Summary

The U.S. Department of Energy (DOE or the Department) is proposing to clean up surface contamination and implement a ground water compliance strategy to address contamination that resulted from historical uranium-ore processing at the Moab Uranium Mill Tailings Site (Moab site), Grand County, Utah. Pursuant to the National Environmental Policy Act (NEPA), 42 *United States Code* (U.S.C.) §§ 4321 et seq., DOE prepared this environmental impact statement (EIS) to assess the potential environmental impacts of remediating the Moab site and vicinity properties (properties where uranium mill tailings were used as construction or fill material before the potential hazards associated with the tailings were known). DOE analyzed the potential environmental impacts of both on-site and off-site remediation and disposal alternatives involving both surface and ground water contamination. DOE also analyzed the No Action alternative as required by NEPA implementing regulations promulgated by the Council on Environmental Quality. DOE has determined that its preferred alternatives are the off-site disposal of the Moab uranium mill tailings pile, combined with active ground water remediation at the Moab site. The preferred off-site disposal location is the Crescent Junction site, and the preferred method of transportation is rail. The basis for this determination is discussed later in this Summary.

The 12 cooperating agencies are

Federal
- Bureau of Land Management
- National Park Service
- U.S. Army Corps of Engineers
- U.S. Environmental Protection Agency
- U.S. Fish and Wildlife Service
- U.S. Nuclear Regulatory Commission

State
- State of Utah

Tribal
- Ute Mountain Ute Tribe

County
- Grand County
- San Juan County

Local
- City of Blanding
- Community of Bluff

DOE has entered into agreements with 12 federal, tribal, state, and local agencies to be cooperating agencies in the development and preparation of this EIS. Several of the cooperating agencies have jurisdiction by law and intend to use the EIS to support their own decision-making. The others have expertise relevant to potential environmental, social, or economic impacts within their geographic regions. During the preparation of the EIS, DOE met with the cooperating agencies, provided them with opportunities to review preliminary versions of the document, and addressed their comments and concerns to the fullest extent possible. DOE received over 1,600 comments on the draft EIS from the public, federal, state and local agencies, tribes, governors, and members of Congress. DOE has considered these comments in finalizing the EIS and has provided responses to all comments in the EIS.

Regulatory Requirements

In 1978, Congress passed the Uranium Mill Tailings Radiation Control Act (UMTRCA), 42 U.S.C. §§ 7901 et seq., in response to public concern regarding potential health hazards of long-term exposure to radiation from uranium mill tailings. Title I of UMTRCA requires DOE to establish a remedial action program and authorizes DOE to stabilize, dispose of, and control uranium mill tailings and other contaminated material at 24 uranium-ore processing sites and associated vicinity properties. Vicinity properties are those off-site areas near the Moab millsite that can be confirmed to be contaminated with residual radioactive material (RRM). UMTRCA also directed the U.S. Environmental Protection Agency (EPA) to promulgate cleanup standards, which are now codified at Title 40 *Code of Federal Regulations* Part 192 (40 CFR 192), "Health

[*] Substantive changes made to the text of the EIS between draft and final have been marked with sidebars in the margins.

and Environmental Protection Standards for Uranium and Thorium Mill Tailings," and directed the U.S. Nuclear Regulatory Commission (NRC) to oversee the cleanup and license the completed disposal cells.

In October 2000, Congress enacted the Floyd D. Spence National Defense Authorization Act for Fiscal Year (FY) 2001 (Public Law 106-398), amending UMTRCA Title I (the authority to perform surface remedial action expired in 1998 for all other DOE sites) to give DOE responsibility for acquisition and remediation of the Moab site in accordance with UMTRCA Title I. The Floyd D. Spence Act also directed DOE to enter into arrangements with the National Academy of Sciences (NAS) to obtain the technical advice, assistance, and recommendations of NAS in objectively evaluating costs, benefits, and risks associated with various remediation alternatives. Previously, in September 1998, the Moab mill owner, the Atlas Minerals Corporation (Atlas), filed for bankruptcy. The bankruptcy court appointed NRC and the Utah Department of Environmental Quality beneficiaries of a bankruptcy trust created in March 1999 to fund future reclamation and site closure. Later, the beneficiaries selected PricewaterhouseCoopers to serve as trustee. To support its remediation decision-making, in 1999 NRC completed the *Final Environmental Impact Statement Related to Reclamation of the Uranium Mill Tailings at the Atlas Site, Moab, Utah* (NUREG-1531, March 1999), which proposed stabilizing the tailings impoundment (pile) in place. In accordance with Public Law 106-398, DOE acquired the site in 2001 to facilitate remedial action. DOE's EIS builds upon the analyses and the alternatives evaluated in NRC's EIS and expands the scope of the EIS to include ground water remediation and vicinity properties.

Background

As shown in Figure S–1, the Moab site lies approximately 30 miles south of Interstate 70 (I-70) on U.S. Highway 191 (US-191) in Grand County, Utah. The 439-acre site is located about 3 miles northwest of the city of Moab (Figure S–2) on the west bank of the Colorado River at the confluence with Moab Wash. The site is bordered on the north and southwest by steep sandstone cliffs. The Colorado River forms the eastern boundary of the site. US-191 parallels the northern site boundary, and State Road 279 (SR-279) transects the west and southwest portion of the property. The Cane Creek Branch of the Union Pacific Railroad traverses a small section of the site just west of SR-279, then enters a tunnel and emerges about 1.5 miles to the southwest. Arches National Park has a common property boundary with the Moab site on the north side of US-191, and the park entrance is located less than 1 mile northwest of the site. Canyonlands National Park is located about 12 miles to the southwest.

History of the Moab Site

The Moab site is the site of a former uranium-ore processing facility that was owned and operated by the Uranium Reduction Company and later Atlas under a license issued by NRC. The mill ceased operations in 1984 and has been dismantled except for one building that is currently used by DOE for vehicle maintenance and could be used as office space in the future during site remediation. During its years of operation, the facility accumulated approximately 10.5 million tons of uranium mill tailings. Uranium mill tailings are naturally radioactive residue from the processing of uranium ore. Decommissioning of the mill began in 1988, and an interim cover was placed on the tailings pile between 1989 and 1995.

In 1996, Atlas submitted a reclamation plan and an application to NRC for an amendment to its existing NRC license to allow for reclamation of the site. Under the license amendment, Atlas was required to reclaim the tailings impoundment in accordance with the October 1996 submittal to NRC titled *Final Reclamation Plan, Atlas Corporation Uranium Mill and Tailings Disposal Area*.

The amendment to the NRC license also required preparation of an EIS to assess potential impacts from the 1996 reclamation plan, but Atlas filed for bankruptcy before the EIS could be completed and was released from all future liability with respect to the uranium mill facilities and tailings pile at the Moab site.

As reported in the 1999 Final NRC EIS, which proposed stabilizing the tailings pile in place, NRC received numerous comments both in favor of and opposed to the proposed action. However, the EIS did not address ground water compliance or remediation of vicinity properties. NRC documented U.S. Fish and Wildlife Service (USF&WS) concerns regarding the effects of contaminants reaching the Colorado River; specifically, the effects on four endangered fish species and critical habitat. (In 1998, USF&WS had concluded in a Final Biological Opinion that continued leaching of existing concentrations of ammonia and other constituents into the Colorado River would jeopardize the razorback sucker and Colorado pikeminnow.)

To minimize potential adverse effects to human health and the environment in the short term, former site operators, custodians, and DOE have instituted environmental controls and interim actions at the Moab site. Controls have included storm water management, dust suppression, pile dewatering activities, and placement of an interim cover on the tailings to prevent movement of contaminated windblown materials from the pile. Interim actions have included restricting site access, monitoring ground water and surface water, and managing and disposing of chemicals to minimize the potential for releases to the environment. A pilot-scale ground water extraction system was implemented in the summer of 2003 to reduce the quantity of ground water contaminants discharging to the Colorado River.

Federal and state regulatory agencies have expressed concern about the effects of disposing of contaminated materials at the site and the effects of contaminated ground water entering the Colorado River. Stakeholders, including local and state governments, environmental interest groups, and downstream users of Colorado River water, have also expressed concern.

Current Status of the Moab Site

The tailings are located in a 130-acre unlined pile that occupies much of the western portion of the site. The top of the tailings pile averages 94 feet (ft) above the Colorado River floodplain (4,076 ft above mean sea level) and is about 750 ft from the Colorado River. The pile was constructed with five terraces and consists of an outer compact embankment of coarse tailings, an inner impoundment of both coarse and fine tailings, and an interim cover of soils taken from the site outside the pile area. Debris from dismantling the mill buildings and associated structures was placed in an area at the south end of the pile and covered with contaminated soils and fill. Radiation surveys indicate that some soils outside the pile also contain radioactive contaminants at concentrations above the EPA standards in 40 CFR 192.

Besides tailings, contaminated soils, and debris, other contaminated materials requiring cleanup include ponds used during ore-processing activities, disposal trenches, other locations used for

waste management during mill operation, and buried septic tanks that are assumed to be contaminated. DOE estimates the total residual radioactive material at the Moab site and vicinity properties has a total mass of approximately 11.9 million tons and a volume of approximately 8.9 million cubic yards (yd^3). Evidence indicates that historical building materials may contain asbestos.

Ground water in the shallow alluvium at the site was contaminated by ore-processing operations. The Colorado River adjacent to the site has been affected by site-related contamination, mostly due to ground water discharge. The primary contaminant of concern in ground water and surface water is ammonia. Other contaminants of potential concern are manganese, copper, sulfate, and uranium.

In addition to the contaminated materials currently at the Moab site, approximately 39,700 tons of tailings may have been removed from the Moab millsite and used as construction or fill material at homes, businesses, public buildings, and vacant lots in and near Moab. As a result, these vicinity properties may have elevated concentrations of radium-226 that exceed the maximum concentration limits in 40 CFR 192. On the basis of preliminary surveys conducted in the 1970s by EPA, 130 potential sites may require remediation. However, using past statistics and experience, DOE believes that only about 98 vicinity properties would actually need to be remediated. Additional characterization would be necessary to identify the current number and locations of vicinity properties. In accordance with the requirements of UMTRCA, DOE is obligated to remediate those properties where contaminant concentrations exceed the maximum concentration limits in 40 CFR 192, along with the Moab site.

Purpose and Need for Agency Action

The Moab site and vicinity properties near Moab, for which DOE has been given responsibility, contain contaminated materials in concentrations that exceed 40 CFR 192 maximum concentration limits and present a current and long-term potential source of risk to human health and the environment. DOE needs to take action to remediate the Moab site in accordance with UMTRCA Title I to fulfill its responsibilities under Public Law 106-398.

Alternatives

DOE is proposing to (1) remediate approximately 11.9 million tons of contaminated materials located on the Moab site and approximately 39,700 tons located on vicinity properties and (2) develop and implement a ground water compliance strategy for the Moab site. The reasonable surface remediation alternatives consist of encapsulating the contaminated material either on the Moab site or at one of three potential off-site locations. Under either the on-site or off-site disposal alternatives, ground water remediation would be implemented as part of the proposed activities. A No Action alternative is analyzed to provide a basis for comparison to the on-site and

Costs of Remediation Alternatives (Surface and Ground Water)

On-Site Disposal
- $249 million

Klondike Flats
- Truck—$407 million
- Rail—$469 million
- Slurry Pipeline—$472 million

Crescent Junction
- Truck—$411 million
- Rail—$472 million
- Slurry Pipeline—$479 million

White Mesa Mill
- Truck—$497 million
- Slurry Pipeline—$543 million

No Action Alternative
- No costs incurred

(see Table 2–35 in EIS)

off-site disposal alternatives, as required by NEPA. Under the No Action alternative, there would be no remediation either on-site or off-site.

Remediation of Surface Contamination and Ground Water

Each alternative (with the exception of the No Action alternative) would include both on-site and off-site activities:

- *Construction and Operations at the Moab Site*—these activities would include those needed for surface remediation, ground water compliance, and reduction of the contaminant mass in ground water discharging to the Colorado River. These activities would also include construction and operation of any transportation facilities needed at the site to either dispose of the contaminated material on the site or remove the materials from the site for off-site disposal.
- *Characterization and Remediation of Vicinity Properties*—these activities would include surveying, sampling soil, removing contaminated materials, and restoring and landscaping the properties. Contaminated materials from vicinity properties would first be transported to the Moab site under all remediation alternatives.
- *Construction and Operations at One of Three Off-Site Disposal Locations*—these activities are addressed only for the off-site disposal alternative and would include construction and operation of the disposal cell and any transportation facilities needed at any of the off-site disposal locations for handling and disposal of contaminated materials.
- *Construction and Operations Relating to Transportation*—these activities would include the following components:
  - Transportation of contaminated materials from vicinity properties to the Moab site (the estimated volume of contaminated materials from vicinity properties is included as part of the total volume of contaminated materials to be disposed of under all alternatives).
  - Transportation of materials from borrow areas to the Moab site and, under the off-site disposal alternative, to one of three off-site disposal locations.
  - Under the off-site disposal alternative, transportation of contaminated materials from the Moab site to one of three off-site disposal locations. Transportation would be by truck, rail, or slurry pipeline. In addition to transportation of contaminated materials to one of the off-site locations, construction activities would include (1) temporarily expanding existing roads and rail lines with overpasses and new sidings to provide safe access to the proposed sites, and (2) installing and later removing the slurry pipeline.
- *Monitoring and Maintenance*—these activities would include inspections and sampling conducted in accordance with the site's Long-Term Surveillance and Maintenance Plan, which would be approved by NRC for the disposal cell.

On-Site Disposal

The on-site disposal alternative would involve placing contaminated site materials and materials from vicinity properties on the existing tailings pile and stabilizing and capping the tailings pile in place. The cap would be designed to meet EPA standards for radon releases. Surface remediation would remove surface contamination to either:

- A concentration of radium-226 in land averaged over any area of 1,076 square feet (100 square meters) that does not exceed the background level by more than 5 picocuries per gram (pCi/g) averaged over the first 6 inches (15 cm) of soil below the surface and 15 pCi/g averaged over 6 inches (15 cm) of soil more than 6 inches (15 cm) below the surface (40 CFR 192.12); or
- Supplemental standards under 40 CFR 192.21.

Final design and construction of the cap would meet the requirements for disposal cells under applicable EPA (40 CFR 192) standards. Flood protection would be constructed along the base of the pile, and cover materials for radon attenuation and erosion protection would be brought to the site from suitable borrow areas.

Supplemental Standards and Surface Contamination

Remedial action will generally not be necessary when (1) residual radioactive materials (RRM) occur in locations where remedial actions would pose a clear and present risk of injury to workers or the public, (2) remediation would produce health and environmental harm that is clearly excessive compared to the health or environmental benefits, or (3) the costs of remedial action are unreasonably high relative to the long-term benefits. This includes instances where site-specific factors limit the RRM hazards and locations from which they are difficult to remove or where only minor quantities of RRM are involved (40 CFR 192.21).

Under this alternative, the existing Moab Wash would be rechanneled to run through the former millsite area. Rechanneling would begin before completion of the disposal cell. The reconfigured channel would discharge into the river upstream near the approximate location of the pre-milling operations discharge point.

Following completion of on-site disposal, the area outside the cell would be recontoured, reclaimed, and revegetated. The disposal cell would be enclosed and protected by a security chain-link fence around its perimeter to discourage access.

Remediation of contaminated materials on the site and at vicinity properties is estimated to take 7 to 10 years to complete and cost approximately $166 million. This cost and time estimate does not include ground water remediation.

Off-Site Disposal

For the off-site disposal alternative, DOE would remove contaminated materials from the Moab site and transport them to another location for disposal. Approximately 11.9 million tons of contaminated material would be removed from the site. This total consists of the estimated 10.5-million-ton tailings pile; an estimated 600,000 tons of soil that was placed on top of the pile; 566,000 tons of subpile soil (assumed to be 2 ft thick); 234,000 tons of off-pile contaminated site soil; and 39,700 tons of vicinity property material that would be brought to the Moab site before shipment to an off-site location.

On the basis of recent surveys that were not available at the time the draft EIS was developed, DOE has slightly increased its estimate of the volume of contaminated off-pile soil that would be disposed of with the tailings. The increase is less than 1 percent of the total volume of contaminated site material estimated in the draft EIS. The revised total estimates remain approximate and could increase again after more detailed site characterization is complete. The estimated volumes presented in the draft EIS represented DOE's best estimate based on information available when the draft EIS was developed. Due to the small cumulative change, the draft EIS estimates have been retained as a constant in the EIS for purposes of assessing and

comparing the impacts of each alternative. DOE would use the most current and reliable estimates of the volumes of all contaminated site material in developing a remedial action plan.

At the off-site disposal location, a disposal cell would be constructed. As with the on-site disposal alternative, the disposal cell cap would be designed to meet EPA standards for radon releases. Final design and construction would meet EPA (40 CFR 192) standards for disposal cells. Borrow materials would be obtained from off-site borrow areas for use as tailings cover construction materials and for use as clean backfill at the Moab site and vicinity properties.

DOE has identified three locations in Utah as potential off-site disposal locations (see Figure S–1):

- *Klondike Flats*—Klondike Flats is a low-lying plateau about 18 miles northwest of the Moab site, just northwest of the Canyonlands Field Airport and south-southeast of the Grand County landfill. The Klondike Flats site consists of undeveloped lands administered by the Bureau of Land Management (BLM) and the State of Utah School and Institutional Trust Lands Administration.
- *Crescent Junction*—The Crescent Junction site is approximately 30 miles northwest of the Moab site and 30 miles east of Green River, just northeast of Crescent Junction. The site also consists of undeveloped land administered by BLM and interspersed with lands owned by the State of Utah.
- *White Mesa Mill*—The White Mesa Mill site is approximately 85 miles south of the Moab site, 4 miles from the Ute Mountain Reservation and the community of White Mesa, and 6 miles from Blanding in San Juan County, Utah. This commercial mill is owned by the International Uranium (USA) Corporation (IUC) and disposes of uranium-bearing materials on site in lined ponds. It has been in operation since 1980. Although the facility has an NRC-issued license to receive, process, and permanently dispose of uranium-bearing material, it would need a license amendment from the State of Utah before it could accept material from the Moab site. (Effective August 16, 2004, NRC transferred to the State of Utah the responsibility for licensing, including inspection, enforcement, and rulemaking activities for commercial uranium and thorium milling operations, mill tailings, and other wastes at White Mesa Mill and other uranium licensed milling sites in Utah). Also, expansion of the existing facility would likely be necessary. The mill has the potential to process materials from the Moab site to extract valuable constituents and then dispose of the residues on site or to dispose of the material without processing. At this time, IUC has indicated that it may process water used for slurry transport but would not reprocess tailings.

The Klondike Flats and Crescent Junction sites are off-site disposal locations where new disposal cells could be constructed; the White Mesa Mill site is an existing off-site facility that could receive the contaminated materials, but that would also need a new disposal cell.

For the off-site disposal alternative, three transportation modes are evaluated: truck, rail, and slurry pipeline for some or all of the off-site disposal locations.

- *Truck Transport*—Trucks would use US-191 as the primary transportation route for hauling contaminated materials and oversized debris to the selected disposal site. Trucks would be used exclusively for hauling borrow materials to the selected disposal site. Construction of

highway entrance and exit facilities would be necessary to safely accommodate the high volume of traffic currently using this highway.

- *Rail Transport*—An existing rail line runs from the Moab site north along US-191 and connects with the main east-west line near I-70. The Klondike Flats and Crescent Junction sites could be served from this rail line with upgrades and additional rail sidings. There is no rail access from the Moab site to the White Mesa Mill site. Construction of a rail line from the Moab site to the White Mesa Mill site was not analyzed in detail because of the technical difficulty, potential impacts, and high cost.
- *Slurry Pipeline*—This transportation mode would require the construction of a new buried pipeline from the Moab site to the selected disposal site and a buried water line to recycle the slurry water back to Moab for reuse in the pipeline.

Once the tailings and other contaminated material were removed, the Moab site would be reclaimed by recontouring and revegetating. DOE would evaluate future use of the site after completion of remedial action.

Ground Water Remediation

Ground water remediation would be implemented as described in this section under both the on-site and off-site disposal alternatives. No other approaches to ground water remediation are being proposed. Therefore, this section does not discuss any alternatives for ground water remediation. As part of its UMTRCA responsibilities, DOE established a Uranium Mill Tailings Remedial Action (UMTRA) Ground Water Project and prepared the *Final Programmatic Environmental Impact Statement for the Uranium Mill Tailings Remedial Action Ground Water Project* (PEIS) (DOE/EIS-0198, October 1996) and a Record of Decision (ROD) (62 *Federal Register* 22913 [1997]). The PEIS described and the ROD adopted a ground water remediation framework that considers human health and environmental risk, stakeholder input, and cost. In applying the framework, DOE assesses ground water compliance in a step-by-step approach, beginning with consideration of a no-remediation strategy and proceeding, if necessary, to consideration of passive strategies, such as natural flushing with compliance monitoring and institutional controls, and finally to consideration of more complex, active ground water remediation methods (such as pump and treat), or a combination of strategies, if needed. Through the process defined in the PEIS to assist in the selection of ground water compliance strategies, DOE prepared the *Site Observational Work Plan for the Moab, Utah, Site* (December 2003) (SOWP). The SOWP presents the detailed technical information that supports DOE's selection of a ground water compliance strategy for the Moab site and serves as a ground water technical support document for the EIS. DOE has conducted additional ground water studies since completion of the SOWP. These more recent studies support the conceptual model presented in the SOWP and provide additional technical information regarding ground water and surface water interactions (*Ground Water/Surface Water Interaction for the Moab, Utah, Site* [March 2005]) and the performance of the ground water interim action well fields (*Performance of the Ground Water Interim Action Injection System at the Configuration 2 Well Field* [April 2005] and *Fall 2004 Performance Assessment of the Ground Water Interim Action Well Fields at the Moab, Utah, Site* [January 2005]).

On the basis of this methodology and site-specific modeling, DOE's proposed action for ground water at the Moab site is to apply ground water supplemental standards and implement an active remediation system to intercept and control discharge of contaminated ground water to the

Colorado River. Because of its naturally high salt content, the uppermost aquifer at the Moab site is not a potential source of drinking water. However, discharge of contaminated ground water has resulted in elevated concentrations of ammonia and other site-related constituents in the Colorado River adjacent to the site. These concentrations pose no risk to humans, but ammonia concentrations exceed levels considered to be protective of aquatic life. Therefore, the cleanup objective of the proposed ground water action is to protect the environment, particularly endangered species of fish that are known to use that portion of the river. Active remediation would be necessary to meet this goal.

The active remediation system would extract and treat ground water while natural processes act on ground water to decrease contaminant concentrations to meet long-term protective ground water cleanup goals. Active remediation would cease after long-term goals were achieved. Conceptually, the same system would be installed and operated at the Moab site regardless of whether the on-site or an off-site disposal alternative were implemented. Similarly, the duration of the action would likely be essentially the same regardless of whether the pile was remediated in place or relocated.

Ground Water Compliance Strategies

Supplemental Standards are essentially a narrative exemption from remediating ground water to prescriptive numeric standards (background concentrations, maximum concentration limits, or alternate concentration limits), if one or more of the eight criteria in 40 CFR 192.21 are met. At the Moab site, the applicable criterion is *limited use ground water* (40 CFR 192.21[g]), which means that ground water has total dissolved solids (TDS) concentrations greater than 10,000 milligrams per liter (mg/L). These widespread high TDS concentrations are naturally occurring and are therefore not related to past milling activities at the site. The PEIS also discusses supplemental standards within the context of "no ground water remediation." However, guidance in 40 CFR 192.22 directs that where the designation of limited use ground water applies, remediation shall "assure, at a minimum, protection of human health and the environment."

No Remediation means that no ground water remediation is necessary because ground water concentrations meet acceptable standards. No remediation under the PEIS is not the same as "no action" under NEPA, because actions such as site characterization would be required to demonstrate that no remediation is warranted.

Natural Flushing means allowing the natural ground water movement and geochemical processes to decrease contaminant concentrations.

Active Remediation means using active ground water remediation methods such as gradient manipulation, ground water extraction and treatment, or in situ ground water treatment to restore ground water quality to acceptable levels.

No Action Alternative

Under the No Action alternative, DOE would not remediate contaminated materials either on the site or at vicinity properties. The existing tailings pile would not be covered and managed in accordance with standards in 40 CFR 192. No short-term or long-term site controls or activities to protect human health and the environment would be continued or implemented. Public access to the site is assumed to be unrestricted. All site activities, including operation and maintenance, would cease. A compliance strategy for contaminated ground water beneath the site would not be developed in accordance with standards in 40 CFR 192. No institutional controls would be implemented to restrict use of ground water, and no long-term stewardship and maintenance would take place. Because no activities would be budgeted or scheduled at the site, no further initial, interim, or remedial action costs would be incurred. DOE recognizes that this scenario would be highly unlikely; however, it has been included as a part of the EIS analyses to provide a basis for comparison to the action alternatives assessed in the EIS, as required by NEPA.

Preferred Alternatives

On the basis of the analysis documented in the EIS, the comments received during the public comment period on the draft EIS, and other factors, DOE has determined that its preferred alternatives are the off-site disposal of the Moab uranium mill tailings pile, combined with active ground water remediation at the Moab site. The preferred off-site disposal location is the Crescent Junction site, and the preferred method of transportation is rail.

DOE identified off-site disposal as one of its preferred alternatives for disposal of mill tailings primarily because of the uncertainties related to long-term performance of a capped pile at the Moab site. Issues such as the potential for river migration and severe flooding contributed to this uncertainty. The Crescent Junction site was identified as the preferred off-site disposal location rather than Klondike Flats or White Mesa Mill because Crescent Junction has the longest isolation period (time in which contaminants could reach the ground water); the lowest land-use conflict potential; the shortest haul distance from the rail rotary dump into the disposal cell, reducing the size of the radiological control area; and flat terrain, making operations easier and safer. DOE identified rail as the preferred mode of transportation because compared to truck transportation, rail has a lower accident rate, lower potential impacts to wildlife, and lower fuel consumption. In addition, compared to a slurry pipeline, rail transportation would have a much lower water demand and would avoid landscape scars caused by pipeline construction, which could create moderate contrasts in form, line, color, and texture with the surrounding landscape.

Active ground water remediation was identified as a preferred alternative because the No Action alternative would not meet compliance goals for human health and safety and protection of the environment. An active ground water remediation system would extract and dispose of contaminated ground water while natural processes act on ground water to decrease contaminant concentrations to meet long-term protective ground water cleanup goals. Active remediation would cease after long-term goals are achieved.

DOE will decide whether to select the preferred alternative or another analyzed alternative and publish its decision in a ROD, which will be issued after publication of the final EIS. The ROD will also identify the alternatives considered by DOE in reaching its decision, specify the alternative or alternatives that were considered to be environmentally preferable, and state whether all practicable means to avoid or minimize environmental harm from the alternative selected have been adopted (40 CFR 1505.2). The ROD will be issued no sooner than 30 days following publication of the EPA Notice of Availability of the final EIS.

Upon completion of this EIS and the ROD, DOE will develop a remedial action plan and other planning and monitoring documents for remediation of contaminated materials. The remedial action plan and other planning and monitoring documents will provide the conceptual engineering reclamation design and incorporate a ground water compliance strategy and corrective actions. These documents will also integrate into the remediation strategy measures discussed in the EIS that would reduce or mitigate the impacts that would result from the proposed actions and, where appropriate, identify the mechanisms by which the success of mitigative actions will be evaluated and reported. In addition, as stipulated by the USF&WS in their Biological Opinion (EIS Appendix A3), a biota monitoring plan and a water quality study plan will be generated and implemented to observe and report upon the effects of current and future conditions on fish and evaluate the effectiveness of ground water remediation efforts.

Description and Comparison of Environmental Consequences and Alternatives

The following text summarizes the potential impacts (both adverse and beneficial) to the physical, biological, socioeconomic, cultural, and infrastructure environment that could occur under the on-site disposal alternative, the off-site disposal alternative, and the No Action alternative. Human health impacts are also summarized. This section also compares the major differences in impacts among the alternatives and the differences among transportation modes under the off-site disposal alternative. Table 2–32 of the EIS provides a more detailed comparison of impacts.

Disposal Site, Transportation, and Vicinity Property Impacts

Geology and Soils. Under either the on-site disposal alternative or the No Action alternative, the combination of the processes of subsidence and incision would slowly affect the tailings pile by lowering it in relation to the Colorado River. This impact would not occur under the off-site disposal alternative because the pile would be removed. There is also the potential for minor geologic instabilities in areas surrounding the White Mesa Mill site. Sand and gravel resources beneath the Moab site would be unavailable for commercial exploitation under all the alternatives due to residual contamination, even after surface and ground water remediation was complete. There are no known geologic resources beneath any of the alternative off-site disposal cell locations that would be affected by the proposed actions.

Air Quality. Under the on-site and off-site disposal alternatives, emissions of particulate matter would occur during construction and excavation operations and would require dust control measures. Operation of vehicles and construction equipment would result in emissions of criteria air pollutants. Air pollutant emissions would be greater under the off-site disposal alternative as compared to the on-site disposal alternative, primarily because of the need to transport the tailings. Among the alternative off-site locations, transporting the tailings to the White Mesa Mill site would result in the largest volume of air pollutants because of the longer distance to be traveled. With respect to the alternative modes of transportation under the off-site disposal alternative, transportation of the tailings by slurry pipeline would involve less air pollution than would either truck or rail transportation due to the lower level of exhaust emissions. Such emissions would be greater for truck than for rail transportation. However, none of the proposed action alternatives would result in air emissions that exceed National Ambient Air Quality Standards or Prevention of Significant Deterioration increment limits.

A detailed human health analysis that includes health impacts associated with air quality is provided in Appendix D of the EIS. The design and construction of the disposal cell cover at all disposal sites would ensure that radon emissions would be below applicable health standards. Under any of the proposed action alternatives, long-term air emissions at the Moab site from technologies evaluated for active ground water remediation would not exceed health standards for workers or the public.

Ground Water. Ground water remediation would be implemented under both the on-site and off-site disposal alternatives. Under the on-site and off-site disposal alternatives, supplemental standards would be applied to protect human health. The supplemental standards would include institutional controls to prohibit the use of ground water for drinking water. Under the on-site disposal alternative, the tailings pile would be a continuing source of contamination that would maintain contaminant concentrations at levels above background concentrations in the ground water and, therefore, potentially require the application of supplemental standards (institutional controls) in perpetuity to protect human health. Under the off-site disposal alternatives, contaminant concentrations in the ground water under the Moab site would return to background levels after 150 years, by which time active ground water remediation would have been complete and supplemental standards would no longer be needed. The tailings pile would not be a continuing source of contamination to ground water under the off-site disposal alternative.

DOE estimates that meeting its target ground water remediation goal of 3 milligrams per liter (mg/L) of ammonia in ground water would require active ground water remediation at the Moab site for 80 years under the on-site disposal alternative and for 75 years under the off-site disposal alternative (Figure S–3). DOE estimates that this duration of treatment would ensure that water quality in the Colorado River would remain protective after ground water treatment was terminated. In the near term, DOE estimates that the proposed ground water remediation system would result in surface water quality that is protective of aquatic species in the Colorado River within 5 years after the system was implemented.

DOE also anticipates that contaminant concentrations in ground water and surface water that are protective of aquatic species in the Colorado River could be maintained, under all action alternatives, for the 200- to1,000-year time frame specified in EPA's regulations (40 CFR 192.32[b][1][i]) promulgated under UMTRCA. However, under the on-site disposal and No Action alternatives, natural basin subsidence would result in permanent tailings contact with the ground water in 7,000 to 10,000 years, at which time surface water concentrations would temporarily revert to levels that are not protective of aquatic species in the Colorado River.

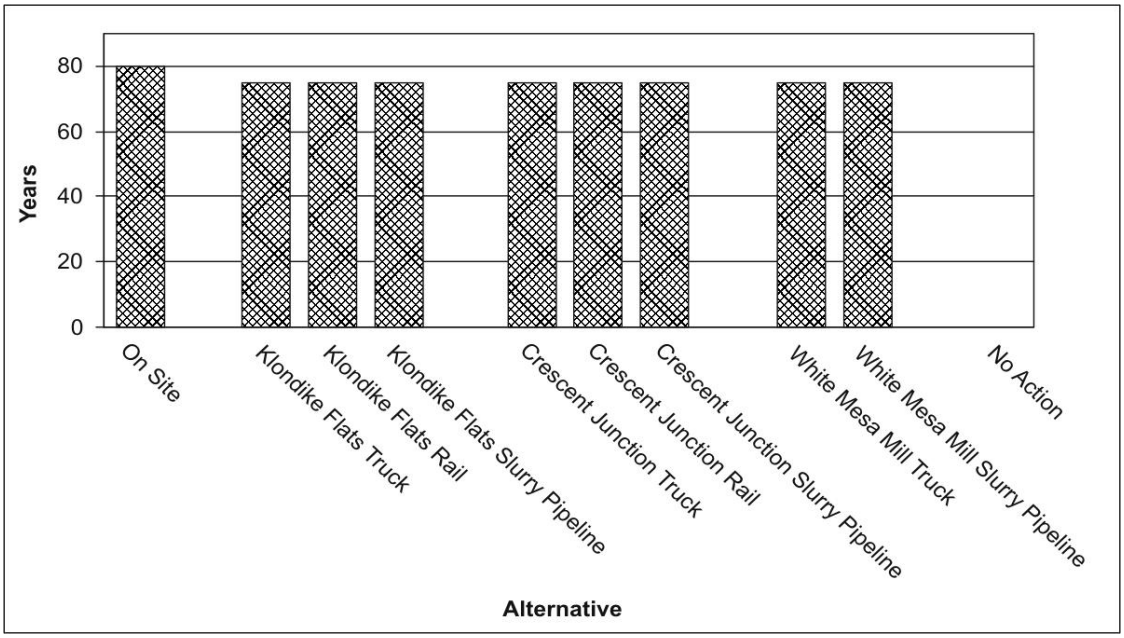


Figure S–3. Estimated Duration of Ground Water Remediation

In addition, under the No Action alternative, ground water beneath the Moab site would remain contaminated, pose an increased risk to human health, and would continue in perpetuity to discharge contaminants to the surface water at concentrations that would not be protective of aquatic species. Cursory characterization indicates a potential for a salt layer in the upper zone of the tailings pile (see Table S–1). Modeling results indicate that under the on-site disposal alternative, contaminants from such a salt layer if present in the tailings pile would reach ground water in approximately 1,100 years and would affect ground water and surface water for approximately 440 years. Because ground water treatment would have been discontinued after an estimated 80 years, surface water concentrations could revert to nonprotective levels.

Surface Water. Under the No Action alternative, ground water and surface water contamination and nonprotective river water quality would continue in perpetuity. As stated in the discussion of ground water impacts, DOE estimates that under all action alternatives, contamination of the Colorado River from ground water discharge would be reduced to levels that would be protective of aquatic species within 5 years after implementation of ground water remediation because of the interception and containment of the contaminated ground water plume. Under the off-site disposal alternative, the removal of the pile coupled with the estimated 75 years of active ground water remediation would result in permanent protective surface water quality. Under the on-site disposal alternative, active ground water remediation would continue for an estimated 80 years.

In addition to natural subsidence described in the discussion of ground water impacts, a Colorado River 100- or 500-year flood could release additional contamination to ground water and surface water under the on-site disposal or No Action alternatives. However, under the on-site disposal alternative, the increase in ground water and river water ammonia concentrations due to floodwaters inundating the pile would be minor, and the impact on river water quality would rapidly decline over a 20-year period. Under the No Action alternative, lesser flood events could also result in the release of contaminated soils to the Colorado River as sediment runoff. In contrast to the on-site disposal and No Action alternatives, the off-site disposal alternative presents no risk of these recurrences of surface water contamination at the Moab site because the tailings pile would be removed.

With the exception of ephemeral streams and impoundments, no surface water exists on or near any of the three off-site disposal locations.

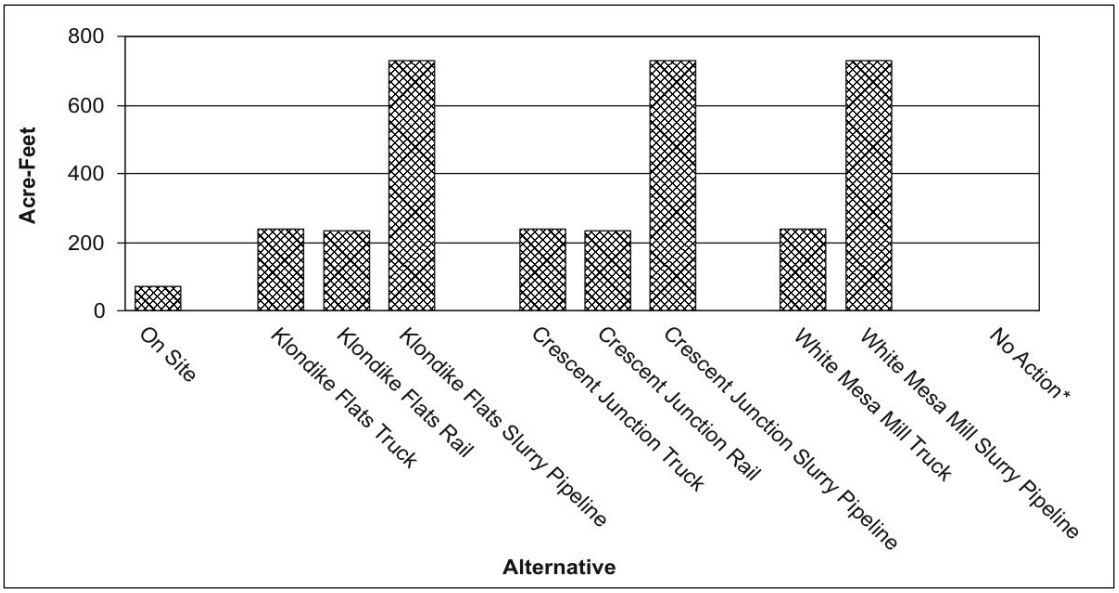
Floodplains and Wetlands. As noted, 100- and 500-year flood events could partially inundate the disposal cell under the on-site disposal alternative or No Action alternative. In addition, approximately 4.7 acres of wetlands could be contaminated in the long term under either of these alternatives. There are no known wetlands on or near the Klondike Flats or Crescent Junction sites, although potential wetlands exist near these sites and on the White Mesa Mill site. Under all the action alternatives, wetland areas on and adjacent to the Moab site could be adversely affected by surface remediation at the site, and for all action alternatives, activities would be necessary within the floodplain at the Moab site. Under the White Mesa Mill off-site disposal alternative, transportation of the tailings by slurry pipeline would require crossing the Colorado River, the Matheson Wetlands Preserve, and a number of perennial and intermittent streams. Potential wetlands near some borrow areas could be affected.

In accordance with its regulations (10 CFR 1022), DOE has prepared the *Floodplain and Wetlands Assessment for Remedial Action at the Moab Site*. This assessment and the Statement of Findings are included in Appendix F of the EIS.

Aquatic Ecology. Under the No Action alternative, the current adverse impacts to the Colorado River and to endangered aquatic species caused by contaminated ground water would continue in perpetuity. In comparison, under either the on-site or the off-site disposal alternative, these adverse impacts would cease within 5 years of the implementation of active ground water remediation, thereby eliminating the potential for impacts to aquatic organisms for the regulatory time frame of 200 to 1,000 years. Under the on-site disposal alternative and the No Action alternative, potential future releases of contaminants from natural subsidence (see the discussion of ground water) would cause adverse impacts to aquatic species in the Colorado River, but these impacts would not occur for at least 7,000 years. Under the off-site disposal alternative, the potential for future contamination from natural subsidence would be eliminated. Under all action alternatives, surface remediation activities at the Moab site would result in temporary disturbance to approximately 1.5 miles (8,100 ft) of Colorado River shoreline.

Annual withdrawals of Colorado River water (nonpotable water) are illustrated in Figure S–4. All of these withdrawals are within DOE's authorized water rights. In addition, under the on-site disposal alternative, the required 70-acre-foot annual withdrawal would not exceed the 100-acre-foot annual limit that the USF&WS considers to be protective of aquatic species. However, this limit would be exceeded under the off-site disposal alternative.

The truck or rail transportation modes would require annual withdrawals of 235 to 240 acre-feet, and the slurry pipeline mode would require annual withdrawals of up to 730 acre-feet, assuming all required slurry makeup and recycle water was drawn from the river. Exceeding the 100-acre-foot limit deemed protective for endangered fish species would be an unavoidable adverse impact. Mitigation would be accomplished in accordance with the cooperative agreement to implement the Recovery Implementation Program for Endangered Fish Species in the Upper Colorado River Basin. The recovery program requires that all Section 7 consultations address water depletion impacts, and a financial contribution (adjusted annually for inflation) be paid to USF&WS to offset the impacts of water depletion. The contribution collected by USF&WS would be used to fund activities necessary to recover the endangered fish as specified in the recovery plan.



*Impact would not occur under this alternative.

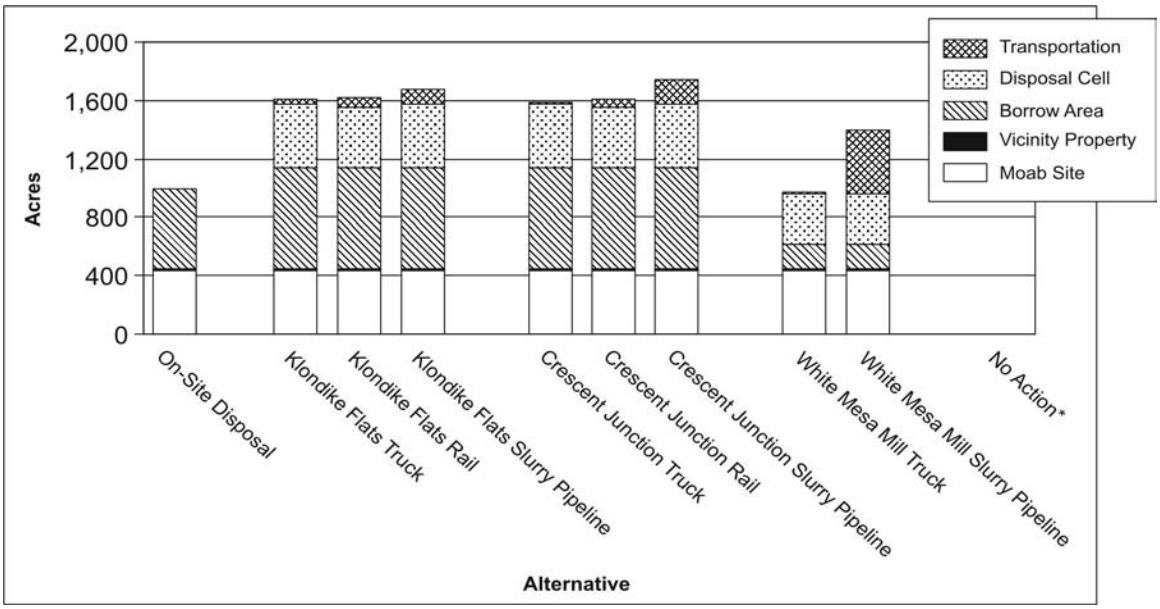
Figure S–4. Annual Withdrawals of Colorado River Water

Terrestrial Ecology. All action alternatives would result in the temporary loss of 50 acres of vegetation and habitat at the Moab site. This would also be an adverse impact to some aquatic species given the proximity of the Colorado River. For any of the action alternatives, effects of human presence could reduce the overall habitat value of the area and could adversely affect two to four threatened terrestrial species if they are present at the site. Impacts of physical disturbance could be avoided or minimized by conducting site-specific investigations prior to any development to determine the presence of any species of concern.

All action alternatives would produce short-term land disturbance to the entire Moab site, to vicinity properties, and to one or more borrow areas. Disposal at any of the three off-site locations would result in land disturbance associated with construction of the off-site disposal cell and the requisite transportation infrastructure.

In general, the vegetation that would be disturbed is sparse and provides only poor habitat for wildlife; however, under the White Mesa Mill slurry pipeline transportation option, much of the land disturbance would occur in previously undisturbed areas. Figure S–5 depicts the total acres of disturbed land for all alternatives and the relative contribution to the total from each activity or facility.

Revegetation would minimize land disturbance impacts over the longer term. Under the No Action alternative, animal intrusion into the tailings pile could result in acute or chronic toxic effects to wildlife. Transportation of the tailings by truck to an off-site disposal location would result in an increase in wildlife traffic kills due to the increase in traffic.



*Impact would not occur under this alternative.

Figure S–5. Maximum Land Disturbance

Land Use. Under any of the disposal alternatives, the land dedicated to the disposal cell would be unavailable for any other uses in perpetuity. Under off-site disposal at the Klondike Flats and Crescent Junction locations, up to 435 acres of undisturbed BLM rangeland would be dedicated to the disposal cell and therefore would be permanently unavailable for grazing rights. Although

there are no known resources beneath the off-site locations, the potential for oil and gas and mineral extraction would be lost in perpetuity. Under off-site disposal at the White Mesa Mill location, up to 346 acres would be dedicated to the disposal cell and therefore would be permanently unavailable for any other uses. However, at the White Mesa Mill site, the land that would be dedicated to the disposal cell has already been committed to the disposal of radioactive material. Under the on-site disposal alternative, the entire 130-acre recontoured disposal cell would be permanently unavailable for any other uses.

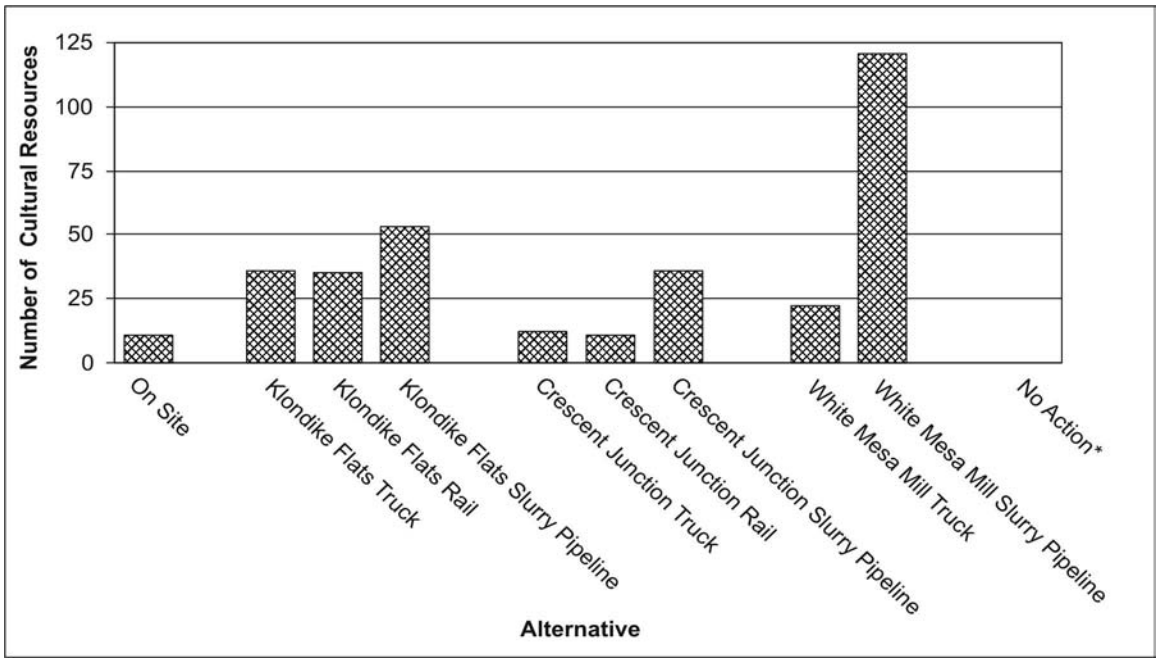
Under either the on-site or any off-site disposal alternative, the land at the Moab site required for ground water remediation infrastructure would be unavailable for any other use for the 75 to 80 years needed to complete ground water remediation. If an evaporation ground water treatment technology were implemented, the evaporation ponds could require up to 40 acres, and support facilities would require additional land.

As mentioned, under the on-site disposal alternative, the entire 130-acre recontoured disposal cell would be permanently unavailable for any other uses. Under either the on-site or the off-site disposal alternative, DOE's goal would be to have as much of the 439-acre Moab site available for unrestricted use upon completion of surface remediation as would be possible. However, it is possible that even after completion of remediation, the entire 439-acre Moab site would remain under federal control permanently. Under any action alternative, final decisions on allowable future land use at the Moab site could be made only after the success of surface and ground water remediation was determined.

Cultural Resources. Only the Moab site and White Mesa Mill site have been field-surveyed; however, cultural resources would probably be adversely affected under all the action alternatives. The numbers of potentially affected cultural resources would vary significantly among the action alternatives (Figure S–6). The on-site disposal alternative would have the least effect on cultural resources, potentially affecting 4 to 11 sites eligible for inclusion in the National Register of Historic Places. The White Mesa Mill slurry pipeline alternative would have the greatest adverse effect on cultural resources, potentially affecting up to 121 eligible cultural sites. The Klondike Flats alternative could adversely affect a maximum of 35 (rail) to 53 (pipeline) eligible sites (depending upon transportation mode), and the Crescent Junction alternative could adversely affect a maximum of 11 (rail) to 36 (pipeline) eligible sites (depending upon transportation mode).

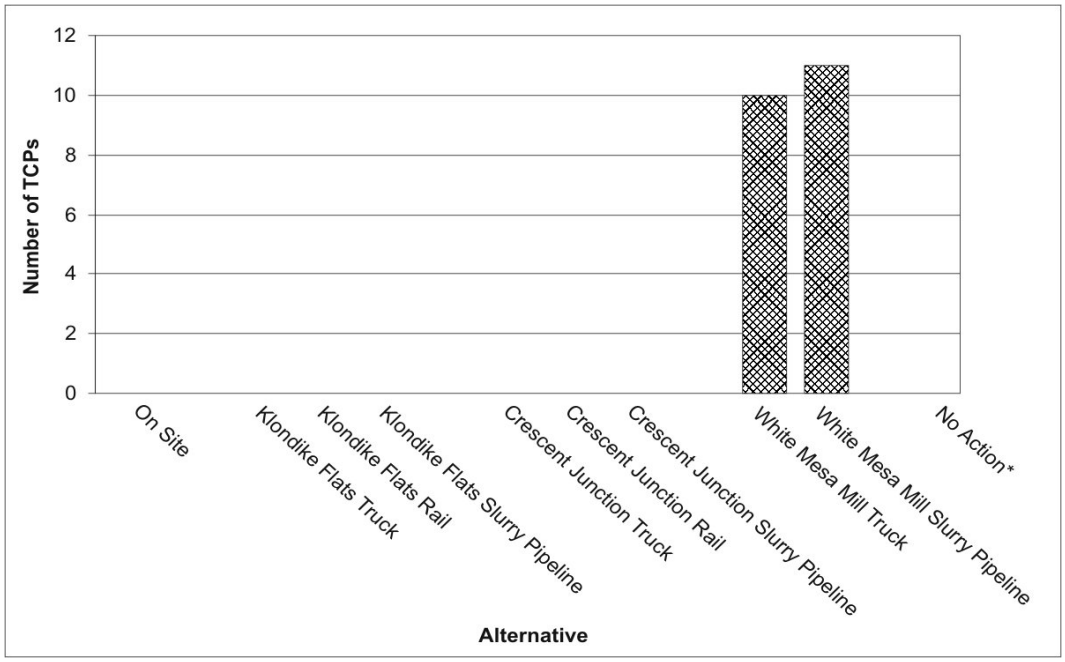
A minimum of 10 to 11 traditional cultural properties would be potentially affected under the White Mesa Mill truck or slurry pipeline alternatives (Figure S–7). (The term "traditional cultural properties" can include traditional cultural practices, ceremonies, and customs.) Mitigation of the potential impacts to cultural sites and traditional cultural properties under the White Mesa Mill alternative would be extremely difficult given the density and variety of these resources, the importance attached to them by tribal members, and the number of tribal entities that would be involved in consultations.

Noise and Vibration. Noise generated by construction and operations under any of the action alternatives would not exceed 65 A-weighted decibels (dBA) at any permanent receptor location. The 65 dBA level is the City of Moab's nighttime limit for residential areas. Remediation activities at vicinity properties under any of the action alternatives would cause temporary increases in local noise levels, and the City of Moab noise standard could be violated. The EIS discusses potential measures to mitigate this impact. Small vibrations from activities at the Moab site could be felt near the boundary of Arches National Park under any of the action alternatives.



*Impact would not occur under this alternative.

Figure S–6. Maximum Number of Potentially Affected Cultural Resources



*Impact would not occur under this alternative.

Figure S–7. Minimum Number of Potentially Affected Traditional Cultural Properties

Under the Klondike Flats or Crescent Junction truck alternatives, truck noise could disturb temporary residents of Arches National Park seasonal housing complex. Under the Crescent Junction truck or rail alternative, residents of Crescent Junction at the intersection of I-70 and US-191 would likely be disturbed by the noise from trucks or trains passing through to the Crescent Junction site. Under the White Mesa Mill truck alternative, residents of Moab, La Sal Junction, Monticello, and Blanding would also probably be disturbed by the increase in truck noise.

Visual Resources. Under the on-site disposal alternative, adverse impacts to visual resources would occur during the short and long terms. Contrasts between the surrounding natural landscape and the newly constructed disposal cell would be strong and would attract the attention of casual observers. Although these contrasts would lessen slightly over time when the side slopes become vegetated, the disposal cell would continue to remain an anomalous feature in perpetuity. Under the No Action alternative, leaving the existing tailings pile in place would result in adverse visual impacts in perpetuity as well. The predominantly smooth, horizontal lines created by the tailings pile contrast moderately and would continue to contrast moderately with the adjacent vertical sandstone cliffs. Visual impacts under both of these alternatives would not be compatible with visual objectives assigned by BLM to nearby landscapes.

Visual Resource Contrast Rating

DOE rated the degree of contrast between natural landscapes and the proposed alternatives as follows:

None: the contrast is not visible or perceived.
Weak: the contrast can be seen but does not attract attention.
Moderate: the contrast begins to attract attention and begins to dominate the landscape.
Strong: the contrast demands attention, will not be overlooked, and is dominant in the landscape.

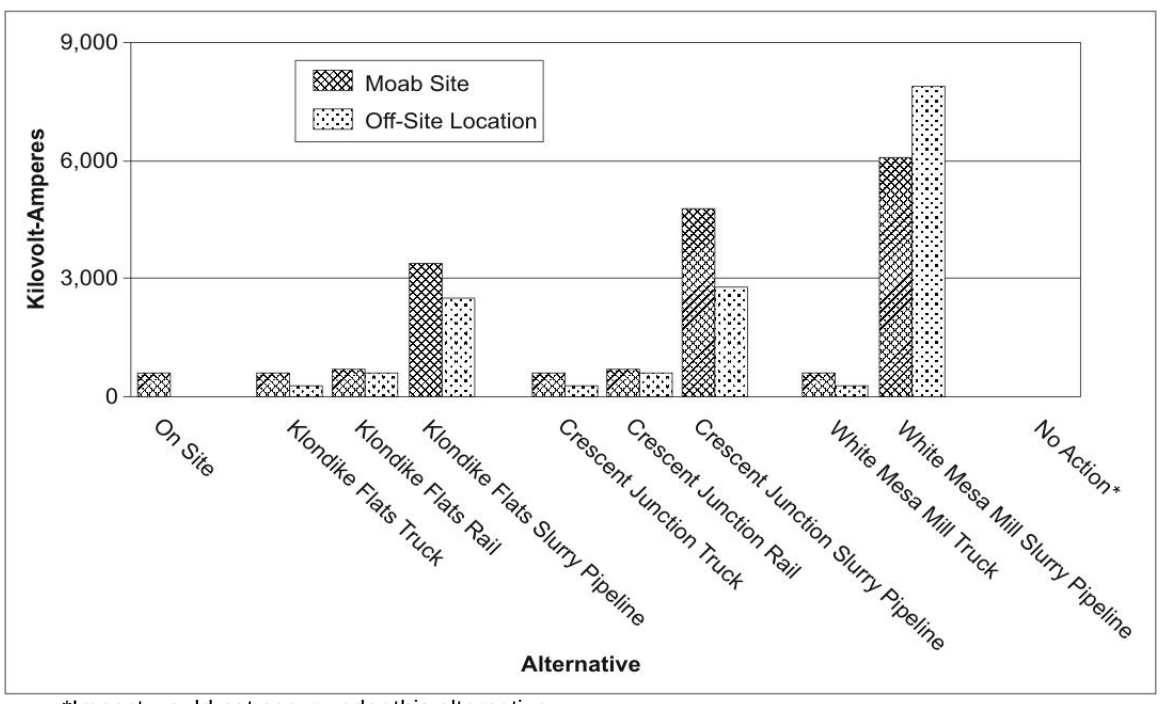
Implementation of the off-site disposal alternative would result in beneficial visual impacts at the Moab site because the pile would be removed and would have negligible to adverse visual impacts at the off-site disposal locations, depending upon viewing location. Disposal at the Klondike Flats site would have mostly negligible impacts over the long term, as the cell would not be visible to most observers. Disposal at the Crescent Junction site would have mostly negligible impacts over the long term, as the cell would create only weak contrasts with the surrounding landscape for most observers (those traveling I-70). One exception would be for travelers at the I-70 scenic overlook. The higher viewing angle at this elevated location would allow observers to view the top and side slopes of the cell. The simple, rectangular form of the cell would contrast strongly with the surrounding landscape during the short term and moderately with the surrounding landscape in the long term. Disposal at the White Mesa Mill site would have mostly negligible impacts over the long term, as the cell would not be visible to most observers. The most adverse short-term impact to visual resources under the off-site disposal alternative would occur if the slurry pipeline transportation option were selected. The landscape scars created by the pipeline would be visible to travelers on US-191 and would create moderate contrasts in form, line, color, and texture with the surrounding landscape.

Infrastructure and Resource Requirements. Under all action alternatives, demand for electricity, potable and nonpotable water, and sewage treatment would not exceed local capacity or DOE's withdrawal rights to Colorado River water. However, under the White Mesa Mill slurry pipeline transportation option, a booster pump station on the pipeline approximately 30 miles beyond the Moab site would be required. Powering the new pump station would require (1) adding a substation transformer at the Utah Power La Sal substation, (2) installing approximately 3 miles

of new distribution line to service the booster pump station, and (3) upgrading the existing line from the La Sal substation to its current endpoint in Lisbon Valley. The required upgrade would entail modifications to line and pole configurations and capacities as necessary to accommodate the increased electric load represented by the booster pump station. A slurry pipeline to White Mesa Mill may also require a new substation transformer at Utah Power's Blanding substation and upgrades to the existing distribution line from the Blanding substation to the White Mesa Mill site. Exact upgrade requirements would be determined by the requisite detailed electrical engineering study if slurry pipeline transportation to White Mesa Mill were implemented. Total diesel fuel consumption under the on-site disposal alternative would be 4 million to 5 million gallons. Total fuel consumption under the off-site disposal alternative would range from 12 million to 20 million gallons for truck transportation, from 10 million to 11 million gallons for rail transportation, and from 7 million to 9 million gallons for slurry pipeline transportation.

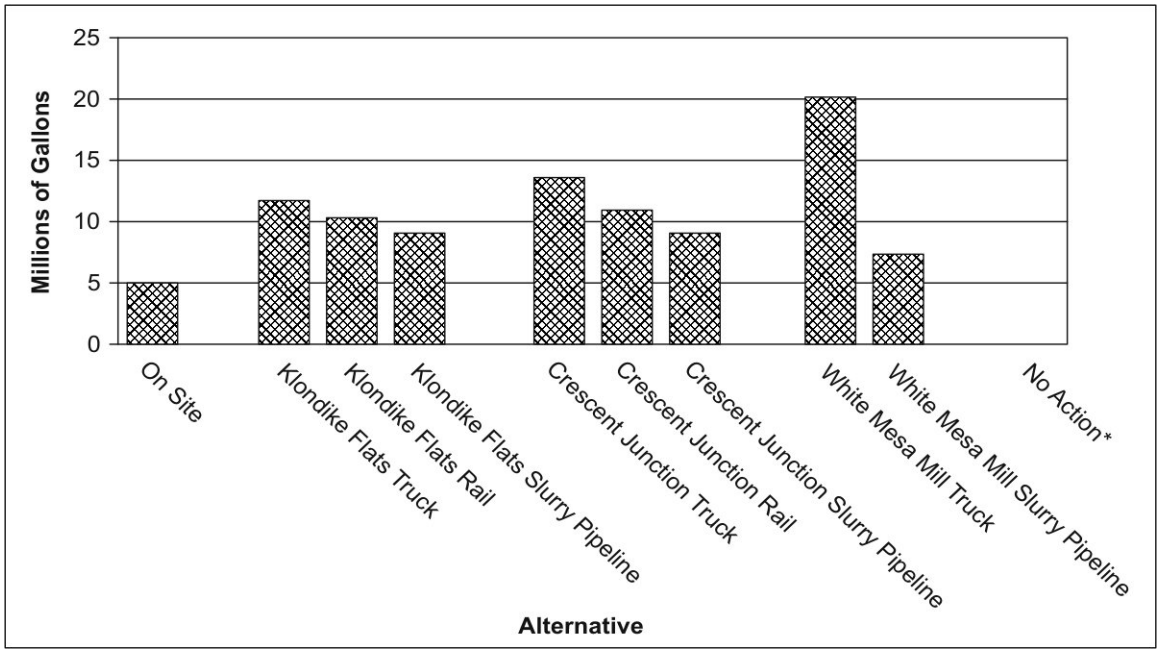
Weekly generation of sanitary sewage during surface remediation activities would range from 10,000 gallons (on-site disposal alternative) to 21,000 gallons (truck transportation option).

Figure S–8 through Figure S–12 compare the major resource and infrastructure requirements among the alternatives. These figures show that power and nonpotable water requirements would be significantly higher for the slurry pipeline alternative than for other alternatives. Fuel requirements for the White Mesa Mill truck alternative would be noticeably greater than for other alternatives because of the greater trucking distance. Sanitary waste generation would be greater for off-site disposal (15,000 to 21,000 gallons per week) than for on-site disposal (10,000 gallons per week), reflecting the larger work force and multiple work locations.



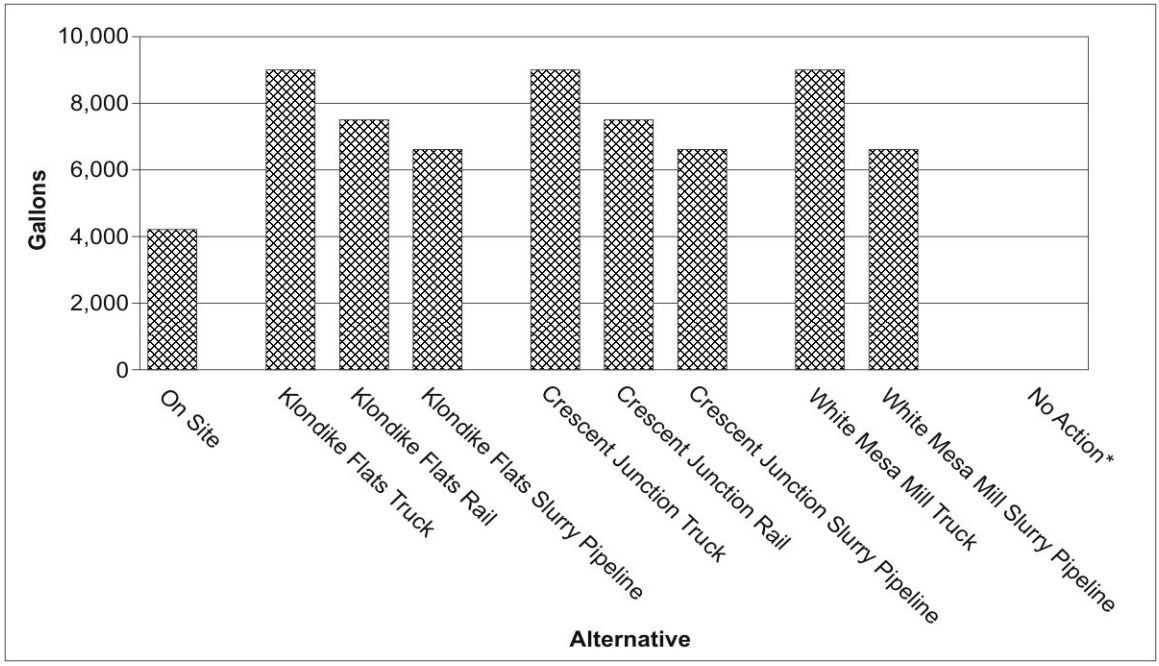
*Impact would not occur under this alternative.

Figure S–8. Power Requirements



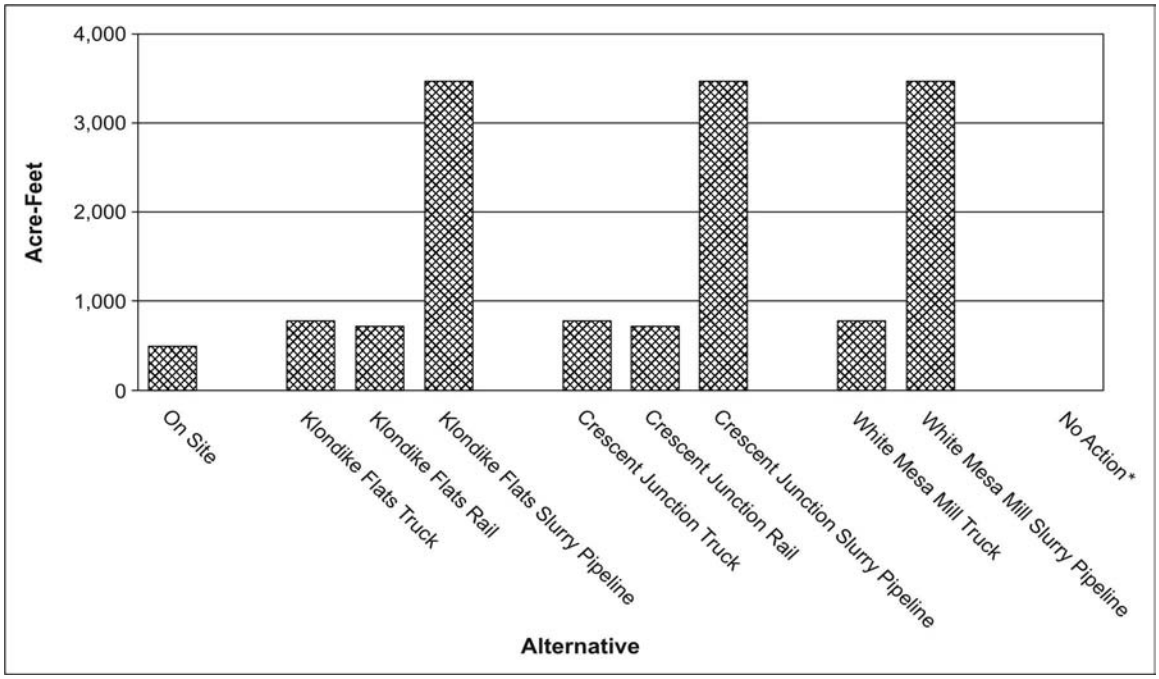
*Impact would not occur under this alternative.

Figure S–9. Total Fuel Consumption



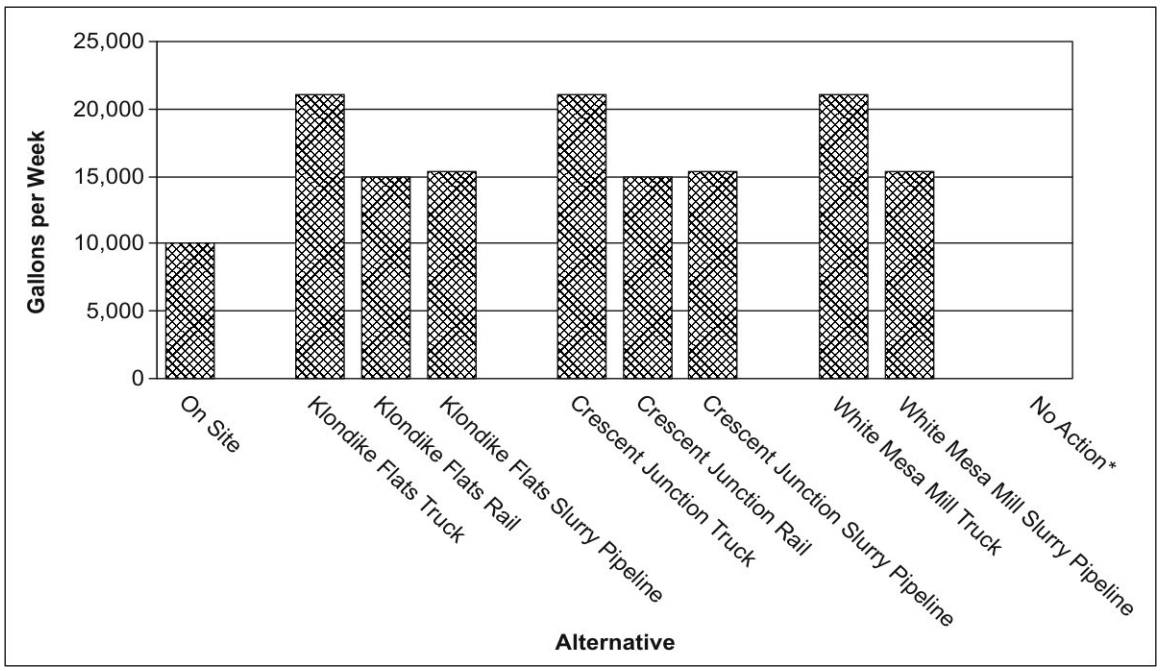
*Impact would not occur under this alternative.

Figure S–10. Daily Potable Water Consumption



*Impact would not occur under this alternative.

Figure S–11. Total Nonpotable Water Consumption

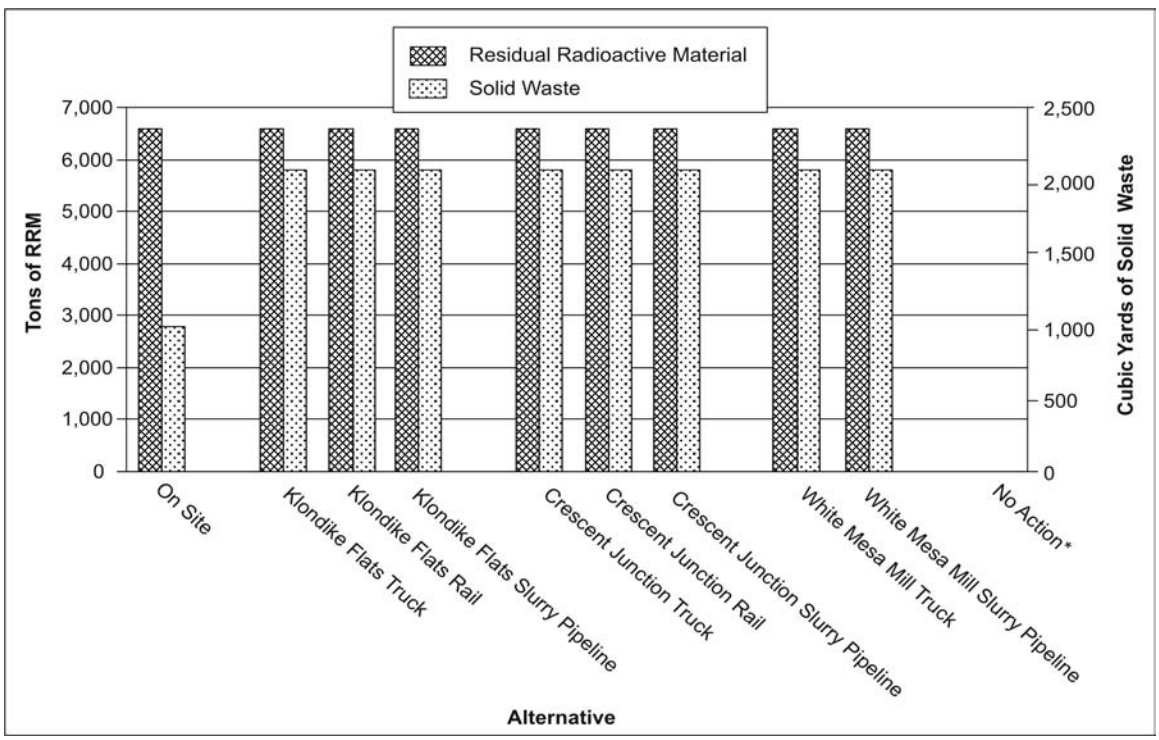


*Impact would not occur under this alternative.

Figure S–12. Sanitary Waste Generation

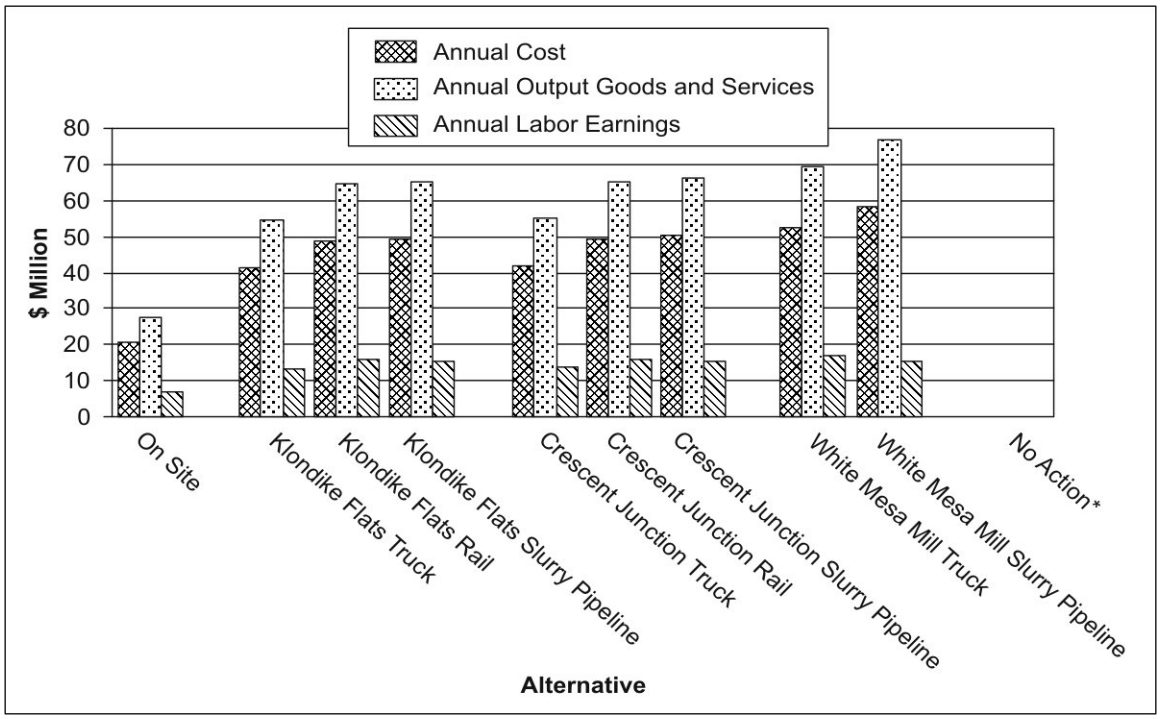
Waste Management. All action alternatives would generate identical amounts of RRM from treatment of contaminated ground water (Figure S–13). Assuming ground water treatment would entail an evaporation technology, DOE estimates that this waste stream would consist of approximately 6,600 tons of RRM annually for 75 to 80 years and would be disposed of in the disposal cell or at another licensed facility. Surface remediation at the Moab site would generate approximately 1,040 yd^3 of solid waste annually under all action alternatives. Under any off-site disposal alternative, another 1,040 yd^3 of solid waste would be generated annually. These solid waste streams would be disposed of in the disposal cell or in local landfills. Landfills at Moab and Blanding could accommodate this volume of solid waste.

Socioeconomics. Figure S–14 and Figure S–15 compare socioeconomic costs and benefits (annual cost, output of goods and services, labor earnings, and job generation) among the alternatives. Of the action alternatives, on-site disposal would be the least expensive ($20.7 million annual average), assuming an 8-year period for surface remediation. The off-site disposal alternative would average between $41.3 million (Klondike Flats site) to $52.5 million (White Mesa Mill site) annually, using truck transportation. Rail transportation to Klondike Flats or Crescent Junction would average approximately $49 million annually. Slurry pipeline transportation would average between $49.4 million (Klondike Flats site) and $58.3 million (White Mesa Mill site) annually. The annual cost of each alternative would be directly proportional to the number of jobs that would be created regionally and the annual output of goods and services for each alternative.



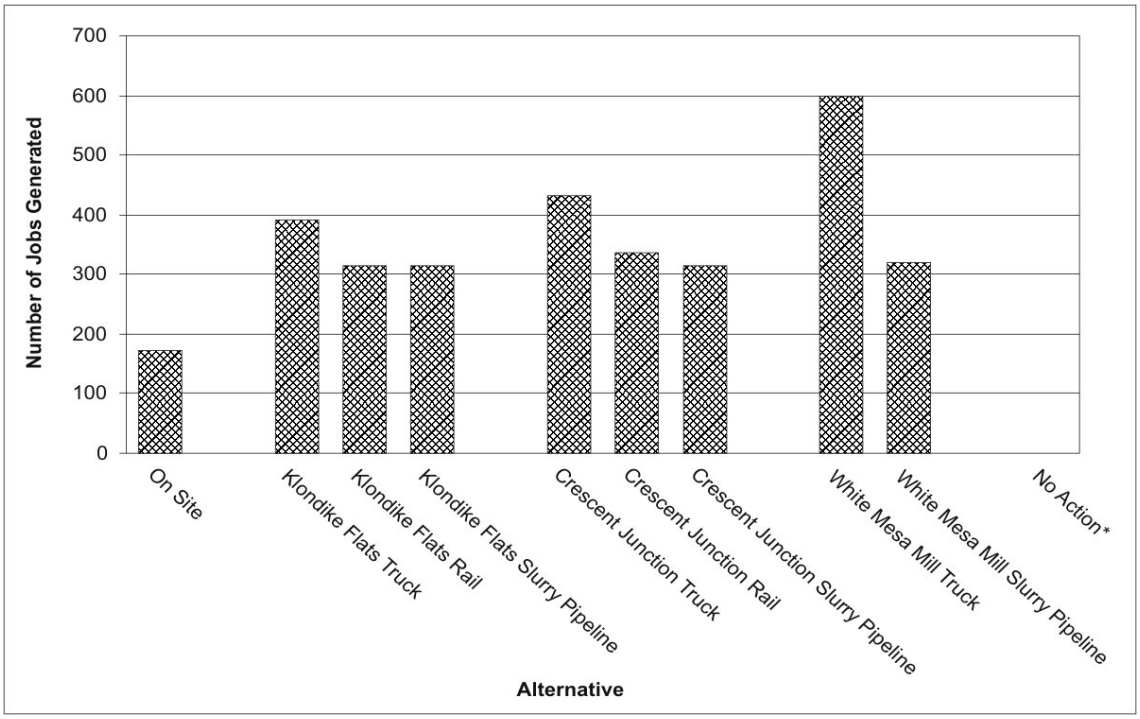
*Impact would not occur under this alternative.

Figure S–13. Annual Generation of RRM and Solid Waste



*Impact would not occur under this alternative.

Figure S–14. Annual Costs and Benefits



*Impact would not occur under this alternative.

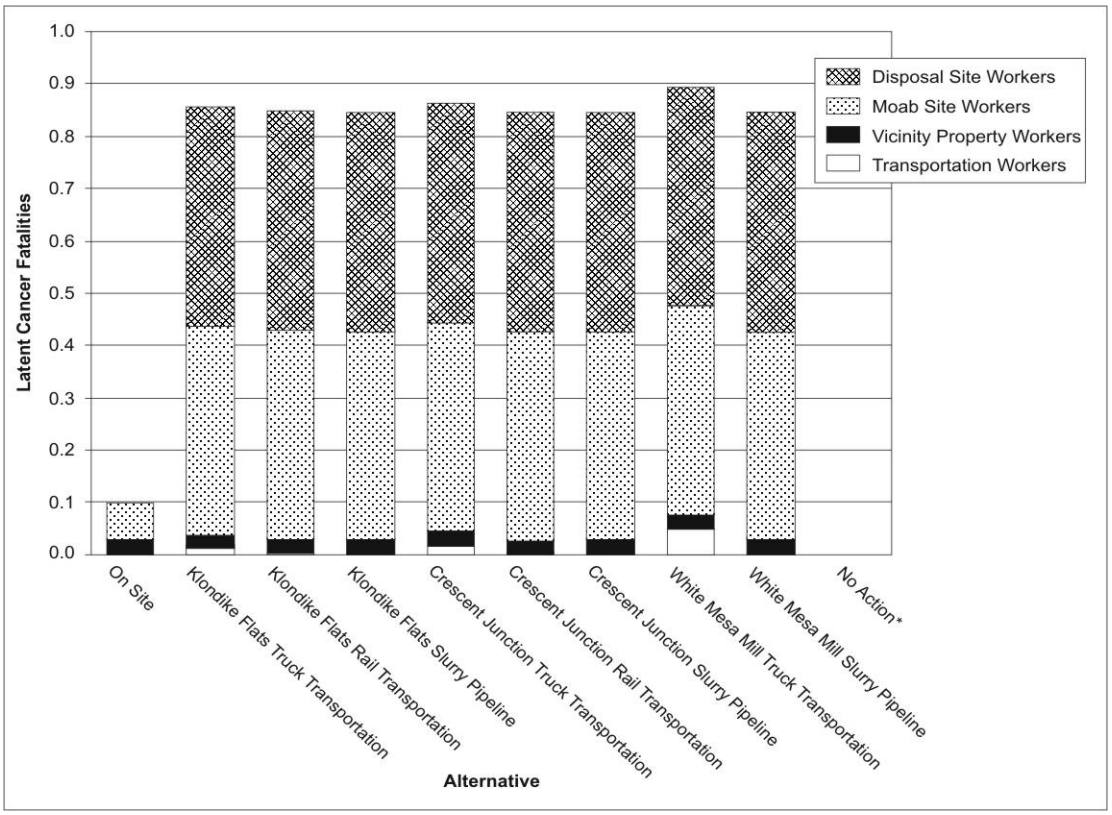
Figure S–15. Generation of New Direct and Indirect Jobs

The largest number of new direct and indirect jobs (778) would occur during the first year only of the White Mesa Mill pipeline alternative. For all pipeline alternatives, during the first year, the labor force would be higher due to pipeline construction; during years 2 through 8, the number of new jobs would be lower. On a sustained basis (years 2 through 8), the largest number of new direct and indirect jobs, 598, would occur under the White Mesa Mill truck transportation alternative (Figure S–15). The smallest number of new direct and indirect jobs, 171, would occur under the on-site disposal alternative. Under both the on-site and off-site disposal alternatives, the increased work force would tend to cause some crowding-out impacts in hotels, apartments, and campgrounds in the Moab area during the peak tourism season, but lower vacancy rates would be expected during the off-season as workers took up temporary accommodation in the two-county region of influence. Crowding-out impacts would not be expected to occur in the White Mesa Mill area because of the availability of housing and accommodations.

The potential socioeconomic impacts from the No Action alternative would relate to potential longer-term damages that would result from leaving the pile and contaminated materials at vicinity properties where they are in their present form. These damages would include potential adverse impacts to human health, diminished quality of land and water resources, and potential losses in future economic development opportunities. In addition, implementation of the No Action alternative would result in loss of employment for the three to four individuals currently employed at the Moab site.

Human Health. No construction-related fatalities from industrial accidents are predicted to occur under any of the alternatives. However, construction and operations activities under all of the action alternatives would result in the exposure of workers and the public to very small amounts of radiation, which would present a risk of latent cancer fatalities among the workers and the public. Figure S–16 shows total latent cancer fatalities for all workers by alternative and indicates the relative contribution to this impact for Moab site workers, disposal site workers, vicinity property workers, and transportation workers. The figure illustrates that latent cancer fatality risk to vicinity property and transportation workers would be very low compared to workers at the Moab site or at off-site locations. Site worker risk under the on-site disposal alternative would be less than half that under the off-site disposal alternative. Disposal at any of the three off-site locations would result in about 1 latent cancer fatality among the total worker population. The No Action alternative would result in no worker fatalities.

Figure S–17 illustrates the latent cancer fatalities predicted for members of the public from exposure to all sources of project-related radiation except for exposure to radiation at vicinity properties, which is presented in Figure S–18. Estimates of latent cancer fatalities shown for the action alternatives in Figure S–17 assume public exposure during the course of remediation activities and for 30 years thereafter. Approximately 1 latent cancer fatality would occur under the off-site disposal alternative from exposure to radiation (excluding exposures to vicinity property material), and this fatality would be almost entirely associated with exposure to radiation from remediation activities at the Moab site as opposed to off-site locations (Figure S–17). Among the three transportation modes, the slurry pipeline mode represents the lowest public risk (0.75 latent cancer fatality) compared to 1.0 latent cancer fatality for truck or rail transportation. In contrast, the on-site disposal alternative represents a risk of about one-quarter of a latent cancer fatality among the public, and the No Action alternative represents just over 5 latent cancer fatalities among the public over a 30-year time period.



*Impact would not occur under this alternative.

Figure S–16. Latent Cancer Fatalities Among Workers

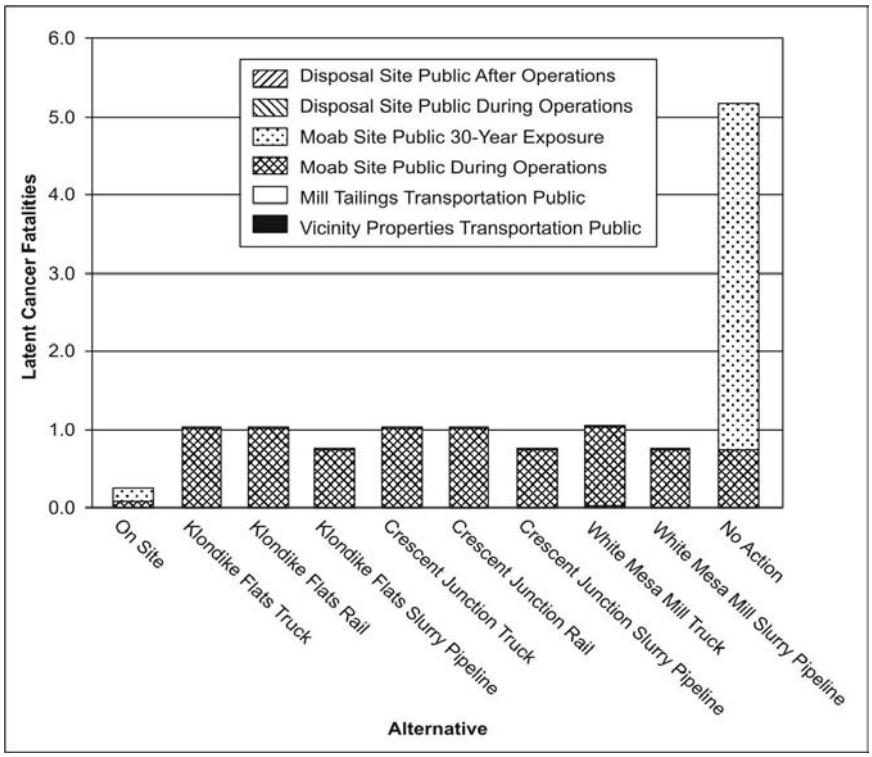


Figure S–17. Public Latent Cancer Fatalities (Excluding Vicinity Property Exposure)

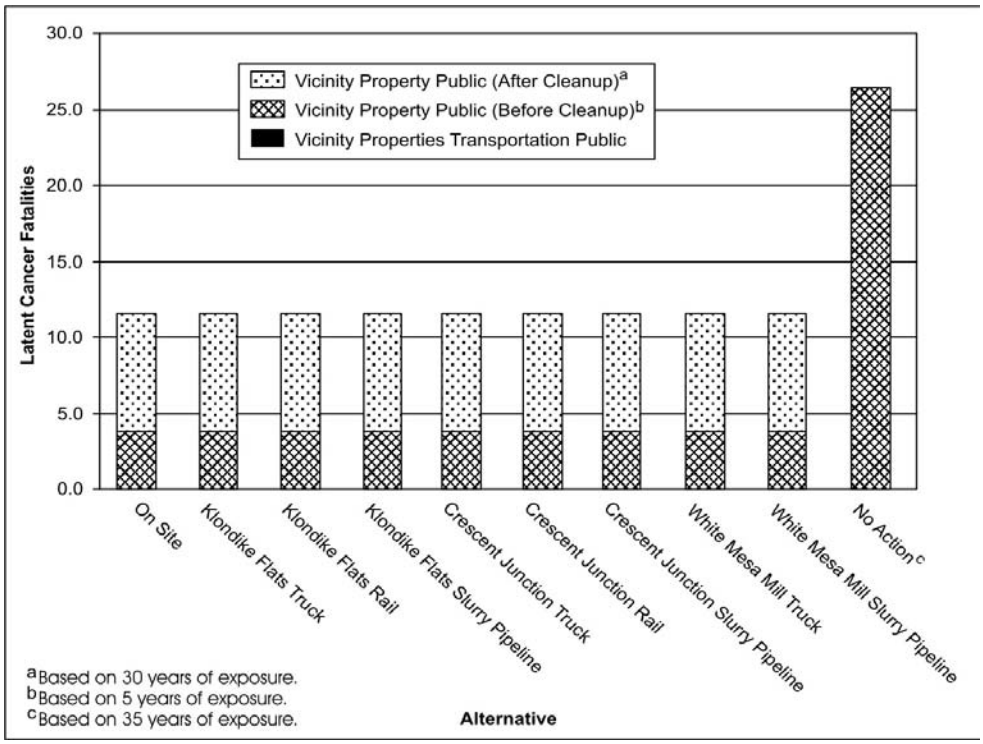


Figure S–18. Public Latent Cancer Fatalities from Vicinity Property Exposure

Figure S–18 illustrates the potential latent cancer fatalities among members of the public due to exposure to radiation at vicinity properties based on the conservative assumptions used for analyses. For the action alternatives, this figure shows the relative contribution to the aggregate risk for 5 years before and for 30 years after remediation. DOE estimates that there would potentially be 12 latent cancer fatalities among the public under any action alternative and 26 latent cancer fatalities if the No Action alternative were implemented. These risks reflect ongoing long-term exposure dating back to the beginning of mill operations.

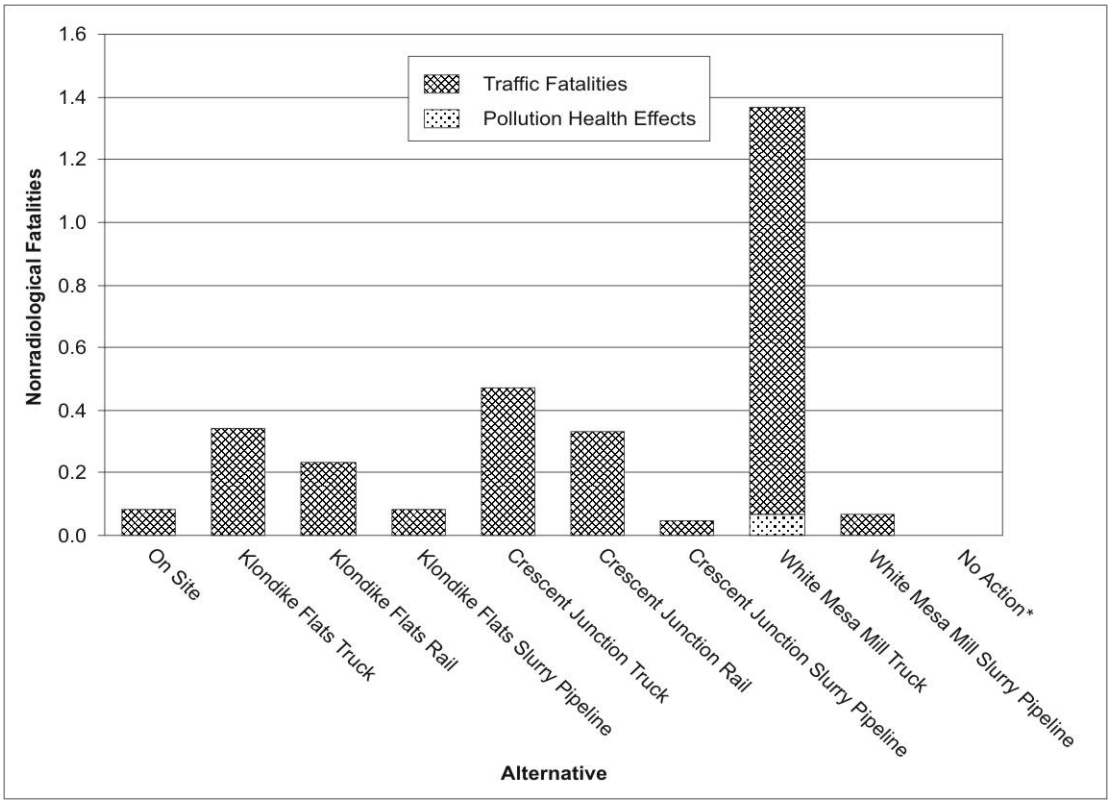
The design life of the disposal cell for the uranium mill tailings is 200 to 1,000 years. Over this period of time, the amount of radioactivity in the disposal cell will decrease slightly, less than 1 percent, due to the decay of the radionuclides in the uranium mill tailings. In the time frame of 200 to 1,000 years, the major route of exposure of people would be through the inhalation of radon progeny from the disposal cell. Even though DOE's experience supports a conclusion that radon release rates from the capped pile would be negligible, and DOE's long-term monitoring and maintenance of the site would ensure cap integrity, for the purpose of supporting analyses of long-term performance and impacts, DOE has also assessed impacts assuming the maximum allowable release rate of radon, 20 picocuries per square meter per second, under EPA's regulations (40 CFR 192).

On the basis of this emission rate, after the disposal cell cover was installed the annual latent cancer fatality risk from radon for a nearby resident at any of the disposal sites is estimated to be 8.9×10^{-5} per year of exposure. As with the radioactivity in the disposal cell, the annual risk would also not decrease appreciably over the 200- to 1,000-year time. Therefore, the annual latent cancer fatality risk for a nearby resident would be about the same immediately after the cover was installed as it would be 1,000 years after the cover was installed.

Long-term population risk assessment for this 1,000-year period would be greatly influenced by changing demographics. For comparison among the on-site and off-site alternatives, assuming no changes in population numbers or geographic distribution yields the following population risks over 1,000 years: the population around the Moab site would incur 6 latent cancer fatalities; the population around the Klondike Flats site would have a latent cancer fatality risk of 0.09; the population around the Crescent Junction site would have a latent cancer fatality risk of 0.07; and the population around the White Mesa Mill site would have a latent cancer fatality risk of 0.1.

Release of uranium mill tailings in a truck or rail transportation accident would not be expected to result in any latent cancer fatalities to either the exposed population or the maximally exposed individual.

Figure S–19 compares nonradiological fatalities predicted among members of the public due to project-related traffic accidents and to exposure to project-related nonradiological pollutants during surface remediation activities. There would be less than one-tenth of one fatality due to exposure to nonradiological pollutants (for example, exhaust emissions) under any action alternative (Figure S–19). Traffic fatalities would be directly proportional to truck shipment miles; fewer than one traffic fatality is predicted to occur under any action alternative except the White Mesa Mill truck alternative, where 1.3 traffic fatalities are predicted.



*Impact would not occur under this alternative.

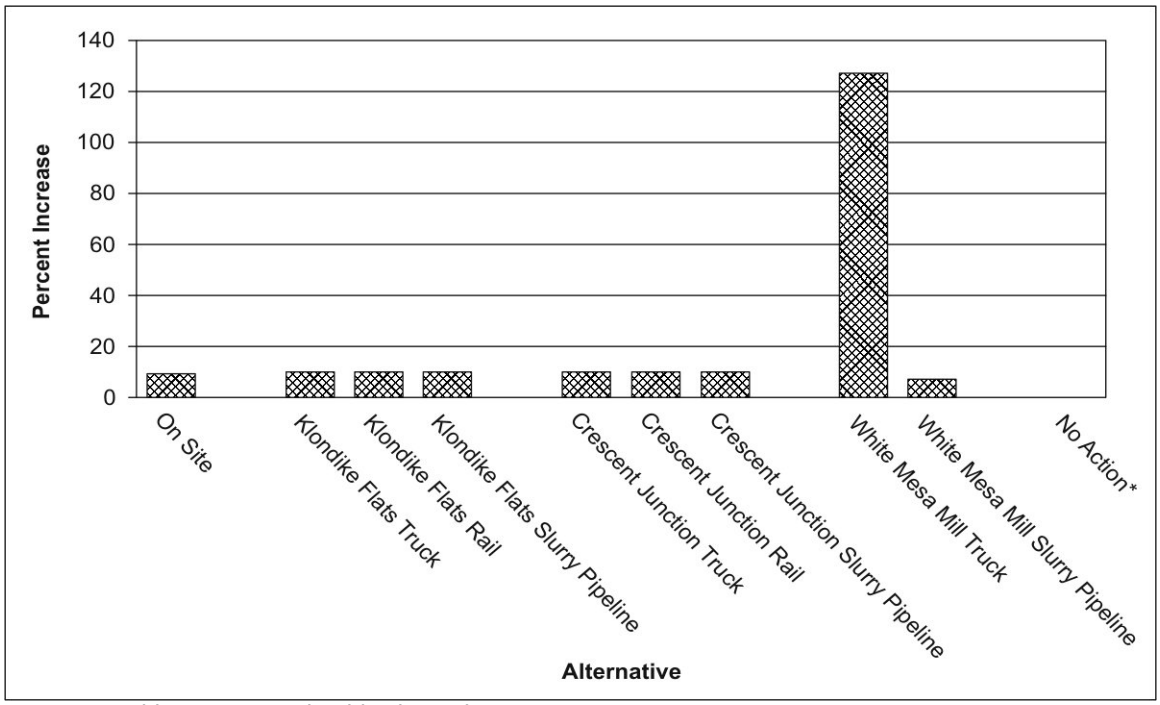
Figure S–19. Nonradiological Transportation Fatalities

Traffic. Figure S–20 through Figure S–22 depict traffic impacts among the alternatives. All the proposed action alternatives would result in increased traffic on local roads and US-191. Among the three off-site disposal locations, truck transportation to the White Mesa Mill site would represent the most severe impact to traffic in central Moab, an area that the Utah Department of Transportation currently considers to be highly congested. Transportation of contaminated materials from the Moab site to the White Mesa Mill site would result in a 127-percent increase in average annual daily truck traffic through Moab. In contrast, if the tailings were trucked to the Klondike Flats or Crescent Junction sites, or if either the rail or slurry pipeline transportation modes were implemented for any of the off-site disposal locations, there would be only a 7-percent increase in truck traffic through central Moab from shipments of vicinity property materials under all action alternatives, and only a 2- to 3-percent increase from shipments of borrow materials for the on-site disposal alternative or for off-site disposal at the Klondike Flats or Crescent Junction locations. All alternatives would also result in an overall increase in the average annual daily truck traffic on US-191, both north and south of Moab, from shipments of contaminated materials and borrow materials. These impacts would be most severe with the off-site truck transportation mode, which would increase average annual daily truck traffic on US-191 by 95 percent for the Klondike Flats or the Crescent Junction alternative and by 65 to 186 percent for the White Mesa Mill alternative, depending on the segment of US-191.

In comparison, the on-site disposal alternative and the rail or pipeline off-site alternatives would increase average annual daily truck traffic on US-191 only by 7 percent. Assuming conservatively that each worker would commute through Moab, the increase in all traffic through central Moab due to commuting workers would be minor for all alternatives, ranging from a 1- to 5-percent increase. As shown in Figure S–19, DOE estimates that less than one traffic fatality would occur for all alternatives and transportation modes with the exception of truck transportation to White Mesa Mill, for which modeling predicts that 1.3 traffic fatalities would occur.

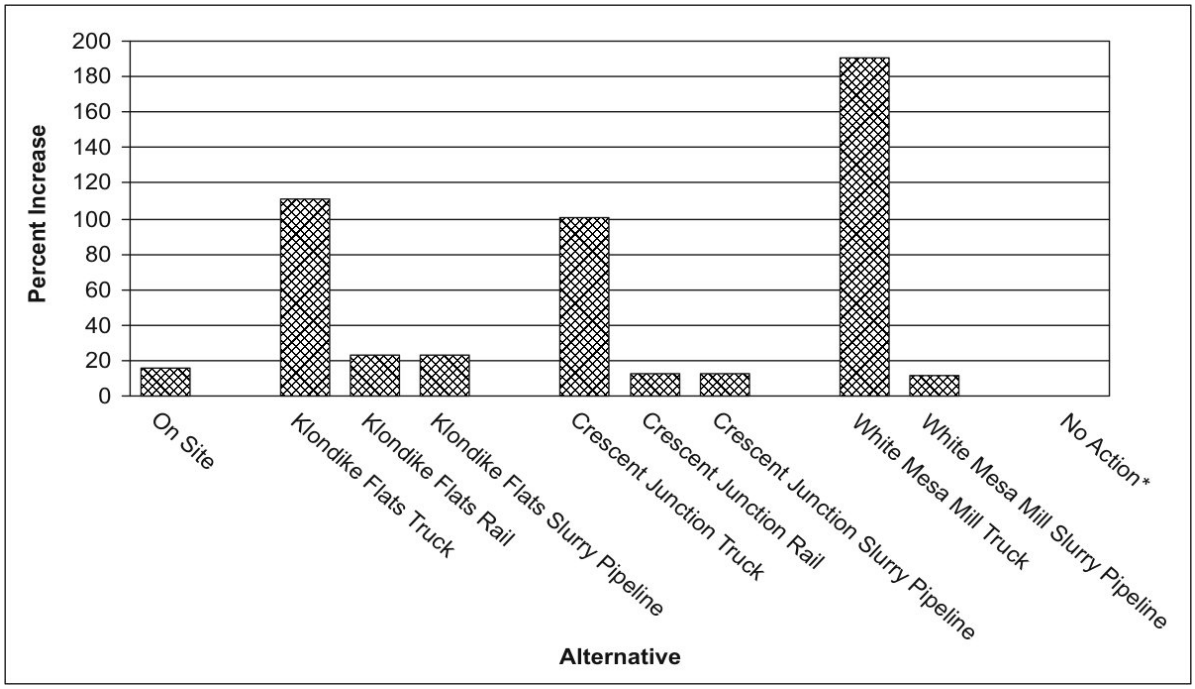
Environmental Justice. Disproportionately high and adverse impacts to minority and low-income populations would occur under the White Mesa Mill off-site disposal alternative (truck or slurry pipeline transportation) as a result of unavoidable adverse impacts to at least 10 to 11 potential traditional cultural properties located on and near the White Mesa Mill site, the proposed White Mesa Mill pipeline route, the White Mesa Mill borrow area, and the Blanding borrow area. Moreover, if the White Mesa Mill alternative were implemented, it is likely that additional traditional cultural properties would be located and identified during cultural studies. DOE would address the potential for adverse impacts to these properties once they were discovered.

The sacred, religious, and ceremonial sites already identified as traditional cultural properties are associated with the Ute, Navajo, and Hopi cultures and people. Currently, there are no known traditional cultural properties at any other site, although the potential for their being identified during cultural studies and consultations ranges from low to high, depending on the site and mode of transportation. The impacts to all other resource areas analyzed in the EIS (for example, transportation or human health) would not represent a disproportionate adverse impact to minority and low-income populations under any alternative.



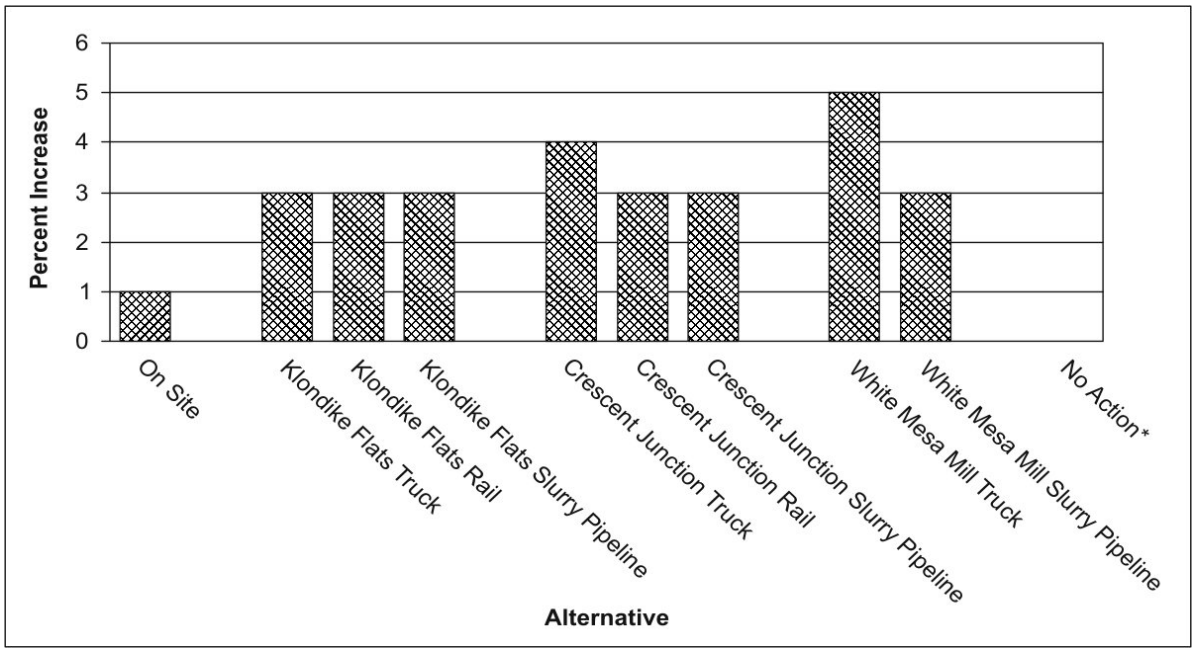
*Impact would not occur under this alternative.

Figure S–20. Increase in Truck Traffic in Downtown Moab



*Impact would not occur under this alternative.

Figure S–21. Increase in Truck Traffic on US-191



*Impact would not occur under this alternative.

Figure S–22. Increase in Moab Traffic from Commuters

Disposal Cell or Tailings Pile Failure. Under the on-site remediation alternative and No Action alternative, a disposal cell or tailings pile failure could pose a risk under the residential scenario and could result in adverse impacts to aquatic receptors from uranium and ammonia concentrations in the Colorado River. The risk would be much lower for the off-site disposal locations because the sites are not located near a river, do not have historical seismic activity, are not prone to subsidence attributed to salt dissolution below the alluvial basin, and are located away from population centers and sensitive habitats. The possibility and consequences of a tailings pile failure are greatest under the No Action alternative because it would not include the use of engineering controls to mitigate impacts from floods and other natural events as would occur under the on-site disposal alternative.

Overall, the on-site disposal alternative would result in the lowest radiological exposures to workers and the public, fewest cultural resource and transportation impacts, and lowest costs while meeting the minimum regulatory requirements for stabilization and protection over the 200- to 1,000-year regulatory time frame. In addition, ground water remediation costs are comparable to those of all the off-site disposal alternatives. However, the on-site disposal alternative presents uncertainties regarding (1) long-term protection of aquatic species from ground water contaminants and (2) the stability of the tailings pile and associated contaminants, which have the potential to be affected by the dynamic forces of the Colorado River and subsidence due to an actively dissolving salt dome beneath the site.

The off-site alternatives would provide significantly decreased uncertainty regarding the long-term protection and stability concerns associated with the on-site disposal alternative. However, relocating the tailings would increase the radiological dose to workers and the public, though these risks could be managed to acceptable levels. In addition, off-site disposal would increase the potential for cultural resource impacts and transportation risks. Further, relocating the tailings would increase the project costs by approximately 60 to 120 percent over the on-site disposal

alternative. The Klondike Flats and Crescent Junction alternatives would provide the closest off-site repository locations with similar desirable geologic and hydrogeologic conditions, access to transportation infrastructure, and levels of site disturbance. The Crescent Junction site is farther from Moab than the Klondike Flats site but offers several advantages, including the longest hydrogeologic isolation period (time in which contaminants could reach the ground water); the lowest land-use conflict potential; the shortest haul distance from the rail rotary dump into the disposal cell, reducing the size of the radiological control area; and flat terrain that would make operations easier and safer. In comparison, the Klondike Flats location would require construction of a new public access road parallel to Blue Hills Road and a 1- to 4-mile truck haul road that would traverse the steep bluffs (20- to 30-percent grade) north of Blue Hills Road. The truck haul road would require radiological controls from a rail spur to the disposal cell site.

Of the three alternative off-site locations, the White Mesa Mill site would require the greatest distance for transportation, would have the greatest potential for adversely affecting cultural resources and traditional cultural properties, and would have the shortest hydrogeologic isolation period. Implementing that alternative using truck transportation would cause extensive adverse traffic impacts in the cities of Moab, Monticello, and Blanding. This off-site alternative would also be the most expensive because of its greater distance from the Moab site.

The No Action alternative would not afford remediation of surface contamination, which includes the existing tailings pile, contaminated materials and buildings, contaminated site soils, and contaminated soils from vicinity properties. The existing tailings pile with its interim cover would not be stabilized, no site controls to protect human health or the environment would continue or be implemented, and public access to the site would be unrestricted. This would result in conditions that would not be protective of public health and the environment and would be in conflict with the requirements of 40 CFR 192 and the requirements of the Floyd D. Spence Act. A more detailed discussion of the differences among alternatives is provided in the EIS in Table 2–32.

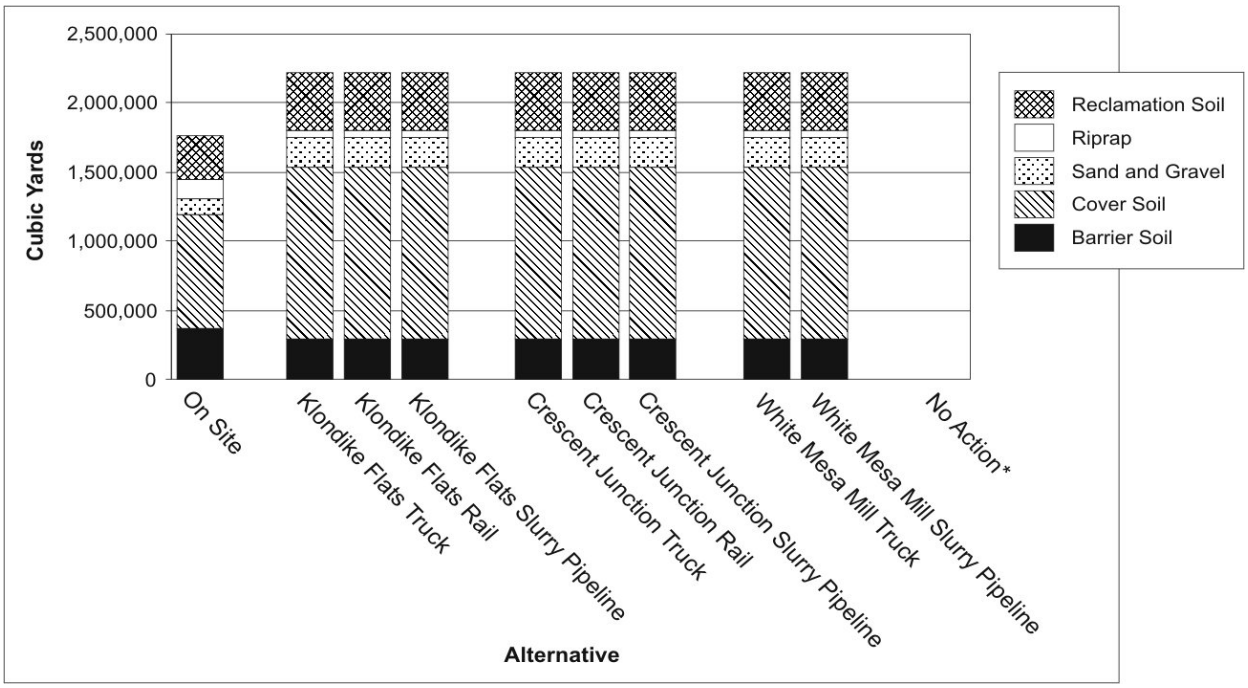
Borrow Area Impacts

Impacts to borrow areas would occur under any of the alternative actions. However, impacts at borrow areas are discussed in this section and in the EIS as a separate, stand-alone topic in response to a request by BLM, one of the cooperating agencies. BLM indicated that analyzing impacts to borrow areas as a stand-alone topic would facilitate the subsequent analyses necessary to authorize DOE to use borrow material at BLM-managed borrow areas.

Five different borrow materials would be needed to construct a disposal cell cover and to reclaim some site surface areas after completion of remediation under all action alternatives. These materials are cover soils, radon/infiltration barrier soils, sand and gravel, riprap, and Moab site reclamation soils. DOE assessed the potential impacts of removing these materials from 10 different borrow areas (Crescent Junction, Floy Wash, Courthouse Syncline, Klondike Flats, Tenmile, Blue Hills Road, LeGrand Johnson, Papoose Quarry, Blanding, and White Mesa Mill). Figure S–23 shows the locations of the 10 borrow areas analyzed.

The impacts of removing materials from the proposed borrow areas would be similar among all the sites. Two of the borrow areas (LeGrand Johnson and Papoose Quarry) are existing commercial borrow areas. Seven borrow areas are on land managed by BLM (Floy Wash, Blue Hills Road, Crescent Junction, Courthouse Syncline, Klondike Flats, Tenmile, and Blanding) and would require the issuance of a free-use permit by BLM. The last borrow area lies within the boundaries of the White Mesa Mill site.

All the off-site disposal locations would require approximately the same amount of borrow material (2.2 million yd^3), about 20 percent more than the 1.8 million yd^3 that would be needed for the on-site alternative (Figure S–24). The relative amounts of the five types of borrow material would be very similar for all alternatives, and approximately 90 percent of the required borrow material would be excavated soil (Figure S–24).



*Impact would not occur under this alternative.

Figure S–24. Borrow Material Requirements

Only two borrow areas (LeGrand Johnson and Papoose Quarry) are not likely to have federally listed threatened or endangered species occurring on or near the site. Potential impacts to plants and wildlife would be limited to terrestrial ecological resources during the time frame the borrow areas were used. Because of the lack of aquatic resources at the borrow areas, no short-term impacts would occur. No long-term impacts to aquatic or terrestrial resources would occur following reclamation of the borrow areas. Klondike Flats and Tenmile are the borrow areas with the highest potential for affecting cultural resources. DOE would conduct Class III cultural resource surveys as necessary to identify the precise number and types of cultural sites that may be present at a potential borrow area and would work with BLM (if the area were on land managed by BLM), the State Historic Preservation Officer, affected Native American tribes, and the Advisory Council on Historic Preservation to determine appropriate mitigation measures for affected sites if cultural resources were found.

Consequences of Uncertainty

The purpose of this EIS is to assess and compare the potential environmental impacts associated with reasonable alternative actions to remediate the uranium mill tailings pile at Moab and contaminated ground water beneath the site. The EIS describes these impacts as accurately as possible given the available data and certain assumptions as required under the Council on Environmental Quality's NEPA regulations (40 CFR 1502.22). However, DOE recognizes that uncertainties are associated with these assumptions and that some of the assumptions could turn out to be inaccurate. Other areas of uncertainty involve differences between DOE and one or more of the cooperating agencies regarding regulatory or scientific interpretations. These uncertainties are relevant to decision-making, because if any of the assumptions underlying the EIS change significantly, the impacts as described could also change. It is important that decision-makers are cognizant not only of the nature and range of uncertainties inherent in the EIS but also of the potential consequences of these uncertainties. This section delineates the major uncertainties and, to the extent possible, describes the potential consequences of them.

The uncertainties identified and acknowledged in the EIS include areas as diverse as the future regulatory environment, the duration of worker exposure to radiation, ground water modeling assumptions, and the timing of congressional appropriations. Some of these uncertainties would be "alternative neutral" in that the consequence of the uncertainty would be expected to affect all alternatives in the same way and to the same degree, with the exception of the No Action alternative. Other uncertainties would be irrelevant to some alternatives but of significant potential consequence to others. For example, the uncertainties surrounding the speed and direction of river migration are relevant to the on-site and No Action alternatives but are of no consequence under the off-site disposal alternative because the pile would have been removed. Another area of uncertainty is Congressional funding for the project. If funding appropriated by Congress is insufficient to meet projected schedule, delays and cost overruns could occur for any of the identified alternatives.

The majority of these uncertainties relate to the intrinsic variability and heterogeneity of the natural media to which the Department is applying engineering solutions. The types and degrees of uncertainty identified in this section are typical of those that have been encountered during the characterization and remediation of the previous 22 sites designated under Title I of UMTRCA and are similarly typical of the uncertainties associated with this stage of decision-making for remedial action projects. Based on the Department's extensive history with the remediation of uranium mill tailings sites, reasonable conservatism has been employed in characterizing the costs, resources, and impacts associated with meeting the statutory requirements of UMTRCA and NEPA. To be consistent with the Council on Environmental Quality requirements for incomplete or unavailable information (40 CFR 1502.22), within this EIS DOE has explicitly identified its assumptions where information may be limited, clearly indicated the methods and models used in its analyses, and evaluated the potential relevance of incomplete or unavailable information to decision-making.

Table S–1 identifies the major areas of uncertainty, characterizes the changes that might occur in the predicted impacts, and establishes the relative effect that such changes in impacts might have on the alternatives evaluated in this EIS. In addition, further discussion regarding controversy over river migration, contaminant flow under the Colorado River to the Matheson Wetlands Preserve, and appropriate compliance standards for ground water remediation is provided in "Responsible Opposing Views."

Table S–1. Consequences of Uncertainty

	EIS Uncertainty/Assumption	Consequences
1.	**Ground Water and Site Conceptual Model Assumptions** On the basis of ground water modeling and the current site conceptual model, the EIS presumes that a target near-river ground water remediation goal of 3 mg/L ammonia can be achieved for the on-site disposal alternative and for all off-site disposal alternatives, and that this goal will result in sustained post-remediation surface water concentrations of 0.6 to 6 mg/L total ammonia after 75 to 80 years of active ground water remediation. (**Note:** River water quality would be acceptable within 5 years after implementation of ground water remediation because of plume interception). The EIS presumes that without catastrophic events, this surface water concentration would be sustained for at least 1,000 years after completion of ground water remediation for the on-site alternative and permanently for the off-site alternative. Uncertainties are associated with the ground water modeling input parameters and associated model results, including contaminant distribution coefficients, first-order decay rates for ammonia, pore fluid concentrations, flow parameters, and the efficiency of natural flushing.	The consequences of using an erroneous value for the ground water flow and transport input parameters apply to all the alternatives. At the **upper limit of the uncertainty**, the actual concentrations of ammonia could be at least 10 times greater than predicted. Therefore, it is possible that the on-site disposal alternative would never achieve the 3-mg/L ammonia target goal. For the off-site disposal alternative, there is no uncertainty that the target goal would eventually be achieved, because the tailings, which are the source of some of the ammonia, would be removed. However, there is uncertainty associated with the time frame required for the ammonia concentrations to attenuate to the target goal. If actual ground water concentrations are 10 times greater than predicted, the time frame to achieve protective concentrations in the surface water could be greater than the predicted 75 years for the off-site disposal alternative. If the target goal of 3 mg/L ammonia in ground water could never be achieved for the on-site alternative or could not be achieved in 75 years for the off-site disposal alternative, DOE could be required to continue active ground water remediation for an indefinite period beyond the projected 75 to 80 years to maintain protective surface water quality. The annual generation of 6,600 tons of RRM, the estimated $906,000 in annual ground water treatment costs, and the institutional controls associated with ground water remediation activities would all continue for an indefinite period beyond the currently projected 75 to 80 years. At the **lower limit of the uncertainty**, the actual ammonia concentrations could be at least 2 times lower than predicted. Therefore, it is possible that even the No Action alternative could achieve the 3-mg/L ammonia target goal. It is also possible that the on-site and off-site disposal alternatives could achieve the 3-mg/L target goal earlier than the predicted 75- to 80-year time frame, resulting in lower costs for ground water remediation than estimated.

Table S–1. Consequences of Uncertainty (continued)

	EIS Uncertainty/Assumption	Consequences
2.	**Surface Water Compliance Standards** Partly on the basis of past experience, it appears reasonable to DOE that protection for aquatic species would be achieved at total ammonia concentrations in surface water of (1) 3 mg/L, representing the lower limit of the range of the acute criteria that would be met everywhere in the river (assumes no dilution) and (2) 0.6 mg/L, representing the lower limit of the range of the chronic criteria that would be met outside a mixing zone (assumes dilution). (**Note:** Because of plume interception, total ammonia concentrations in the river would be less than these levels within 5 years after implementation of ground water remediation.) However, DOE acknowledges that the Utah Department of Environmental Quality disagrees with this position regarding the applicable acute and chronic compliance standards and whether a chronic mixing zone would be appropriate.	Because ground water remediation is proposed under all action alternatives, the consequences of the uncertainties associated with applicable compliance standards apply to the on-site and all off-site disposal alternatives. However, the consequence of this uncertainty is greatest for the on-site disposal alternative. If DOE's assumption regarding a mixing zone is incorrect, and a mixing zone does not apply, then the 0.6- to 6-mg/L chronic criteria for ammonia concentrations in surface water would be required to be met everywhere in the river (no dilution). The length of time required for active ground water remediation would increase in order to achieve a lower ammonia concentration in the ground water and the identified applicable compliance standard in surface water. To achieve 0.6 mg/L would likely require about 90 (rather than 75) years for the off-site disposal alternative and more than 200 (rather than 80) years for the on-site disposal alternative. The annual generation of 6,600 tons of RRM, the estimated $906,000 in annual ground water treatment costs, and the duration of institutional controls associated with ground water remediation activities would all be prolonged accordingly.
3.	**Tailings Characteristics (Nonradiation)** The proposed conceptual designs and schedules for removal of the mill tailings pile under the off-site disposal alternative are based on DOE's experience and assumptions about the physical and chemical characteristics of the tailings pile. These assumptions, which include the tailings moisture content and driability, particle size distribution, and the concentrations and distributions of organic and inorganic contamination, are based on field characterization studies, DOE's experience with other UMTRCA sites, and historical Moab site data. However, DOE acknowledges that there are uncertainties in these assumptions. These pile characteristic uncertainties could affect final surface remediation cost and schedule but would not affect the ability of an engineered design to ensure that the stability requirements of 40 CFR 192 were met.	The consequences of the uncertainty about the physical and chemical characteristics of the tailings apply primarily to the off-site disposal alternative because under on-site disposal, the pile would remain largely undisturbed. However, some of the uncertainties affect the three transportation modes differently. If assumptions regarding **average moisture content** are low and the tailings are less driable than assumed, longer drying times would be required, and the schedules for the truck and rail transportation modes could be longer than projected. Associated costs would increase accordingly. However, prolonging the duration required for truck transport could also have the positive impact of reducing the daily truck traffic volume. Moisture content uncertainty would not affect the slurry pipeline because drying would not be required. If assumptions regarding the **average particle size of the tailings materials** are low, additional mechanical processes could be required to reduce their size. This would negatively affect cost and schedule estimates. The slurry pipeline option would be especially sensitive to this uncertainty because the material must be sieved to a specified mesh for slurry formation. The rail option is also sensitive because materials must be small enough to be loaded and transported on a conveyer for loading gondola cars. Additional truck transport could be required under the rail or pipeline options if size distribution estimates were wrong. This would result in more truck traffic and possibly more accidents than the EIS projects. For all alternatives, if additional mechanical size reduction were required, there would be a concurrent increase in worker exposures to contaminated dust.

Table S–1. Consequences of Uncertainty (continued)

	EIS Uncertainty/Assumption	Consequences
4.	**Mass and Volume of Excavated Contaminated Soil and Reclamation Soil** Under the on-site disposal alternative, approximately 234,000 tons (173,000 yd^3) of contaminated soils at the Moab site would be excavated and disposed of with the tailings. Under the off-site disposal alternative, approximately 234,000 tons (173,000 yd^3) of contaminated site soil at the Moab site and approximately 566,000 tons (420,000 yd^3) of contaminated subpile soils would be excavated. For all action alternatives, these materials would be disposed of in the same manner as the tailings. The EIS assumes that 320,000 to 425,000 yd^3 of clean reclamation soil (10,000 to 13,000 shipments from Floy Wash) would be needed to backfill the Moab site to an approximate average depth of 6 inches. However, DOE acknowledges uncertainties associated with these estimates.	Because off-pile contaminated soil excavation and backfilling is proposed for the on-site and all off-site disposal alternatives, the consequences of the associated uncertainty applies to all action alternatives, but the extent of some of the consequences varies; the off-site truck disposal consequences are the most extensive. Under the off-site disposal alternative, if DOE has significantly underestimated the volume of contaminated off-pile soil that would need to be excavated, there would be a commensurate increase in the amount of material to be transported to an off-site disposal location. Although the potential increase in transported volume is not expected to be large compared to the existing pile volume, it would increase the projected numbers of truck and rail shipments, fuel use, truck traffic and accidents (truck transport), population exposures to radiation, water consumption (especially for the slurry pipeline option), and transportation-related costs and schedules. For all action alternatives, there would be an increase in worker exposure to contamination associated with the deeper excavation and more suspended contaminated dust. Under the on-site disposal alternative, there would be a commensurate increase in the amount of material to be disposed of in the Moab pile (surcharge). This could increase the required amounts of radon barrier and cover borrow material, which would increase land disturbance at borrow areas and increase associated truck traffic and fuel-use impacts. Under all action alternatives, if more than the projected number of shipments of clean backfill from borrow areas were necessary, there would be a proportional increase in disturbed land at borrow areas and a proportional increase in borrow truck traffic, fuel consumption, traffic accidents, and truck-related adverse noise.
5.	**Residual Subpile Contamination** Even after subpile soils are removed to a sufficient depth to meet all radiological cleanup standards in 40 CFR 192, residual contamination could remain below the depth of remediation at depths that could affect ground water quality.	This uncertainty applies only to the off-site disposal alternatives and applies to each of them equally. The primary consequence of this uncertainty is that the off-site disposal alternatives do not guarantee removal of all potential sources of mill-related ground water contamination. Achieving and maintaining post-remediation protective river water quality could require continuing with active ground water remediation for an indefinite period beyond the projected 75 to 80 years. The annual generation of 6,600 tons of RRM, the estimated $906,000 in annual ground water treatment costs, and the institutional controls associated with ground water remediation activities could all continue for an indefinite period beyond the currently projected 75 to 80 years. Alternatively, the consequence could be the need to excavate subpile soils to a depth that is greater than currently projected; in that case, the consequences would be similar to those described in number 4.

Table S–1. Consequences of Uncertainty (continued)

	EIS Uncertainty/Assumption	Consequences
6.	**Extent of Contaminated Vicinity Properties** The EIS assumes the need to remediate 98 of 130 vicinity properties and that approximately 39,700 tons (29,400 yd^3) of material would be transported to the Moab site over a period of 1 to 3 years for subsequent on-site or off-site disposal with the tailings.	Because vicinity property remediation is proposed for the on-site and all off-site alternatives, the consequences of the associated uncertainty apply to all action alternatives. If additional vicinity properties required remediation, the labor, volumes, and impacts associated with their remediation would increase proportionally. All of these consequences would affect all action alternatives, although the cumulative impact on traffic in central Moab would be most severe for the White Mesa Mill truck transportation alternative, under which truck traffic in central Moab is currently estimated to increase by 127 percent. If vicinity property transport trips were to double, truck traffic in central Moab would increase by 135 percent under the White Mesa Mill alternative. The estimated mass of vicinity property material requiring remediation (39,700 tons) is less than one third of 1 percent of the estimated mass of the uranium mill tailings pile. Consequently, even if the mass of vicinity property material requiring remediation were twice or three times what DOE estimates, the impacts on the final dimensions of the disposal pile and, in the case of off-site transportation alternatives, on the total numbers of off-site shipments would be minor. The major consequences of this uncertainty would be associated with (1) the local traffic and traffic on US-191 required to transport the contaminated vicinity property material to the Moab site, (2) the volumes of required backfill material, and (3) the associated traffic. The EIS estimates that if all vicinity properties were remediated in 1 year, it could require 48 daily trips on US-191. This traffic volume, and in particular the impact on the highly congested area of central Moab, would increase proportionally if additional vicinity properties required remediation. There would also be a proportional increase in the exposure of workers and the public to contamination and the general disruptions and displacements associated with the remediation activities.

Table S–1. Consequences of Uncertainty (continued)

	EIS Uncertainty/Assumption	Consequences
7.	**Worker Dose Rates and Exposure Times** Estimates of the length of time that would be required to excavate the pile and transport it to an off-site location (off-site disposal alternatives) assume that the level of radiation to which workers would be exposed would allow workers to work a 10-hour shift. There are, however, uncertainties about the dose of radiation to which workers would be exposed once the interim cover was removed and pile relocation operations were begun.	The consequences of this uncertainty apply primarily to the off-site disposal alternatives because under the on-site disposal alternative the tailings pile would not be excavated, although there would still be emplacement of contaminated soils (surcharge), material from vicinity properties, and a permanent cover. In the EIS, worker dose estimates were based on the highest radiation levels and radon concentrations measured when the Moab pile was excavated to construct an evaporation pond. However, if radiation levels or radon concentrations are higher, and if under the off-site disposal alternatives it were determined that some or all workers could not work a full 10-hour shift because of radiation levels, there would be several possible management strategies, including (1) using more cumbersome personal protective equipment, (2) augmenting the work force to reduce the daily dose to individual workers while maintaining the current schedule, or (3) prolonging the schedule to allow the same number of workers to be exposed to reduced daily doses. If the level of potential worker exposure required DOE to implement any of these strategies, the duration of the project would be longer than currently projected. An augmented workforce would exacerbate commuter traffic and socioeconomic and other workforce resource demands. More extensive radiation monitoring and personnel decontamination facilities could be required. It is unlikely that this uncertainty would adversely affect ground water remediation schedules or the projected time for achieving acceptable river water quality.
8.	**Extent of Cultural Resources and Traditional Cultural Properties** The EIS acknowledges uncertainties in the number and density of potentially affected cultural resources and traditional cultural properties. It is possible that detailed surveys or traditional cultural property studies that would be conducted for the preferred alternative identified in the final EIS would identify a significantly richer cultural resource than indicated by existing, less detailed, or adjacent surveys.	Although this uncertainty affects all alternatives to some degree, the consequences would be greatest for the White Mesa Mill alternative, in particular for the White Mesa Mill slurry pipeline option. The likelihood that additional traditional cultural properties (not identified in the final EIS) would be identified after completion of site-specific surveys and studies is extremely high. Results of required cultural resource surveys and traditional cultural property studies might show that the White Mesa alternative could be more costly to implement because of the severity of impacts to newly discovered cultural resources.

Table S–1. Consequences of Uncertainty (continued)

	EIS Uncertainty/Assumption	Consequences
9.	**River Migration** On the basis of river morphology, soil-formation evidence on terraces bounding the valley, and lack of terraces within the valley, DOE has concluded that Moab Valley is subsiding because of salt dissolution and that the river will occupy the lowest portion of the valley. Evidence presented in DOE's river migration report suggests that the valley is subsiding more rapidly in areas away from the pile, which will force the river to move southeastward away from the pile. However, DOE acknowledges the uncertainty in this interpretation and that the State of Utah disagrees with DOE's position. The State argues that the river has migrated widely across the tailings and millsite area in the geologic past and that DOE should take the conservative approach and assume that river migration could impinge on and undermine the existing tailings pile in the future. DOE is continuing to work with the State and the other cooperating agencies to develop additional information to narrow the uncertainties regarding river migration.	The consequence of this uncertainty applies to the on-site disposal and No Action alternatives. The uncertainty has no significance under the off-site disposal alternative because the pile would be removed. DOE's analysis supports the position that any potential river migration toward the pile would not occur as a catastrophic event but rather gradually in small increments, allowing ample time to implement sufficient engineering controls that would adequately mitigate river migration for the regulatory time frame of 200 to 1,000 years specified in 40 CFR 192. Preliminary evaluation of appropriate engineering mitigation suggests that a riprap wall could be constructed between the river and the disposal cell to deflect river encroachment, in the unlikely event that it occurred. The potential costs for such a mitigation effort have been roughly estimated to range from $0.5 million to $2.0 million, depending on the location and nature of the encroachment, the size of materials required, and method of construction. In addition, it is likely that these costs would be spread over many years and possibly even decades, depending on the nature and rate of river encroachment. If river migration and encroachment were to occur to a great degree, significantly lessening the transport distance from the disposal cell to the river, surface water ammonia concentrations and concentrations of other contaminants of concern could revert to nonprotective levels, and additional engineered remedies or pile relocation could be necessary to meet UMTRCA requirements, potentially increasing program costs by tens to hundreds of millions of dollars. At the extreme, perpetual treatment or mitigation might be required, or the pile would have to be relocated after all on-site reclamation efforts and costs had been committed.
10.	**Catastrophic Floods** The EIS assumes that a catastrophic flood event (300,000 cubic feet per second [cfs], the NRC-specified Probable Maximum Flood [PMF]) will occur no more than once in 500 years. Further, during flood events that exceed bankfull flow capacities of the Colorado River, most of the flow and flow energy are dissipated in the Matheson Wetlands Preserve away from the tailings pile. However, the possibility of a catastrophic flood cannot be eliminated because part of the Moab site tailings impoundment is located within the 100-year floodplain of the Colorado River and within the floodplain of the PMF of both the Colorado River and Moab Wash. The 100-year floodplains for Moab Wash and the Colorado River occupy over one-third of the Moab site. During a 100-year flood event, it is estimated the water level would be 3 to 4 ft above the base of the tailings pile. The floodplain area for the Colorado River extends the length of the eastern site boundary from the river's edge to distances ranging from 500 to 1,200 ft west and is approximately 10 ft above the average river level.	The consequence of this uncertainty applies to the on-site and No Action alternatives. The uncertainty has no significance under the off-site disposal alternatives because the pile would be removed. If 20 to 80 percent of the tailings pile were washed into the river, it would have serious adverse impacts on the riparian plant and animal life and would affect the health and safety of residents along the river and of river guides who may spend up to 50 days on the river in a given year. Such a flood event could also affect the tourist economy of Moab if users of the river corridor avoided the area after such an event.

Table S–1. Consequences of Uncertainty (continued)

	EIS Uncertainty/Assumption	Consequences
11.	**Shallow Ground Water Discharge/Matheson Wetlands Preserve** DOE site investigation results indicate that the shallow ground water contaminant plume in the upper fresh-to-brackish zone is discharging to the west bank of the river. Similarly, this upper fresh-to-brackish zone is discharging from the Matheson Wetlands Preserve to the east bank of the river. Evidence that ground water is discharging to the river from both banks and that the river essentially acts as a barrier to shallow ground water flow beneath the river is presented by the ground water elevation contours shown in the SOWP. However, DOE acknowledges that the University of Utah and the State of Utah disagree with this interpretation and have reported that shallow ground water and mill-related contaminants could be traveling in the brine zone under the river to areas in the Matheson Wetlands Preserve and beyond.	At the upper limit of the uncertainty, the long-term presence of the tailings pile could result in a perpetual source of contaminants that would prohibit achieving protective surface water quality criteria on one or both sides of the river and could result in perpetual ground water remedial action or a perpetual, but limited, adverse impact in the surface waters directly adjacent to the site. At the lower limit of the uncertainty, the long-term contribution of the tailings would be insignificant to the surface water quality and would not require a different scope or magnitude of ground water remediation and therefore would not affect decision-making.
12.	**Future Land Use** Because of uncertainty regarding the success of surface remediation and the possible use of “off-pile” areas of the site to support ground water remediation for 75 to 80 years, DOE has assumed that the entire site would be unavailable for future uses at this time and would be retained for long-term stewardship.	The uncertainty regarding the future use of the Moab site applies to all action alternatives. Decisions on the future use of the Moab site could not be made until surface remediation was complete in 7 to 10 years, and possibly longer, following the issuance of a ROD under either the on-site or off-site disposal alternatives. Such future-use decisions would depend in large part on the success of surface remediation, a condition that cannot be known at this time. In addition, it is possible that continuing ground water remediation activities would make the site unavailable for other uses until such activities were complete in 75 to 80 years. The possible uses of the site in 75 to 80 years when ground water remediation actions would be completed are too speculative to analyze meaningfully at this time. For these reasons, future-use scenarios were not analyzed in the EIS.
13.	**Congressional Appropriations** The schedules and budgets presented in the EIS for all the action alternatives assume that Congress would appropriate the money to complete the actions in the proposed time frames.	If Congress did not appropriate the necessary money, the program would not be implemented, and the impacts described under the No Action alternative would persist. Active ground water remediation (on-site and off-site disposal alternatives) could not be implemented, and Colorado River water would remain unprotected indefinitely. Reduced or incremental appropriations could delay realization of protective river water quality until the active ground water remediation was funded and the ground water contaminant plume was intercepted and contained. If any of the activities under the off-site disposal alternative were implemented and then shut down before completion because of appropriated funds being pulled back, there could be higher human health risks to exposed populations than the EIS estimates because of their more prolonged exposure to radiation from the open Moab pile or the incomplete new disposal cell.

Table S–1. Consequences of Uncertainty (continued)

	EIS Uncertainty/Assumption	Consequences
14.	**White Mesa Mill License Amendment** In the EIS, DOE assumes that if the White Mesa Mill alternative were selected, the NRC/State of Utah would amend IUC's current operating license.	DOE presumes that the IUC proposal could be selected (in a ROD) prior to an NRC or State decision to amend the current license. The ROD could stipulate that implementation of the decision would not begin until the requisite amendment was obtained and that if the amendment were denied, the ROD would be modified and another alternative selected. If the White Mesa Mill site were selected and the requisite license amendment subsequently denied, there would be some additional costs due to the delay and need to revise the ROD. Any funds invested in Class III cultural surveys, other White Mesa Mill site characterization studies, and land acquisition would have been wasted.
15.	**Other Contaminants of Concern** The EIS presumes that proposed ground water remediation would extract enough contaminated ground water before it enters the river to achieve a ground water concentration of 3 mg/L ammonia and would also clean up other contaminants to their appropriate and respective cleanup levels. DOE presumes that these other contaminants would reach protective levels within the same time frame that it would take for ammonia to reach protective levels because their concentrations are less elevated above applicable cleanup criteria (e.g., surface water standards), the constituents are less widespread, or they occur at elevated concentrations less frequently. However, DOE acknowledges that there is uncertainty in this assumption due to factors such as differences in solute transport and sorption mechanics.	The consequences of this uncertainty would apply to all action alternatives but would be of greater concern under the on-site disposal alternative. If, after 75 to 80 years of active ground water remediation, it was determined that concentrations of other mill-related contaminants of concern had not been reduced to acceptable levels, ground water remediation would continue until the concentrations reached acceptable levels. The annual generation of 6,600 tons of RRM, the estimated $906,000 in annual ground water treatment costs, and the institutional controls associated with ground water remediation activities would all continue for an indefinite period beyond the currently projected 75 to 80 years.

Table S–1. Consequences of Uncertainty (continued)

	EIS Uncertainty/Assumption	Consequences
16.	**Limited-Use Aquifer** Supplemental standards for ground water quality have been proposed on the assumption that the portion of the aquifer currently and potentially affected by site-derived contamination meets the criteria for limited use as defined in EPA guidance. NRC has suggested that the alluvial aquifer, currently not classified by the State of Utah, may not be suitable for application of supplemental standards on the basis of limited-use criteria. In addition, the State of Utah has indicated that it may have jurisdiction over ground water quality as it relates to protection of ecologically important surface waters. DOE estimates that 97 percent of the upper alluvial aquifer contains water with total dissolved solids (TDS) concentrations greater 3,000 mg/L, which is the threshold for limited-use classification under the Utah ground water classification system, and that over 80 percent of the upper alluvial aquifer contains natural salinity in excess of 10,000 mg/L TDS. Under the provisions of 40 CFR 192, supplemental standards are appropriate for ground water classified as limited use because of naturally occurring poor ambient water quality.	Although DOE presumes that application of supplemental standards is appropriate, should supplemental standards not be implementable, the ground water and surface water protection strategy would need to change and would potentially include strategies such as the application of alternate concentration limits (ACLs) and institutional controls in addition to the active remediation already proposed. The impacts of such alternate strategies would include additional costs and time for ground water modeling and risk analyses to support the ACL application to NRC, long-term monitoring at the points of compliance and points of exposure, and additional regulatory review by NRC and other appropriate agencies. Active ground water cleanup beyond what is currently projected is not likely to be required for the protection of aquatic species.
17.	**Tailings Consolidation** Under the on-site disposal alternative, there is uncertainty regarding the length of time required for the tailings pile to consolidate (settle) sufficiently after loading of surcharge material to allow for final cover emplacement. The EIS schedule acknowledges and allows 2 years for this uncertainty.	This uncertainty applies only under the on-site disposal alternative. If more than 2 years were required for pile consolidation, emplacement of the final cover, and therefore project completion, would be delayed. There would be some additional costs. Adverse visual impacts and worker and public radiation exposure would be prolonged.

Table S–1. Consequences of Uncertainty (continued)

	EIS Uncertainty/Assumption	Consequences
18.	**Salt Layer Migration** The EIS acknowledges the possible existence of an ammonia salt layer in the pile.	This uncertainty applies only to the on-site disposal alternative and the No Action alternative. If such a layer exists, modeling results indicate that under the on-site disposal alternative, contaminants from the salt layer could reach ground water in approximately 1,100 years (beyond the regulatory design life span of the disposal cell) and could affect ground water and surface water for approximately 440 years. Under the No Action alternative, contaminants from the salt layer could reach ground water within approximately 170 years and could affect it for approximately 50 years. Under the on-site disposal alternative and the No Action alternative, potential future releases of contaminants from the ammonia salt layer in the tailings pile would cause adverse impacts to aquatic species in the Colorado River.
19.	**Use of Tandem Trucks** On the basis of DOE's experience and the preliminary discussions with the Utah Department of Transportation, the EIS assumes that overweight (tandem truck) permits would be required and could be issued. On the basis of prior DOE experience with tailings hauls, it does not appear reasonable that a single truck haul would be considered by contractors responding to the bid package. However, it is possible that Utah would not issue the requisite oversize permits.	This uncertainly primarily affects the off-site truck haul alternative, although to a lesser degree it also affects borrow material transport under all action alternatives and transport of oversized debris under the rail or pipeline off-site disposal alternatives. If the State of Utah did not permit the use of tandem trucks, then significant additional adverse impacts would be associated with the off-site truck haul disposal alternative. The estimated daily truck trips to haul contaminated materials and borrow materials could increase substantially, as would fuel use, traffic accidents, traffic-related air pollution, and truck driver exposures to radiation.

Cumulative Impacts

The on-site and off-site disposal locations under consideration are located in rural areas with no other major industrial or commercial centers nearby. No past, present, or reasonably foreseeable future actions are anticipated to result in cumulative impacts when considered with the alternatives assessed in this EIS. However, seasonal tourism in and around Moab, and to a lesser extent at the off-site disposal locations, could have a cumulative impact on traffic congestion in central Moab especially under the truck transportation mode where truck traffic would increase by over 100 percent.

Unavoidable Impacts, Short-Term Uses and Long-Term Productivity, and Irreversible or Irretrievable Commitment of Resources

Compared to current levels of radiation dose and excess cancer risk, there would be a slight increase in exposure and risk to the public and to workers during the estimated 7 to 10 years during which surface remediation and tailings disposal operations would be ongoing under the on-site or the off-site disposal alternative. This transient increase in dose and excess cancer risk over current levels would end upon completion of surface remediation at the Moab site, vicinity properties, or at an off-site disposal location. Upon completion of operations, public exposure would gradually approach levels attributable to natural background. Current, preremediation levels of dose and risk to the public near the Moab site are the same as those that would result under the No Action alternative. Thus, the on-site or the off-site alternative would result in a temporary increase in public and worker exposure and risk compared to the No Action alternative. However, because the No Action alternative would result in the indefinite continuation of the current dose to the public from the tailings pile and vicinity property material, over the long-term the No Action alternative would result in higher levels of latent cancer fatalities to the public than would on-site or off-site disposal (see Figures S–17 and S–18). Under the truck transportation option, there would be a slight increase in the potential for traffic fatalities.

Under the action alternatives, there would be an unavoidable increase in truck and other construction-related traffic and traffic due to commuting workers. This unavoidable adverse impact would occur 5 to 7 days a week, would last for the duration of Moab site surface remediation activities (up to 8 years), and would primarily but not exclusively affect US-191. Off-site transportation of tailings by truck would result in the greatest increase in traffic. The highest traffic impacts would occur if tailings were trucked to White Mesa Mill. Under this disposal alternative and transportation mode there would be an unavoidable impact (127 percent increase in truck traffic) on the already congested traffic situation in downtown Moab.

There is also potential for unavoidable impacts to cultural or archaeological resources and traditional cultural properties from off-site disposal at the White Mesa Mill site and the construction of a pipeline to the White Mesa Mill site. There is a similar potential at the other off-site locations; however, because of the much lower densities of known resources at the other off-site locations, it is more likely that such impacts could be avoided.

Implementation of the alternatives would create a conflict between the local, short-term uses of the environment and long-term productivity. Under all alternatives, land required for the disposal cell would be unavailable for other uses in perpetuity (130 to 435 acres). This conflict would be more significant under the on-site disposal alternative, given the proximity of the Moab site to the city of Moab and heavily used recreation areas such as Arches National Park. This conflict would be the least significant for the White Mesa Mill site location because that site already includes four uranium mill tailings disposal cells.

The irreversible or irretrievable commitment of resources that would occur if the on-site or off-site disposal alternative were implemented are (1) the use of fossil fuels in the transport of tailings and borrow materials, (2) the use of borrow materials, (3) the use of steel if slurry pipeline transport were chosen, (4) the use of Colorado River water, and (5) the use of land for the disposal cell in perpetuity.

Major Conclusions, Areas of Controversy, and Issues to be Resolved

This section describes the major conclusions, areas of controversy (including those raised by agencies and the public), and the issues to be resolved (including the choice among alternatives).

Major Conclusions

The following conclusions are based on the analysis of environmental consequences described in the EIS:

- Most impacts associated with the on-site and off-site disposal alternatives would not be permanent or irreversible. The exceptions are unavoidable impacts to human health, cultural resources, land use, and resource consumption.
- Surface remediation would require about the same amount of time (7 to 10 years) under either the on-site or the off-site disposal alternative.
- Surface remediation under the off-site disposal alternative would cost 2 to 3 times more than under the on-site disposal alternative.
- For ground water remediation, the capital costs and annual operating costs would be identical, and the duration of ground water remediation would be very similar (75 to 80 years) under either the on-site or off-site disposal alternative.
- The Klondike Flats, Crescent Junction, and White Mesa Mill sites are off-site disposal locations where new disposal cells would need to be constructed. Although the White Mesa Mill site is an existing off-site facility that could receive the contaminated materials, it would also require new disposal cell construction.
- The potential environmental impacts of off-site disposal at the Klondike Flats site and the Crescent Junction site would be very similar.
- Among the three off-site disposal locations analyzed, White Mesa Mill would entail unique cultural and environmental justice impacts due to the proximity of the Ute community and the richness of the known and potential cultural resource inventory on or near the White Mesa Mill site and the White Mesa Mill pipeline corridor.

- Transporting the tailings by truck to any of the three potential off-site locations would noticeably increase truck traffic on US-191 for up to 8 years. If the tailings were trucked to White Mesa Mill, the increase in truck traffic through already congested central Moab would represent a severe, ongoing impact.
- The No Action alternative would pose the greatest risk to human health over the long term due to the continuation of current levels of public exposure to radiation at vicinity properties and at the Moab site.

Areas of Controversy

Several areas of continuing controversy have emerged as a result of DOE's discussions and consultations with cooperating and other agencies or as a result of public comments. Some of these issues and controversies derive directly from technical or regulatory uncertainties. Nontechnical issues and controversies have their origins in policies, perspectives, or positions endorsed by specific agencies or members of the public.

One area of controversy involves the ground water remediation standard to be applied. Based on its calculations, DOE has concluded that protection for aquatic species would be achieved at total ammonia concentrations in surface water of 3 mg/L (acute criteria) and 0.6 mg/L (chronic criteria that assumes dilution within a mixing zone). USF&WS agrees with DOE that the target goal of 3 mg/L (acute criteria) in ground water that DOE has selected would be protective of aquatic species in the Colorado River. However, the Utah Department of Environmental Quality disagrees with DOE's selection of the acute standard and has stated that the chronic standard (0.6 mg/L) should be applied to ground water. The consequences of the State's position could lengthen the duration of ground water remediation and are discussed in more detail in "Consequences of Uncertainty" and "Responsible Opposing Views."

There are also some areas of technical disagreement regarding long-term site risks. These risks are associated with uncertainties in processes potentially occurring over hundreds or thousands of years that are not amenable to short-term resolution. For example, professional differences of opinion with the State of Utah on river migration and transport of contaminants under the Colorado River to the Matheson Wetlands Preserve can be resolved with certainty only through long-term monitoring. The potential consequences of these differing opinions with regard to environmental impacts are discussed in "Consequences of Uncertainty," in Table S−1, and in "Responsible Opposing Views." While acknowledging these as areas of scientific controversy, DOE does not believe that it is necessary to conclusively resolve these technical controversies before making informed site remediation decisions. DOE will, however, incorporate protocols into its ROD, which will be elaborated upon in a subsequent remedial action plan, to require long-term processes to be monitored in a manner that would allow timely remedial action to be taken if DOE's assumptions were subsequently shown to be in error.

DOE recognizes each of these perspectives and, as appropriate, has incorporated them into the analysis of impacts. DOE will take these views into account when it makes its decision on the ultimate disposition of the tailings pile following the issuance of the final EIS.

Issues to be Resolved

The primary issue to be resolved is whether to dispose of the Moab uranium mill tailings pile on-site or off-site. If the off-site disposal alternative were selected, DOE must decide which of the three off-site disposal locations should be selected and which mode of transportation (truck, rail, or slurry pipeline) should be used. Ground water remediation would occur under any of the action alternatives. Selection of the No Action alternative for either surface or ground water remediation would not fulfill DOE's obligations under federal law to protect human health and the environment.

Responsible Opposing Views

As a result of comments received during the public comment period and consultations with the 12 cooperating agencies, DOE has identified three general topics on which there are responsible opposing views to DOE's position regarding the remediation alternatives for the Moab site: river migration, contaminated ground water flow under the river to the Matheson Wetlands Preserve, and the appropriate compliance standard for aquatic species in the river. This section presents a summary of the responsible opposing views, DOE's position on these topics, and the implications of the opposing views. Section 2.6.4 presents a more detailed discussion.

Responsible Opposing Views on River Migration

Several commentors, including state and federal agencies, presented their views regarding the EIS's characterization that the dominant direction of river migration over the next 200 to 1,000 years will be away from the site and that, should the tailings and associated wastes be remediated on site, the infrastructure proposed under this alternative could be built and maintained in a manner protective of public safety and the environment. Specifically, commentors based their views on different interpretations of data addressed in the EIS; their views are discussed in the following paragraphs.

- *U.S. Geological Survey (USGS) Study* (USGS 2005; see reference in Section 2.8). In a recent study, the USGS explored the hydraulic conditions of the existing channel geometry and three hypothetical channel scouring geometries under 100-year (97,600 cubic feet per second [cfs]), 500-year (120,000 cfs), and Probable Maximum Flood (PMF) (300,000 cfs) discharge conditions. The State of Utah and others have interpreted the results of this study to indicate that substantial potential for erosion of the riverbank adjacent to the tailings pile exists and that this potential poses a sufficient threat and uncertainty to warrant relocation of the tailings to a more geologically stable location.
- *Interpretation of Historical Documents*. Dr. John Dohrenwend questioned DOE's interpretation of the 80-year history documented by historical maps and aerial photographs and raised concerns that the photographs were not properly registered or interpreted. If they were properly registered or evaluated, they would show that the Colorado River is not migrating south and east away from the tailings pile, but rather north and west toward the pile. Comment 429 in EIS Volume III, "Comment Responses," presents the complete text of Dr. Dohrenwend's opposing view.

- *Significance of Flows into the River*. Dr. John Dohrenwend suggested that flows from Courthouse Wash have deposited sediments on the south side of the Colorado River channel and, therefore, have actively contributed to the northward migration of the river channel, not a southward and eastward migration as indicated in the EIS.
- *Interpretation of Data*. The State of Utah and Dr. John Dohrenwend questioned DOE's interpretation of available well log and borehole data. The commentors interpreted the available data to indicate that the valley fill is not thickest and deepest south of the present location of the river channel, but rather beneath or perhaps several hundred feet north of the present river channel. The opposing interpretation is that if the thickest and deepest valley fill deposits mark the position of maximum valley subsidence, there would be strong reason to suppose that continuing subsidence could cause the river to move closer to the pile.

  Dr. Dohrenwend also interpreted subsurface data as showing that conditions directly beneath the tailings pile are much more complex than presented in the EIS. The opposing interpretation is that the data indicate localized subsidence of the valley floor and that the subsidence must be considered as a potentially serious geologic hazard.

- *Dissolution of Salt Layers*. Dr. John Dohrenwend presented an alternative view on the influence of basin subsidence on river migration as evidenced by distribution of coarse river gravels and cobbles. Dr. Dohrenwend maintains that the Colorado River and its local tributaries deliver far more sediment to the valley floor than could ever be accommodated by the valley's slow subsidence. Therefore, ongoing deposition by the Colorado River and by Mill Creek and Pack Creek are the principal processes controlling the surficial geology and geomorphology of Moab Valley.

The overall concern expressed by commentors is that the EIS has mischaracterized the available data and that the dynamic and often unpredictable nature of the river system and the inevitable migration of the river toward the site over geologic time make on-site disposal an inappropriate alternative.

<u>DOE's Position on River Migration</u>

DOE's position is stated in a 2003 river migration report: "Although a conclusive prediction of future river movement is not possible, evidence suggests that the river is and will continue migrating to the south and east away from the existing tailings pile" (DOE 2003a; see reference in Section 2.8). The basis for this claim is supported by the following technical arguments:

- Historical evidence of river migration indicates that the river has remained stable to moderately stable for the last 120 years, suggesting that catastrophic rapid channel migration is unlikely and indicating that all floods have dissipated by overflow into the Matheson Wetlands Preserve.
- Sediment deposition from Courthouse Wash and Moab Wash has pushed the river channel south into Moab Valley.
- The current location of the Colorado River is approximately 1,100 ft south of the terrace formed at the confluence of Courthouse Wash and the Colorado River, suggesting that the river has moved south since the time the terrace gravels were deposited. The terrace age indicates that the right riverbank has been stable for the last 30,000 years.

- The thickness and distribution of basin-fill sediments in Moab Valley indicate past and continuing salt dissolution of the valley. Subsidence creates a zone of accommodation for alluvial fill material transported by the Colorado River.

- The rate and character of salt dissolution in the Moab Valley area indicate that significant dissolution has occurred in the past and has trapped large quantities of sediment.

The absence of a cobble-gravel bedload downstream of the Portal (the location where the river exits Moab Valley and enters a canyon) suggests current salt dissolution of Moab Valley. Ongoing dissolution will tend to control the position of the Colorado River, and based on geologic evidence, subsidence is occurring beneath the Matheson Wetlands Preserve.

Implications of Opposing Views on River Migration

If the river migrates gradually to the north and west toward the disposal cell, annual inspections would provide the opportunity to implement additional mitigation measures beyond the disposal cell riprap side slopes and engineered buried riprap barrier wall already included in the conceptual design. These measures could potentially involve additional bank armoring and stabilization and enhancement of the disposal cell riprap side slopes and engineered buried riprap wall. These efforts could involve additional temporary impacts at riprap borrow sources, temporary disturbances in the floodplain and riverbank areas, and additional transportation impacts associated with transporting the riprap or stabilization materials to the site. The cost of these measures could run to several million dollars.

Responsible Opposing Views on Contaminant Flow Under the River

Dr. Kip Solomon and Phil Gardner of the University of Utah and commentors from the State of Utah, which commissioned Dr. Solomon's study, opposed DOE's view regarding the fate and transport of site-derived contaminants in ground water. This view states that these contaminants have migrated, and continue to migrate, under the Colorado River toward the Matheson Wetlands Preserve and that they pose a potential hazard to public health and the environment. This view is based primarily on the interpretation of three types of information: (1) a ground water flow gradient map based on calculated hydraulic heads that account for the effects of salinity on flow potential, (2) measured uranium concentrations in ground water on both sides of the Colorado River, and (3) analysis of stable isotopes of dissolved oxygen and hydrogen in ground water.

Gardner and Solomon (2003; see reference in Section 2.8) conducted studies at the site using calculated values of equivalent freshwater head to plot contours of equal potential. From the results, the authors infer that ground water on the project side of the river has the capacity to flow under the river toward the Matheson Wetlands Preserve.

Uranium concentrations in ground water at five wells on the project side of the river and 14 wells southeast of the river suggested that uranium concentrations in wells along the river's east bank and in and near the Matheson Wetlands Preserve were derived from contaminated ground water on the Moab site.

Two cross-sections by Gardner and Solomon (2003; see reference in Section 2.8) containing measured oxygen isotope ratios did not conform to DOE's conceptual model of ground water flow at the Colorado River, which hypothesizes that the river itself or an area close to its east bank acts as a ground water divide. The authors concluded from the isotope ratios that ground water from the project site migrates to deeper ground water below the Matheson Wetlands Preserve.

The Gardner and Solomon study also used dissolved ammonia concentrations on either side of the Colorado River as additional evidence to support a sub-riverbed hydraulic connection between the project site and the Matheson Wetlands Preserve. Tailings-related, high ammonia contamination on the site is obvious, and the authors suggest that slightly elevated ammonia concentrations in ground water on the east side of the river are probably caused by subsurface transport from the site.

DOE's Position on Contaminant Flow Under the River

DOE's conceptual model of ground water flow at and near the project site considers the Colorado River and a limited area located just to the southeast of the river to be a site of both regional and local discharge for subsurface water. Ground water discharges to this area because the elevation of the river surface and shallow ground water to the immediate southeast is less than the flow potentials measured in ground water at the project site, in areas lying farther to the east and closer to the city of Moab, and in brine located beneath the river. Ground water flow converges toward the river from all of these zones, and a ground water divide occurs either in the river itself or slightly east of the river. This flow pattern prevents water from migrating beneath the river to the Matheson Wetlands Preserve.

The unique salinity conditions in ground water in the study area are attributed to the river's natural tendency to act as a site of regional discharge. Very saline water to brine is observed on both banks of the river at about the elevation of the riverbed. DOE views this phenomenon as a form of saltwater upconing that is similar to the upconing that would occur below a well that withdraws relatively fresh ground water above a saline zone.

Information supporting this conceptual model includes flow potential data on both sides of and near the river. From prominent studies of regional ground water flow over brine sources, it can be deduced that such upward gradients are expected in the vicinity of a site of ground water discharge. In effect, the brine at the discharge site acts as a barrier to ground water flow, thus limiting flow from one of its sides to the other.

The occurrence of ammonia (as nitrogen) concentrations in the 3- to 5-mg/L range measured just to the southeast of the river can be explained by the natural upconing of briny water in the vicinity of the river. Ammonia levels in wells screened within uncontaminated brine near the river are typically in the 3- to 4.5-mg/L range. In addition, oil and gas wells drilled into the Paradox Formation in the vicinity of Moab Valley have encountered brine with ammonia concentrations as high as 1,330 mg/L.

Implications of Opposing Views on Contaminant Migration Under the River

If significant contaminant mass has flowed and continues to flow beneath the river eastward toward the Matheson Wetlands Preserve, contaminant concentrations would increase in the

ground water in these areas. The existing concentrations of ammonia, uranium, sulfate, and chloride on the east side of the river are all within the range of natural background. It is not clear that future contaminant migration to the east side of the river would cause a significant health risk to the public or the environment. Because of the naturally high concentrations of TDS, chloride, and sulfate in all but the shallowest waters on the east side of the river, the incremental addition of contaminants from the Moab site would not reasonably result in a significant increase in risk to receptors, given the poor ambient water quality and lack of exposure pathway.

The current water quality of all but the upper few feet of the several-hundred-foot-thick aquifer on the east side of the river, like that on the west (tailings) side of the river, is an order of magnitude worse than any potential use criteria (more than 80,000 mg/L TDS—more than twice the salinity of sea water). Due to the naturally high salinity of the ground water on the east side of the river it is not used for drinking water, irrigation, or livestock watering.

Responsible Opposing Views on the Appropriate Compliance Standard

The State of Utah and others presented opposing views regarding DOE's target cleanup goal for ground water of 3 mg/L ammonia (as nitrogen). The opposing view is that the ground water cleanup goal for ammonia should be the chronic Ambient Water Quality Criteria (AWQC) for ammonia, rather than the acute standard. The commentors maintain that a 0.6-mg/L ammonia goal must be met in ground water to ensure that it can also be met in quiet backwater areas that serve as endangered fish habitat. Their interpretation disagrees with DOE's interpretation that ground water discharging to the surface will undergo dilution by a factor of 10 or more. The high standard deviation associated with the average dilution factor is cited as evidence that there is no statistical basis for DOE's assumed dilution factor. The opposing view contends that a much more rigorous sampling is required before a defensible dilution factor can be established. Commentors further argued that unless DOE better understands the geochemical behavior of ammonia as it is transferred from ground water to surface water, DOE has no choice but to apply the 0.6-mg/L criterion as a conservative interim cleanup goal. This State of Utah also maintains that the State can enforce the appropriate protective criteria in ground water.

<u>DOE's Position on the Appropriate Compliance Standard</u>

DOE's target cleanup goal for ammonia in ground water is based on the national AWQC, considerable study of ground water and surface water data, and direct consultation with the USF&WS. These data were collected expressly to determine the validity of the conceptual site model and to better understand ground water-surface water interactions and the effect of discharge of ground water to the Colorado River. Results of these evaluations were presented in several documents (see Section 2.6.4). Also, the USF&WS has since prepared a Biological Opinion, which concurs that the target cleanup goal for ammonia in ground water is reasonable. In its Biological Opinion, the USF&WS indicates that additional studies are required as a reasonable and prudent measure to increase confidence for this target goal.

Available data indicate that concentrations of constituents generally decrease significantly as ground water discharges to and mixes with surface water (a 10-fold decrease was noted). More recent data collected by DOE since the SOWP support the position that a 10-fold dilution factor does apply in most instances where the ground water plume is discharging to the river adjacent to the site.

Implications of Opposing Views on the Appropriate Compliance Standard

If the State's view prevailed, the proposed action for ground water remediation would change only in the duration for which the system would be operated. It is expected that the proposed ground water action would mitigate all impacts to the river within 10 years of implementation and would be operated for 75 years to meet the 3-mg/L ammonia target cleanup goal. Should the target cleanup goal be 0.6 mg/L, the proposed ground water action may need to be operated for at least 200 years. If this were the case, a commensurate increase in annual operation and maintenance costs, generated wastes, and water resource impacts would result for the additional period of operation. Although DOE would commit to completing its cleanup responsibilities in this case, DOE cannot now reasonably assure continued maintenance of active ground water remediation for 200 years or more. The uncertainty regarding achieving these cleanup goals is discussed in "Consequences of Uncertainty."

Public and Agency Review of the Draft Environmental Impact Statement—Process and Results

This section documents the process DOE used to solicit public and agency comments on the draft EIS and shows the number and types of comment documents received; summarizes key issues identified in the comment documents; and identifies major changes made in the final EIS in response to comments received on the draft EIS.

Overview of Review Process

The comment period on the draft EIS began with the issuance of EPA's Notice of Availability on November 12, 2004 (69 *Federal Register* 65427), and ended on February 18, 2005. DOE also issued a Notice of Availability of the EIS on December 3, 2004 (69 *Federal Register* 70256). Copies of the draft EIS were distributed to members of Congress; to federal, state, and tribal agencies and governments; to local officials; and to persons and organizations who expressed an interest in the EIS. The draft EIS was made available electronically on the DOE Grand Junction website and on the DOE NEPA website. Copies of the draft EIS were also placed in the Grand County Public Library, Blanding Branch Library, the White Mesa Ute Administrative Building, and the DOE Public Reading Room in Grand Junction, Colorado.

During the public comment period, DOE held four public hearings in Utah to present information and receive oral and written comments on the draft EIS. These meetings were held in Green River (January 25, 2005), 7 attendees; Moab (January 26, 2005), 93 attendees; White Mesa (January 27, 2005), 21 attendees; and Blanding (January 27, 2005), 19 attendees. Information about the meetings was published in DOE's Notice of Availability in the *Federal Register* and in local Utah newspapers.

DOE received approximately 1,600 comment documents on the draft EIS. Comment documents were submitted by electronic mail (e-mail), voice mail, facsimile, and regular mail. Oral comments given at the public hearings were transcribed and entered into a relational database. Most comment documents were brief, raising a single issue pertaining to the draft EIS. Other comment documents were lengthy, raising multiple issues; in these cases, individual comments were extracted and a separate response was prepared for each comment.

All comment documents and their responses were tracked using a relational database. Table S–2 shows the number of comment documents received, broken out by type of submittal.

Table S–2. Number of Comment Documents Received

Type of Submittal	Number
Orally at Public Hearings	
Moab	30
White Mesa	13
Green River	4
Blanding	2
E-Mail	1,289
Voice Mail	146
Fax and U.S. Mail	103

Major Issues Raised in Comment Documents

DOE analyzed all comment documents to identify the major issues raised in them. About 90 percent of the approximately 1,600 comment documents shared a common sentiment: *the tailings pile should be moved from its present location adjacent to the Colorado River*. The many comment documents supporting relocation included a wide range of reasons for doing so. Among the comments that strongly supported moving the pile "somewhere," many were equally adamant about where the pile should not be moved—specifically, that it should not be moved to the White Mesa Mill alternative location. However, a few comment documents did support relocation to White Mesa Mill, especially by slurry pipeline. This section summarizes the thirteen major issues raised in the comment documents and gives a synopsis of DOE's response or position.

Catastrophic Failure—The pile should be relocated because a major earthquake or 500-year flood could result in a catastrophic failure of the pile. Many comments expressed concern that a catastrophic failure of the disposal cell caused by an earthquake or a 500-year flood could spill the contents of the pile into the Colorado River and thereby pose an unacceptable downstream risk to human health, the environment, and the recreational use and value of the river.

DOE does not agree that seismic issues are a significant concern at the Moab site. In the vicinity of the site, the Moab Fault consists of two branches—the main Moab Fault and the west branch of the Moab Fault. No historical macroseismicity has been noted along the Moab Fault, and microseismicity studies have not revealed any earthquakes associated with the fault. The site area is in Uniform Building Code 1, indicating lowest potential for earthquake damage. For geologic and geophysical reasons, the Moab Fault system is not a capable fault and does not pose a significant earthquake or surface-rupture threat to the present tailings pile.

The EIS assumes that a catastrophic flood (300,000 cfs, the type of flood specified by NRC as a PMF) will occur no more than once in 500 years—twice during the 1,000-year regulatory period. The possibility of a catastrophic flood cannot be eliminated because part of the Moab site tailings impoundment is located within the 100-year floodplain of the Colorado River and within the floodplain of the PMF of both the Colorado River and Moab Wash. The 100-year floodplains for Moab Wash and the Colorado River occupy over one-third of the Moab site. However, during floods that exceed bankfull flow (that is, when water just begins to flow over a streambank's

inside bend) in the Colorado River, most of the flow and flow energy are dissipated in the Matheson Wetlands Preserve away from the tailings pile.

The EIS addresses impacts from a catastrophic disposal cell failure. Although the likelihood of a catastrophic event would be very small over the design life of an on-site disposal cell, this type of failure was assumed to occur in order to evaluate the potential consequences, because they would differ between on-site and off-site disposal alternatives. The EIS acknowledges that if 20 to 80 percent of the tailings pile were washed into the river, it would have serious adverse impacts on riparian plant and animal life and would affect the health and safety of residents along the river and of river guides. The flood mitigation factors for periodic, less severe flooding would also mitigate the impacts of a catastrophic flood.

Flooding—The pile should be relocated because episodic flooding of the site has occurred in the past, will occur in the future, and will wash contaminants into the river. DOE agrees that episodic flooding of the site has occurred in the past and will occur in the future. The EIS acknowledges the potential for episodic flooding of the tailings pile under the on-site disposal alternative, such as occurred in 1984, and quantifies the impacts that could result from such inundation. The floodplain area for the Colorado River extends the length of the eastern site boundary from the river's edge to distances ranging from 500 to 1,200 feet west and is approximately 10 feet above the average river level. Based on analyses in the EIS, DOE estimates that during a 100-year flood, the water level would be 3 to 4 feet above the base of the tailings pile. These impacts include additional leaching of contaminants into the ground water and subsequent migration to the river. Very conservative model results suggest that near the bank of the Colorado River, the maximum ammonia (as nitrogen) concentration in ground water could increase by just over 2 mg/L in approximately 10 years after a 100-year flood. However, effects of the tailings inundation would decline rapidly over a period of approximately 20 years after the flood. As required in 10 CFR 1022, "Compliance with Floodplain and Wetlands Environmental Review Requirements," a floodplain and wetlands assessment of the proposed alternative actions is provided in the EIS.

The on-site disposal alternative includes measures to mitigate floodwater impacts. If on-site disposal were selected, an on-site disposal cell would include side slopes armored with riprap of sufficient size to mitigate erosion from floodwaters and a barrier wall between the river and the cell to deflect river encroachment. These engineered designs would further reduce the already low probability of a catastrophic failure of the cell should river migration begin to occur unexpectedly. The descriptions of the conceptual cell cover and barrier wall design have been expanded in the EIS to state that riprap materials would be sized to withstand the maximum river forces recently identified by the USGS and that the barrier wall would be of sufficient length to deflect river encroachment. The final design specifications for the wall (including, for example, its dimensions) would be developed in a remedial action plan if the on-site alternative were selected. The estimated cost range for remediation would accommodate materials consistent with the recent USGS report.

River Migration—The pile should be relocated because the river is migrating toward the pile, which will exacerbate flooding. There are responsible opposing views on the question of whether the Colorado River is migrating toward the tailings pile, which would tend to exacerbate flooding impacts, or away from the tailings pile, which would tend to mitigate flooding impacts. A new section has been added to present these opposing views on river migration (and other topics) and to summarize their technical basis and implications. DOE's view is that, although a

conclusive prediction of future river movement is not possible, evidence suggests that the river is migrating, and will continue to migrate, to the south and east, away from the existing tailings pile, during the 200- to 1,000-year regulatory performance period. The responsible opposing view is that the river channel has migrated both towards and away from the Moab millsite in the past 80 years, and that it could do so in the future.

The overall concern expressed by commentors is that the EIS has mischaracterized the available data and that the dynamic and often unpredictable nature of the river system, the site-specific conditions, and the inevitable migration of the river toward the site over geologic time make the on-site disposal alternative unacceptable because the potential impacts of river migration would pose unacceptable risks to local and downstream users and to ecological receptors of the Colorado River corridor.

Endangered Fish—The pile should be relocated because it is leaching contaminated ground water into the river, which poses a threat to endangered fish. Underlying the many comments that expressed support for relocation is the view that the on-site disposal alternative would be unable to achieve surface water quality in the Colorado River adjacent to the tailings pile that would be protective of the endangered fish species known to inhabit those waters. DOE and the Utah Department of Environmental Quality (UDEQ) have opposing views regarding the ammonia surface water standard (protective criteria) for a ground water cleanup goal that was used in the EIS. The EIS has been expanded to present and discuss these views. The basis for the ammonia surface water standard for a ground water cleanup goal was developed in consultation with the USF&WS as specified in the Endangered Species Act. The USF&WS states in its Biological Opinion:

> The FWS has considered all of UDEQ's comments in our analysis of the effects to listed species associated with ground water remediation and we agree that many warrant further study (see Incidental Take Statement). Based on our review of the available information, and with recognition that there are uncertainties in both DOE's and UDEQ's analyses, the Service has determined that DOE's premise that 3 milligrams per liter (mg/L) ammonia in groundwater will result in protective concentrations in all surface water habitats presents a reasonable approach to the problem.

DOE's estimates of the duration and cost of ground water remediation are predicated on the assumption that 3 mg/L ammonia in ground water will result in protective concentrations in all surface water habitats. However, "Implications of Responsible Opposing Views" discusses, to the extent possible, the potential implications if the DOE and USF&WS view on this issue is in error and the UDEQ position is correct. If applicable protective criteria could not be achieved or would require longer than DOE estimates, DOE recognizes that the duration of ground water remediation, especially under the on-site disposal alternative, would be substantially longer than estimated, and that the estimated $906,000 per year cost of ground water remediation would continue beyond the currently estimated 75 to 80 years.

Subsidence—The pile should be relocated because it has no liner and will eventually come into permanent contact with ground water. Under the on-site disposal alternative, the pile would remain unlined. Over geologic time, the process of subsidence, which is caused by ground water dissolving the salt formations under the tailings pile, will eventually cause the bottom of the tailings pile to converge with the underlying ground water at an estimated rate of approximately 1.4 feet per 1,000 years. At this rate, DOE estimates that the tailings in the disposal cell would

come into permanent contact with ground water in approximately 7,000 to 10,000 years, assuming the minimum depth to ground water ranges from 5 to 7 feet.

Active ground water remediation would result in protective levels in surface water approximately 10 years after the issuance of a ROD and implementation of remedial action. Active ground water remediation could be terminated in 75 to 80 years, when ammonia concentrations in ground water reached the target goal. DOE acknowledges uncertainties in its ground water model assumptions and responsible opposing views regarding the applicable compliance standard and recognizes that these factors could result in longer active ground water remediation. Regardless of the duration of active ground water remediation, DOE believes that under the on-site disposal alternative, protective levels in surface water could be achieved and sustained for the 200- to 1,000-year regulatory time frame despite the absence of a liner. However, DOE acknowledges that, as a result of subsidence under the on-site disposal alternative, surface water concentrations could revert to levels that are not protective in 7,000 to 10,000 years.

Matheson Wetlands Preserve—The pile should be relocated because contamination is migrating under the river and affecting the Matheson Wetlands Preserve. DOE's position is that contamination is not migrating under the river and affecting the Matheson Wetlands Preserve. DOE's conceptual model of ground water flow at and near the project site considers the Colorado River and perhaps a limited area just southeast of the river to be a site of both regional and local discharge for ground water. Ground water discharges to this area because the elevation of the river surface and shallow ground water to the immediate southeast is less than the flow potentials measured in ground water at the project site, in areas lying farther to the east and closer to the city of Moab, and in brine located below the river. Accordingly, ground water flow converges toward the river from all of these zones, and a ground water divide occurs either in the river itself or slightly east of the river. This flow pattern prevents water from migrating beneath the river to the Matheson Wetlands Preserve.

However, there is a responsible opposing view of the fate and transport of site-derived contaminants in ground water. This view, which was expressed in many comments, states that these contaminants have migrated, and continue to migrate, under the Colorado River toward the Matheson Wetlands Preserve and that they pose a potential hazard to public health and the environment. This view is based primarily on the interpretation of three types of information: (1) a potentiometric surface map (water table) based on calculated hydraulic heads that account for the effects of salinity on flow potential, (2) measured uranium concentrations in ground water on both sides of the Colorado River, and (3) analysis of stable isotopes of dissolved oxygen and hydrogen in ground water.

Both views on the question of contaminant migration under the river are based on differing interpretations of technical data. The section on Responsible Opposing Views summarizes presents both views and also discusses the implications of these opposing views. Section 2.6.4 presents a more detailed discussion.

Uncertainties with On-site Disposal—The pile should be relocated because the numerous uncertainties, especially about long-term questions, could adversely affect the cost and reliability of on-site disposal. It is possible that on-site disposal would cost much more than DOE estimates. These uncertainties could be largely eliminated if the pile were moved to a newly constructed disposal cell with better geologic confinement. DOE agrees that there are numerous uncertainties and assumptions, including long-term ones, that could increase the duration of

remedial action under the on-site disposal alternative and could therefore increase the lifetime cost of the on-site disposal alternative. Each recognized area of uncertainty and the potential consequence, including cost, where applicable, are described (see Table S-1).

In some instances, it is not possible to quantify the potential impacts of uncertainties on cost estimates. For example, one area of uncertainty frequently cited as potentially affecting the cost of the on-site disposal alternative is the applicable compliance standard for surface water ammonia and, by extension, the length of time required for ground water treatment to achieve protective concentrations in surface water. DOE assumes that the lower end of the range of acute criteria (3 mg/L ammonia) applies. But if the more stringent lower end of the range of chronic criteria (0.6 mg/L ammonia) applies, it could significantly extend the duration of ground water remediation. Uncertainties associated with the cost, duration, and ability to achieve protective criteria in surface water depend on multiple and potentially additive or offsetting factors. Such factors include variations in the composition of the tailings pore water, geochemical changes that occur over time, transport of contaminants to the surface water, changing regulatory criteria, and the evolving configuration of the near-bank river system. Accurately quantifying the individual and collective uncertainty of these factors would be an extremely complex exercise, and the value of the results in the decision-making process would likely be disproportionate with the required effort. Consequently, DOE acknowledges that the estimated annual cost of ground water treatment ($906,000) and the cost of disposing of the resultant residual radioactive material could extend beyond the 80 years that DOE currently estimates for the on-site disposal alternative.

Other areas of uncertainty where DOE acknowledges the potential to increase the lifetime cost of the on-site disposal alternative include the ground water and site conceptual model assumptions and the postulated, but as yet unconfirmed, presence of a salt layer in the tailings pile. These uncertainties are discussed in Table S–1.

Finally, there are also areas of short-term uncertainty that apply solely or primarily to off-site disposal and that could increase the estimated cost of this alternative. Examples include (1) the final mass and volume of contaminated material in, under, and adjacent to the tailings pile that would need to be excavated and transported and (2) worker radiation dose rates and exposure times. These uncertainties are also discussed in Table S–1.

Downstream Impacts—The pile should be relocated because of the potentially harmful impacts it poses to downstream recreational users, residents, and businesses. The public based its support for relocating the pile on a wide range of reasons, many of which reflected concerns over harmful impacts to downstream recreational users, residents, and businesses. DOE carefully considered the analyses provided in the EIS, the consequences of the uncertainties characterized in the EIS, all responsible opposing views, and the numerous public comments received on the draft EIS, including about 1,400 comment documents that supported relocating the tailings pile. Based on these considerations, in the final EIS DOE identifies off-site disposal at the Crescent Junction site using rail transportation and active ground water remediation as its preferred alternatives for the remediation of the Moab mill tailings, vicinity properties, and contaminated ground water.

However, it is DOE's position that any of the proposed actions described in the EIS would provide long-term protection of human health and the environment within the regulatory time frame of 200 to 1,000 years. Moreover, DOE emphasizes that the final decision on which alternative will ultimately be selected and implemented will be identified in and promulgated through the ROD, which DOE expects will be issued in late 2005.

Even though our studies indicate that the on-site disposal alternative can be protective, none of the studies can eliminate all of the public concern. Further, under the on-site alternative, there is potential for additional risk to public health and safety due to the long-term disposal performance uncertainties and exposure pathways. These potential future scenarios for the Moab milling site would not exist under the off-site alternative. DOE believes that the final design of either an on-site or an off-site disposal cell would meet the requirements in 40 CFR 192 and would receive full review and concurrence from the NRC. A final disposal cell design would be developed in a remedial action plan after DOE issues its ROD.

Aesthetics and the Local Economy—The pile should be relocated because it is unattractive and discourages tourism in the Moab area. DOE agrees that the on-site disposal alternative would likely have unavoidable adverse impacts on visual resources. From key observational points, the predominantly smooth horizontal lines created by an on-site disposal cell would continue to produce a strong to moderate contrast with the adjacent sandstone cliffs. The visual contrasts that would occur under this alternative would not be compatible with the Class II objectives that BLM has assigned to the nearby landscapes. Although DOE is not required to meet the objectives of BLM's visual resource management system on the DOE-owned Moab site, the system provides a useful way to measure the effects of a proposed action on visual resources.

Since 1995 tourism-recreation employment has grown by some 20 percent and now accounts for at least 45 percent of Grand County's total employment. This implies that visual impacts from the tailings pile are not significantly discouraging tourism.

Public Health and Radon Risks—The pile should be relocated because it emits radon gas and poses a public health risk. For each of the proposed alternative actions, human health risks, including risks from exposure to radiation expressed as latent cancer fatalities, are analyzed and compared in the EIS. DOE agrees with the basic premise that relocating the tailings pile to a new isolated location would minimize long-term public exposure to tailings-related radiation. Based on the analyses in the EIS, while the greatest short-term risk to the public from radiation exposure at the Moab site, excluding vicinity property exposure, would be associated with the No Action alternative (see Figure S–17), there are other long-term risks that would be mitigated under the off-site alternatives.

Under any of the off-site disposal alternatives, during the period of surface remediation, there would be some increased public risk stemming from the need to disturb the existing tailings pile cover and transport the tailings. This temporary increase in public exposure and risk would not occur under the on-site disposal alternative because a fortified cap would be applied without disturbing the existing cap. Contaminated vicinity property material, which may be the greatest source of public exposure to mill-related radiation, would be removed and isolated under either the on-site or off-site disposal alternative. DOE considered public exposure in identifying an off-site location as its preferred surface remediation alternative and will continue to consider public exposure in its final decision.

Land Use—The pile should be relocated to make better use of the prime location it occupies. Several commentors expressed opinions that seemed to be based on a belief that relocating the tailings pile would free up all or most of the Moab site for other uses. DOE recognizes the strategic location and potential value of the Moab site real estate. However, DOE believes that exercising caution is preferable to speculating on future land uses. Even under the off-site alternative, the land area required for ground water remediation, which could exceed 40 acres, would be unavailable for an estimated 75 years. Under any of the off-site alternatives, it would be DOE's goal to have as much as possible of the 439-acre Moab site available for unrestricted use upon completion of surface remediation. However, it is possible that even after completion of remediation, the entire 439-acre site would remain under federal control in perpetuity. Under any action alternative, final decisions on allowable future land use at the Moab site could be made only after the success of surface and ground water remediation was determined.

Cultural Impacts to Native American Communities—The pile should not be relocated to White Mesa Mill because doing so under either of the two transportation modes proposed for the White Mesa Mill alternative, truck or slurry pipeline, would seriously (and, in some cases, irreversibly) disturb many Native American cultural sites and traditional cultural properties. Traditional cultural properties are those associated with traditional cultural practices, ceremonies, and customs. Although only the Moab site and the White Mesa Mill site have been field surveyed for cultural sites, some cultural sites would probably be adversely affected under any of the proposed action alternatives, including on-site disposal. Under any of the action alternatives, 4 to 11 cultural sites at the Moab site could be adversely affected. Under the off-site disposal alternative, the number of additional cultural sites potentially adversely affected varies widely among the alternative locations and modes of transportation.

Because of the proximity of the Ute Mountain Ute Tribe to the White Mesa Mill site, the White Mesa Mill disposal alternative would present unique and unavoidable potential adverse impacts to at least 10 traditional cultural properties. Based on preliminary surveys and consultations with multiple Tribal representatives, DOE expects that impacts to traditional cultural properties would be far less likely at the Klondike Flats or Crescent Junction locations. Moreover, any mitigation to traditional cultural property impacts at White Mesa Mill would be extremely difficult or impossible and would involve numerous tribal entities. DOE considered adverse impacts to the Ute Mountain Ute Tribe in its identification of Crescent Junction as its preferred disposal location and will continue to consider these impacts in its final decision.

Traffic through Moab—The pile should not be relocated to White Mesa Mill by truck due to the major traffic impact on highly congested areas, especially in Moab. DOE agrees that relocating the tailings pile by truck to White Mesa Mill would necessitate traveling through the city of Moab on US-191. As seen in Figure S–20, transporting the tailings to the White Mesa Mill site by truck would result in an estimated 127-percent increase in average annual daily truck traffic through Moab—a severe and unavoidable adverse impact. Moreover, the Utah Department of Transportation considers this area to be highly congested. Trucking the tailings to White Mesa Mill would also mean traveling through Monticello and Blanding.

In contrast, if the tailings were trucked to either Klondike Flats or Crescent Junction, the trucks would not have to pass through any cities or towns; however, the trucks would have to pass the entrance to Arches National Park.

Major Revisions to the EIS

This section lists the major revisions to the EIS. DOE made 10 major, substantive revisions and numerous minor or editorial revisions in response to comment documents received on the draft EIS. Substantive revisions to the text are marked by a sidebar in the margin. The following paragraphs summarize the 10 major revisions to the EIS.

Preferred Alternatives. In the draft EIS, DOE did not identify a preferred alternative. DOE has identified the combination of off-site disposal at the Crescent Junction site using rail transportation and ground water remediation at the Moab site as its preferred alternatives.

Responsible Opposing Views. Based on continuing consultations with cooperating agencies and comment documents received on the draft EIS, DOE has identified three issues about which there are responsible opposing views: (1) river migration, (2) transport of contaminated ground water beneath the Colorado River to the Matheson Wetlands Preserve, and (3) the applicable surface water compliance standard.

USGS Maximum River Force Study. The descriptions of the conceptual cell cover and barrier wall design for the on-site disposal alternative have been expanded to state that riprap materials would be sized to withstand the maximum river forces recently identified by USGS and that the barrier wall would be of sufficient length to deflect river encroachment.

USF&WS Biological Opinion. The USF&WS Biological Opinion, dated May 2005, has been added to the EIS. The USF&WS concurred with DOE's determination that off-site disposal at the Crescent Junction site (preferred alternative) would not jeopardize the continued existence of plant species; nor would bird or terrestrial animal species be jeopardized. USF&WS also concurred with DOE's determination that off-site disposal and active ground water remediation at the Moab site (preferred alternative) would not jeopardize endangered aquatic species and critical habitat in the Colorado River at Moab, subject to the provisions, terms and conditions, and conservation recommendations included in the Biological Opinion. The USF&WS will allow the incidental take of varying numbers of the four endangered fish species in this segment of the Colorado River for a maximum 10-year period following the ROD, provided DOE

- Pays a one-time water depletion fee of approximately $3,800.
- Monitors backwater habitats near the Moab site and effects on fish.
- Evaluates the effectiveness of "initial actions."
- Addresses uncertainties by developing a surface water monitoring plan.
- Monitors and addresses potential effects on the south side of the Colorado River.

In addition, DOE would consult with the USF&WS regularly and reinitiate formal consultation if required. DOE would also consider implementing conservation recommendations as necessary.

Floodplain and Wetlands Statement of Findings. A Statement of Findings (Floodplain and Wetlands Assessment for Remedial Action at the Moab Site) has been added to the EIS.

Worker Radiation Dose. In the draft EIS, DOE applied an overly conservative assumption for identifying the source term of radiation to which workers would be exposed under the on-site disposal alternative. This analysis has been revised.

State of Utah Regulatory Authority. The EIS has been revised to recognize the State's regulatory authority at the White Mesa Mill/International Uranium Corporation site.

Flood Protection at the Moab Site. The EIS has been revised to state that the storm water management infrastructure at the Moab site would be designed and constructed to control a reference 100-year flood rather than a 25-year flood.

10-Fold Dilution Factor. The EIS has been revised with a new reference to address the appropriateness of an assumed 10-fold dilution factor for ammonia as it migrates from ground water and enters surface water in the Colorado River.

Contaminants of Potential Concern. The EIS has been updated with an expanded discussion of the screening process for contaminants of potential concern.