COVER SHEET

Lead Agency: U.S. Department of Energy

Cooperating Agencies:

- National Park Service
- Bureau of Land Management
- U.S. Fish and Wildlife Service
- U.S. Environmental Protection Agency
- U.S. Nuclear Regulatory Commission
- U.S. Army Corps of Engineers
- State of Utah
- Ute Mountain Ute Tribe
- San Juan County
- Grand County
- City of Blanding
- Community of Bluff

Title: Remediation of the Moab Uranium Mill Tailings, Grand and San Juan Counties, Utah, Draft Environmental Impact Statement (DOE/EIS–0355D).

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Abstract:

The purpose of the *Remediation of the Moab Uranium Mill Tailings, Grand and San Juan Counties, Utah, Draft Environmental Impact Statemen*t is to provide information on the environmental impacts of the U.S. Department of Energy's (DOE's) proposal to (1) remediate approximately 11.9 million tons of contaminated materials located on the Moab site and approximately 39,700 tons located on nearby vicinity properties and (2) develop and implement a ground water compliance strategy for the Moab site using the framework of the *Final Programmatic Environmental Impact Statement for the Uranium Mill Tailings Remedial Action Ground Water Project* (DOE/EIS-0198, October 1996). The EIS will be used to inform the public of the information being used by DOE in decision-making for the remediation of the Moab site. The surface remediation alternatives analyzed in the draft EIS include on-site disposal of the contaminated materials and off-site disposal at one of three alternative locations in Utah using one or more transportation options: truck, rail, or slurry pipeline. This draft EIS evaluates the environmental consequences that may result from implementing the reasonable alternatives, including health impacts to the public, impacts to ground water and surface water, traffic impacts, and impacts to other resources. The draft EIS also analyzes a No Action alternative, under which DOE would not implement any surface or ground water remedial actions. DOE has not yet identified a preferred alternative; a preferred alternative will be identified in the final EIS after consideration of public comments, the information provided in this EIS, and other factors, including the costs of the alternative actions.

Public Comments:

Public hearings on the draft EIS will be held in January 2005. Oral and written comments are invited at these hearings. Commentors are also encouraged to send written comments until February 18, 2005, or email to moabcomments@gjo.doe.gov to the DOE Grand Junction address provided above. DOE will consider all public and agency comments submitted during the public comment period on the draft EIS in preparing the final EIS. Comments received after the close of the public comment period will be considered to the extent practicable.

DOE/EIS–0355D

Remediation of the Moab Uranium Mill Tailings, Grand and San Juan Counties, Utah, Draft Environmental Impact Statement

November 2004

Summary

U.S. Department of Energy

Office of Environmental Management

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Acronyms

BLM	Bureau of Land Management
CFR	*Code of Federal Regulations*
cfs	cubic feet per second
dBA	A-weighted sound level (decibels)
DOE	U.S. Department of Energy
EIS	environmental impact statement
EPA	U.S. Environmental Protection Agency
ft	feet
FY	fiscal year
IUC	International Uranium (USA) Corporation
mg/L	milligrams per liter
NEPA	National Environmental Policy Act
NRC	U.S. Nuclear Regulatory Commission
pCi/g	picocuries per gram
pCi/m^2-s	picocuries per square meter per second
PEIS	Programmatic Environmental Impact Statement (for the UMTRA Ground Water Project)
PMF	probable maximum flood
ROD	Record of Decision
RRM	residual radioactive materials
SOWP	Site Observational Work Plan
TDS	total dissolved solids
UMTRA	Uranium Mill Tailings Remedial Action (Project)
UMTRCA	Uranium Mill Tailings Radiation Control Act
U.S.C.	*United States Code*
USF&WS	U.S. Fish and Wildlife Service
yd^3	cubic yards

End of current text

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 draft 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.

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 draft 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.

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. 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 and Environmental Protection Standards for Uranium and Thorium Mill Tailings," and assigned 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 (which 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 owners, 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.

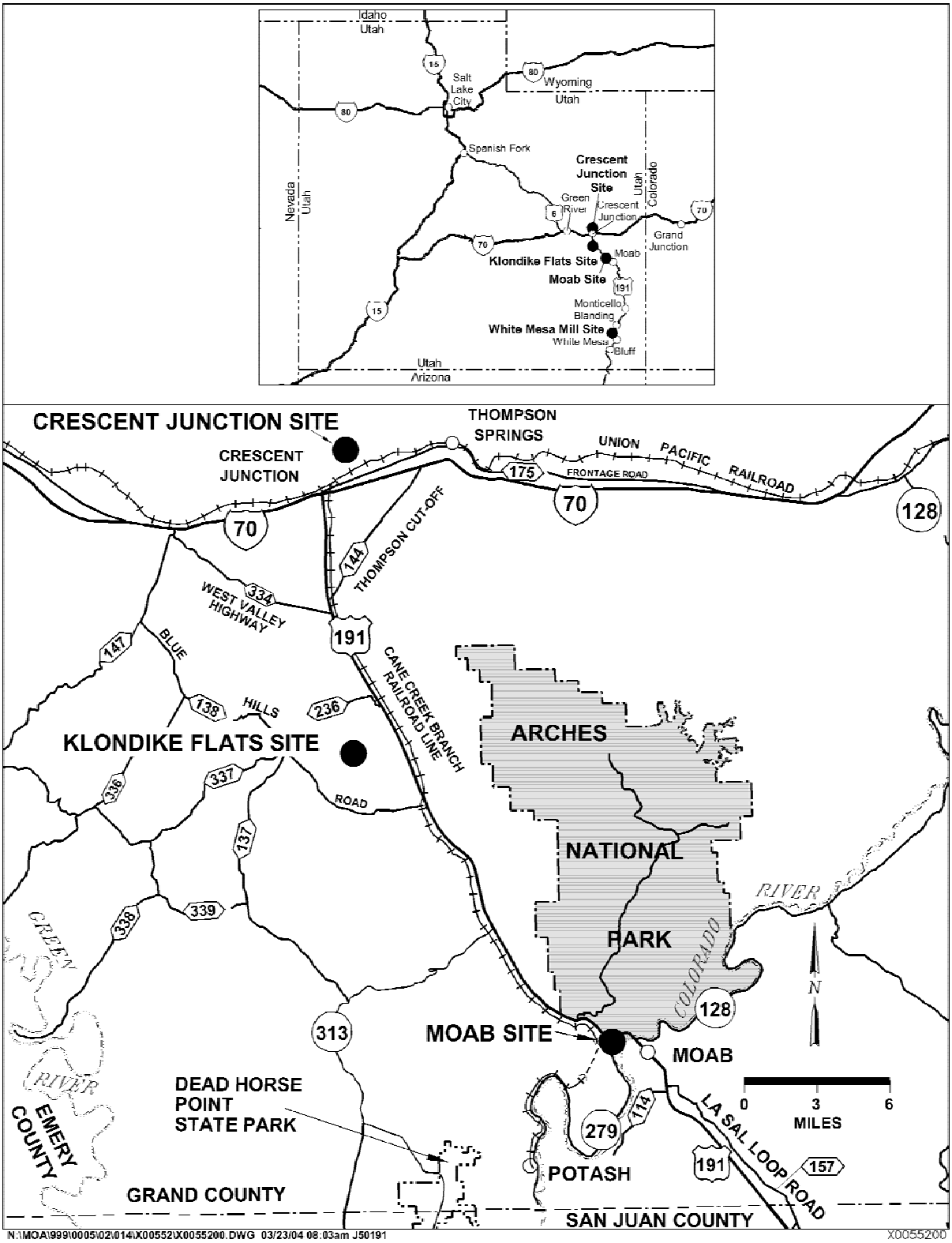

Figure S–1. Location of the Moab Site in Grand County, Utah

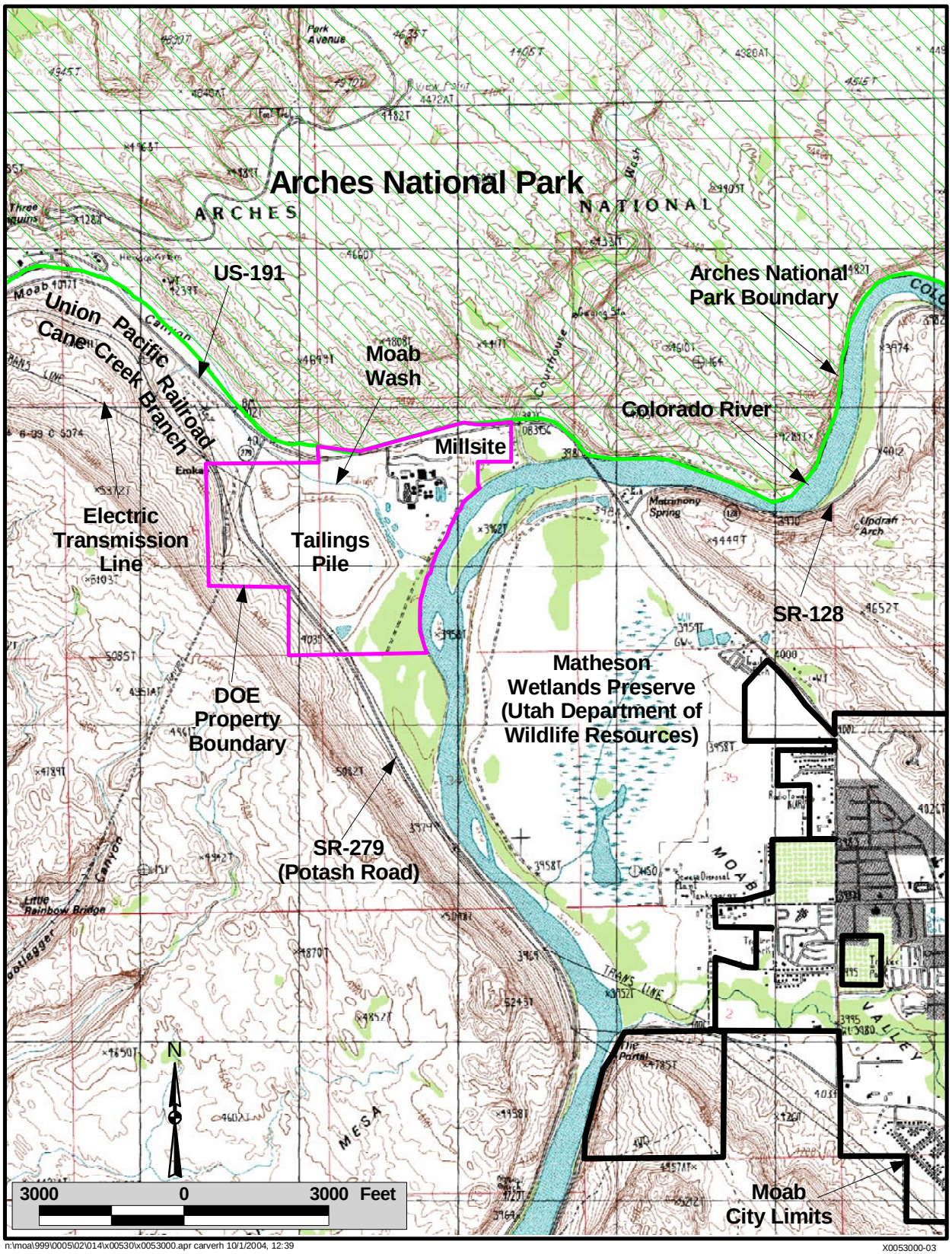

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Figure S–2. Location of the Moab Site in Relation to the City of Moab

As reported in the 1999 Final NRC Environmental Impact Statement, 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 contaminated 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.

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 off-site disposal alternatives, as required by NEPA.

Surface Remediation Alternatives

On-Site Disposal
- Cost $166 million
- 7 to 10 years to complete

Off-Site Disposal
- Cost $329 million to $464 million (depending on location and transportation option)
- Up to 8 years to complete

No Action Alternative
- No costs incurred
- All activities at the Moab site would cease, affecting 3 to 4 current employees

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 Moab site and/or the off-site 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 that does not exceed the background level by more than 5 picocuries per gram (pCi/g) averaged over the first 6 inches of soil below the surface and 15 pCi/g averaged over 6-inches of soil more than 6 inches 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.

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 Utah the responsibility for licensing, inspection, enforcement, and rulemaking activities for uranium and thorium milling operations, mill tailings, and other wastes.) 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.

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 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 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.

The off-site disposal of contaminated materials, including those from vicinity properties, is estimated to take up to 8 years to complete and to cost $329 million to $393 million for the closest site (Klondike Flats) and $418 million to $464 million for the farthest site (White Mesa Mill), depending on the transportation mode selected. These cost and time estimates do not include ground water remediation.

Ground Water Remediation

- Cost $10.75 million for design and construction and $906,000 annually under both on-site and off-site disposal alternatives
- 75 to 80 years to complete under either on-site or off-site disposal alternatives

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.

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

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.

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.

It would cost approximately $10.75 million to design and construct a ground water remediation system under either the on-site or off-site disposal alternative and approximately $906,000 annually to operate and maintain it. Construction would be completed approximately 5 years after issuance of a ROD for this EIS. The system would operate for 75 to 80 years.

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 Alternative

DOE has not yet determined whether on-site or off-site disposal is its preferred alternative. DOE has not yet identified either a preferred location for an off-site disposal cell or a preferred mode of transportation for relocating the tailings if the off-site disposal alternative is selected. However, with the exception of the No Action alternative, the proposed ground water strategy would be applicable to both the on-site and off-site alternatives. DOE intends to consider the results of the analyses provided in this draft EIS, the relative costs among the alternatives, and other factors, such as public and agency comments on this draft EIS (including the views of cooperating agencies), in determining its preferred alternative for the disposal cell location and remediation of vicinity properties. DOE's preferred alternative will be based on these considerations and identified in the final EIS.

Several cooperating agencies have expressed preferences for off-site disposal. In some instances, the areas of controversy reflect an opinion on which of the alternative actions DOE should select as its preferred alternative. The State of Utah has stated that the tailings should be moved to an off-site location due to uncertainties in predicting river migration and the ability of on-site disposal to meet protective aquatic standards. The City of Moab and Grand County have stated that the tailings pile should be moved to Klondike Flats for aesthetic and other reasons.

The Ute community expressed a strong preference that the tailings pile should not be moved to White Mesa Mill due to the high potential for adverse impacts to cultural resources, traditional cultural properties, and other impacts. As downstream users, the Town of Bluff also objects to disposal at White Mesa Mill. However, San Juan County and the City of Blanding have stated

that the future reuse of a slurry pipeline to White Mesa Mill would offer substantial economic benefits to agriculture in the region.

Description and Comparison of Environmental Consequences

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.

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. Under any of the action alternatives, approximately 234,000 tons of contaminated site soil would be excavated and disposed of with the tailings.

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 about the same for truck or 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 has determined 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.

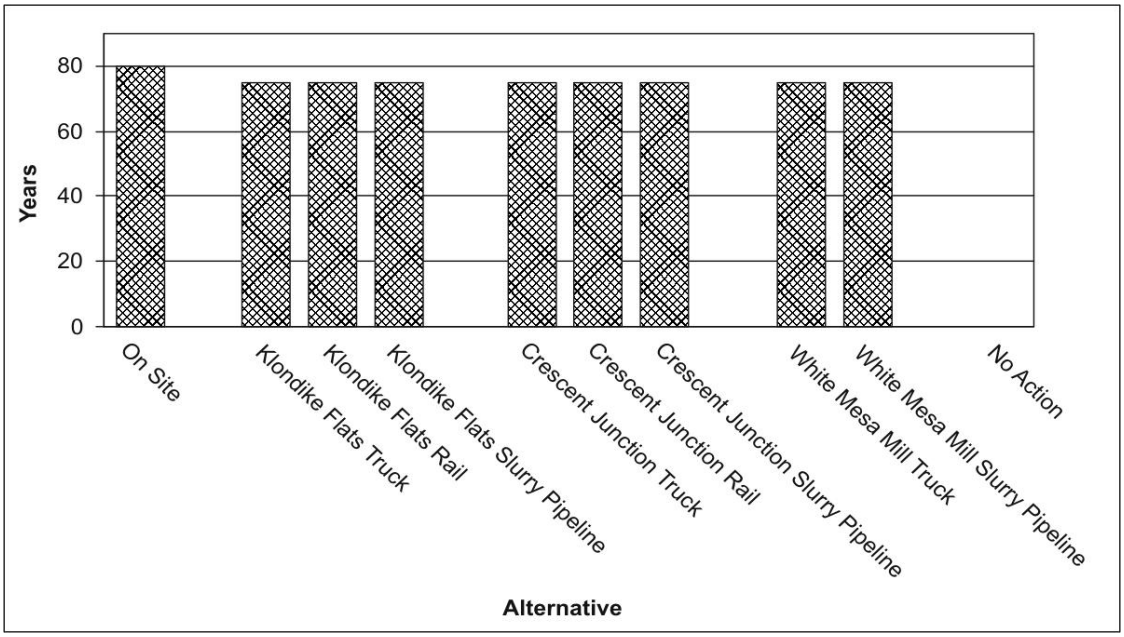


Figure S–3. Estimated Duration of Ground Water Remediation

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-to-1,000-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. In addition, under the No Action alternative, ground water beneath the Moab site would remain contaminated, would not be protective of human health, and would continue in perpetuity to

discharge contaminants to the surface water at concentrations that would not be protective of aquatic species. Modeling results indicate that under the on-site disposal alternative, contaminants from the potential salt layer 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.

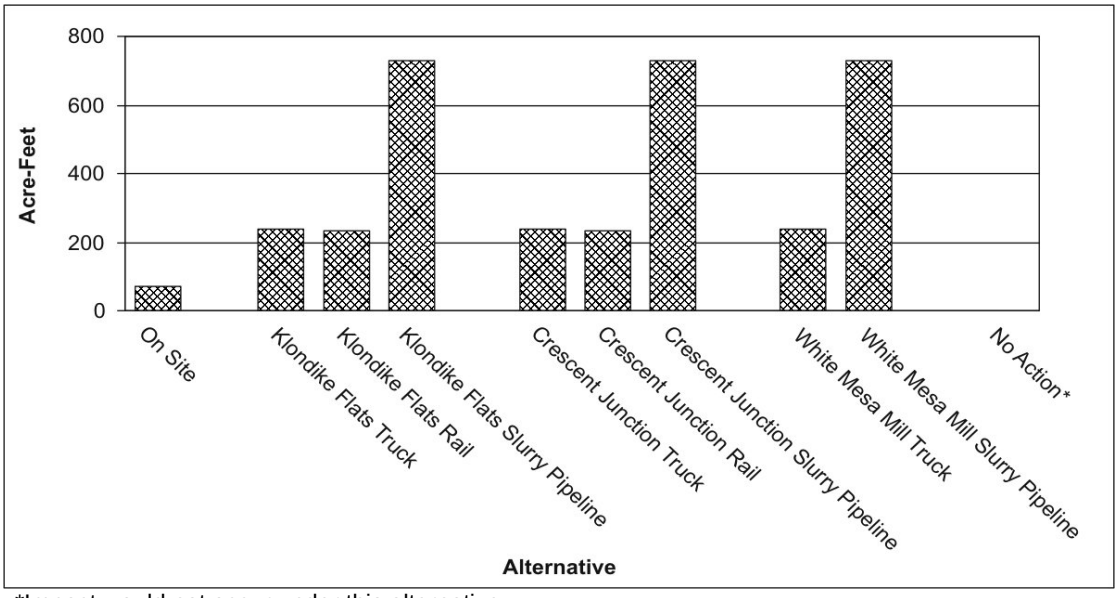
Floodplains and Wetlands. As noted, 100- and 500-year flood events could partially inundate the disposal cell under the on-site disposal alternative or No Action alternative. In addition, less than 1 acre of wetlands could be contaminated in the long term under either of these alternatives. There are 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 is included in the EIS as Appendix F.

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.



*Impact would not occur under this alternative.

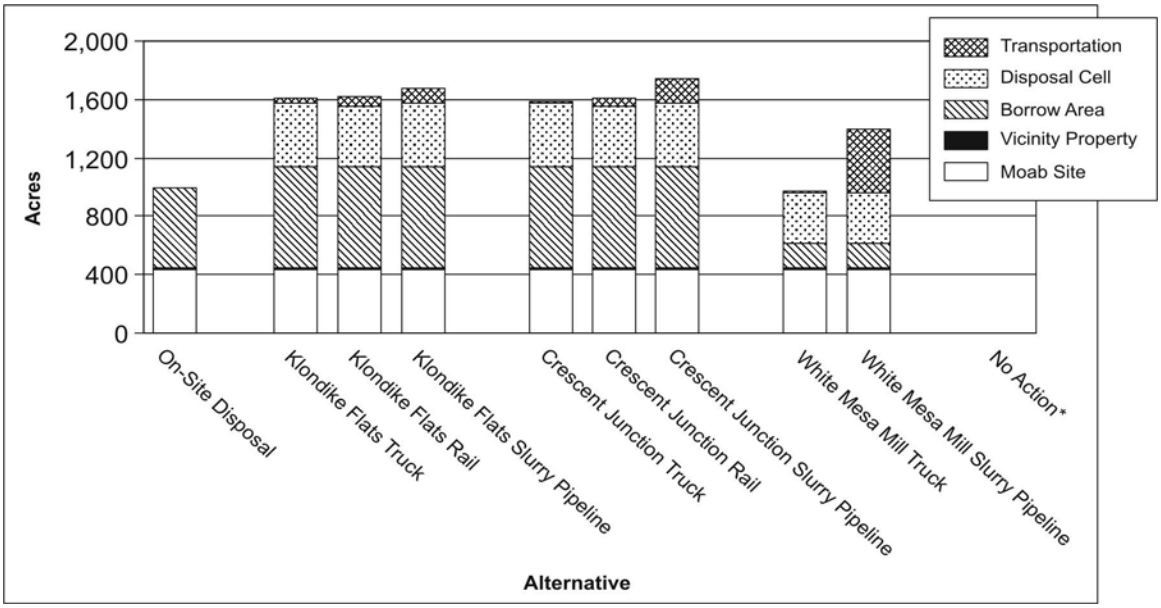
Figure S–4. Annual Withdrawals of Colorado River Water

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.

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 associated with five activities or facilities.



*Impact would not occur under this alternative.

Figure S–5. Maximum Land Disturbance

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.

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.

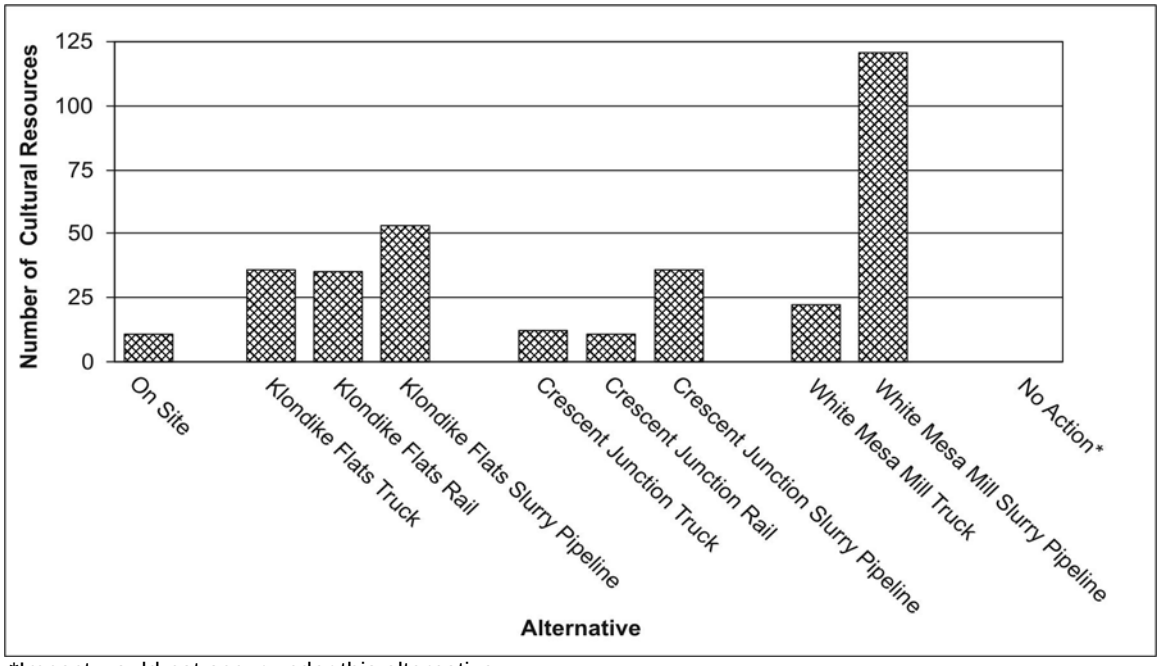
Under either the on-site or any off-site disposal alternative, the land at the Moab site required for ground water remediation infrastructure would be unavailable for any other use for the 75 to 80 years needed to complete ground water remediation. If an evaporation ground water treatment technology 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 to 53 eligible sites (depending upon transportation mode), and the Crescent Junction alternative could adversely affect a maximum of 11 to 36 eligible sites (depending upon transportation mode).

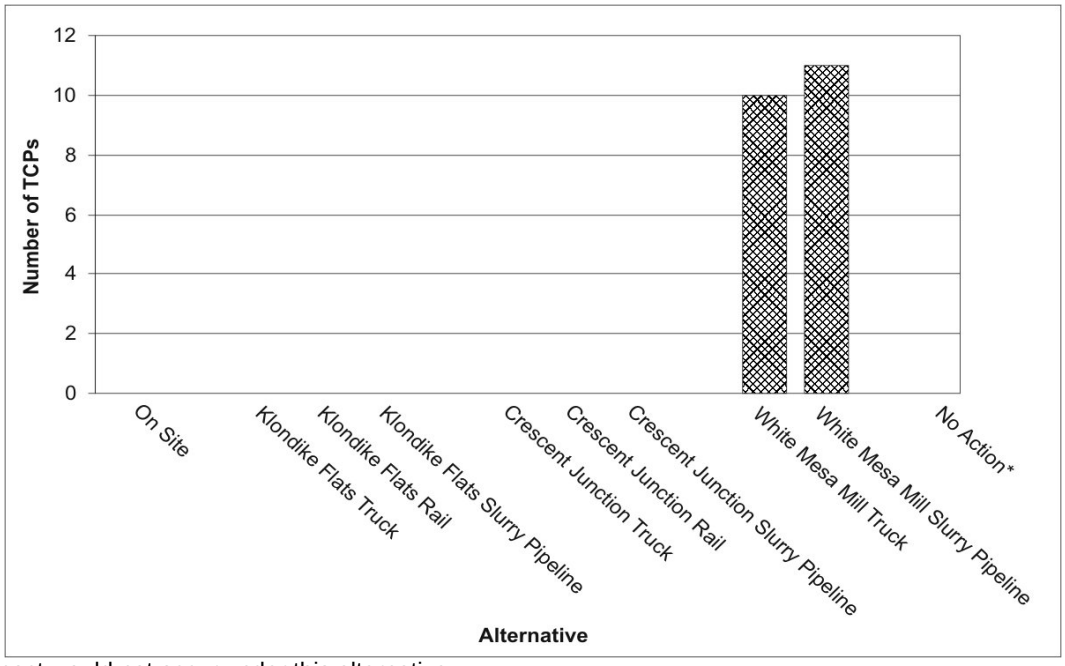
A minimum of 10 to 11 traditional cultural properties would be potentially affected under the White Mesa Mill truck or slurry pipeline alternatives (Figure S–7). (The term "traditional cultural properties" can include traditional cultural practices, ceremonies, and customs.) Mitigation of the potential 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. Small vibrations from activities at the Moab site could be felt near the boundary of Arches National Park under any of the action alternatives. Under the Klondike Flats or Crescent Junction truck



*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

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 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 would 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.

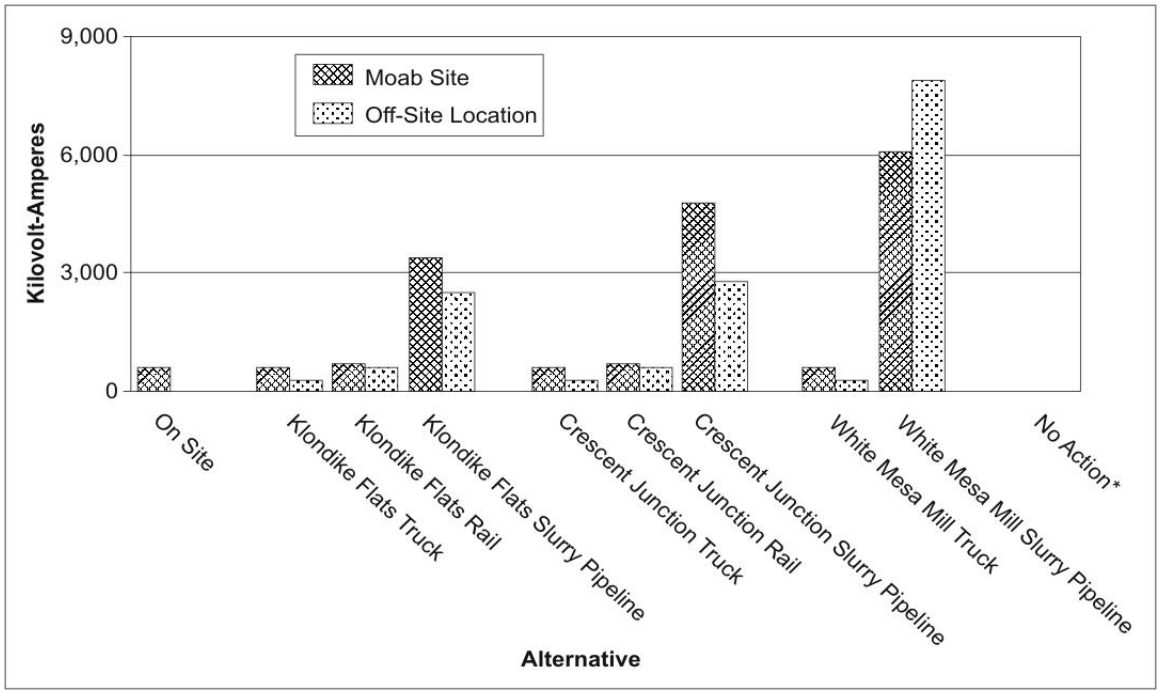
Total diesel fuel consumption under the on-site disposal alternative would be 4 million to 5 million gallons. Total fuel consumption under the off-site disposal alternative would range from 12 million to 20 million gallons for truck transportation, from 10 million to 11 million gallons for rail transportation, 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.

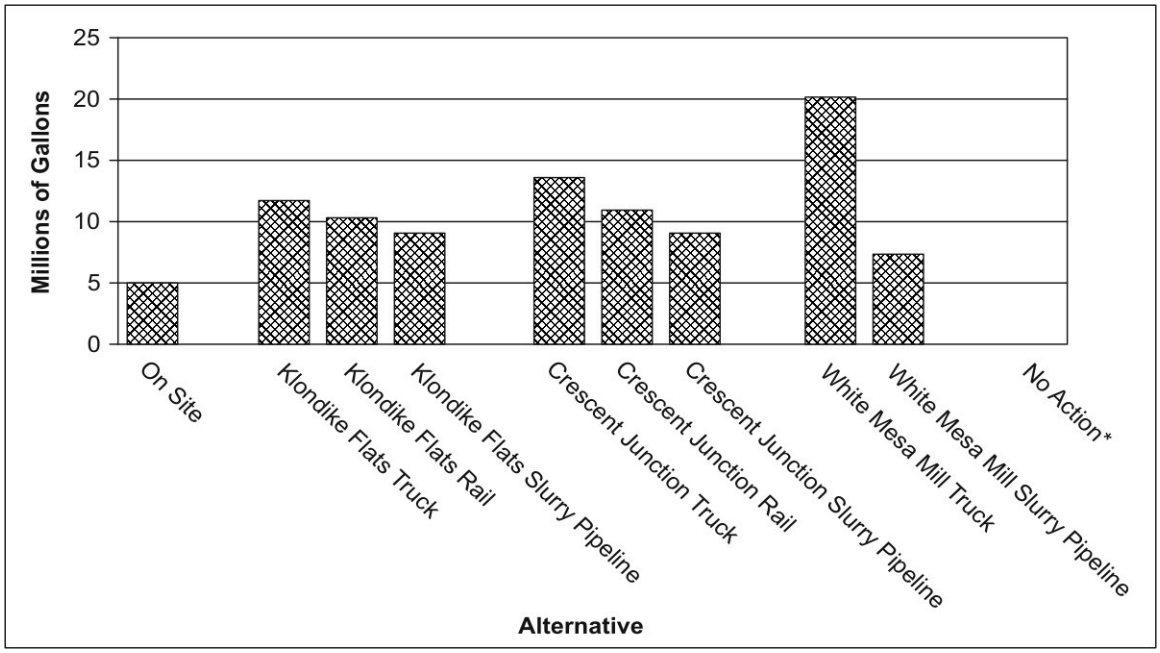
Waste Management. All action alternatives would generate identical amounts of residual radioactive materials (RRM) from treatment of contaminated ground water (Figure S–13). Assuming ground water treatment would entail an evaporation technology, DOE estimates that this waste stream would consist of approximately 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 $58.2 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.



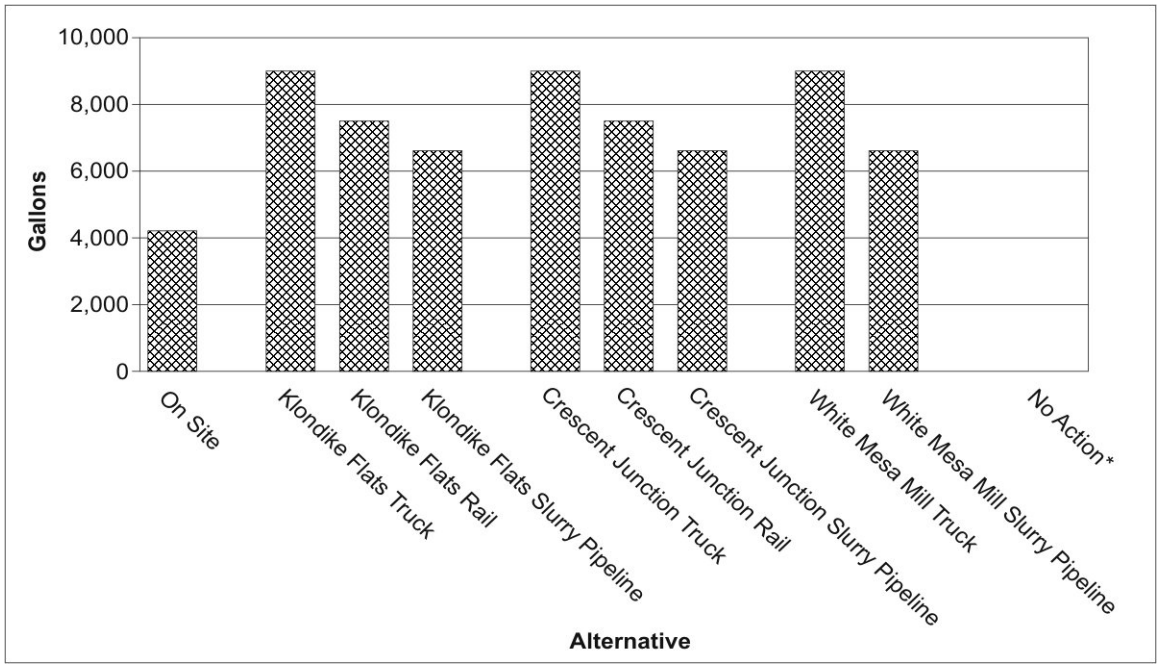
*Impact would not occur under this alternative.

Figure S–8. Power Requirements



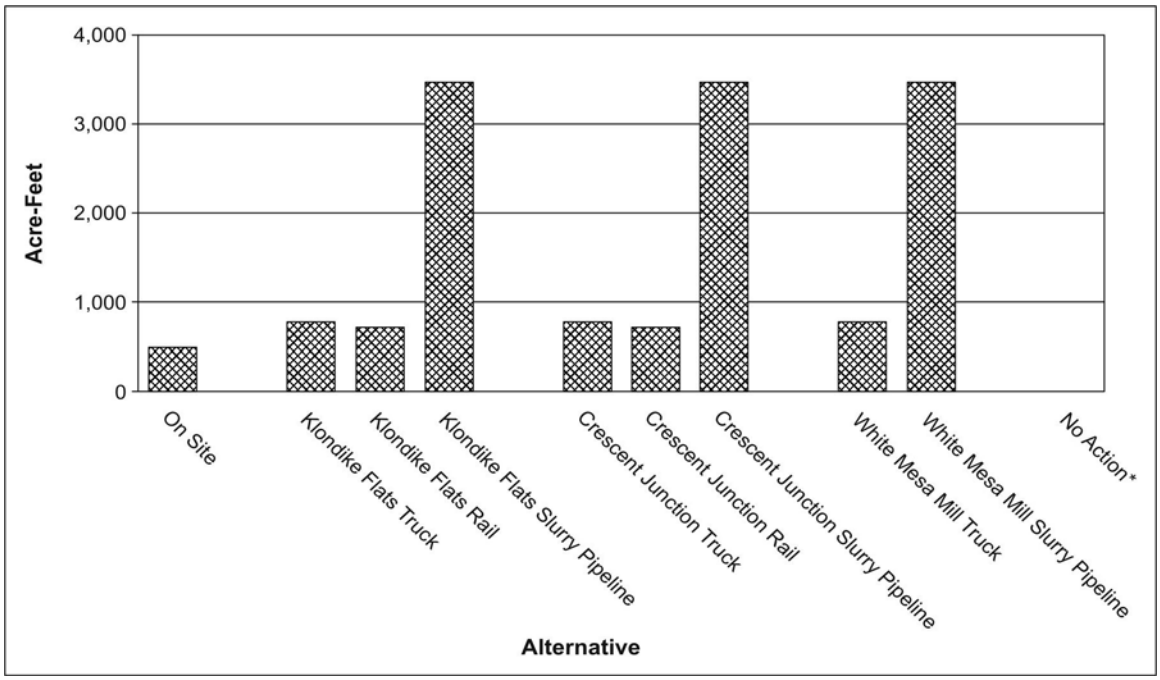
*Impact would not occur under this alternative.

Figure S–9. Total Fuel Consumption



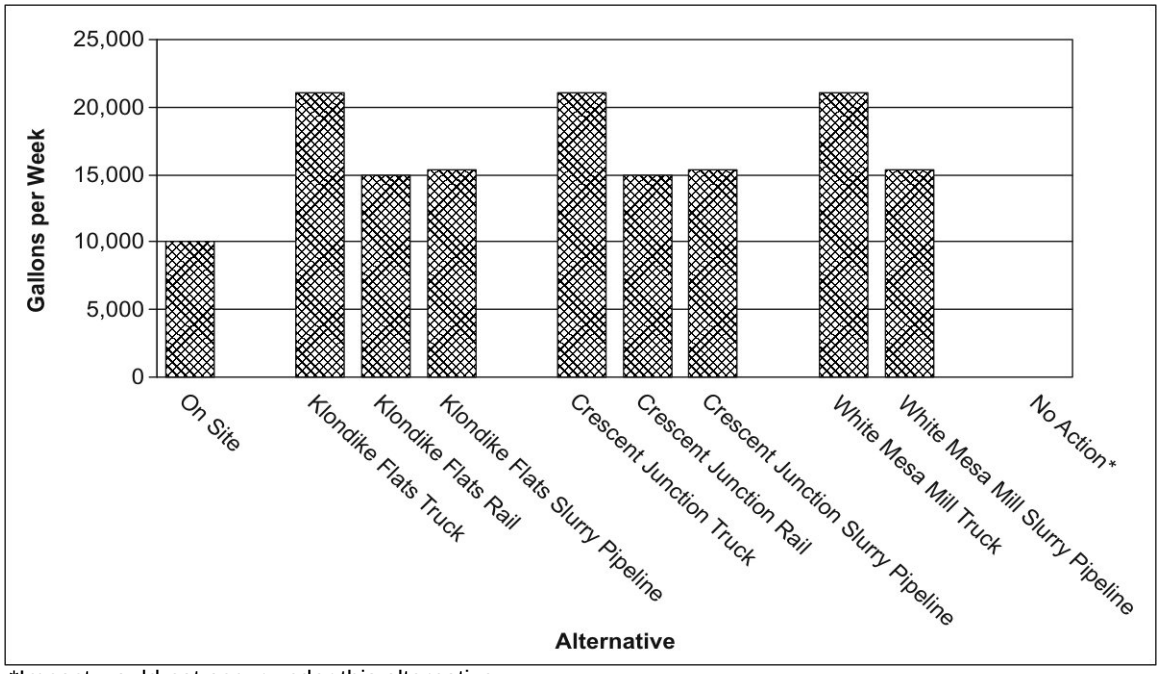
*Impact would not occur under this alternative.

Figure S–10. Daily Potable Water Consumption



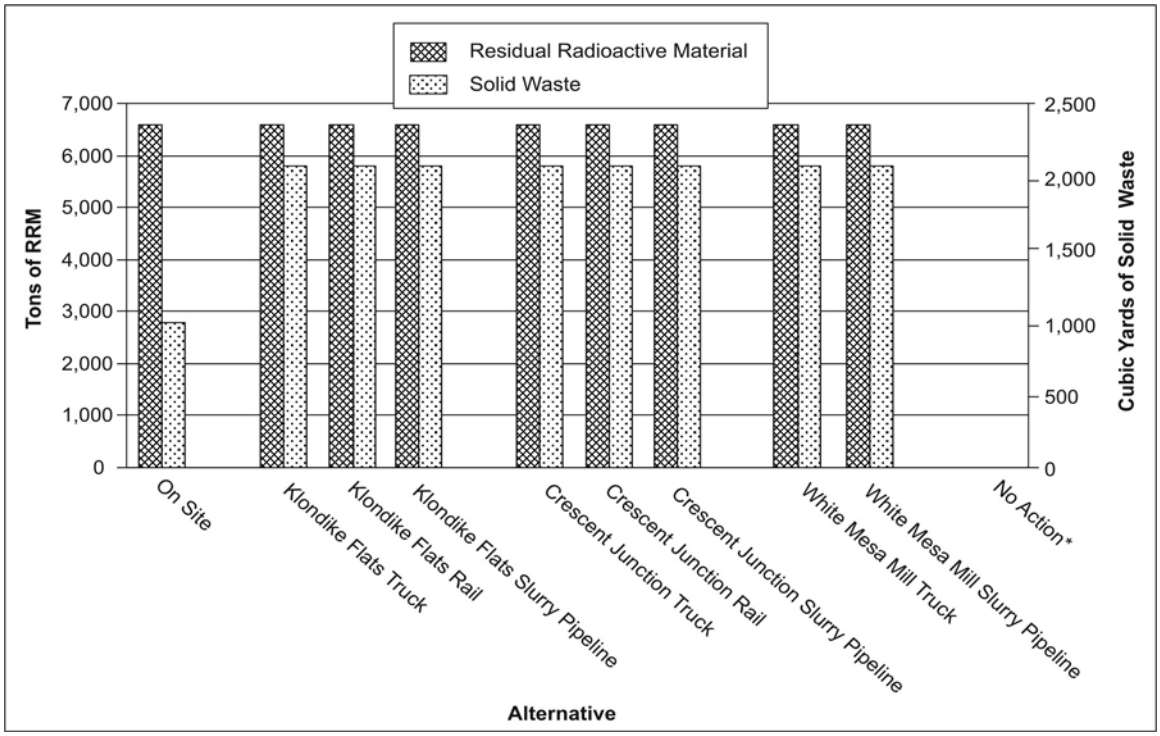
*Impact would not occur under this alternative.

Figure S–11. Total Nonpotable Water Consumption



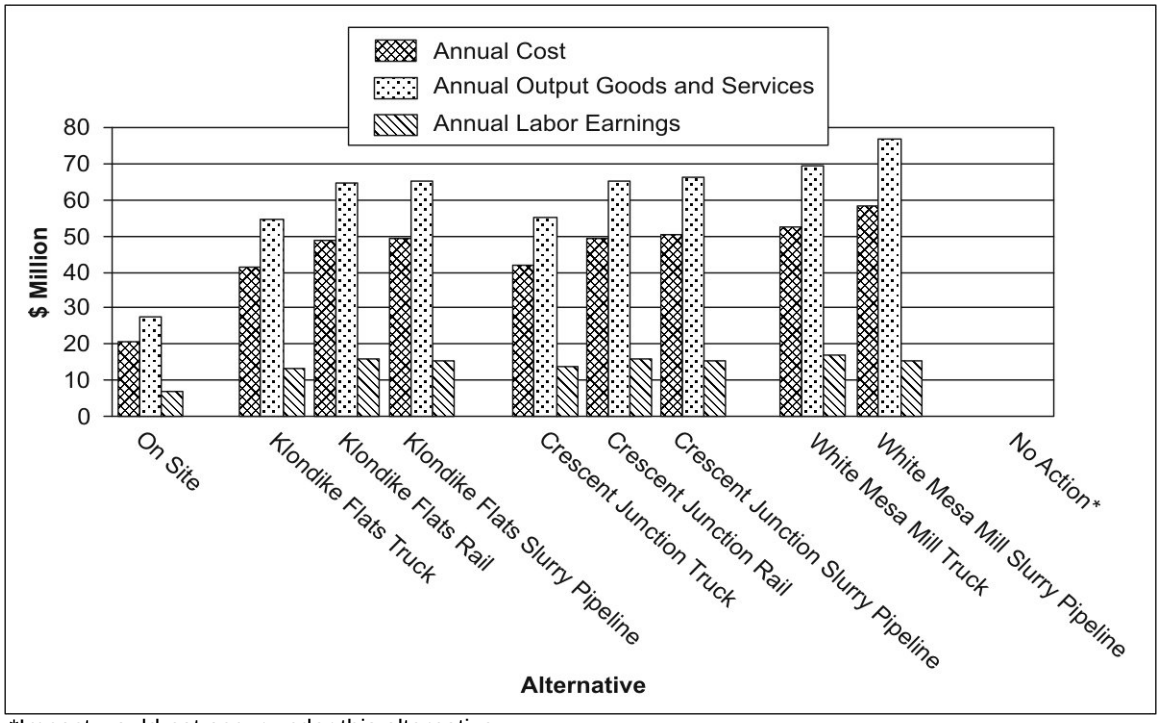
*Impact would not occur under this alternative.

Figure S–12. Sanitary Waste Generation



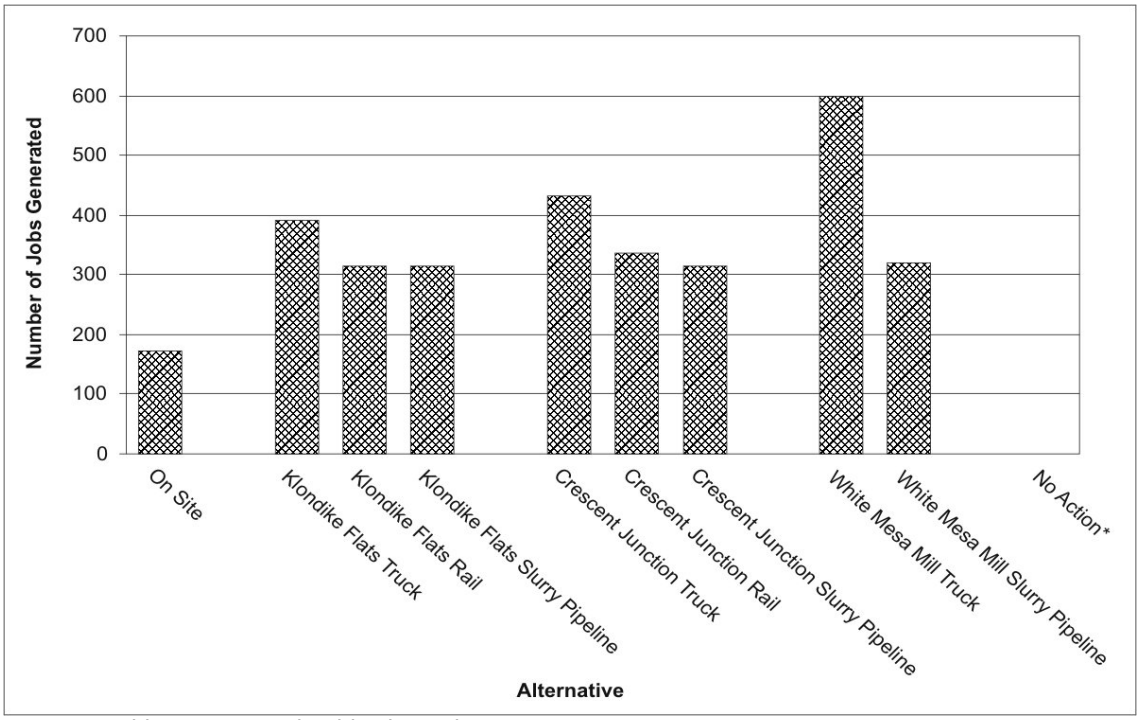
*Impact would not occur under this alternative.

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.

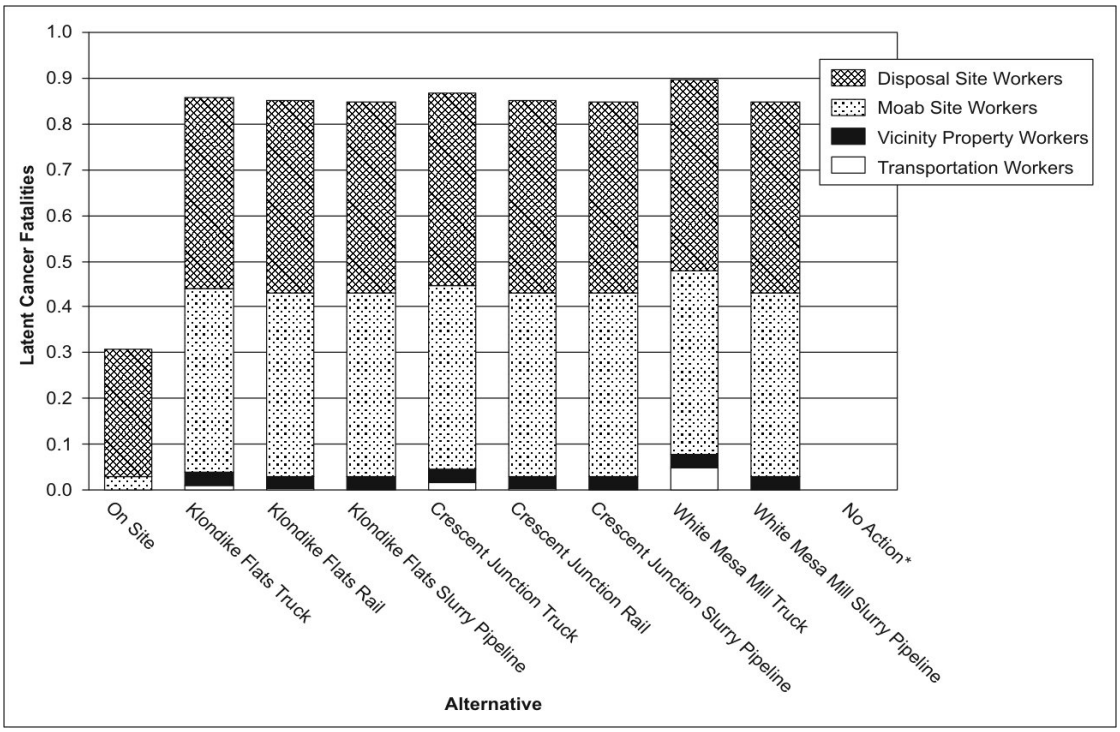
Figure S–15. Generation of New Direct and Indirect Jobs

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

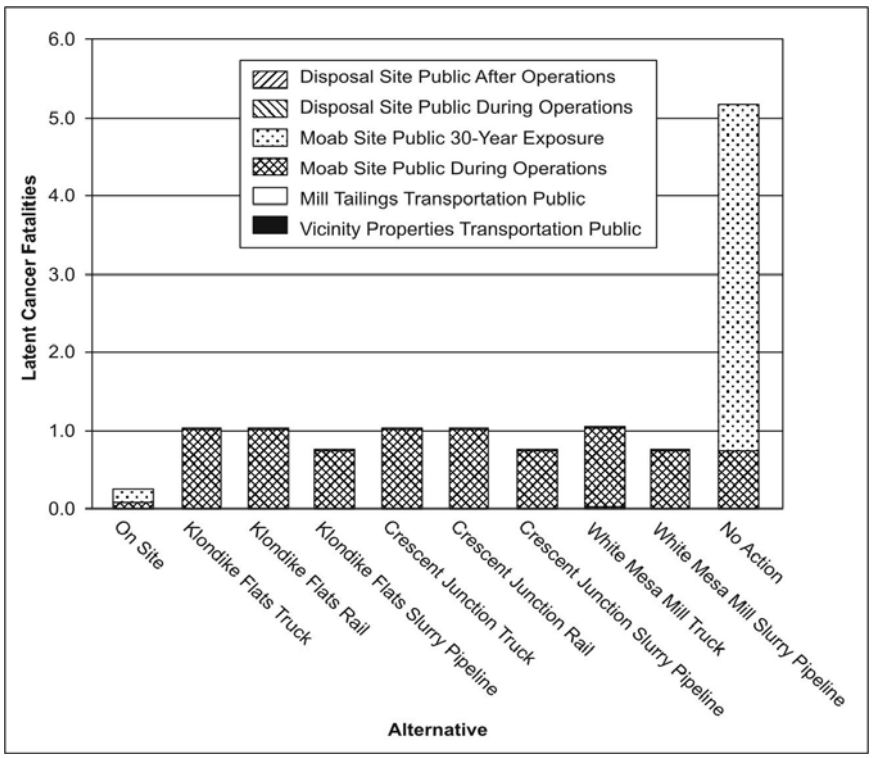


Figure S–17. Public Latent Cancer Fatalities (Excluding Vicinity Property Exposure)

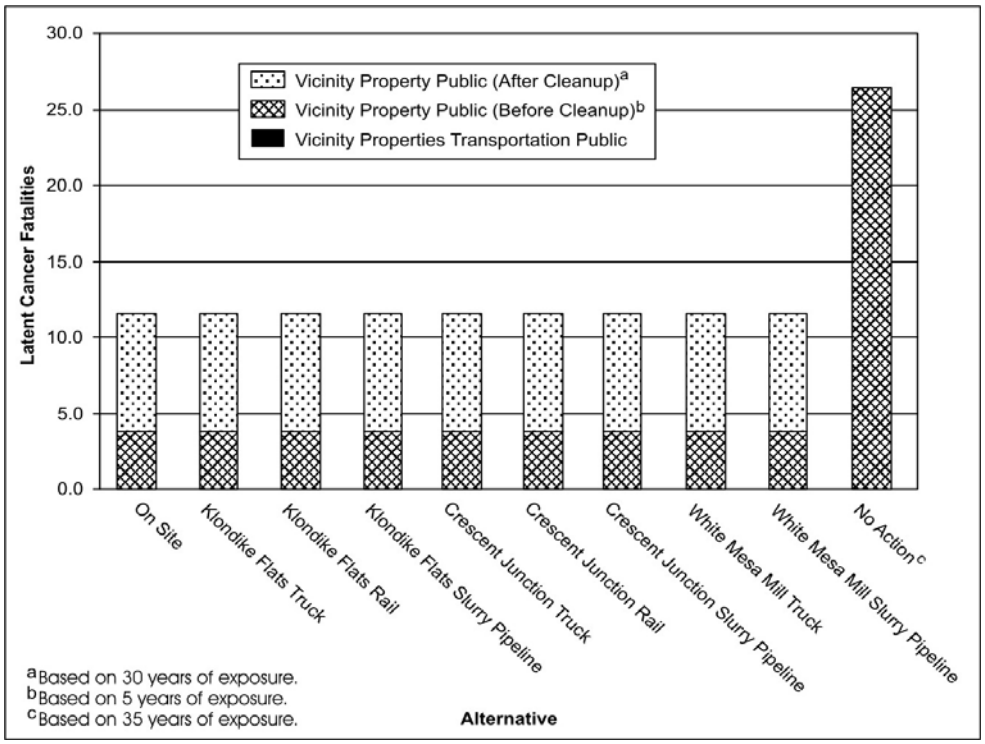


Figure S–18. Public Latent Cancer Fatalities from Vicinity Property Exposure

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 pCi/m^2-s, 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.

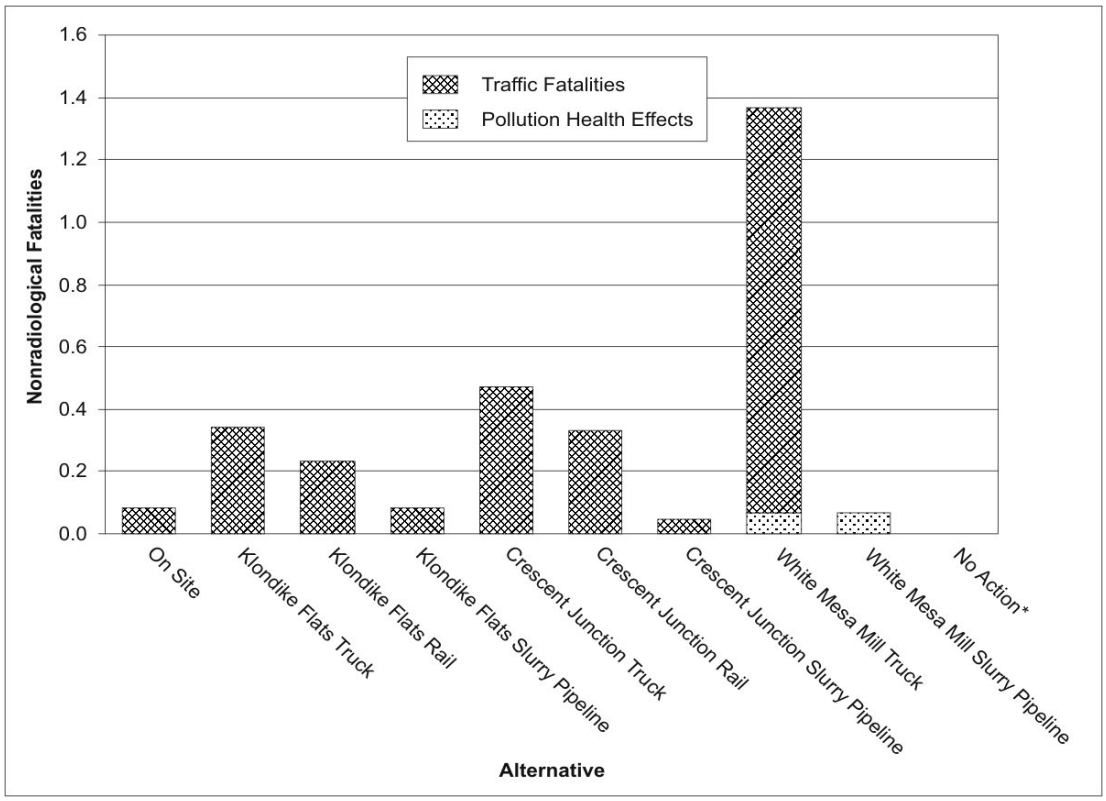
Long-term population risk assessment for this 1,000-year period would be greatly influenced by changing demographics. For comparison among the on-site and off-site alternatives, assuming no changes in population numbers or geographic distribution yields the following population risks over 1,000 years: 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.

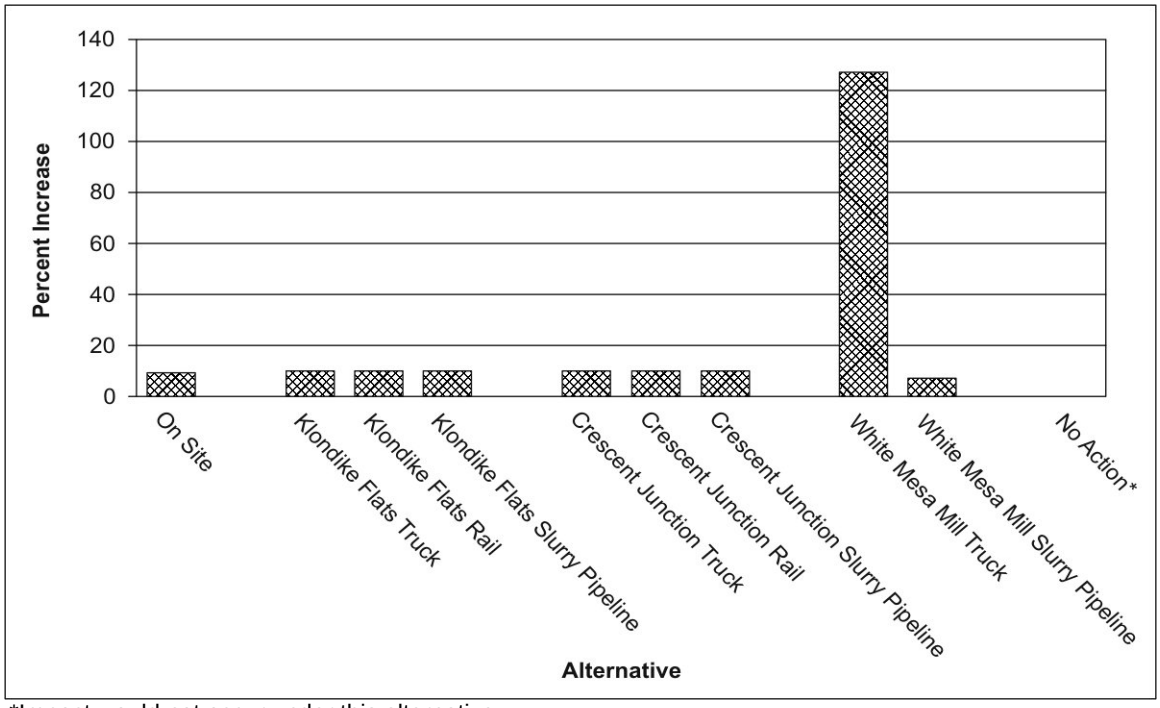
Traffic. Figure S–20 through Figure S–22 depict traffic impacts among the alternatives. All the proposed action alternatives would result in increased traffic on local roads and US-191. Among the three off-site disposal locations, truck transportation to the White Mesa Mill site would represent the most 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.



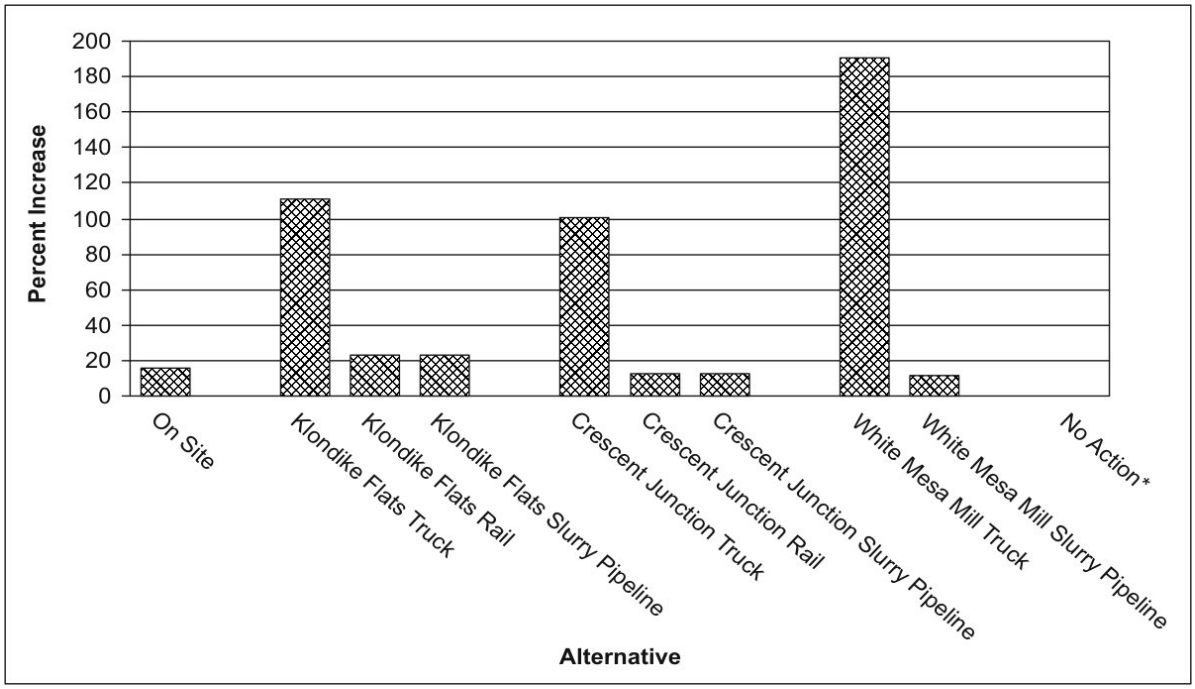
*Impact would not occur under this alternative.

Figure S–19. Nonradiological Transportation Fatalities



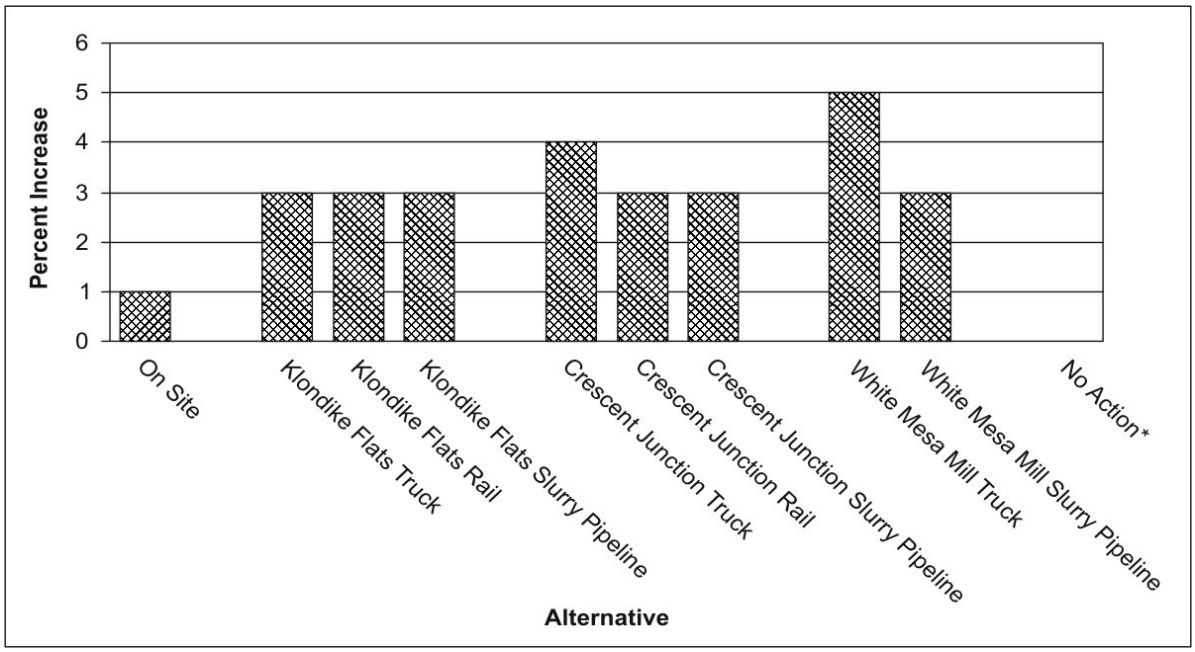
*Impact would not occur under this alternative.

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

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.

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.

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.

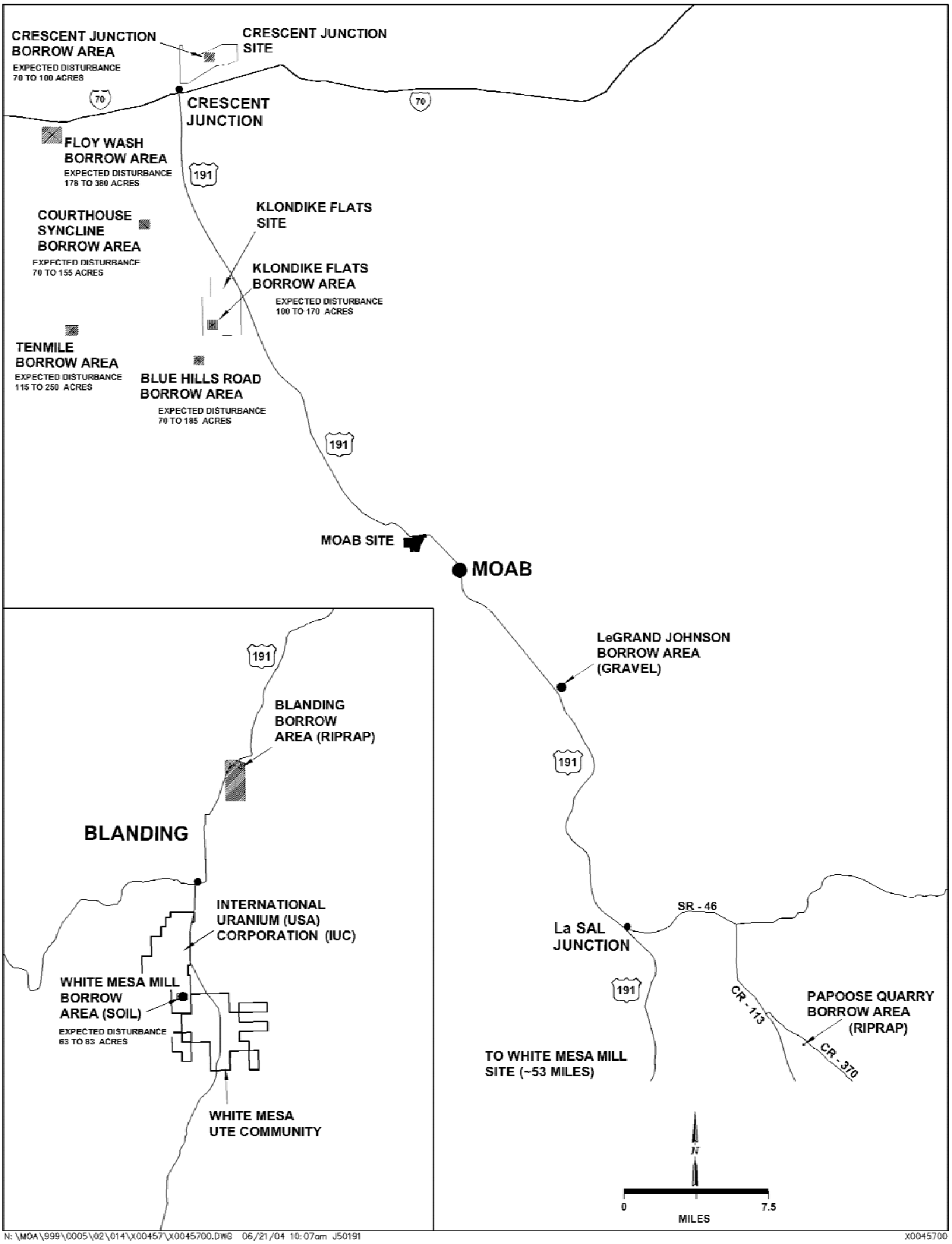
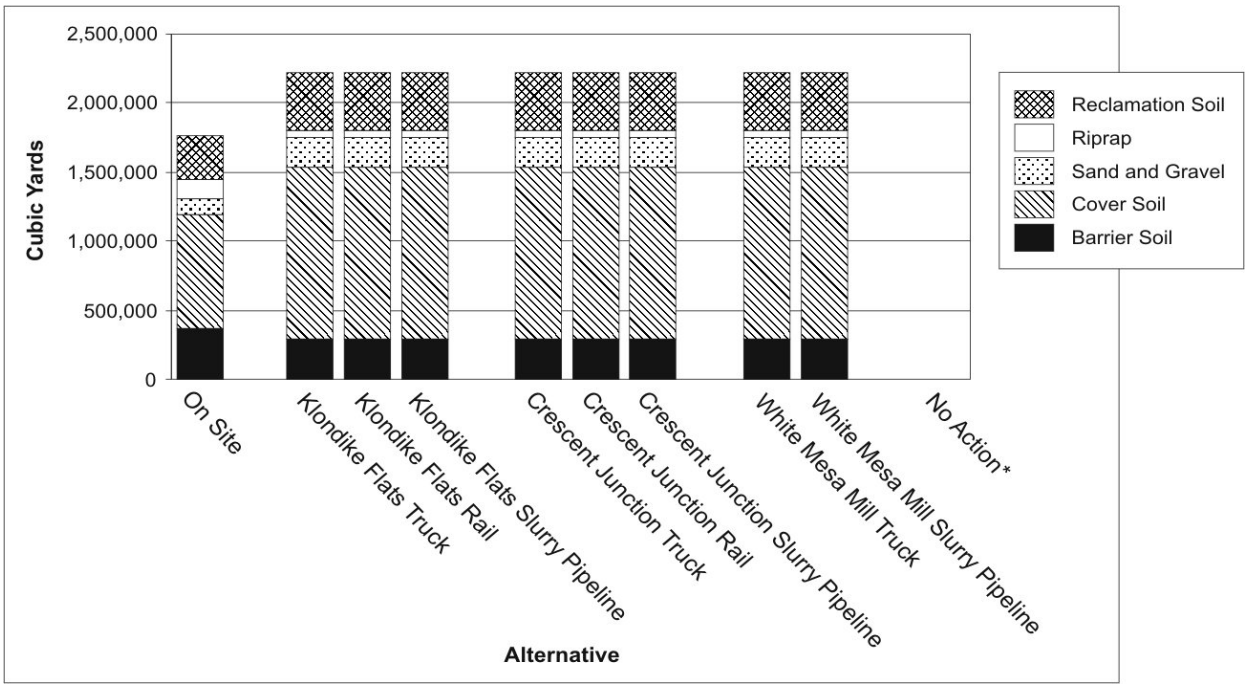


Figure S–23. Borrow Areas

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).

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.



*Impact would not occur under this alternative.

Figure S–24. Borrow Material Requirements

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 (for example, congressional appropriations) 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 or No Action alternatives but are of no consequence under the off-site disposal alternative because the pile would have been removed.

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.

With the exception of ground water modeling, should the Department's characterization, assessment, or assumptions prove incorrect, the resultant changes in impacts would not be significant enough to affect the principal reclamation decision of whether to relocate the tailings from their current location. Ground water modeling is an inherently subjective science that combines scientific facts with scientific observations and expert assumptions to develop a comprehensive image of a natural system, which in the case of the Moab site has been disturbed by human activities. To support the modeling effort, DOE has acquired a level of data for the Moab site consistent with its approach at the previous 22 UMTRCA sites that DOE has remediated. Additional long-term ground water and surface water sampling and analysis could be conducted and used to refine the computer model predictions and reduce uncertainties. However, further narrowing the model uncertainties by incorporating additional monitoring results could require as much as half of the predicted 75- to 80-year remediation period to validate the performance of the model.

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.

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. In the Klondike Flats site area, no past, present, or reasonably foreseeable future actions are anticipated to result in cumulative impacts when considered with the proposed action. However, the following present and reasonably foreseeable future actions could result in cumulative impacts to the other sites when considered together with the on-site or off-site disposal alternative:

- Seasonal tourism in and around Moab—Activities at the Moab site (and to a lesser extent at the off-site disposal locations), together with tourism, could have a significant cumulative impact on traffic congestion in central Moab and could have socioeconomic impacts related to available housing and public safety (police, fire, and hospitals).
- Widening of US-191 between Moab and SR-313—Because this upgrade is planned to be completed in 2004, it is unlikely that this highway construction project and the transport of uranium mill tailings from the Moab site would result in cumulative impacts.
- Planned Williams Petroleum Products pipeline project—The impacts of constructing and operating the Williams pipeline project adjacent to DOE's proposed Crescent Junction site, including increases in truck traffic and consequences of an accident, could result in cumulative impacts when considered together with the impacts of constructing and operating a uranium mill tailings disposal cell at the Crescent Junction site.
- Ongoing activities at the White Mesa Mill site—Although mill operations and disposal of tailings from the Moab site would occur on the White Mesa Mill site, the two operations are not expected to result in cumulative radiation doses to the workforces for each operation because there would be sufficient distance between the two operations. If IUC decided to expand its operations at the White Mesa Mill site, this would result in an increase in the disturbed area and a potential increase in the disturbance of cultural resources.

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, consequently 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 Flow 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 draft 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 bank-full 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 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 (DOE 2003b). 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 7 to 10 years. 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.

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 and Crescent Junction sites are off-site disposal locations where new disposal cells would need to be constructed; the White Mesa Mill site is an existing off-site facility that could receive the contaminated materials.
- 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. For example, while DOE has not yet

identified a preferred alternative, several cooperating agencies have expressed a preference, which are discussed under "Preferred Alternative."

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 goals 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 and acute standard should be the same (0.6 mg/L). The consequences of the State's position could lengthen the duration of ground water remediation and were discussed in more detail under "Consequences of Uncertainty."

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 under "Consequences of Uncertainty" and in Table S−1. 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.