity, flush sediments from spawning area, rejuvenate food production, and form gravel and cobble deposits used during spawning. Young require low-velocity shoreline habitats, including eddies and backwaters, that are more prevalent under base-flow conditions (USF&WS 2002c).

Humpback chub are more sedentary than other native Colorado River fishes and are capable of completing their life cycle in relatively short stretches of the river. Radiotelemetry and tagging studies consistently show high fidelity by humpback chub for specific river locations occupied by respective populations. Six extant wild populations are known in the Upper Colorado Basin: (1) Black Rocks, Colorado River, Colorado; (2) Westwater Canyon, Colorado River, Utah; (3) Yampa Canyon, Yampa River, Colorado; (4) Desolation/Gray Canyons, Green River, Utah; (5) Cataract Canyon, Colorado River, Utah; and (6) mainstem Colorado River in Marble and Grand Canyons and the little Colorado River, Arizona (USF&WS 2002c). The nearest downstream population occurs in Cataract Canyon (over 50 miles downstream of the Moab site) (USF&WS 2002c). The population in Cataract Canyon consists of about 500 adults (USF&WS 2003c). Populations in the Upper Colorado River Basin appear healthy and stable. The population at Black Rocks and Westwater Canyon, near the Colorado-Utah state line, is estimated at about 2,900 adults (USF&WS 2003c).

Known Occurrences in the Project Area. Five individuals were collected from a reach about 19 river miles downstream of the Moab site, possibly associated with populations upstream of the Moab site in Westwater Canyon and Black Rocks (NRC 1999, Valdez and Williams 1993).

Threats. Threats to this species include streamflow regulation, habitat modification, predation by non-native fish species, parasitism, hybridization with other native *Gila*, and pesticides and pollutants (USF&WS 2002c).

A1−7.1.4 Bonytail

Habitat/Distribution/Known Occurrences in the Project Area. Little is known about the specific habitat requirements of bonytail because this species was extirpated from most of its historical range prior to extensive fishery surveys (USF&WS 2002d). The bonytail uses mainstem river channels, where it has been observed in pools and eddies, as well as inundated riparian areas. Available distribution data show that flooded bottomland habitats are important growth and conditioning areas for bonytail, particularly as nursery habitats for young (USF&WS 2002d). Potential habitat for both adult and juvenile fish exists in the reach of the Colorado River near the Moab site.

Currently, no self-sustaining populations of bonytail exist in the wild, and very few individuals have been caught throughout the Upper Colorado Basin (USF&WS 2002d). Since the mid-1990s, the recovery program has been reintroducing hatchery-reared fish in the Colorado River. Some of the stocked fish have been recaptured, indicating at least short-term survival (USF&WS 2002d). Recaptures of these stocked individuals have been increasing in recent years throughout the river, including near the Moab site (USF&WS 2004a). In 2003, a stocked adult bonytail was captured by USF&WS at river mile 66.2, just upstream of the Moab site (USF&WS 2004b). In 2004, a stocked adult was captured at river mile 69.2. (USF&WS 2004c).

Threats. Threats to this species include streamflow regulation, habitat modification, competition with and predation by non-native fish species, hybridization, and pesticides and pollutants (USF&WS 2002d).

A1−7.2 Potential Effects of Proposed Actions on Aquatic Species

The impacts described below would be applicable at the Moab site, under either on-site or off-site disposal alternatives.

Mechanical Disturbance. The impact to aquatic species due to construction and operations at the Moab site would be from mechanical disturbances and loss of vegetation along the shoreline of the Moab Wash and Colorado River. Activities at the Moab site would likely disturb about 8,100 ft of Colorado River shoreline. The vegetation along the shoreline, consisting primarily of tamarisk, would be removed in order to excavate and remove contaminated materials (i.e., soils contaminated with residual radioactive material). The vegetation along the shoreline, consisting primarily of tamarisk, would be removed in order to complete remediation of the tailings pile. The tamarisk along the banks of Moab Wash as it enters the Colorado River would likely be removed as well.

The effects of mechanical disturbance would include the loss of shade and cover over the shoreline and potentially a loss of surface stability that could lead to increased erosion and

siltation into the wash and river. Impacts to threatened and endangered species due to these changes would be minimal. The shade and cover provided by the tamarisk is only along the edge of the river during high and moderate flows of the river. At low river flows, the shoreline vegetation provides no shade, and the flow into the wash is cut off. The potential also exists for water intake structures in the river to result in mortality to eggs, larvae, young-of-the-year, and juvenile life stages. DOE would minimize this potential by using one-quarter to three-eighths-inch screened mesh on water intake structures.

Effects from siltation and erosion into the river and wash could fill in backwater areas that may be important to macroinvertebrates and fish. Moab Wash has been documented as potential pikeminnow nursery habitat that could be affected by siltation and erosion (NPS 2003). Erosion along the river shoreline could create new backwater areas, but these would likely be temporary based on river stage.

Federally listed species that could be potentially affected by the changes to the shoreline include the endangered Colorado pikeminnow, razorback sucker, humpback chub, and bonytail. The Colorado River reach near the Moab site has been designated as critical habitat (50 CFR 17.95) for all four federal endangered fish species. Juvenile and adult Colorado pikeminnow and stocked adult razorback sucker and bonytail have been collected near the Moab site. Moab Wash and the riparian vegetation adjacent to the Colorado River potentially provide nursery habitat for young-of-the-year fish (NRC 1999, NPS 2003, UDWR 2003a). Erosion and siltation events that change the depth and configuration of these backwater areas are likely to have an effect on the extent of nursery habitat for endangered fish. Other fish, macroinvertebrates, and emergent plants associated with the backwater areas are also likely to be affected by erosion and siltation. The effects of erosion and siltation would be prevented or reduced by minimizing shoreline disruption, replacing vegetation, and installing erosion control devices.

Noise. Noise from site construction and operations is not expected to affect the aquatic environment. Activities along the shoreline are likely to be of short duration and are not likely to cause macroinvertebrate or fish communities to avoid the area.

Other Human Disturbances. Aspects of human presence such as personnel or vehicle movement and supplemental lighting are not expected to affect the aquatic environment.

Water depletion in the Colorado River as a result of remediation of the Moab site would be in accordance with the Cooperative Agreement to implement the "Recovery Implementation Program for Endangered Fish Species in the Upper Colorado River Basin" (USF&WS 1987). The Cooperative Agreement was signed by the Secretary of the Interior and by the governors of the states of Colorado, Utah, and Wyoming. The recovery program requires that all Section 7 consultations address depletion impacts. A key element of the program requires a one-time contribution of $10 per acre-foot (adjusted annually for inflation) based on the average annual depletion through activities at the site, to be paid to USF&WS. The balance of the payment would be due at the commencement of construction at the site. The impacts due to water depletion can be offset by the one-time contribution, appropriate legal protection of instream flows pursuant to state law, and accomplishments of activities necessary to recover the endangered fish as specified in the recovery plan (NRC 1999). Further consultation to determine the financial contribution based on water depletion, and required permits, if any, would be necessary.

Disposal Cell Failure from Natural Phenomena. This section addresses the potential natural processes that could cause a failure of the disposal cell at the Moab site and the expected consequences and potential risks associated with a contaminant release. The degree of contaminant impact to endangered species would depend upon (1) the type, duration, and areal extent of the failure event, and (2) the mass and concentrations of contaminants released into the Colorado River. Due to uncertainties associated with a contaminant release, and cumulative effects that are not contaminant-related, specific impacts to endangered species are difficult to assess.

Two basic types of failures could occur: catastrophic and long-term. These are described in more detail in Section 4.1.17 of the EIS. A catastrophic (i.e., sudden and unexpected) failure could occur as a result of a major flood or seismic event and would likely affect the entire Moab region. The analysis of a catastrophic failure considered the following assumptions to estimate the concentrations of uranium and ammonia as nitrogen in Colorado River water (DOE 2003c):

- Volumes of 20 and 80 percent of the tailings eroded into the river at a constant rate over a period of 10 hours (NRC 1999).
- Disposal cell failure occurs during a PMF, and the average river flux over the 10-hour period is 150,000 cfs, or half the 300,000 cfs maximum flux (NRC 1999).
- Concentrations of uranium and ammonia in tailings pore fluids and solid phases are the geometric means of all tailings samples.
- Uranium partitions between solid-phase tailings and river water according to a linear relationship with a distribution ratio of 3.0 milliliters per gram.
- All ammonia is dissolved into the river water (based on its common occurrence in soluble salts at the Moab site).
- Colorado River water mixes with Green River water at a ratio of 1.2:1.0, a 30-year average value determined from river gage stations at Cisco, Utah (Colorado River), and Green River, Utah (Green River) (USGS 2004).
- There is no dispersion of the dissolved phase.
- Colorado River water mixes uniformly with 50 percent of the water in Lake Powell; Lake Powell contains 6.85 trillion gallons (USBR 2004).
- There is no sorption of dissolved contaminants to clean suspended load in the river.

While engineering design of the disposal cell could compensate somewhat for this type of catastrophic event, planned mitigation would, at best, be speculative. A long-term, slow release could occur as a result of river migration, basin settling, or periodic erosion of the cell cover. Long-term failures assume smaller-quantity releases over an extended period (many years); a continuation of this type of release would also require a failure of long-term management (a scenario that assumes no repairs to the damaged cell would be done). This type of release, which is possible at all Uranium Mill Tailings Radiation Control Act (UMTRCA) Title I sites, can be mitigated. DOE's newly created (2003) Office of Legacy Management is responsible for monitoring and mitigating this type of release.

The focus of this analysis is to evaluate the potential qualitative consequences of contaminants in the water and sediments of the Colorado River based on a significant (catastrophic) release of

tailings. DOE has evaluated the hydrologic and geologic conditions of the northwestern portion of Spanish Valley and the Colorado River corridor at Moab (see Sections 3.1.1, 3.1.6, and 3.1.7 of the EIS). DOE has determined that catastrophic failure of the pile from sudden or catastrophic lateral migration of the Colorado River into the Moab site for the disposal cell design period of 200 to 1,000 years does not pose a realistic hazard. Given the known geologic and hydrologic context, the likelihood of catastrophic failure, though not statistically quantified, is considered extremely unlikely. Although the probability of a significant release would be very small over the design life of the on-site disposal cell, this type of failure was assumed to occur in order to qualitatively evaluate the potential consequences (risks).

The hypothetical catastrophic failure could release a large quantity of tailings into a relatively small volume of water compared to long-term releases, which would release a small quantity of tailings into a large volume of water (river flow over many years). Consequently, the assumptions associated with the hypothetical catastrophic event would yield the worst-case situation (more tailings released and higher contaminant concentrations in water).

For purposes of analysis, a large disposal cell failure (20 to 80 percent of the tailings eroded) was assumed to occur over a short duration (10 hours). Although such a large event would be unlikely, the analysis is useful in projecting potential environmental consequences of a worst-case scenario. The Colorado River was assumed to be at high flood stage during the tailings release. Concentrations of uranium, ammonia as nitrogen, and radium-226, the most prevalent contaminants, were estimated for the failure scenarios.

Sediment released during a catastrophic event would deposit in the river bottom or along banks or become part of the suspended load. Fine-grained portions of the sediment would remain in suspension and rapidly transport downstream. Where the river overflowed its banks, fine-grained sediment would be deposited by settling in standing water. The concentrations of contamination in backwater areas would depend on (1) the proportion of fine-grained tailings to clean suspended load, (2) concentration in the suspended tailings, and (3) the mass deposited over a given area. During periods of low flow, fine-grained sediment would be deposited; during high flow, these deposits would be remobilized and transported farther downstream. The sediment would be dispersed and mixed with clean sediment during transport, causing a continuous decrease in contaminant load. Detailed studies of deposition of radioactive sediment in the Colorado River Basin have shown that very small amounts of contamination would be expected to accumulate in the main river channel (HEW 1963).

After a catastrophic failure, contaminants would likely cause short-term adverse impacts to aquatic receptors in surface waters and sediments adjacent to the site. These negative impacts would likely decrease as the contaminant concentrations were reduced through dilution and dispersion downstream. Impacts from elevated ammonia levels at the Moab site downstream to Lake Powell would likely be short-term. Ammonia degrades and volatilizes and would not be expected to persist in the environment. Although the uranium surface water benchmarks would be exceeded, impacts would more likely occur from elevated concentrations in the sediment. Uranium accumulates in sediments and enters the food chain by adsorption on surfaces of plants and animals and by ingestion of sediments and contaminated food (Driver 1994; Cooley and Klaverkamp 2000; Swanson 1983). Thus, impacts from uranium in the sediments may be longer term because it complexes with sediments where it is likely to be more persistent.
Catastrophic disposal cell failure as a result of an unexpected event could also cause negative impacts to aquatic habitat within areas that are relatively close to the site. Habitat loss could

include degradation of backwater nursery areas as a result of elevated concentrations of contaminants and sediment loading. This loss could be extensive in the short term. Once the river dynamics normalized, newly created fish habitat, including backwater areas, could be adversely affected, depending on the duration and concentrations of the contaminant release.

Catastrophic disposal cell failure would also result in increased turbidity and sediment, which could affect the aquatic and benthic producers. The loss of primary producers would affect the entire food chain.

If mitigated, long-term failure would not likely result in negative impacts to aquatic biota. DOE's Office of Legacy Management is responsible for monitoring and mitigating this type of release. In addition, all currently available evaluations of the site's geologic and hydrologic conditions suggest that future lateral migration of the river will tend toward the east, away from the site (see Table 2−33, No.10 in the EIS). Also, DOE has incorporated a buried riprap diversion wall into the on-site disposal design to mitigate potential impacts should lateral river migration occur. It has been estimated that this engineering control could easily be enhanced, expanded, or modified in the future should river migration encroach on the site and the disposal cell.

Effects of Flooding on Ground Water Remediation. Catastrophic flooding could also affect the aquatic environment by flooding the ground water remediation systems. The interim action and proposed ground water remediation includes wells or shallow trenches located between the foot of the pile and the river's edge (Section A1−4.3). As discussed in Section 3.1.8 of the EIS, the location for these systems is in the 100-year floodplain. If a flood were to inundate the remediation systems, ground water with contaminant concentrations exceeding the aquatic benchmarks could pass through the region toward the river. DOE expects that remediation systems would be quickly restored after the flood waters receded. USF&WS would be notified if ground water remediation systems were shut down due to flooding, and the river environment would be monitored to determine if the concentrations of contaminants of concern exceed benchmark.

Temperature. Temperature can influence the development, metabolism, motility, and mobility of fish; effect the expression of other environmental factors; and destroy the integrity of a fish, causing its death (Beitinger et al. 2000). Colorado pikeminnow spawn when the water temperature reaches 16 to 22 °C (61 to 72 °F), and the humpback chub spawns at temperatures greater than 17 °C (63 °F) (Muth et al. 2000). The Colorado pikeminnow, humpback chub, bonytail, and razorback sucker prefer temperatures between 24 and 25 °C (75 and 77 °F) (Bulkley and Pimentel 1983). Razorback suckers avoid temperatures above 27.4 °C (81 °F) and below 14.7 °C (58 °F) (Bulkley and Pimentel 1983). Young-of-the-year pikeminnow stop growing at temperatures less than 13 °C (55 °F) (Trammell and Chart 1998). During the fall and early winter, as the water temperature cools to less than 13°C (55 °F), the habitat available for overwintering become very important (Trammell and Chart 1998). A preference for temperatures somewhat warmer than the main river channel may also be important. However, in a study of the Colorado River pikeminnow nursery habitat, it was noted that fluctuations of temperature in backwater areas result in a lower mean daily temperature than in the main channel and that if pikeminnow closely follow temperature gradients, movement in and out of backwaters would be more frequent that previously assumed (Trammell and Chart 1998). The season of year, turbidity, and the temperature of the ground water can affect the fluctuation of temperature in the backwater relative to the main channel.

Impacts associated with activities related to remediation would not be expected to influence the temperature of the Colorado River. Leachate from the pile travels through the ground water pathway into the river, and the temperature gradient is not expected to affect the aquatic environment.

Chemical Impacts to Aquatic Species. The tailings pile on the Moab site is the source of chemical contamination to ground water, which in turn is the source of contamination influencing the Colorado River.

Characterization of the aquatic environment near the site is described in Chapter 3.0 of the EIS. Characterization has included sampling sediment, fish tissue, and surface water near the Moab site and upstream background surface water. Sediment samples of the Colorado River were collected from 1995 through 1997; however, those samples were not considered in this analysis because of comments in the USF&WS 1998 Final Biological Opinion (NRC 1999) concerning the quality of the data for evaluation of impacts. Concerns for the quality of the sediment data include inappropriate procedures and protocols for sample collection and inadequate collection of samples for statistical evaluation. Fish were collected for tissue analyses from 1995 through 1997, and the fish tissue samples also were not considered in this analysis because of comments on data quality that were similar to those made about sediment samples in the USF&WS 1998 Final Biological Opinion. An evaluation of the means and standard deviations for all the combined fish tissue data does not show a strong statistical difference in concentrations in the tissues collected upstream of the Moab site compared to those collected downstream.

The screening of contaminants is presented in Appendix A2 of the EIS and summarized here. The screening is based on surface water samples collected by Shepherd Miller, Inc. (SMI), DOE, and USGS. Samples were collected by SMI and DOE from 2000 through 2002. These data are presented in Appendix D of the SOWP (DOE 2003a). Water sample data were collected by USGS from 1998 through 2000 and are presented in *A Site-Specific Assessment of the Risk of Ammonia to Endangered Colorado Pikeminnow and Razorback Sucker Populations in the Upper Colorado River Adjacent to the Atlas Mill Tailings Pile, Moab, Utah* (USGS 2002). Many of the samples from other studies were considered, but quality issues were discovered during the evaluation of data for surface water samples taken prior to 2000. These issues included insufficient information to determine the location of the analyzed sample and laboratory quality control and quality assurance questions. Contaminants of potential concern for the Moab site were identified from institutional knowledge about the uranium milling processes used during operation of the Atlas mill and from the NRC EIS (NRC 1999). Surface water monitoring data were evaluated to determine if maximum concentrations were above detection limits, background levels, and federal and state criteria (i.e., benchmarks) for surface water quality.

The 2000 through 2002 surface water sampling data set was examined first to determine which sample results were above the detection limit set by the laboratory (Appendix A2 of the EIS). If an analyte was not detected, the laboratory reported a value equal to the method detection limit. Analytes not detected were assessed using values corresponding to one-half the method detection limit, based on EPA protocol (EPA 2001a, 2001b). The maximum concentration for the contaminant at any location or time was then compared to the maximum background concentration. Three upstream locations were considered as background stations for the Moab site. If a constituent was undetected in all background samples, then one-half the reported detection limit was used in the evaluation. Finally, the maximum concentration above background was compared to benchmarks for evaluating impacts to aquatic biota.

Benchmarks for the contaminants at the Moab site included the NWQC (EPA 2002) and proposed State of Utah water quality criteria (UAC 2003). The benchmarks used in the contaminant screening are listed in Appendix A2 of the EIS. Narrative and numeric water quality criteria are the foundation of a water-quality-based control program. The Clean Water Act standards mandate that water standards be established (33 U.S.C. 1251 et seq.). Water quality standards define the goals for a waterbody by designating its uses, setting criteria to protect those uses, and establishing provisions to protect water quality from pollutants. Utah's water quality standards are applicable to "waters of the State." Utah water quality standards apply to all waters within the state of Utah, with the exception of those waters that are within Indian Country, as defined in 18 U.S.C. Section 1151. DOE notes that the ground water discharge at the Moab site is not a point source water discharge requiring a permit and that residual radioactive material is not considered a "pollutant" under the Clean Water Act (40 CFR § 122.2; see also Utah Administrative Code Section R317-8-1.5[34] and [35]). However, DOE is proposing to remediate ground water discharging from the Moab site under 40 CFR 192. DOE recognizes the need to comply with surface water quality criteria to the extent practical, including the need to minimize, and preferably eliminate, risks to human health and the environment. Thus, the surface water standards set by Utah, including federal and state water quality criteria, were used for this assessment.

In some cases, federal or state criteria have not been established for contaminants of potential concern in surface water. Therefore, criteria established by Suter and Tsao (1996) for aquatic biota were used. Suter and Tsao (1996) provide a compilation of aquatic toxicity values, including National Ambient Water Quality Criteria, derived Tier II values (secondary chronic and acute values), and chronic values from a variety of other government sources.

Impacts to aquatic organisms can result from either acute or chronic exposures to contaminants of potential concern (Appendix A2 of the EIS). An acute exposure is defined as "the highest concentration of a material in surface water to which an aquatic community can be exposed briefly without resulting in an unacceptable effect" (EPA 2002). A chronic exposure is defined as "the highest concentration of a material in surface water to which an aquatic community can be exposed indefinitely without resulting in an unacceptable effect" (EPA 2002). Currently, the State of Utah criteria include an acute, 1-hour exposure and a chronic, 4-day exposure. As mentioned, Suter and Tsao (1996) were used where state and federal standards were not available. However, they used a method referred to as Tier II to establish criteria for aquatic benchmarks using fewer data than required by EPA in the NWQC. Also, they developed estimated lowest chronic values for fish extrapolated from laboratory studies. The standards are discussed further in Appendix A2 of the EIS.

The 2000 through 2002 surface water sampling data were compared to the ecotoxicological screening benchmarks (Appendix A2 of the EIS). This comparison further pared the list of contaminants of potential concern for assessing potential impacts to aquatic biota. Contaminants were not considered further when (1) the maximum concentration and maximum background concentration were below detection limits and below all benchmarks, or (2) the maximum concentration was less than all the benchmarks. These contaminants were further evaluated on the basis of the number of samples, location of the samples, and relevance of the flow regime at the time of sampling in comparison to the potential for exposure to aquatic biota.

The 1998 through 2000 data summarized in *A Site-Specific Assessment of the Risk of Ammonia to Endangered Colorado Pikeminnow and Razorback Sucker Populations in the Upper Colorado River Adjacent to the Atlas Mill Tailings Pile, Moab, Utah* (USGS 2002) were also examined. Results presented in the USGS report indicate that the pile represents a localized source of ground water input containing elevated levels of contaminants, including copper, manganese, zinc, and radiochemicals. These contaminants were measured at levels that exceeded benchmarks during the low-water hydrologic period ranging from August through March. Based on the results of this study, USGS summary data for copper, manganese, zinc, and total alpha were evaluated using the process previously described. These results are discussed where applicable within the constituent-by-constituent discussions in Appendix A2 of the EIS.

Based on the evaluation of contaminants of potential concern in Appendix A2 of the EIS, the contaminants that would require further assessment and continued monitoring during ground water remediation for the Moab site are ammonia, copper, manganese, sulfate, and uranium. If active remediation of the ground water near the Colorado River were conducted, the maximum concentrations of these contaminants of concern in the region where the ground water enters the river (nearshore environment) would decrease to levels below acute and chronic benchmarks. It is DOE's position that if acute criteria can be met everywhere, then chronic criteria can be met outside the mixing zone. (Section A1–4.3.2 of this BA, and Section 2.3.2.1 of the EIS). In addition, available data regarding interaction of ground water and surface water indicate that concentrations of most constituents decrease significantly as ground water discharges to and mixes with surface water (a 10-fold decrease is observed on average). Consequently, there is a reasonable assurance that protective surface water concentrations could be achieved by meeting less conservative goals than chronic standards in ground water. DOE believes that a target goal of 3 mg/L in ground water (the low end of the reasonable acute range) would provide adequate surface water protection. The 3-mg/L concentration represents a 2- to 3-order-of-magnitude decrease in the center of the ammonia plume and would be expected to result in a corresponding decrease in surface water concentrations. Coupled with the average 10-fold dilution, and the tendency for ammonia to volatilize, this concentration should result in compliance with both acute and chronic ammonia standards in the river everywhere adjacent to the site. Therefore, DOE proposes to use the 3-mg/L concentration of ammonia as a target goal for evaluating ground water cleanup options. Potential synergistic effects between contaminants would be reduced through ground water remediation. Continued monitoring during active ground water remediation would be necessary to verify that contaminant concentrations remained below both acute and chronic benchmarks for aquatic species.

Radiological Impacts to Aquatic Species. The primary source of radiological contamination to enter the aquatic environment at the Moab site is ground water. The routes of exposure for the radiological contaminants are the same as those for chemical contaminants. The contributors to radiological dose to the aquatic organisms at the Moab site that have been monitored include lead-210, polonium-210, radium-226, radium-228, radon-222, thorium-230, uranium-234, and uranium-238, and the general indicator of radionuclides, gross alpha and gross beta.

The RESRAD Biota Code (Version 1.0 Beta 3, June 3, 2003) was used to screen the dose rate to aquatic organisms based on the maximum observed concentrations of uranium-238, uranium-234, and radium-226 (DOE 2002b). These isotopes represent the highest values analyzed for radionuclides from 2000 to 2002. The protocol for screening assessment includes multiple tiers. The first-tier screening assessment using the maximum observed concentrations had a sum of fractions that equaled 3.16, which exceeded the DOE guidance level of 1.0 for

aquatic biota. A second-tier analysis based on mean concentrations of these three radionuclides of those values above detection resulted in a sum of fractions value of 0.29. The results of the second-tier analysis indicate that dose rates are below the guidance level associated with the 1.0-rad-per-day criterion adopted by DOE for screening dose rates to aquatic organisms.

The results of the RESRAD assessment indicate that the actual dose rates to aquatic organisms are below a population-effect level. There are no guidelines for radiological effects to individuals, which is important in evaluating impacts to threatened and endangered species. The studies that were completed for the 1.0-rad-per-day criterion were based on exposures to organisms for 1 year, and then normalized to a dose rate based on a day. One can interpret these results to mean that a dose rate of 1.0 rad per day, if sustained for a year, would have an effect on some individuals but not on the population as a whole. Based on monitoring results from 2000 to 2002 and on the life styles of the endangered fish around the Moab site, radionuclides in ground water discharging to the river currently are not expected to adversely affect the aquatic environment.

In its site-specific assessment, the USGS concluded that there would be "no significant biological impacts to fish populations caused by radionuclide concentrations sampled in the Colorado River and sediments." It found that "radiochemical concentrations are elevated in ground water below the Moab pile; however, these waters do not result in a high radiation exposure to fish" (USGS 2002).

Ground water extraction near the Colorado River and the use of freshwater injection would further decrease the maximum concentrations of radionuclides in the shoreline of the Moab site. These activities would be necessary for reducing impacts from chemical contaminants. They would also reduce the potential for radiological effects to individuals, which is important to endangered species as well as populations.

A1−8.0 Analysis for Terrestrial Species

A1−8.1 Species Accounts and Status in the Proposed Action Area

Spatial data for federally listed plant and animal species were obtained from the Utah Conservation Data Center (UCDC). This data set was compiled by the Utah Natural Heritage Program (UNHP) of the UDWR, in which species occurrences are depicted as points at a scale of 1:24,000 on 7.5-minute topographic quad maps. Spatial data depicting the project areas were overlaid on the spatial data depicting the occurrence of species of concern. Table A1−4 summarizes the listing status for terrestrial species discussed in this BA.