2.0 Description of Proposed Alternative Actions

This chapter describes the on-site disposal alternative (Section 2.1) and the off-site disposal alternative (Section 2.2). Ground water remediation is described separately (Section 2.3), although it would be common and integral to both disposal alternatives.

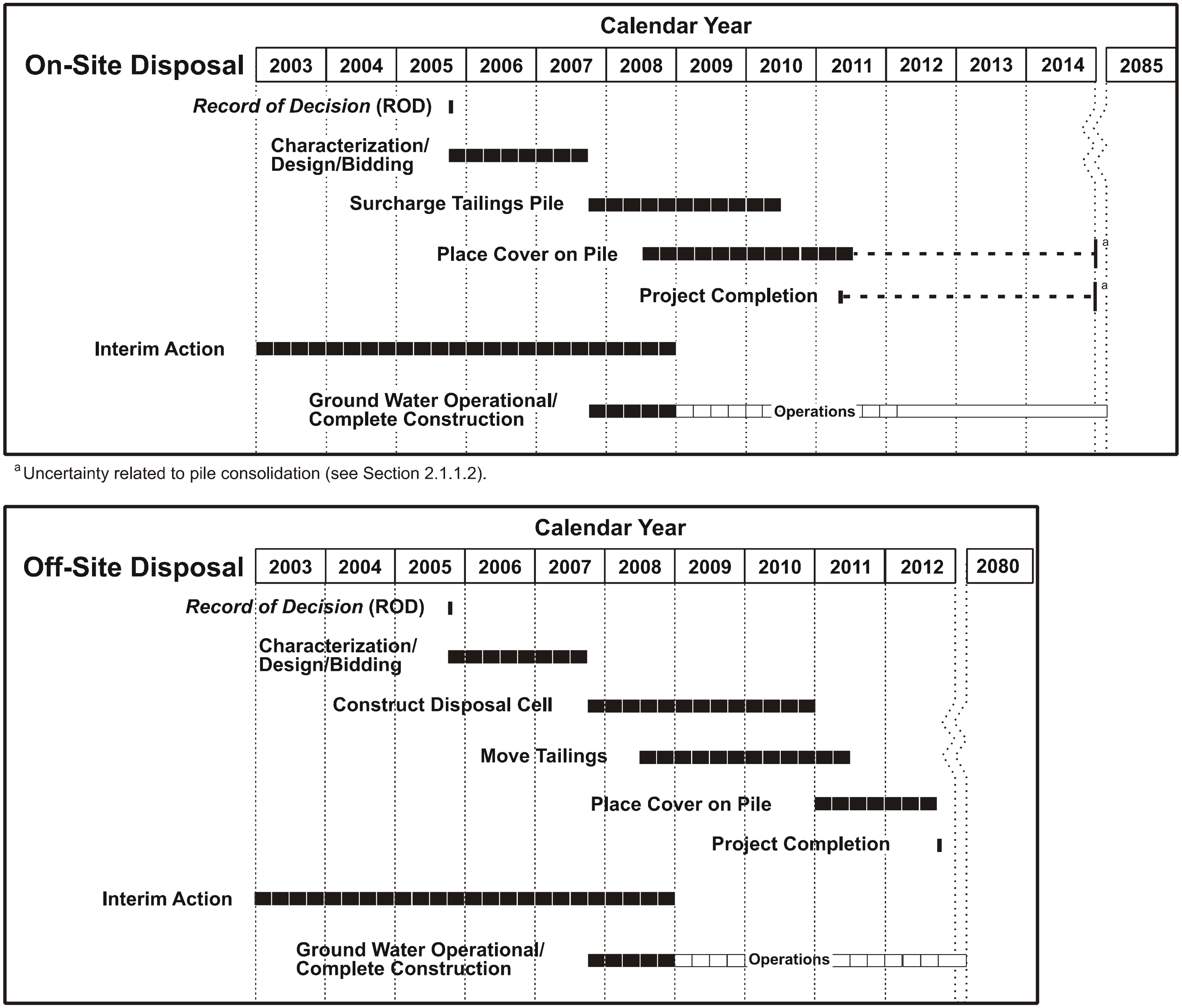
DOE proposes two principal alternatives for remediation of contaminated surface materials at the Moab site and vicinity properties: (1) on-site disposal and (2) off-site disposal. In addition, DOE is proposing one action to remediate contaminated ground water under the Moab site and to protect ground water and surface water quality at the Moab site and at an off-site disposal cell location if the proposed off-site disposal alternative is implemented. Ground water remediation would be an integral element of both the on-site and off-site disposal alternatives. After considering the analyses provided in the EIS, agency and public comments, and other factors relevant to the decision process, such as cost, DOE has identified (Section 1.4.5) off-site disposal at Crescent Junction using mostly rail transportation and some trucks for hauling borrow material and oversized debris, and active ground water remediation as its preferred alternatives.

Figure 2–1 shows the overall schedule for completing the proposed action assuming implementation of a single daily work shift. Detailed schedules for (1) the on-site disposal alternative, (2) the off-site disposal alternative under each of the three possible modes of transportation, and (3) ground water remediation are provided in subsequent sections where each alternative action is described in detail.

On-Site Disposal: Under the on-site disposal alternative (Section 2.1), the existing tailings pile would be converted into a permanent, engineered, disposal cell into which all on-site and vicinity property contaminated material would be encapsulated. Upon completion of excavation and placement of all contaminated material, the disposal cell would be stabilized, recontoured, and covered. This alternative is similar to that proposed by the Atlas Corporation and described in Section 2.1 of NRC's 1999 EIS (NRC 1999), with the exception of engineering design changes (for example, under the current proposed design, the cell acts as a positive drainage cover) and the introduction of the proposed ground water remediation. No on-site contaminated materials would be transported off the site. However, contaminated materials at vicinity properties would be transported to the Moab site on public roads.

Off-Site Disposal: Under the off-site disposal alternative (Section 2.2), the tailings pile, contaminated on-site soils and materials that are not yet in the pile, and contaminated materials from the vicinity properties would be transported to one of three proposed off-site disposal locations: Klondike Flats, Crescent Junction, or White Mesa Mill. Contaminated materials would be transported to the disposal sites using one of three modes of transportation: truck, rail, or slurry pipeline; however, rail transportation is not an option for transportation to the White Mesa Mill site (see Section 2.5.2 for further discussion). Figure 2–2 shows the locations of the three alternative off-site disposal locations in relation to the Moab site.

Ground Water Remediation: Regardless of whether surface remediation involved on-site or off-site disposal, active remediation is proposed for contamination remaining in ground water beneath the Moab site to prevent further degradation of surface water quality. This active remediation would be conducted in conjunction with the application of supplemental standards.



[a] Uncertainty related to pile consolidation (see Section 2.1.1.2).

Figure 2–1. Schedule of Activities for On-Site and Off-Site Disposal—Summary

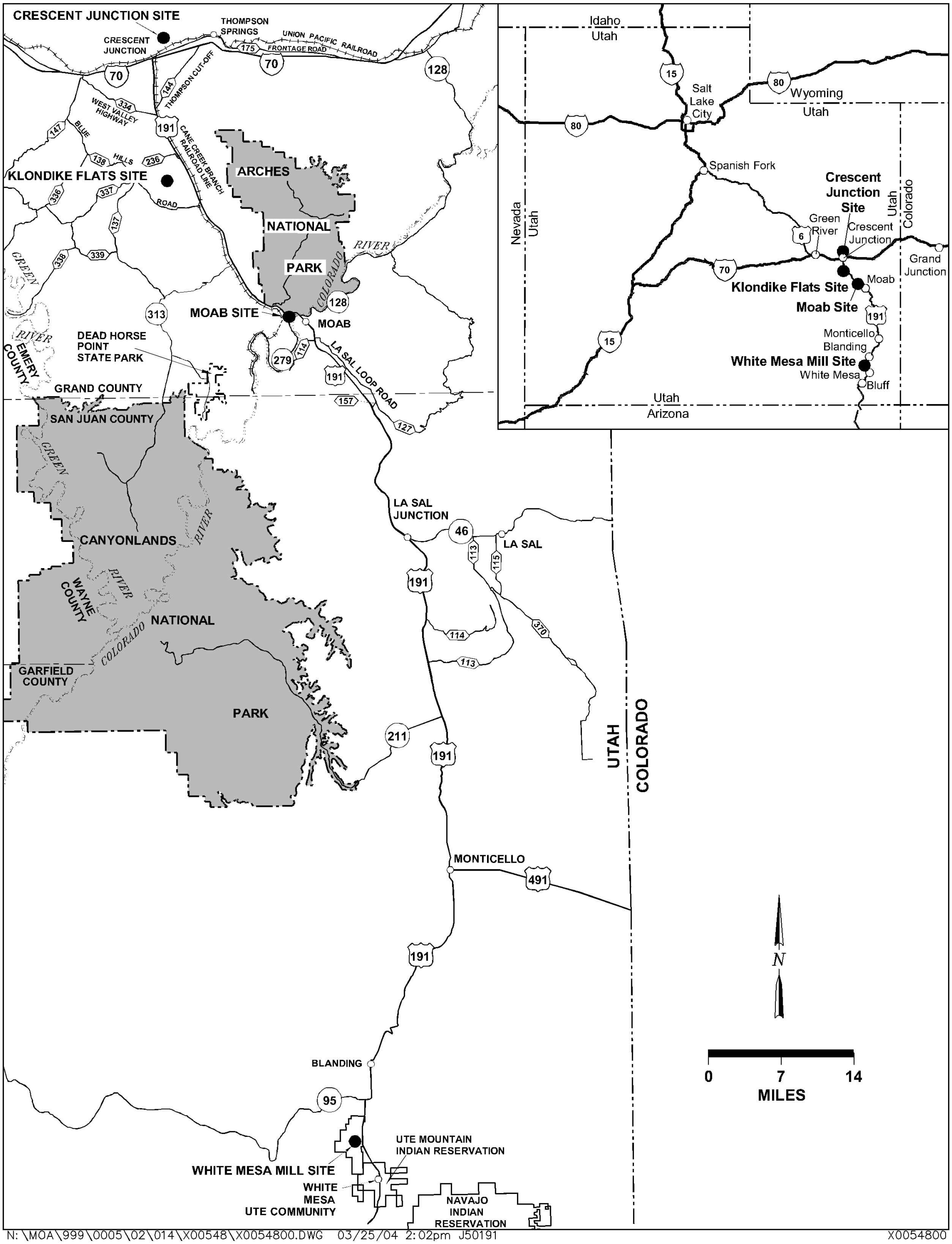


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Figure 2–2. Disposal Site Alternative Locations

The focus of active remediation would be on preventing contaminated ground water from reaching potentially sensitive surface water areas, as opposed to accelerating the removal of contaminants from the aquifer, although it is anticipated that remediation should enhance the cleanup process. The proposed action would intercept ground water before it entered the surface water, thereby providing plume containment and contaminant mass reduction. In addition, injection and/or application of fresh water collected from the Colorado River upstream from the Moab site and pumped from the Moab site water storage ponds may provide a continuous source of uncontaminated water to the margins of the river where contaminant exposure could be the greatest.

DOE also analyzes the No Action alternative (Section 2.4), which serves as a baseline for comparing all alternatives, as required by NEPA regulation. Section 2.5 discusses alternatives that were considered but dismissed from detailed discussion in the EIS. Section 2.6 compares the impacts that would result among the five alternatives, including the No Action alternative. Other decision-making factors, such as costs and comments received from NAS, are discussed in Section 2.7.

2.1 On-Site Disposal Alternative

Figure 2–3 illustrates the major Moab site features and approximate locations of temporary on-site areas and facilities that would be utilized under the on-site disposal alternative.

The major activities that would occur if the on-site disposal alternative were implemented would be

- Construction and operations at the Moab site (Section 2.1.1).
- Characterization and remediation of vicinity properties and disposal of contaminated materials at the Moab site (Section 2.1.2).
- Construction and operations at the borrow areas (Section 2.1.3).
- Monitoring and maintenance at the Moab site after site remediation was complete (Section 2.1.4).
- Ground water remediation at the Moab site (Section 2.3).

Resource requirements for remediation activities are discussed in Sections 2.1.5 and 2.2.7.

For the on-site disposal alternative, DOE assumed one work shift schedule for site and vicinity property remediation; that is, a single 12-hour work shift from 7:00 a.m. to 7:30 p.m., 7 days per week, 50 weeks per year. Only one work shift schedule was considered because the controlling factor determining how quickly work could progress for the on-site disposal alternative would be the rate at which the tailings pile consolidated or settled after excavated site soil and vicinity property material were placed on top of the pile. It could take 3 to 5 years for the pile to settle sufficiently to allow cap construction to begin. This consolidation process is discussed further in Section 2.1.1.2. A double work schedule for excavating soil and loading contaminated materials on the pile would not offer advantages in terms of project completion because of the need to wait for sufficient pile settling. However, to allow some flexibility in targeting a project completion date, DOE did consider a 2-year and a more aggressive 1-year time frame for completing

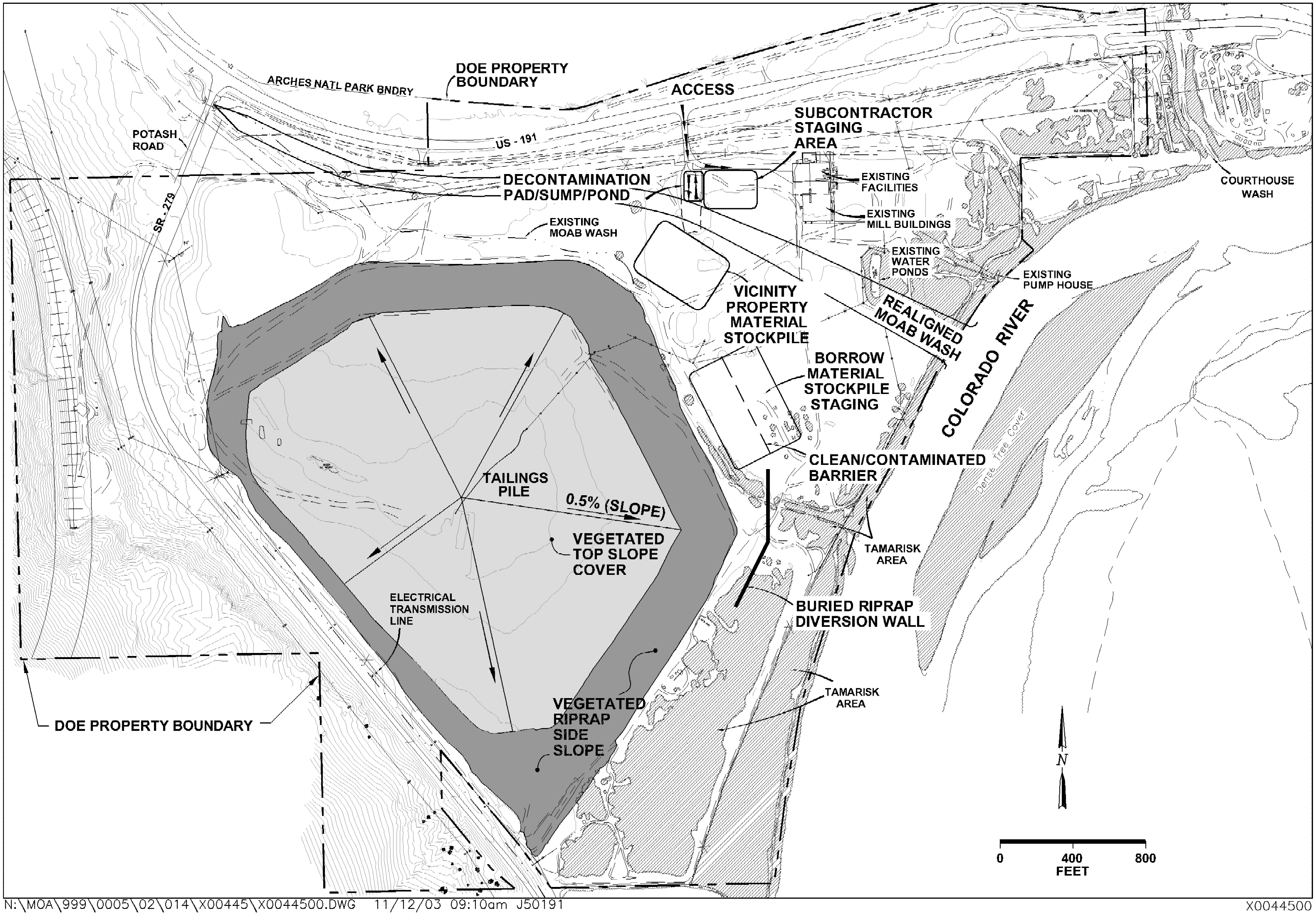
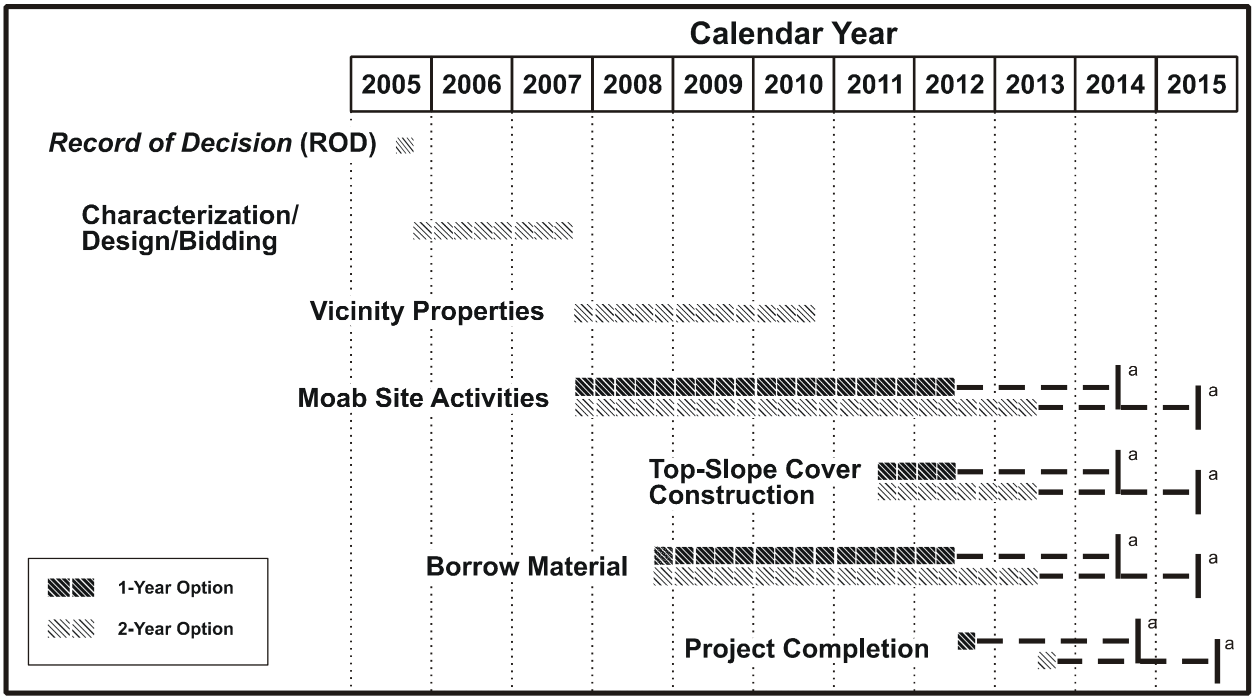


Figure 2–3. Moab Site Plan, On-Site Disposal Alternative

construction of the top slope cover once settling was sufficiently under way. Both top slope cover construction schedules would employ a single work shift; the difference would be in the number of workers.

DOE estimates that all surface remediation activities under the on-site disposal alternative would be completed 7 to 8 years from the issuance of a ROD, depending on whether the 2-year or 1-year top slope cover construction schedule were implemented (Figure 2–4). However, as indicated in the figure, the schedule allows for a possible extension of approximately 2 years because of the 2-year uncertainty associated with the amount of time it would take for the tailings pile to consolidate.



[a]Uncertainty related to pile consolidation (see Section 2.1.1.2).

Figure 2–4. On-Site Disposal Alternative Surface Remediation Activity Schedule

2.1.1 Construction and Operations at the Moab Site

For the purpose of describing the on-site alternative activities, this section addresses four elements: (1) site preparation, infrastructure enhancement, and controls; (2) contaminated material remediation operations; (3) disposal cell recontouring, slope stabilization, and capping; and (4) site reclamation.

2.1.1.1 Site Preparation, Infrastructure Enhancement, and Controls

Storm Water Management System

Storm water management controls are regulated under the Utah Pollutant Discharge Elimination System General Permit for storm water discharges from construction activities. Under these regulations, the State of Utah requires development of a storm water pollution prevention plan using good engineering practices before construction can begin. The existing plan would be modified to include descriptions of additional control measures that would be implemented. A storm water management system would be implemented to prevent water, sediments, soils, and materials from the site, any of which may be contaminated, from reaching Moab Wash and the Colorado River during the construction period. The system, which would comply with all applicable federal and state regulatory requirements, would be designed to control a reference 100-year storm event throughout the construction period and would include new or improved berms, drainage ditches and basins, hay bales, sediment traps, and silt fence fabric.

The existing Moab Wash would be rechanneled to run through the former millsite area (see Figure 2–3). 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-operations discharge point. The channel would be designed to carry runoff that has the approximate magnitude of a 200-year flood. Flood protection along the base of the pile would protect it from more significant floods. Material excavated during construction of the reconfigured channel would be used as either cover material for the pile or backfill for other areas of the site. Any material identified as contaminated would be placed on the tailings pile before the cover was installed. DOE would also perform flood analyses of Courthouse Wash to ensure that site design requirements consider the contribution of potential flooding from Courthouse Wash.

As an element of the storm water management plan identified in Section 4.7.3, “Mitigative Measures,” mountain snow pack and precipitation data would be monitored throughout the winter and spring seasons during the period of active remediation. This information would be used to track flooding potential so appropriate site management and mitigation measures could be implemented in a timely manner to ensure control of contaminants and protection of public safety and the environment.

Radiological Controls

The following radiological controls would be implemented to minimize the potential for personnel contamination or the spread of radioactive material.

Barriers

Radiation barriers would consist of signs and a system of steel “T” posts supporting standard yellow/magenta ropes to delineate radiation control areas. This action is consistent with DOE radiation safety requirements.

Personnel Screening and Decontamination

Personnel entering the site would be required to sign daily site access logs. Access to contamination areas would be controlled through a modular trailer that would be located at the site entrance (identified as the access area on Figure 2–3). A second modular trailer would be dedicated to laundering contaminated clothing. Contaminated wastewater from the laundry facility would be collected in lined ponds or sumps and eliminated using evaporation techniques, used for dust control applications during construction, or reused in equipment decontamination operations. Any excess would be distributed across the tailings surface before final covering was complete. Screening and decontamination would be performed according to appropriate DOE standards and procedures.

Vehicle and Equipment Screening and Decontamination

A vehicle and equipment decontamination facility with one bay would be constructed and located approximately as shown in Figure 2–3. Additional bays would be constructed if needed. The facility would be used to screen vehicles entering and leaving contamination areas on the site and to decontaminate any contaminated vehicles before they were released to leave the site. Similar decontamination stations used at other UMTRCA sites have used approximately 1,500 gallons of water per day. Drainage from decontamination spray-down operations would be directed to floor drains leading to a concrete sediment trap. Water would be decanted from the sediment trap into a double-lined recycle pond approximately 50 by 50 by 5 ft. Pumps installed in the recycle pond would provide recycled water to the spray hoses at the concrete pad. As needed, water to replace losses due to evaporation or overspray would be either piped below ground approximately 450 ft from the existing pump station water storage ponds (Figure 2–3) or supplied from water trucks. As construction activities involving contaminated materials decreased and as decontamination operations decreased, remaining or excess contaminated water not lost to evaporation would be sent to the tailings placement operations for use in dust control.

Dust Control

Windblown tailings and other contaminated material could create fugitive dust emissions. A dust control system would be implemented following provisions in the *Fugitive Dust Control Plan for the Moab, Utah, UMTRA Project Site* (DOE 2002a), which complies with State of Utah requirements specified in the *Utah Administrative Code* titled “Emission Standards: Fugitive Emissions and Fugitive Dust” (UAC 2000). Water for compaction and dust control would be drawn from the Colorado River. Dust suppressants such as calcium chloride, which would be stored in tanks, could also be used. Water would be stored in tanks or in the existing water storage ponds and applied only as needed, using the most economical and efficient delivery method.

Water Pumping Station Enhancements

Currently, nonpotable water from the Colorado River is pumped from an intake structure (pump house) to two connected, unlined water storage ponds located on the northeastern portion of the Moab site (Figure 2–3). This water is allocated under water rights held by DOE, which authorize 3 cubic feet per second (cfs) consumptive use and 3 cfs nonconsumptive use. Water from the pumping station would be used for all nonpotable water needs at the site. The water intake structure would be screened to ensure protection of aquatic species. In addition, the existing pumping station, piping, and storage ponds would require repairs and upgrades to supply the water demand during construction. Repairs required would include piping and pipe support structures, storage pond dredging, and general maintenance.

Temporary Field Offices

Temporary field offices would be installed to provide workspace, parking, and amenities for construction, management, or other personnel working on the site but not directly involved with field activities. The temporary field offices and other erected or emplaced facilities or structures would be painted a color similar to the background soils or vegetation to reduce visual impacts to travelers on US-191 and SR-279. The area, which would be located near existing trailers, would be graded and surfaced with a gravel base. The offices would be mobile trailers and would require setup and installation of electric utility service. The offices' sanitary sewer lines would be connected directly into a new holding tank system that would be pumped regularly by a local septic tank pumping vendor.

Vehicle Maintenance Area

The existing mill building would be converted into a vehicle maintenance area for on-site equipment. This conversion would require minor upgrades and maintenance to the building such as electrical service improvements and roofing upgrades. Spill containment areas for storage of engine oils, hydraulic fluids, and other hazardous materials associated with equipment maintenance would be constructed in the maintenance area.

Borrow Material Storage Area

Borrow materials obtained from off-site locations for use as tailings cover construction materials or clean backfill are discussed in Section 2.1.3. A borrow material storage area would be constructed for temporary storage of borrow materials. The area would occupy approximately 5 acres and would be located on top of clean (uncontaminated) soil (Figure 2–5) in an area already remediated. Off-site dump trucks delivering borrow materials to the site would dump them in the clean area and never enter the contamination zone.

Fuel Storage Area

A fuel storage and refueling area would be located within the contamination boundary to service on-site vehicles (Figure 2–5). The area would store from 5,000 to 20,000 gallons each of gasoline and diesel fuel. The area would include approved emergency containment berms around the tanks to contain spills, leaks, or ruptures and to provide adequate protection from precipitation and floodwaters resulting from a 25-year storm event as a minimum. A central delivery point for local vendors to resupply the storage tanks would be used to transfer the delivered fuel over or through contamination boundaries. Appropriate radiological and safety control practices and procedures would be followed.

Night Lighting

Grand County public land policy provides that if projects on public lands require night lighting, such lighting should be shielded and otherwise designed to prevent light pollution. DOE believes that some night lighting would be required as an occupational safety measure. However, the extent and duration of required night lighting would depend largely on the final work shift schedules that are used and the season of the year. If work activities continued after dark, night lighting would be a standard occupational safety measure. If and when required, mobile lighting would be moved from place to place as needs and work progress dictated. Either gasoline- or diesel-powered mobile lighting would be used and would have a minimum power of 500 watts. All night lighting would be shielded to reduce night sky glare that could be visible from Arches National Park.

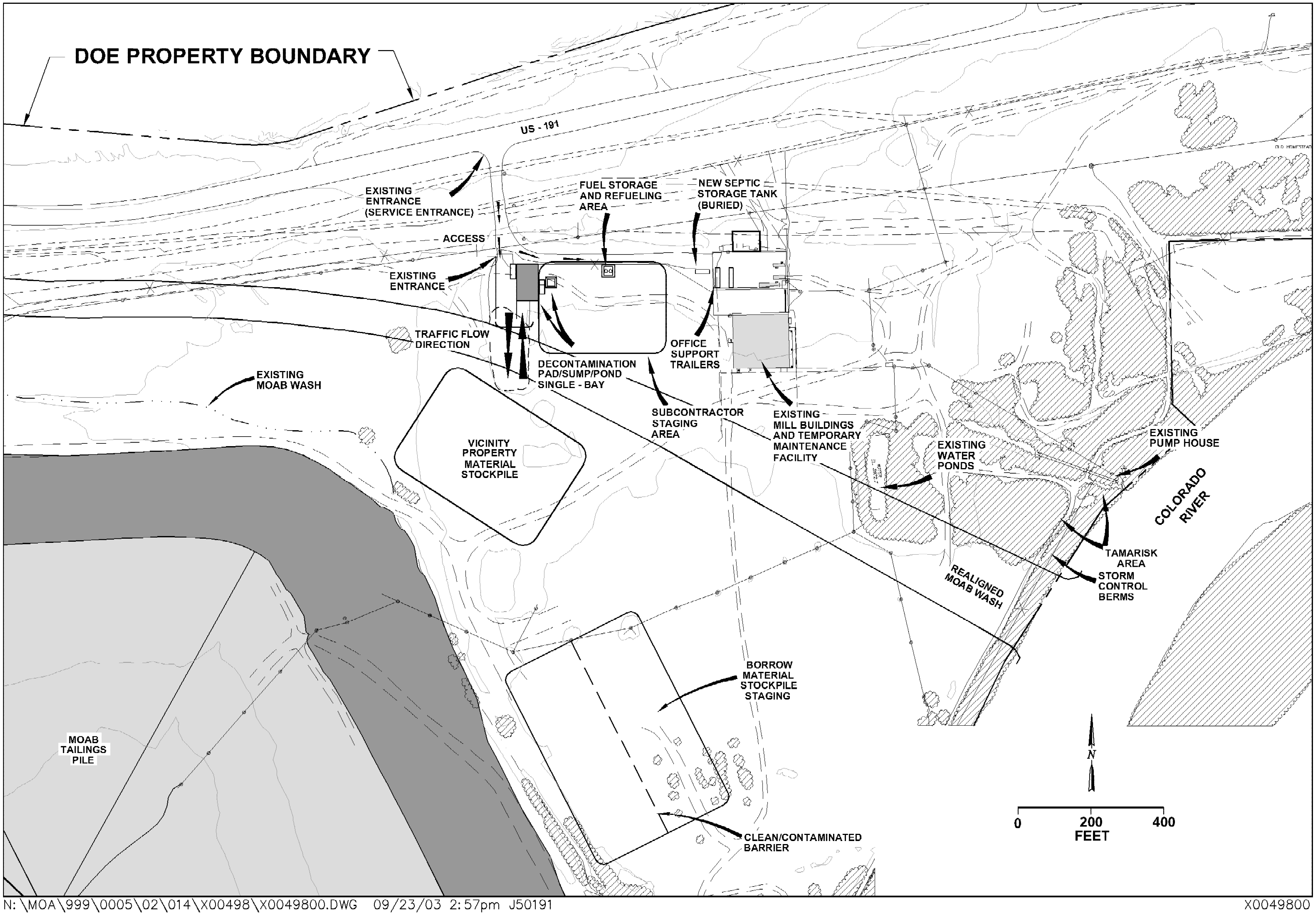


Figure 2–5. Locations of Temporary Moab Site Construction Facilities, On-Site Disposal Alternative

2.1.1.2 *Contaminated Material Remediation Operations*

Contaminated Soil, Vegetation, and Debris

Backhoes and bulldozers would be used to excavate contaminated surface areas of the site to a depth where the concentration of radium-226 averaged over any area of 1,076 square feet (ft^2) (100 square meters) does not exceed the background level by more than 5 picocuries per gram (pCi/g) averaged over the first 6-inch-thick (15 cm) layer of soil below the surface and 15 pCi/g averaged over 6-inch-thick (15 cm) layers of soil more than 6 inches (15 cm) below the surface (40 CFR 192.12), except where the provision for the application of supplemental standards under 40 CFR 192.21 apply. Excavated areas would be cleared and grubbed prior to removal of contaminated soils, and grubbed material would be hauled with contaminated soils.

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).

An estimated 234,000 tons of contaminated site materials would be excavated from the site, loaded into dump trucks, hauled to the top of the tailings pile, and deposited on top of the center of the pile above the slimes (very fine grained tailings fraction). On the basis of recent surveys that were not available at the time the draft EIS was developed, DOE has slightly increased its estimate of the volume of contaminated off-pile soil that would be disposed of with the tailings. The increase is less than 1 percent of the total estimated volume of contaminated site material. The revised total estimates remain approximate and could increase again after more detailed site characterization is complete. The estimated volumes presented in the draft EIS represented DOE's best estimate based on information available when the draft EIS was developed. Due to the small cumulative change, the draft EIS estimates have been retained as a constant in the final EIS for purposes of assessing and comparing the impacts of each alternative. DOE would use the most current and reliable estimates of the volumes of all contaminated site material in developing the remedial action plan.

The weight of contaminated soils and debris placed on the tailings is called "surcharge." Placing surcharge material on the slimes to accelerate settling is called "preconsolidation loading," and the process of settling that ensues is called "consolidation." DOE estimates that the consolidation loading process may require 3 to 5 years before the pile would settle sufficiently to allow final cover emplacement. To prevent cover cracking due to pile settling, final cover placement would not begin until 90 percent of the predicted consolidation settlement was complete.

Settling, or pile consolidation, is a short-term engineering phenomenon that could affect the stability of the pile, especially the cap. It refers to the gradual compacting and lowering of the height of a tailings pile. It is caused by the weight of the pile squeezing liquids from slimes downward and out of the pile. The addition of new material or surcharge to the top of the pile results in added weight and accelerates the settling process.

It is important that settling be essentially complete (90 percent consolidation) before the final cap is put on a tailings pile; otherwise, local or differential settling could cause the cap to bow, buckle, or crack. This could result in failure of the cap, water intrusion into the interior of the disposal cell, and an increased chance for contaminants to mobilize and migrate out of the disposal cell. Under the on-site disposal alternative, DOE estimates that after surcharge loading was complete, it would take 3 to 5 years for the pile to settle sufficiently to allow final cover emplacement.

Certain areas of the site are covered with vegetation, notably the tamarisk areas illustrated in Figure 2–3 and Figure 2–5. The tamarisk and materials from clearing and grubbing would be felled and chipped or crushed prior to being hauled to and spread over the disposal cell. Miscellaneous materials, including debris from the existing mill facilities, would be deposited in an area adjacent to the pile's southeastern edges and covered with contaminated soil. This area would ultimately be stabilized under the final tailings cover.

Demolition and Disposal of Existing Mill Facilities

After DOE consulted with the State Historic Preservation Officer and agreed on mitigation measures, some or all of the remaining mill structures and features, shown on Figure 2–5, would be demolished due to varying levels of residual contamination found within the structures. The primary mill features remaining include the Uranium Reduction Company general office/warehouse/machine shop, pump house and pipeline, several sheds, scale house, and railcar loading structure. The resulting debris would be sized, loaded onto dump trucks, and hauled to and deposited in the disposal cell. The 680 ft of chain link fence would also be taken down and disposed of at the disposal cell as potentially contaminated debris.

2.1.1.3 Disposal Cell Recontouring, Stabilization, and Capping

Figure 2–6 is a conceptual cross-section of the final condition of the disposal cell. The figure also illustrates the types and approximate dimensions of the materials that would be placed on the sides and top of the pile to contain radon emissions and stabilize the cell. This is a conceptual design and diagram only. The conceptual design is strictly intended to establish a reasonable basis for evaluating environmental impacts between the alternatives associated with this component of site remediation and reclamation. This assumed design is not intended to commit DOE to any specific cover design. A detailed design would be developed in the remedial action plan following the ROD. Should the final design differ substantially from the design considered here, DOE would assess the significance of these changes as they relate to the decision-making process and the requirements of NEPA.

Section 2.2.5.2 discusses the White Mesa Mill disposal cell, for which a different cover design is addressed. The design for the White Mesa Mill site disposal cell cover is different from the design described for the other disposal alternatives because it is based on an unsolicited proposal submitted to DOE and reflects a design more typical of UMTRCA Title II uranium mill tailings reclamation. A brief description of the White Mesa Mill cover design is also included in Appendix B. By including both design approaches, DOE has attempted to support decision-making by presenting a range of potential cover design approaches and a sense of the associated impacts related to the cover component selected for the final remedy.

After all contaminated materials were relocated to the top of the tailings pile and the consolidation process was under way, final side slope grading and recontouring would begin. The side slopes would be recontoured to a 3:1 horizontal:vertical (3H:1V) slope, a downward angle of approximately 19 degrees. Final side slope cover construction would begin after the slopes were graded.

Final cover construction would start with placement of the compacted soil layer that would form the radon barrier. Clayey soil borrow material (see Section 2.1.3.1) would be transported to the site in tandem trailers, conveyed by on-site vehicles to the base of the pile, then pushed up the recontoured slopes with a dozer. These materials would be moisture-conditioned and compacted to achieve the appropriate density specifications and quality assurance/quality control criteria.

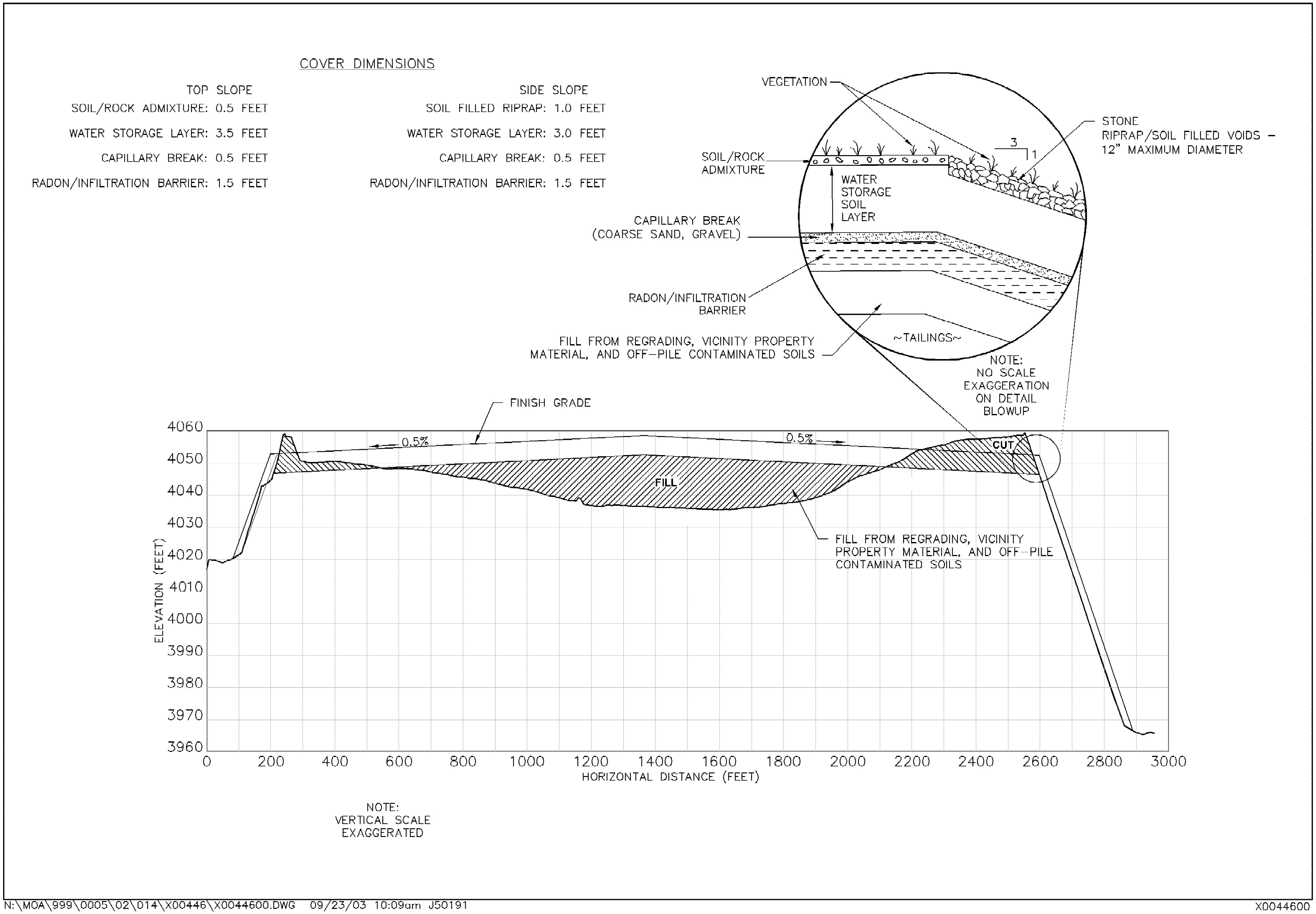


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Figure 2–6. Typical Cross-Section of the Disposal Cell, On-Site Disposal Alternative

Placement of the capillary break sand/gravels and the water storage soil layer above the radon barrier would follow, using a similar procedure. Erosion control stone riprap would be the final layer placed on the side slopes. After the required thickness of riprap was placed on the side slopes, interstitial voids in the riprap would be loosely filled with soils and seeded with native or adapted plant species. A riprap-filled toe apron would provide erosion protection at the toe and prevent destabilizing of the impoundment. DOE would determine riprap sizing and durability following procedures outlined in the *Technical Approach Document* (DOE 1989). Riprap sizing requires knowledge of flow velocity, which will be obtained by verifying initial velocities identified in a recent USGS study (USGS 2005).

Construction of the remainder of the top slope cover would be similar to that of the side slope with the exception of the erosion protection layer. The top slope would use a soil/rock admixture for initial erosion protection. Rocks would be spread on the surface of water-balance soils and mixed into it. The rock admixture would provide additional erosion protection and cover vegetation growth medium.

More detailed descriptions and technical discussions of the disposal cell cover design concept and borrow materials are provided in Appendix B, "Assumed Disposal Cell Cover Conceptual Design and Construction," and Section 2.1.3.1.

2.1.1.4 Site Reclamation

When the disposal cell construction is completed, recontouring and revegetating, where needed to limit erosion, would be performed to reclaim the area outside the cell. Native plant species would be used to revegetate the site. Clean reclamation soil (320,000 yd^3) would be applied to an average depth of 6 inches over the area outside the cell to meet the radium-226 subsurface soil standard of 15 pCi/g above background averaged over a 1,076-ft^2 area. The standard would apply regardless of future land use decisions.

A buried riprap diversion wall would also be constructed along the Colorado River as proposed by Atlas Corporation and approved by NRC (Figure 2–3). The buried riprap diversion wall would be constructed from relatively large riprap (12- to 36-inch diameter). Although DOE's assessment of river migration (DOE 2003a) suggests that this diversion wall would not be required, it would provide additional assurance that the design life of the cell could be met. The length and design of the wall would be addressed at the conceptual design stage.

2.1.2 Characterization and Remediation of Vicinity Properties

Because of the range of variables and uncertainty associated with Moab site vicinity properties (e.g., their exact number, size, location, and extent of contamination), the specific actions that DOE proposes to take at each property would necessarily vary. The following sections provide a general overview of the activities that DOE would undertake to survey, characterize, and remediate Moab site vicinity properties. Data obtained from characterization of the Moab site suggest that vicinity properties surrounding the site will contain contamination requiring remediation. These properties include portions of state highway and railroad rights-of-way, BLM property, and Arches National Park.

Properties in the vicinity of the Moab millsite (Figure 2–7) that can be confirmed to be contaminated with residual radioactive materials (RRM) would be eligible for inclusion in the

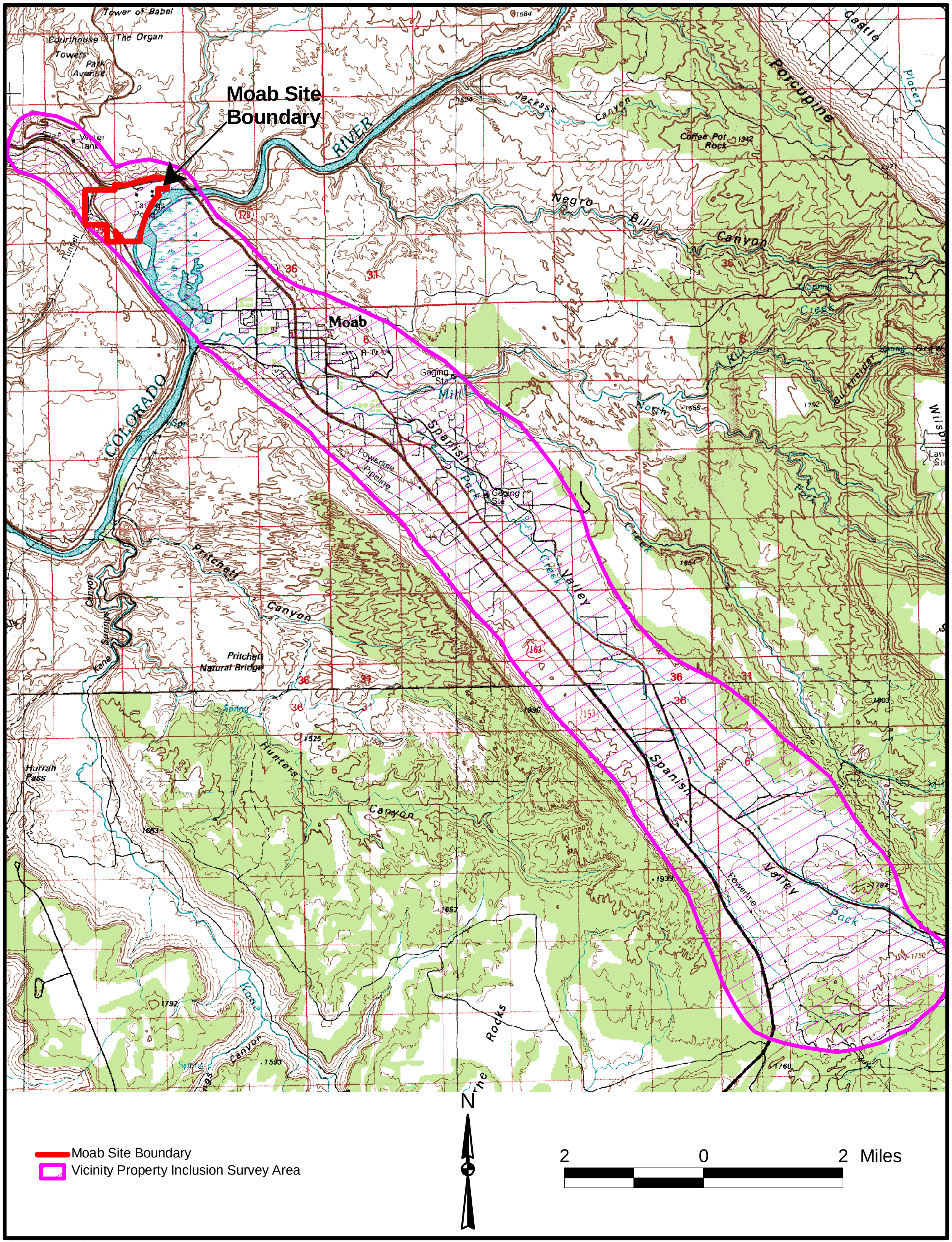

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Figure 2–7. Vicinity Property Inclusion Survey Area vicinity property program. For the purposes of this program, RRM contamination is intended to be restricted to materials directly related to the milling process and is not intended to include uranium or vanadium ores or other naturally occurring radioactive materials not directly related to the milling process.

Conceptually, ores or other naturally occurring radioactive materials not directly related to the milling process would not be eligible for remediation under this program unless it could be demonstrated that these materials are inextricably mixed with RRM.

Unless specifically excluded under EPA's supplemental standards (40 CFR 192.21), contaminated materials on vicinity properties in which radium-226 concentrations averaged over any area of 1,076 ft^2 (100 square meters) exceed the background level by more than 5 pCi/g averaged over the first 6 inches (15 cm) of soil below the surface and 15 pCi/g averaged over 6-inch-thick (15 cm) layers of soil more than 6 inches (15 cm) below the surface (40 CFR 192.12) would be hauled by truck from the vicinity property to the Moab site. These materials would be unloaded in a vicinity property material stockpile area (see Figure 2–5) pending final placement in the disposal cell. DOE estimates that approximately 2,940 trips using 10-yd^3 dump trucks would be required, each averaging approximately 4 miles one way to the Moab site. The trips would generally involve using residential streets to access US-191 and established haul routes to the Moab site. If necessary, trucks would be decontaminated at both the vicinity property and at the millsite. An equivalent volume of fill material and truck traffic from the LeGrand Johnson borrow area (located in Spanish Valley) would be required.

A detailed outline of the remedial action process is provided in the *Vicinity Properties Management and Implementation Manual* (VPMIM) (DOE 1988). DOE intends to work with NRC to update the procedures in the VPMIM to reflect lessons learned from the Grand Junction, Colorado, and Monticello, Utah, vicinity property programs and amendments to UMTRCA. An example of lessons learned would be establishing the protocol for evaluating and mitigating elevated radon levels in structures after completion of remedial action. In the past, NRC did not require its approval of individual radiological and engineering assessments (REAs) as long as the VPMIM was followed, unless they involved supplemental standards. DOE intends to continue this practice.

2.1.2.1 Survey and Characterization

DOE would identify properties to be surveyed and radiologically characterized to determine their eligibility for remediation. By definition, DOE would designate the 130 properties identified in EPA's 1971 survey (EPA 1971) as vicinity properties, provided contamination on a property meets the regulatory definition of RRM. The 1971 survey used a mobile gamma scan procedure. A field team investigated gamma anomalies on a property after the property owner granted access. The survey team tried to identify the source of the contamination and whether it was from tailings, ore, or other radioactive materials.

For the purpose of identifying the scope of the vicinity property program, a specified area is proposed for DOE to perform additional gamma radiation surveys (see Figure 2–7). DOE proposes to limit surveys to the 130 designated properties and to properties within the area shown in Figure 2–7 whose owners request a survey. DOE would advertise through the newspaper and other media that a vicinity property program was being conducted and that owners should contact DOE for gamma surveys. However, DOE would also consider requests from other individuals or entities if they could demonstrate that contaminated material might be on their property and that it might be tied to Moab millsite activities. Prior to gamma survey work, DOE would obtain the consent of the property owner for access as provided under UMTRCA.

Characterizations would include gamma surveys, soil samples, and radon daughter concentration measurements. A summary of the characterization data and remediation design would be documented in an REA. Results of these characterization studies would be used to determine which properties require mitigation and remediation to meet the standards of 40 CFR 192.

2.1.2.2 Remediation

After the characterization process, remediation would involve execution of a remedial action agreement (RAA), contracting, health and safety planning, excavation, transportation, restoration, preparation of a completion report, certification, and document transfer/archiving. DOE would obtain an RAA from each property owner whose property required remedial action. Each RAA would describe a plan for remedial action based on the selected option in the final REA. It also would provide assurance that the property would be restored to its pre-remedial action condition to the extent practicable, a release of liability to DOE from the owner, and if required, provisions for dislocation and temporary relocation and reimbursement costs for the property owner or tenant. An RAA would also provide that DOE would obtain title to the RRM removed from the property.

From experience with Monticello and Grand Junction vicinity properties, DOE assumes that up to 98 of the currently identified 130 Moab vicinity properties may require remediation, and that the average Moab vicinity property remediation would involve 300 yd^3 of contaminated material and would disturb 2,500 ft^2 of surface area. Using the average remediation volume and an estimate that 98 properties would be included, DOE estimates that approximately 29,400 yd^3 (about 39,700 tons) of contaminated material would be remediated. Should additional properties in the proposed inclusion survey area be identified, it is assumed that the effort and volumes would increase proportionally.

Alternatives for remedial action would depend on the number of properties where contaminant concentrations exceed EPA standards, the complexity of the properties, the levels of congressional funding, and the length of time the disposal cell remained open. DOE estimates that remedial actions would be conducted at a rate of 33 to 98 properties per year, or for a period of about 1 to 3 years.

At 300 yd^3 per property, 30 trips per property averaging 4 miles to the Moab site would be required. Trucks would be tarped and decontaminated before leaving a property. A typical route would be one-half mile along residential streets and an average 3.5-mile trip through town on US-191. The equivalent number of trips for backfill material (sand, loam, silty loam) would also be required. Dust suppression would normally not be required due to the small size of the excavations; however, a water truck would be used as needed to control dust and supply compaction water.

DOE estimates that a typical vicinity property remediation would take 4 to 6 weeks to remove tailings, replace with backfill, and restore landscaping. A standard workweek of 10 hours per day, 4 to 5 days per week, would be used. Longer days could be used occasionally to accommodate a special need, such as a concrete pour. If remediation of all 98 vicinity properties were completed in 1 year (250 days), it could require up to 24 daily round trips on US-191 transporting vicinity property material to the Moab site and backfill material to the remediated properties.

After remediation was complete, DOE would develop the completion report documenting that the property was remediated to EPA standards in 40 CFR 192 and issue a certification to the owner if the standards were met.

2.1.2.3 Residual Radioactive Materials Combined with Other Hazardous Components

RRM combined with other hazardous components could be present on some vicinity properties. Other hazardous components on vicinity properties that are combined with RRM would not usually be considered related to the uranium milling process; therefore, these other hazardous components would not be considered RRM. Consequently, the non-RRM hazardous component of this combined waste could be subject to regulation by the Resource Conservation and Recovery Act (RCRA) or the Toxic Substances Control Act (TSCA). This type of combined vicinity property waste was historically referred to as “commingled waste” under the UMTRA Project. For the purpose of establishing a planning basis for waste management analysis in this EIS, DOE has assumed that all commingled waste would ultimately be approved for management and disposal as RRM and would be disposed of in the selected disposal cell. However, if it were determined at a later date that RCRA or TSCA provisions apply to the non-RRM hazardous component of commingled waste, such waste would not be transported directly to the Moab site. DOE would evaluate various potential disposal paths, including treating the commingled waste to render the hazardous component nonhazardous, disposing of the commingled waste in a facility licensed for radioactive mixed waste, or leaving the commingled waste on the vicinity property by implementing supplemental standards in accordance with 40 CFR 192.21.

It could take several additional weeks or months to characterize and remediate a property with commingled waste. The additional time could be required because of the need for DOE decisions regarding the most feasible, cost-effective disposal path; laboratory analyses for characterizing the commingled waste; or treatment of the commingled waste.

DOE does not expect significant quantities of commingled waste on the Moab vicinity properties. A waste management plan for characterization and remediation of commingled waste would be prepared and implemented before remediation of the vicinity properties.

2.1.2.4 Applicable Regulations

DOE anticipates that a U.S. Department of Transportation (DOT) exemption, similar to that obtained for the DOE UMTRA and Monticello Projects, would allow exemption from certain regulations pertaining to the hauling of uranium and thorium mill tailings, soils, and other materials contaminated with low levels of RRM from vicinity properties. This exemption is described in further detail in Section 2.2.4.1.

Most indoor remedial action would require local building permits. These and other local permits would be obtained as necessary. Larger remediations may require storm water control permits, which would typically result in some level of management. Any anticipated disturbance of wetlands or floodplains would follow floodplain and wetland environmental review requirements in 10 CFR 1022, applicable state stream bank alteration permit requirements, or U.S. Army Corps of Engineers 404 permit requirements. Most vicinity properties do not involve discharges of water because excavations do not generally intersect the water table.

2.1.3 Construction and Activities at Borrow Areas

Five different borrow materials obtained from off-site locations would be used to construct the disposal cell cover and to reclaim site surface areas after completion of remediation: cover (moisture storage) soils, radon/infiltration barrier soils, capillary break in the form of sand and gravel, riprap, and reclamation soils. These materials would be excavated from several potential borrow areas and transported in transport trucks to the Moab site, where they would first be stockpiled in an uncontaminated borrow material staging area, then used for cover construction or surface reclamation.

Table 2–1 lists the borrow materials and the potential source locations where they could be obtained for both the off-site and on-site disposal alternatives; the source locations are based on a review of area soil maps and commercial quarries. Figure 2–8 illustrates the potential source locations of borrow materials. The Tenmile, Courthouse Syncline, and Blue Hills Road cover soil borrow areas are near, but not on, the Klondike Flats site, which is discussed in Section 2.2. For purposes of impact analysis in this EIS, Floy Wash, as the site farthest from most alternatives, has been used as the representative soil source for transportation impact assessment for Moab, Klondike Flats, and Crescent Junction alternatives. Final selection of borrow areas would occur after a disposal site is selected in the ROD, and after further borrow area evaluations and consultations with, and permitting from the BLM.

Table 2–1. Borrow Materials and Potential Source Locations

Borrow Material	Potential Source Location
Cover Soils	Floy Wash borrow area Crescent Junction borrow area Tenmile borrow area (near Klondike Flats site) Courthouse Syncline borrow area (near Klondike Flats site) Blue Hills Road borrow area (near Klondike Flats site) White Mesa Mill borrow area
Radon/Infiltration Barrier Soils	Crescent Junction borrow area Klondike Flats site
Sand and Gravel	LeGrand Johnson borrow area
Riprap	Papoose Quarry borrow area Blanding borrow area[a]
Reclamation Soils	Floy Wash borrow area

[a] Source for White Mesa Mill only.

Section 2.1.3.1 describes standards and requirements that would apply to the borrow materials, and Section 2.1.3.2 describes the borrow material excavation procedures that would be used, including transportation routing alternatives, distances, durations, and logistics to transport the borrow materials to the Moab site.

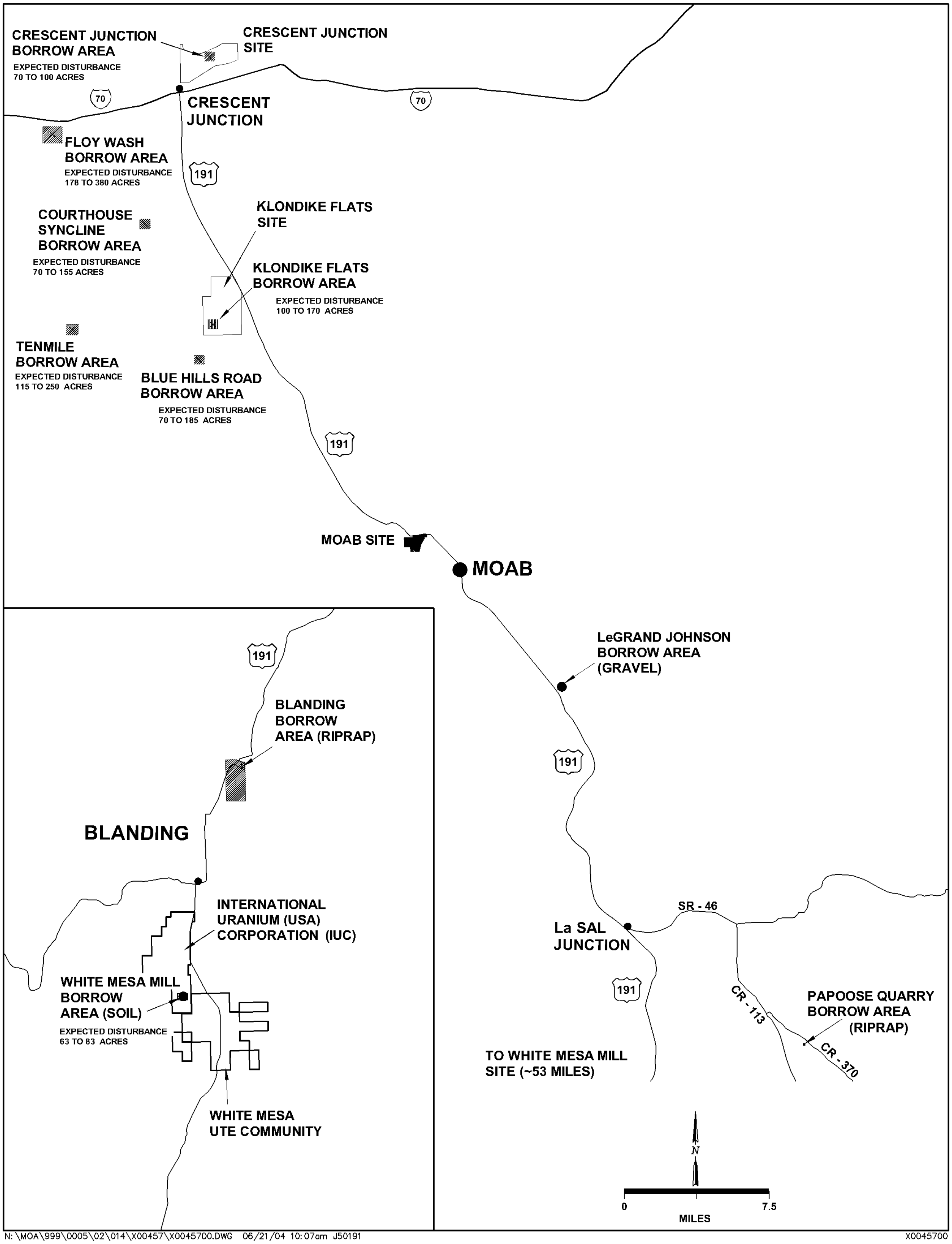

Figure 2–8. Borrow Areas

2.1.3.1 Borrow Material Standards and Requirements

Riprap

Riprap is an outer layer of stone that would serve as an armor to protect the inner layers of water storage soil, capillary break sand and gravel, and radon barrier soil from the erosive effects of wind, precipitation, and flooding. The riprap would meet the NRC durability requirements in NUREG-1623, *Design of Erosion Protection for Long-Term Stabilization* (NRC 2002). Appendix D of NUREG-1623 notes that the principal objective in determining the riprap durability requirements for stabilized side slopes of embankments is to provide a material that meets long-term design requirements. Because the most disruptive event for these designs is likely to be gully erosion, it is important to provide a rock layer that would minimize the potential for gully erosion, which, once started, may worsen and continue unchecked. The Papoose Quarry borrow area listed in Table 2–1 has been sampled and tested by DOE for use at the Monticello disposal cell to verify that the material would meet the durability requirements of NUREG-1623. The nominal diameter of the riprap used to stabilize the disposal cell would be sized to exceed the maximum river forces recently identified by the USGS. In addition, the barrier wall would be of sufficient length and robustness to mitigate river migration into the pile.

Cover Soils

The primary function of the borrow soils used to construct the disposal cell's water storage soil layer would be to minimize infiltration of water to the underlying materials. The water absorption characteristics of these soils would result in water being retained in the soils when plants are dormant. During the growing season, vegetation in the overlying soil/rock admixture or riprap layers would extract stored water and return it to the atmosphere. Consequently, the amount of water that permeates downward would be minimized.

Types of cover soils best suited to this purpose have been selected on the basis of their water-holding and rooting characteristics. Three U.S. Department of Agriculture soil textures—loams, silt loams, and clay loams—would provide the best storage capacities (Stormont and Morris 1998). Potential soil borrow areas have been selected on the basis of availability of these soil types and on logistics and impacts considerations. These soil types would also be used as reclamation soils in all areas of land disturbances.

Sand and Gravel

The primary function of the coarse sand and gravel (capillary break) layer in the disposal cell cover would be to minimize downward movement of water under saturated conditions. The coarse sand and gravel layer would be placed under the finer-grained water storage layer and above the radon barrier soils. The capillary layer would limit downward water movement and increase the water storage capacity of the water storage layer. High tension in the small pores of the fine-grained water storage layer would impede movement of water into the larger pores of the underlying sand and gravel.

Other sand and gravel would be mixed with soil to form the disposal cell's top layer, which would control erosion and provide a matrix for plant growth. The material would meet the same NRC NUREG-1623 durability standards cited for riprap.

Radon/Infiltration Barrier

The radon barrier is a compacted soil layer of clay that would be placed directly above the tailings and contaminated materials to control radon release and limit water infiltration. Clayey soils would be derived from weathered Mancos Shale in the Klondike Flats and Crescent Junction borrow areas. The thickness of the radon barrier would be based on calculations of radon flux using the computer program RADON (NRC 1989). RADON would be applied in an iterative procedure to determine the compacted soil layer thickness that would prevent the annual average radon flux from exceeding 20 picocuries per square meter per second (pCi/m^2-s).

Moab Site Reclamation Soil

Clean, fine-grained, silty- to sandy-loam reclamation soil assumed to come from the Floy Wash borrow area would be used to backfill the entire Moab site to an average depth of 6 inches and to backfill pond areas. The reclamation soil would be used to meet the radium-226 subsurface standard of 15 pCi/g above background averaged over a 1,076-ft^2 area, which would apply regardless of any future land use.

2.1.3.2 *Borrow Material Excavation and Transport Operations*

Cover Soil and Radon Barrier Soil Areas

The procedures used to excavate and transport cover soils and radon barrier soils would be similar regardless of the borrow area selected. The excavation would require dozers to scrape and stockpile the soil, front-end loaders to load trucks from the stockpile, and tandem trucks to transport the material.

The general construction sequence at soil borrow areas would be as follows:

1. Access road upgrades would be required for three of the soil borrow areas: Tenmile (4.5 miles, approximately 9 days construction time), Courthouse Syncline (4.5 miles, approximately 9 days construction time), and Klondike Flats (2.0 miles, approximately 4 days construction time). The duration of road upgrade construction would depend on the extent of the required upgrade and roadbase delivery schedules. DOE estimates that 4 inches of roadbase would be required over the length of the access road and that 0.5 mile of road would be upgraded per day. For the purpose of this EIS, it has been assumed that the roadbase would be delivered from the LeGrand Johnson borrow area located in Spanish Valley.
2. A temporary office trailer and portable toilet would be located at the borrow area. DOE does not expect that utility hookups would be required. Water trucks would be used for dust suppression and would obtain the water from the Colorado River via the Moab site water storage ponds for the Moab, Klondike Flats, and Crescent Junction sites or from deep wells or Recapture Reservoir at White Mesa.
3. Approximately 1 ft of topsoil would be stripped along with clearing and grubbing debris from approximately one-third of the total area that would be disturbed, and the topsoil would be reserved in piles no more than 3 ft high. This topsoil would later be used to reclaim the borrow area.

4. Excavation and removal of borrow materials would be continuous over the course of approximately 1 to 2 years. Dozers would scrape the borrow soil into stockpiles that would subsequently be loaded onto trucks with front-end loaders. DOE estimates that local truckers would transport the materials and that a fleet of approximately 28 trucks would be used.
5. At the Moab site, the borrow soils would first be stockpiled in an uncontaminated area. As construction of the disposal cell cover proceeded and schedule dictated, soils would be taken from the uncontaminated stockpile area and deposited at the base of the disposal cell for emplacement or for interim storage. This process of excavation and transportation to the Moab site would continue until the required volume of borrow soil had been removed.
6. The disturbed borrow area would be reclaimed with the set-aside topsoil and reseeded with native vegetation.

Commercial Quarries

Riprap and sand and gravel excavation and hauling operations at commercial quarries would be governed by the quarry operator’s standard operating procedures. Riprap for the on-site disposal alternative would be obtained from the Papoose Quarry borrow area in Lisbon Valley. It has been assumed that sand, gravel, and road base would be obtained from the LeGrand Johnson borrow area (Gravel Pit) in Spanish Valley. The stockpiling procedures at the Moab site for riprap, sand, and gravel would be similar to those for borrow soils.

Transport Truck Traffic Density

Assuming implementation of the 1-year top slope cover construction option, borrow material transportation would be ongoing for approximately 3.75 years (1,313 days) (Figure 2–4). DOE estimates that the transport of borrow materials would require 43 daily round-trips (shipments) from borrow areas to the Moab site. Table 2–2 shows the estimated daily round-trips, total volume, and total shipments for each of the five types of borrow material. Table 2–3 illustrates the highway segments that could be used to transport them to the Moab site. If the less aggressive 2-year top slope cover construction schedule were implemented, borrow material transport would be ongoing for approximately 4.75 years, and the daily trips shown in Table 2–2 and Table 2–3 would be reduced by approximately 25 percent. As shown in Table 2–1, there are several optional borrow areas for obtaining cover soil. Table 2–3 assumes that all cover soils would come from the Floy Wash borrow area (as would all Moab site reclamation soil) . This option would generate the most traffic on public highways.

Table 2–2. Summary Logistics for Borrow Material Transportation

Borrow Material	Daily Round-Trips (1-year Top Slope Cover Construction Option)[a]	Total Volume (yd^3)	Total Shipments
Cover soils	19	826,000	25,030
Radon/infiltration barrier soils	9	365,000	11,200
Sand and gravel	3	119,300	4,200
Riprap	5	140,000	6,363
Site reclamation soils	7	320,000	9,670
Total	**43**	**1,770,300**	**56,463**

[a] Assumes one shift operating 12 hours a day, 7 days a week would require approximately 3.75 years to complete transportation of the borrow materials.

Table 2–3. Borrow Material Transportation Segments and Distances

Highway	Segment	Material	Distance	Daily Round-Trips (1-year Top-Slope Cover Construction Option)[a]
Interstate 70	Floy Wash to Crescent Junction exit	Floy Wash soils[b]	7 miles	26
U.S. Highway 191	Crescent Junction exit to Moab	Floy Wash soils[b]	28 miles	26
	Klondike Flats to Moab	Radon barrier soils	18 miles	9
		Segment Total	–	35
	La Sal Junction through Moab	Papoose Quarry riprap	22 miles	5
	Spanish Valley through Moab	LeGrand Johnson sand & gravel	6 miles	3
		Segment Total	–	10
Lisbon Valley Road and Utah Route 46	Lisbon Valley to La Sal Junction	Papoose Quarry riprap	6 miles	5

[a] Assumes one shift operating 12 hours a day, 7 days a week would require approximately 3.75 years to complete transportation of the borrow materials.
[b] Includes cover soils and site reclamation soils.

2.1.4 Monitoring and Maintenance

DOE would have responsibility for long-term monitoring of the Moab site after completion of remediation and reclamation activities. Monitoring and maintenance of the Moab site after completion of site remediation would be in accordance with the site's Long-Term Surveillance and Maintenance Plan. The site is a Title I UMTRCA site and falls under NRC's general license pursuant to 10 CFR 40.27. For the license to become effective, NRC must accept the site's Long-Term Surveillance and Maintenance Plan.

As discussed in Section 1.4.5, release of portions of the site for future uses would depend on the success of site remediation. DOE's ultimate goal would be to remediate to unrestricted surface use standards. However, DOE would defer its decisions on the release and future use of the Moab site pending an evaluation of the success of surface and ground water remediation.

Monitoring and inspections would pay particular attention to identifying any lateral stream cutting or migration of the Colorado River. Areas around the buried riprap diversion wall and along the toe of the impoundment would be inspected for erosion. The buried riprap diversion wall would be constructed from relatively large riprap (12- to 36-inch diameter) that would fall into, and fill, voids caused by soil erosion. However, if a soil erosion problem were observed, the eroded area would be remedied by refilling the area with soil, and repairing riprap as necessary.

2.1.5 Resource Requirements

The following sections describe the major resource requirements for the on-site disposal alternative. Where appropriate, resource availability is also discussed.

2.1.5.1 *Labor*

The on-site disposal alternative would require work to be performed at the Moab site, including infrastructure requirements and all the activities required to physically shape the existing tailings pile, construct the cover, and reclaim the site. It would also require work at the vicinity properties and borrow areas. Table 2–4 shows the annual average labor requirements based on a 12-hour work shift option working 7 days per week (4 to 5 days per week for vicinity properties), 350 days per year.

Table 2–4. Average Annual Labor Requirements—On-Site Disposal Alternative

Worker Category	Activity Location			Total
	Moab Site	Vicinity Properties	Borrow Areas[a]	
Equipment operators	18	6	1	25
Site support	13	4	4	21
Truck drivers	4	3	41	48
General labor	12	10	4	26
Total workforce	**47**	**23**	**50**	**120**

[a] Borrow operations would require minimal equipment operators to accommodate haul trucks because of the length and duration of travel between the source and point of use.

2.1.5.2 *Equipment*

The on-site disposal alternative would require equipment to be operating at the Moab site, vicinity properties, and borrow areas, and truck transportation between these areas. Table 2–5 represents the annual average equipment requirements based on a 12-hour work shift option working 7 days per week (4 to 5 days per week for vicinity properties), 350 days per year.

Table 2–5. Average Annual Equipment Requirements—On-Site Disposal Alternative

Equipment Type	Activity Location			Total
	Moab Site	Vicinity Property	Borrow Area	
Tractor	1	–	–	1
Backhoe	2	1	–	3
Grader	3	–	–	3
Trackhoe	–	–	–	–
Front-end loader	1	1	1	3
Water truck	2	1	1	4
21 yd^3 scrapers	2	–	–	2
Dozer	2	–	–	2
Sheepfoot compactor	1	–	–	1
Smooth drum roller	1	–	–	1
Pickup truck	2	2	3	7
End dump truck	1	1	–	2
Skidsteer	–	2	–	2
Tandem truck	–	–	28	28
Total	**18**	**8**	**33**	**59**

2.1.5.3 Land Disturbance

Moab Site and Vicinity Properties

The on-site disposal alternative would disturb approximately 439 acres at the Moab site and 6 acres at vicinity properties.

Borrow Areas

Estimates of required volumes of borrow material are shown in Table 2–2. The range of estimated areas of land disturbance at potential borrow areas is shown in Table 2–6. This table shows all potential borrow area disturbances; however, not all these areas would be used. Final decisions would be based on additional surveys. For the purpose of assessing impacts, DOE estimates that the range of disturbed borrow area land for this alternative would be 140 to 550 acres, depending on the final selection of the borrow area source for cover and reclamation soils and on the final depth to which these soils could be excavated. This estimate excludes disturbances to privately operated commercial quarries that would provide sand/gravel and riprap.

Table 2–6. Estimated Area of Disturbed Land at Borrow Areas

Borrow Material/Area	**Estimated Area of Disturbance (excavated acres or quarried volumes)**	**Estimated Available Area/Volume**
Cover and Reclamation Soils		
Floy Wash	178–380 acres	1,035 acres
Crescent Junction	70–100 acres	4,925 acres
Tenmile	115–250 acres	1,480 acres
Courthouse Syncline	70–155 acres	4,925 acres
Blue Hills Road	70–185 acres	900 acres
Radon Barrier		
Klondike Flats	100–170 acres	10,000 acres
Crescent Junction	70–100 acres	4,925 acres
Sand and Gravel		
LeGrand Johnson	43,000–140,000 yd^3	13,000,000 yd^3
Riprap		
Papoose Quarry	185,000–257,000 yd^3	3,500,000 yd^3
Blanding	8–10 acres[a]	1,355 acres
Soils and Clay		
White Mesa Mill site	63–83 acres	300,000–400,000 yd^3

[a] Assumes rock thickness of 12 ft at borrow area.

2.1.5.4 Fuel

DOE estimates that the on-site disposal alternative would require an annual average of 820,000 to 830,000 gallons of diesel fuel, depending on the top slope cover schedule implemented, and that total fuel consumption for the project would range from 4 million to 5 million gallons.

2.1.5.5 Water

Potable water would be required for drinking, washing, toilets, contaminated clothing laundering, and other uses and would be purchased from the City of Moab. Nonpotable or construction water would be required for dust control, earth compaction, equipment decontamination, and other uses and would be derived from DOE's Colorado River water rights. DOE estimates that the total potable water requirement for the on-site disposal alternative would be 4,200 gallons per day, or approximately 30 gallons per day per worker. DOE estimates that the average annual nonpotable water requirement would be 70 acre-feet, or a project total of approximately 490 acre-feet assuming a 7-year project duration.

2.1.5.6 Solid Waste Disposal

The on-site disposal alternative would generate approximately 1,040 yd^3 of uncontaminated solid waste per year. The solid waste would be disposed of in the Grand County landfill.

2.1.5.7 Sanitary Waste Disposal

DOE estimates that the on-site disposal alternative would result in the generation of approximately 10,000 gallons of sanitary waste per week, or approximately 1,430 gallons per day, assuming a 12-hour shift. Septic holding tanks connected to bathrooms in the trailers would be placed at the Moab site along with portable toilets used to provide sanitary waste service. Both the septic tanks and the portable toilets would be pumped out routinely and disposed of at the city of Moab sewage treatment plant.

2.1.5.8 Electric Power

DOE estimates that under the on-site disposal alternative, the existing electrical service at the Moab site would be required to support an estimated maximum demand of 600 kilovolt-amperes (kVA). The primary demands for this power would be:

- Conversion of the mill building to a vehicle/equipment maintenance shop.
- Field office trailers.
- Office and parking lot security lighting.
- River pump station.
- Decontamination water sprays and recycle pumps.

2.2 Off-Site Disposal Alternative

The off-site disposal alternative would entail excavating and relocating the entire Moab site tailings pile, other contaminated on-site material, and all contaminated material from vicinity properties to one of three alternative off-site disposal cells that would be constructed specifically as a permanent repository for these materials. The three proposed off-site disposal alternatives DOE is evaluating are Klondike Flats and Crescent Junction, which are north of the Moab site, and the White Mesa Mill site to the south. Figure 2–9 shows the Moab site and the three potential disposal sites. DOE is also evaluating three alternative modes of transportation to move

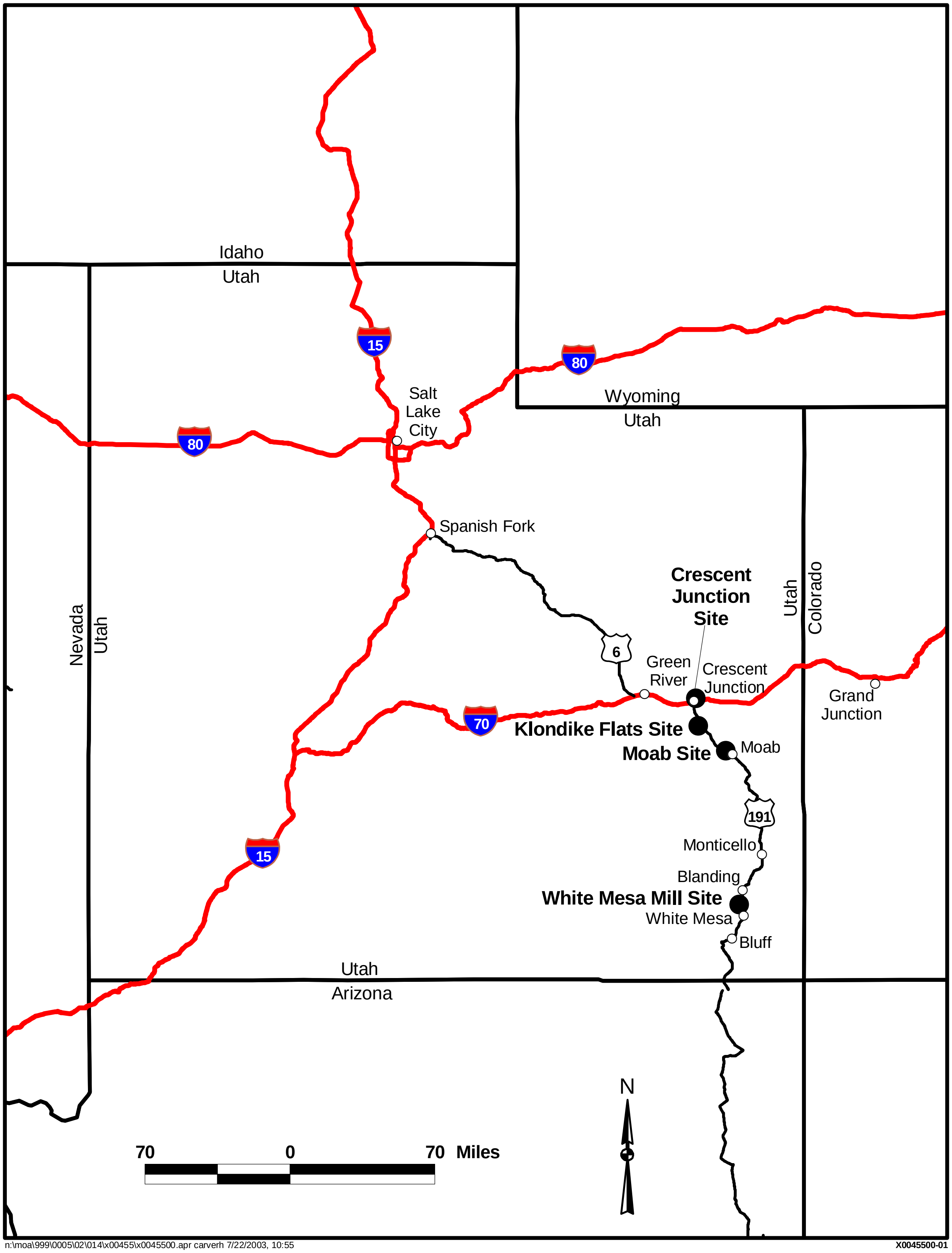

Figure 2–9. Site Location Map

the material to the off-site disposal cell: truck, rail, and slurry pipeline; however, as described further in Section 2.5.2, rail transport is not an option for the White Mesa Mill site. Contaminated material from vicinity properties would first be moved to the Moab site, then transported to the off-site disposal location. Contaminated ground water at the Moab site would also be remediated under the off-site disposal alternative as described in Section 2.3.

The major actions associated with implementing the off-site disposal alternative would be:

- Construction and operations at the Moab site (Section 2.2.1).
- Characterization and remediation of vicinity properties (Section 2.2.2).
- Construction and operations at the borrow areas (Section 2.2.3).
- Transportation of contaminated material from the Moab site to the off-site disposal location (Section 2.2.4).
- Construction and operations at the off-site disposal location (Section 2.2.5).
- Monitoring and maintenance of the off-site disposal cell (Section 2.2.6).
- Ground water remediation at the Moab site (Section 2.3).

Resource requirements for remediation activities are discussed in Section 2.2.7.

For the off-site disposal alternative, where pile consolidation time is not a factor, project completion dates under the truck and rail transportation options could be affected by work schedules. Consequently, for these two modes of transportation, DOE considered two work schedules. The single-shift schedule would be one 12-hour shift, 7:00 a.m. to 7:30 p.m., 50 weeks per year. The double-shift schedule would be two 10-hour shifts, 7:00 a.m. to 5:30 p.m. and 5:30 p.m. to 4:00 a.m., 50 weeks per year. These two schedules were considered to allow flexibility in targeting a project completion date. In this EIS, impacts are generally assessed assuming the more aggressive double-shift schedule is implemented. This was done to ensure that certain impacts unique to the double-shift were addressed. For example, night operations under a double shift could entail impacts to night sky vision, noise, and traffic that would not be considerations under a single-shift scenario. The NPS has expressed concern for these factors in relation to Arches National Park. The one difference in these schedules would be that for truck transportation the schedules would run 7 days per week, and for rail transportation the schedules would run only 6 days per week. This difference would be necessary to accommodate railroad requirements that stipulate 1 day per week be allowed for locomotive and track maintenance.

DOE considered only one schedule for the pipeline transportation option because once pumping operations began they would be in progress 24 hours a day. Processed slurry would be stockpiled, and the factor driving the schedule for project completion would be the diameter of the pipe rather than the number of workers excavating the pile. DOE selected the pipe diameter to allow for a schedule roughly the same as the rail and truck transportation single-shift work schedule that estimates project completion in 2012.

Figure 2–10, Figure 2–11, and Figure 2–12 illustrate the estimated schedules for completing the surface remediation activities for the off-site disposal alternative using the three transportation modes. As seen in the figures, the schedules would be similar for all three modes of transportation. Assuming that a ROD is issued in 2005 and that a single-shift work schedule is implemented for truck or rail transportation, remediation work would begin in late 2007 and would be completed in 2012 for all three modes of transportation, regardless of the off-site disposal cell location. Due to uncertainties in tailings material handling and transportation, the project completion date could extend to 2014. This is based on information developed since the draft EIS. Extending the schedule by two years to 2014 would not result in additional impacts to human health or the environment. This is similar to the schedule that would apply for the on-site disposal alternative if the more aggressive 1-year top slope cover construction schedule were used (see Figure 2–4). However, as shown in Figure 2–10 and Figure 2–11, use of a more aggressive double-shift work schedule for the truck or rail transportation modes would expedite completion of the surface remediation activities by approximately 2 years and result in completion of the surface remediation activities in late 2010 or early 2011. The 2-year schedule uncertainty for pile consolidation discussed in Section 2.1 for the on-site disposal alternative would not apply for the off-site disposal alternative.

2.2.1 Construction and Operations at the Moab Site

This section describes construction and operations at the Moab site under the off-site disposal alternative. Ground water remediation at the Moab site is discussed in Section 2.3. The following subsections address three elements: (1) site preparation, infrastructure enhancement, and control, (2) excavation and processing of tailings and other contaminated material, and (3) Moab site reclamation. Figure 2–13 is a Moab site plan illustrating the major site features and approximate locations of temporary on-site areas and facilities that would be used under the off-site disposal alternative.

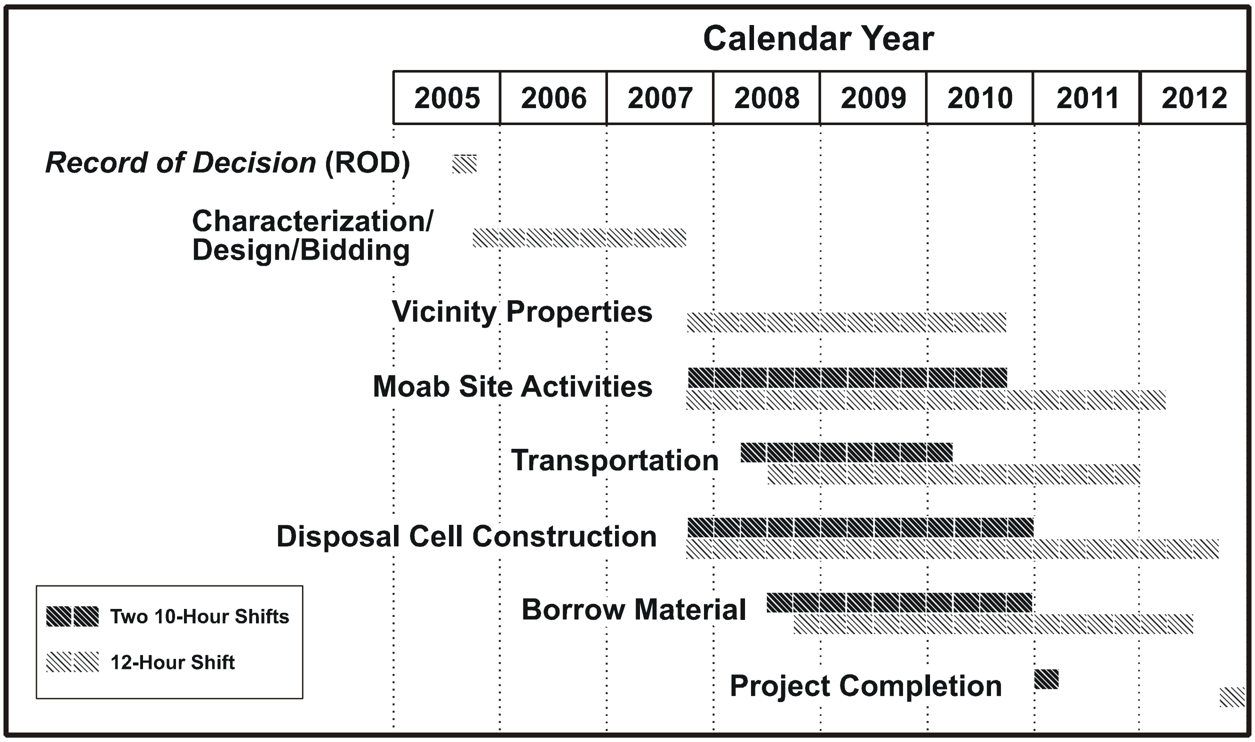

Figure 2–10. Truck Haul Off-Site Disposal Alternative, Surface Remediation Activity Schedule

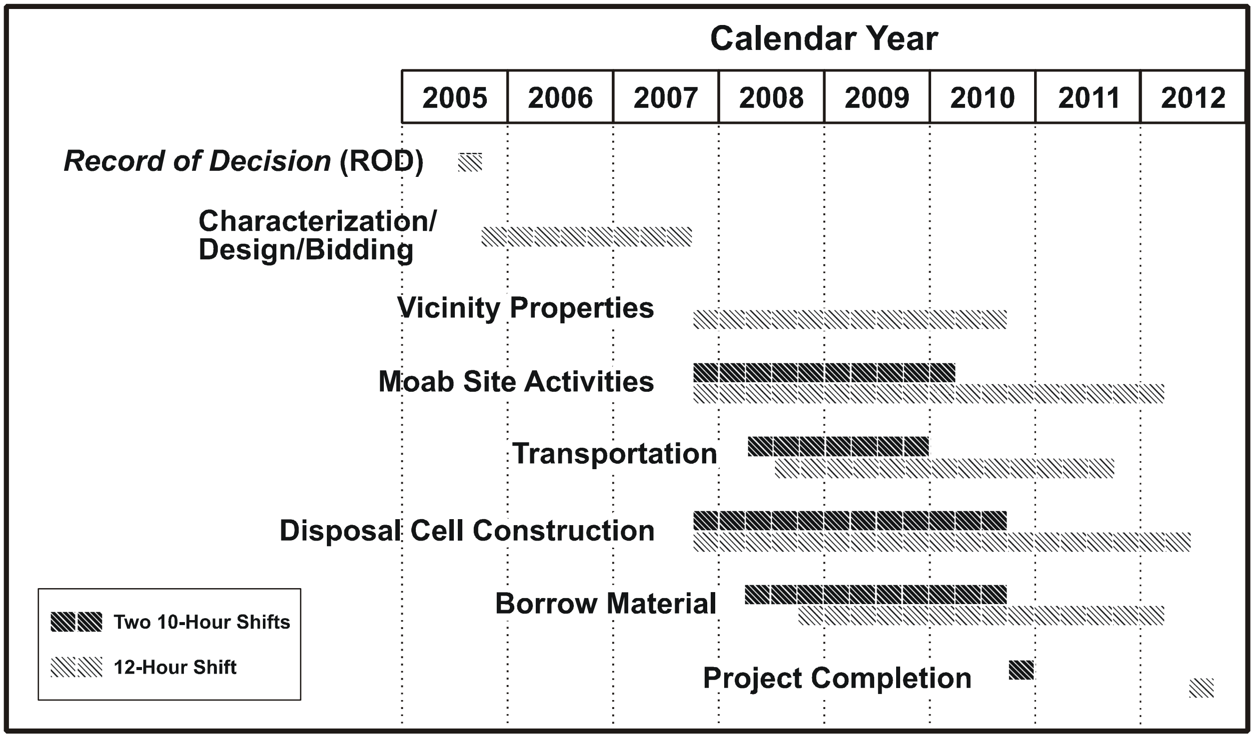

Figure 2–11. Rail Haul Off-Site Disposal Alternative, Surface Remediation Activity Schedule (Project completion may extend to 2014 due to tailings material handling uncertainties)

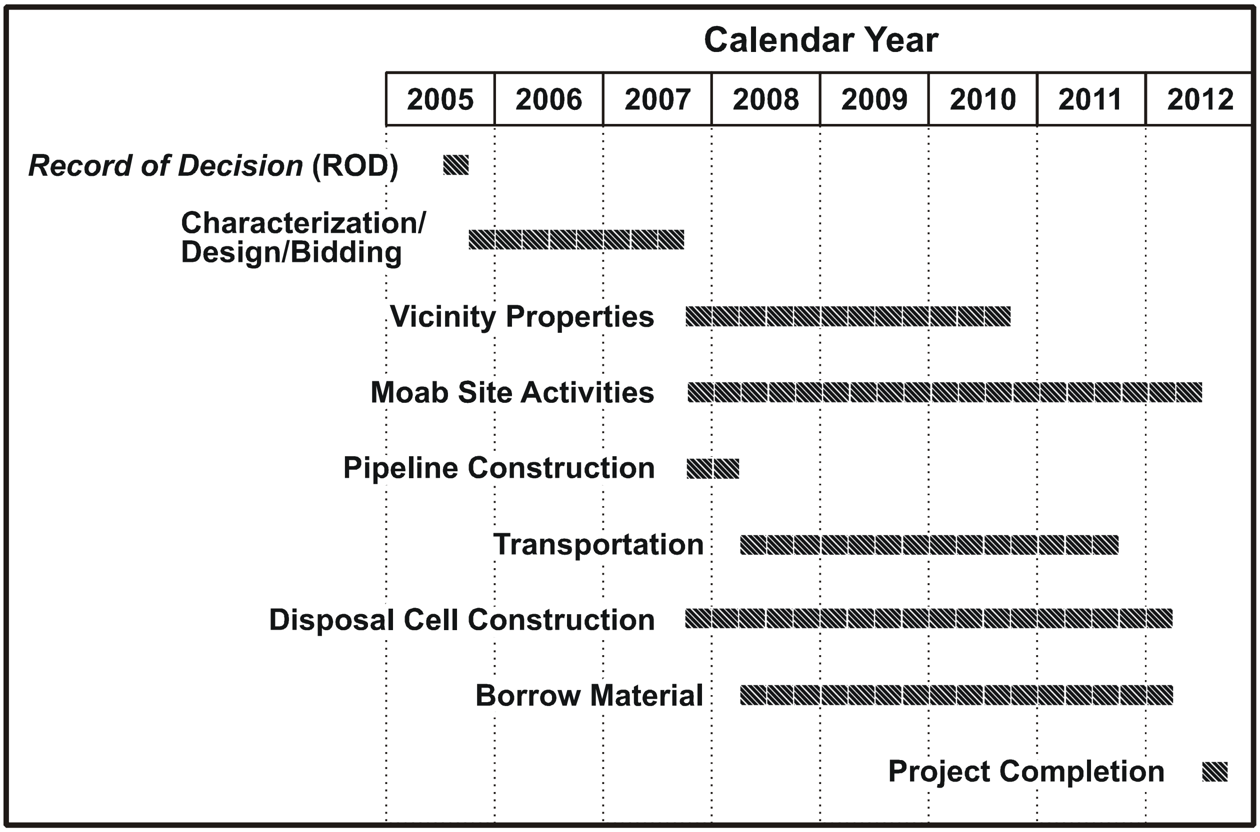

Figure 2–12. Slurry Line Haul Off-Site Disposal Alternative, Surface Remediation Activity Schedule

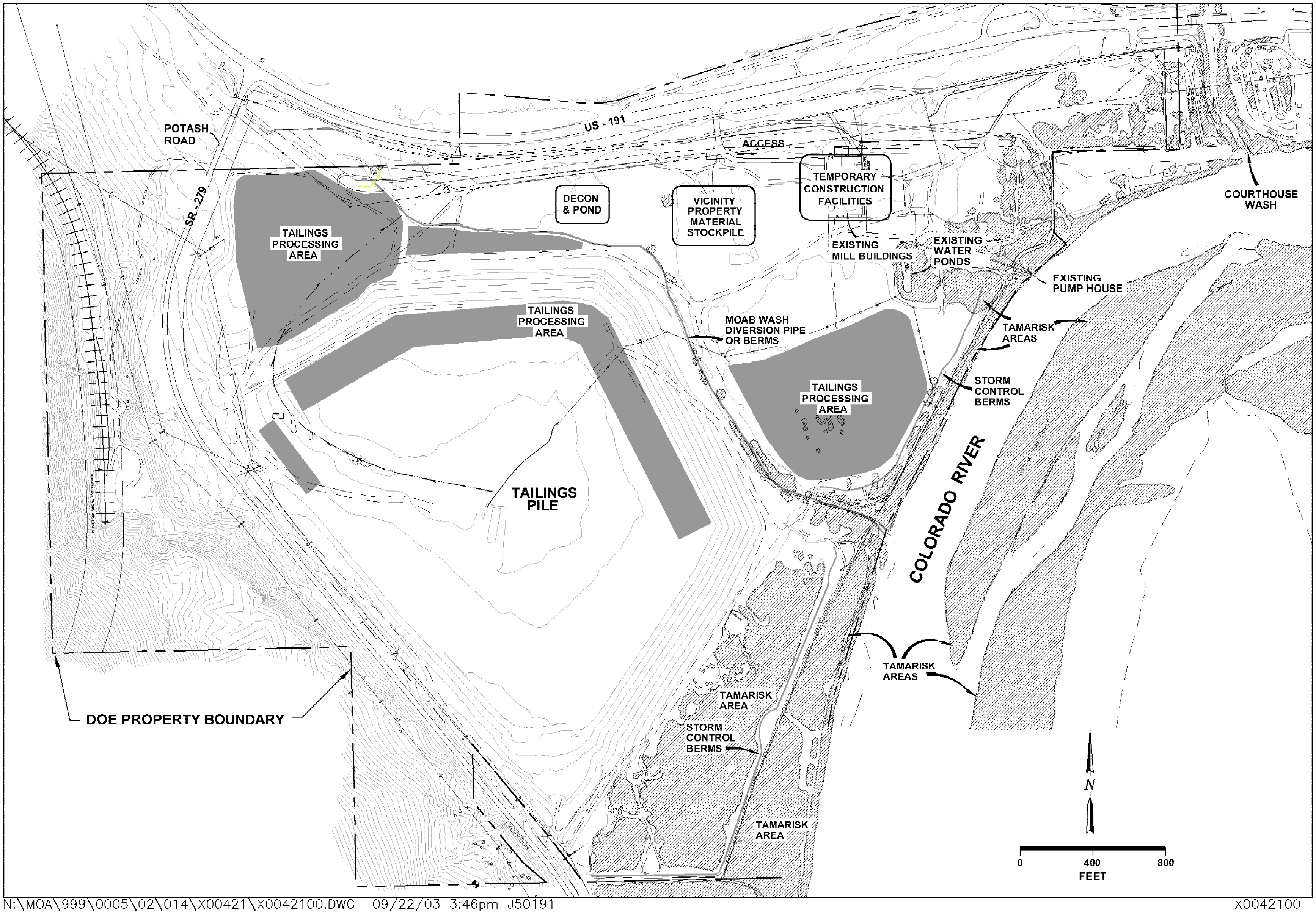

Figure 2–13. Locations of Temporary Moab Site Facilities, Processing (Drying) Areas, and Storm Control Features, Off-Site Disposal Alternative

2.2.1.1 Site Preparation, Infrastructure Enhancement, and Controls

Many aspects of the Moab site preparation, infrastructure enhancement, and controls would be similar to those described in Section 2.1.1.1 for the on-site disposal alternative. The major differences would be associated with the temporary transportation infrastructure, access roads, and vicinity property material storage that would be required for the off-site disposal alternative. As with the on-site disposal alternative, in all instances, new structures or other installed elements would be painted a color to match background soils and/or vegetation in order to minimize visual impacts seen from US-191 or SR-279.

Activities that would be similar or identical to those described in Section 2.1.1.1 include

- Storm water management.
- Dust control.
- Water pumping station enhancements.
- Temporary field offices and staging areas.
- Vehicle maintenance and fuel storage areas.

Temporary Transportation Facilities

Temporary facilities would be necessary to support whichever transportation mode was selected. If the truck option were selected, highway access consisting of an overpass and acceleration and deceleration lanes would be required. If the rail option were selected, a railroad spur and a conveyor system to convey tailings to the railroad cars would be required. If the slurry pipeline option were selected, a pumping station with associated material preparation items would be required. More detailed descriptions of the required temporary transportation facilities that would be constructed at the Moab site are included in Section 2.2.4.

New Access Roads

The existing access road to the Moab site is adequate for only a limited volume of traffic. Construction of approximately 1,000 ft of new access roads to accommodate the added volume of traffic would be required for the off-site disposal alternative. New access roads would be 30 ft wide and gravel-surfaced; therefore, they would not require regular dust control measures. Section 2.2.4 describes the required new or upgraded access roads in greater detail.

Vicinity Property Storage Area

Vicinity property remediation is discussed in Section 2.1.2. Prior to being transported for final disposal, contaminated materials from vicinity properties would be delivered to the Moab site for sizing and processing. These materials would be stored in a vicinity property storage area until ready for processing or transportation.

Radiological Controls

The radiological controls at the Moab site would be structurally and functionally similar to those described in Section 2.1.1.1. One modular trailer would control personnel access to contamination areas. For the truck transportation option, two vehicle/equipment decontamination stations would be constructed: one for vicinity property haul trucks, and a larger one with three to four bays for decontaminating tailings haul trucks. The final size and layout of the facility would reflect the expected volume of truck traffic. For the rail or pipeline options, a single vehicle/equipment decontamination facility would be constructed.

2.2.1.2 Excavation and Preparation of Tailings for Transportation

This section describes the actions that would be necessary at the Moab site to prepare, excavate, and process contaminated material for transportation to an off-site location. This discussion addresses activities up to the time when contaminated materials are loaded into trucks for highway transportation (truck haul transportation alternative) or into the conveyor hopper (rail transportation alternative). The material preparations for truck or rail transport would differ from those for slurry pipeline transport.

Preparation for Truck and Rail Transportation

Before it could be transported by truck or rail, the material in the tailings pile would have to be excavated and dried to a specified moisture content by drying in a process bed and mixing with drier material. For the purposes of this EIS, this drying process has been assumed to bound potential impacts such as air emissions to workers and the public. Approximately 32 acres at the northwest and east base of the pile and an additional 14 acres around the top perimeter of the pile would be used as drying or processing areas. These areas (see Figure 2–13) would be accessed by temporary haul roads. There would be approximately seven separate 6- to 7-acre process beds in the areas. The system would be designed to control a reference 100-year storm event throughout the construction period and would include new or improved berms around the drying beds, drainage ditches and basins, hay bales, sediment traps, and silt fence fabric. DOE has previous experience successfully moving wet tailings, including saturated slimes, at other UMTRCA sites such as at the Riverton (Wyoming), Rifle (Colorado), Monument Valley (Arizona), and Grand Junction (Colorado) sites. The actual method of drying would be developed as part of the engineering design after the ROD and would include controls to prevent contamination of the soils and ground water. Conventional engineering solutions, including a liner for the drying bed or a mechanical system such as a press or centrifuge, would be considered.

Once the process beds and haul roads were constructed, pile excavation would begin. An excavating machine located on the perimeter of the pile would excavate from the center of the pile outward. The excavating machine would drag slimes from the center and pull them over and into the perimeter sands, providing some mixing during the excavation. The coarser tailings sands at the outer perimeter of the pile would be excavated and moved to the process beds using scrapers. This method would allow a progressive top-down excavation sequence that would maintain the stability of the perimeter tailings dike surrounding slimes and also allow continuous use of the perimeter area material for processing.

As saturated slimes were excavated from the center of the pile, the material would be loaded onto trucks and taken to the process beds for mixing and drying. A tractor would turn and dry the graded material until it reached a consistent moisture content suitable for truck or rail transport. Assuming dry tailings were available for mixing with wet tailings, the mixing and drying process for a load of excavated material would take approximately 3 days; if dry tailings were not available for mixing, the material would be processed for 7 days prior to shipment. The approximate maximum daily volume of material that could be placed for processing would be

15,500 yd^3 in each process bed of approximately 6 to 7 acres. Should tailings drying take additional time, slightly greater areas for drying would be necessary to allow sufficient inventory of tailings to be dried and transported according to the planned schedule.

Once the material was sufficiently dry, it would be loaded onto 22-ton tandem trucks (total 44 tons) for off-site shipment if the truck transportation mode were implemented. Alternatively, if rail transport were implemented, the dried material would be transported by a conveyor system and loaded onto waiting gondola cars. After excavation of the pile reached the assumed original grade, it would continue until the cleanup criterion had been met. On the basis of limited existing data, DOE estimates that subpile excavation to a depth of 2 ft would be required.

Preparation for Slurry Pipeline Transportation

Although pile excavation for the slurry pipeline transportation alternative would occur in the same manner as for truck or rail transportation, post-excavation processing would be different because the pipeline mode of transportation would require that the materials be mixed with significant amounts of water to form a slurry. As tailings were excavated, off-highway haul trucks would be loaded at the point of excavation and would deliver the material to a temporary stockpile near the slurry processing area. The material would be screened to separate greater-than-4-inch material from less-than-4-inch material. The larger material, or debris, would be stockpiled for highway truck haul to the disposal cell. Loaders would then deliver the smaller material to slurry process hoppers. Section 2.2.4.3 discusses the slurry pipeline transportation process.

Demolition and Disposal of Existing Mill Facilities

The existing mill facilities would be demolished and disposed of in a manner similar to that described in Section 2.1.1.2, with the exception that demolished material would be stockpiled, sized, and transported to the selected off-site disposal cell rather than deposited in the on-site disposal cell for permanent disposal. For the slurry pipeline and rail transportation alternatives, the demolished materials would be transported by truck.

2.2.1.3 Moab Site Closure

Site reclamation actions would be similar to those described under the on-site disposal alternative (Section 2.1.1.4). However, an additional 130 acres of reclamation would be required at the Moab site under this alternative due to removal of the tailings pile. Potential future uses of the site would be a more significant factor in determining final reclamation actions for the off-site disposal alternative because the pile would be removed. Once all contaminated material was removed from the Moab site, closure would begin and would involve two phases: (1) removal of temporary facilities, and (2) final site reclamation.

Removal of Temporary Construction Facilities

The temporary facilities described under Section 2.2.1.1, as well as concrete slabs, piping, sewage holding tanks, and pond liners, would be removed from the site in accordance with a waste management plan that complied with all applicable federal and state regulations. Wherever possible, materials would be salvaged for reuse at other sites. Unsalvageable materials would be disposed of in the off-site disposal cell, at another licensed facility, or as municipal waste, as appropriate.

Final Site Reclamation

As discussed in Section 1.4.5, release of portions of the site for future uses would depend on the success of site remediation. DOE's ultimate goal would be to remediate to unrestricted surface use standards. However, DOE would defer its decisions on the release and future use of the Moab site pending an evaluation of the success of surface and ground water remediation. Some fencing would be required at least for the 75 years during which ground water remediation would be ongoing. Before backfill and site reclamation and following the removal of the temporary infrastructure, structures, and controls, DOE's contractor would verify that radium-226 concentrations in soil within the Moab site boundary did not exceed EPA standards in 40 CFR 192. The entire site would then be graded and recontoured. The water storage ponds would be backfilled to original grades prior to reclamation. Approximately 425,000 yd^3 of fine-grained silty- to sandy-loam reclamation soil excavated from the Floy Wash borrow area would be imported as backfill for the Moab site. Soils would be prepared for planting by scarifying with a disk harrow. Moisture conditioning would be performed and the area seeded with native or adapted plant species.

Moab Wash would be reconstructed in its general present alignment. After removal of the tailings impoundment and contaminated soils, site topography and future land use are uncertain. Thus, to minimize costs and achieve fluvial stability, the channel would be reestablished in its current location. Additional meanders may be added to increase travel distance of the water and reduce slope to mitigate future erosion caused by higher water flow velocity. The channel would be lined with riprap and designed to carry the estimated runoff volume for a 200-year flood. Larger flows would be allowed to flood into channel overbank areas.

2.2.2 Characterization and Remediation of Vicinity Properties

Characterization and remediation of vicinity properties would be completed as described in Section 2.1.2. The primary difference between the on-site and off-site disposal alternatives with regard to vicinity properties would be the requirement to transport the stockpiled material to an off-site disposal location.

2.2.3 Construction and Operations at Borrow Areas

Descriptions of borrow material site locations, standards, and excavation procedures are the same as those described in Section 2.1.3. However, borrow material traffic density and routing would differ from those described in Section 2.1.3.2 because, with the exception of the Moab site reclamation soil, the borrow materials would be delivered to, or be available at, the selected off-site disposal location.

Transport Truck Traffic Density

As shown in Table 2–7, assuming implementation of a double work shift (for truck or rail haul) DOE estimates that the transport of borrow materials would require a total of 67 daily round-trips for the Klondike Flats off-site disposal alternative and 24 for the Crescent Junction or the White Mesa Mill alternative. (For the slurry pipeline mode, average daily round-trips would be about 30 percent less than those shown in Table 2–7 because of the longer overall schedule for borrow material activities.) Under a double work shift schedule, borrow material transportation would be ongoing for approximately 2.75 years (875 days) for the truck or rail transportation mode (see Figure 2–10 and Figure 2–11). For the slurry pipeline mode, borrow material activities would be ongoing for about 4 years (Figure 2–12). Table 2–7 also shows the total volume and total shipments for each of the five types of borrow materials.

If a single daily work shift schedule were implemented for the truck or rail transportation modes, borrow material transportation would be ongoing for approximately 3.75 years, and the estimated daily round-trips would decrease to approximately two-thirds of the numbers shown in Table 2–7. As shown in Table 2–1, there are several optional borrow areas for obtaining cover soil. Table 2–7 assumes that all cover soil would come from the Floy Wash borrow area (as would all Moab site reclamation soil). This option would generate the most traffic on public highways.

Table 2–7. Summary Logistics for Borrow Material Transport

(Truck or Rail Haul Double Work Shift)

Borrow Material	**Klondike Flats Alternative**			**Crescent Junction Alternative**			**White Mesa Mill Alternative**		
	Daily Round-Trips	**Total Volume (yd^3)**	**Total Ship.**	**Daily Round-Trips**	**Total Volume (yd^3)**	**Total Ship.**	**Daily Round-Trips**	**Total Volume (yd^3)**	**Total Ship.**
Cover soils	43	1,243,000	37,800	NA[a]	1,243,000	NA[a]	NA[a]	1,243,000	NA[a]
Radon barrier soils	NA[a]	294,000	NA[a]	NA[a]	294,000	NA[a]	NA[a]	294,000	NA[a]
Sand and gravel	7	215,750	6,538	7	215,750	6,300	7	215,750	6,300
Riprap	2	43,400	1,973	2	43,400	1,973	2	43,400	1,973
Moab reclam. soils	15	424,867	12,875	15	424,867	12,875	15	424,867	12,875
Total	**67**	**2,221,017**	**59,186**	**24**	**2,221,017**	**21,148**	**24**	**2,221,017**	**21,148**

[a] Material available at off-site disposal location.

2.2.4 Transportation of Tailings Pile and Other Contaminated Material

DOE evaluated the truck and pipeline modes of transportation for all three potential sites. Rail service was determined not feasible for the White Mesa Mill site because no rail service is available; therefore, this mode was evaluated only for the Klondike Flats and Crescent Junction sites. Table 2–8 shows the estimated source material quantities that would be transported under the off-site disposal alternative. On the basis of recent surveys that were not available at the time the draft EIS was developed, DOE has slightly increased its estimate of the volume of contaminated off-pile soil that would be disposed of with the tailings. The increase is less than 1 percent of the total estimated volume of contaminated site material. The revised total estimates remain approximate and could increase again after more detailed site characterization is complete. The estimated volumes presented in the draft EIS represented DOE's best estimate based on information available when the draft EIS was developed. Due to the small cumulative change, the draft EIS estimates have been retained as a constant in the final EIS for purposes of assessing and comparing the impacts of each alternative. DOE would use the most current and reliable estimates of the volumes of all contaminated site material in developing the remedial action plan.

Table 2–8. Source Material Quantities

Source Material	Volume (yd^3)	Weight (dry short tons)
Uranium mill tailings	7,800,000	10,500,000
Pile surcharge	445,000	600,000
Subpile soil	420,000	566,000
Off-pile contaminated site soils	173,000	234,000
Vicinity property material	29,400	39,700
Total	**8,867,400**	**11,939,700**

Figure 2–14 shows the Moab site and the proposed truck and rail routes. The proposed slurry pipeline routes are shown in Figure 2–15, and detailed maps are presented in Appendix C.

2.2.4.1 Truck Transportation

DOE analyzed highway truck transportation for all three alternative sites and two work shift scenarios. Existing highways would be used with some improvements made. In 2004, the Utah Department of Transportation (UDOT) completed the widening of US-191 to a four-lane highway from the Moab site north to SR-313. The truck fleet size would vary depending on the disposal site location. An independent trucking company using its own fleet of trucks would do the trucking.

Summary Tabulation of Truck Transportation Logistics

Table 2–9 summarizes logistics information for truck transportation from the Moab site to the three alternative off-site disposal locations.

Table 2–9. Summary Logistics for Truck Transportation from the Moab Site to Three Alternative Off-Site Disposal Locations

	Miles One-Way from the Moab Site to Alternative Disposal Cells					
	Crescent Junction		**Klondike Flats**		**White Mesa Mill**	
On highways	28		14		84	
On access roads	2		4		1	
Total miles	**30**		**18**		**85**	
Miles through community	0.5		0		9.5[a]	
	Truck Production Estimates for Alternative Disposal Cells					
	Crescent Junction		**Klondike Flats**		**White Mesa Mill**	
	1 shift	**2 shifts**	**1 shift**	**2 shifts**	**1 shift**	**2 shifts**
Daily round-trips	219	384	219	384	219	384
Trucks per fleet	36	37	24	26	78	82
Years to complete	3.5	2.0	3.5	2.0	3.5	2.0
Round-Trip Cycle Times (hours)[b]						
Crescent Junction	1.9					
Klondike Flats	1.3					
White Mesa Mill	4.2					

[a] Route to White Mesa Mill site traverses 2 miles through Monticello, 4 miles through Blanding, and 3.5 miles through Moab.

[b] Cycle times would depend primarily on the round-trip distance. However, other factors considered include highway grades, traveling through communities, nonhighway haul roads, and material handling activities such as loading, unloading, and decontamination.

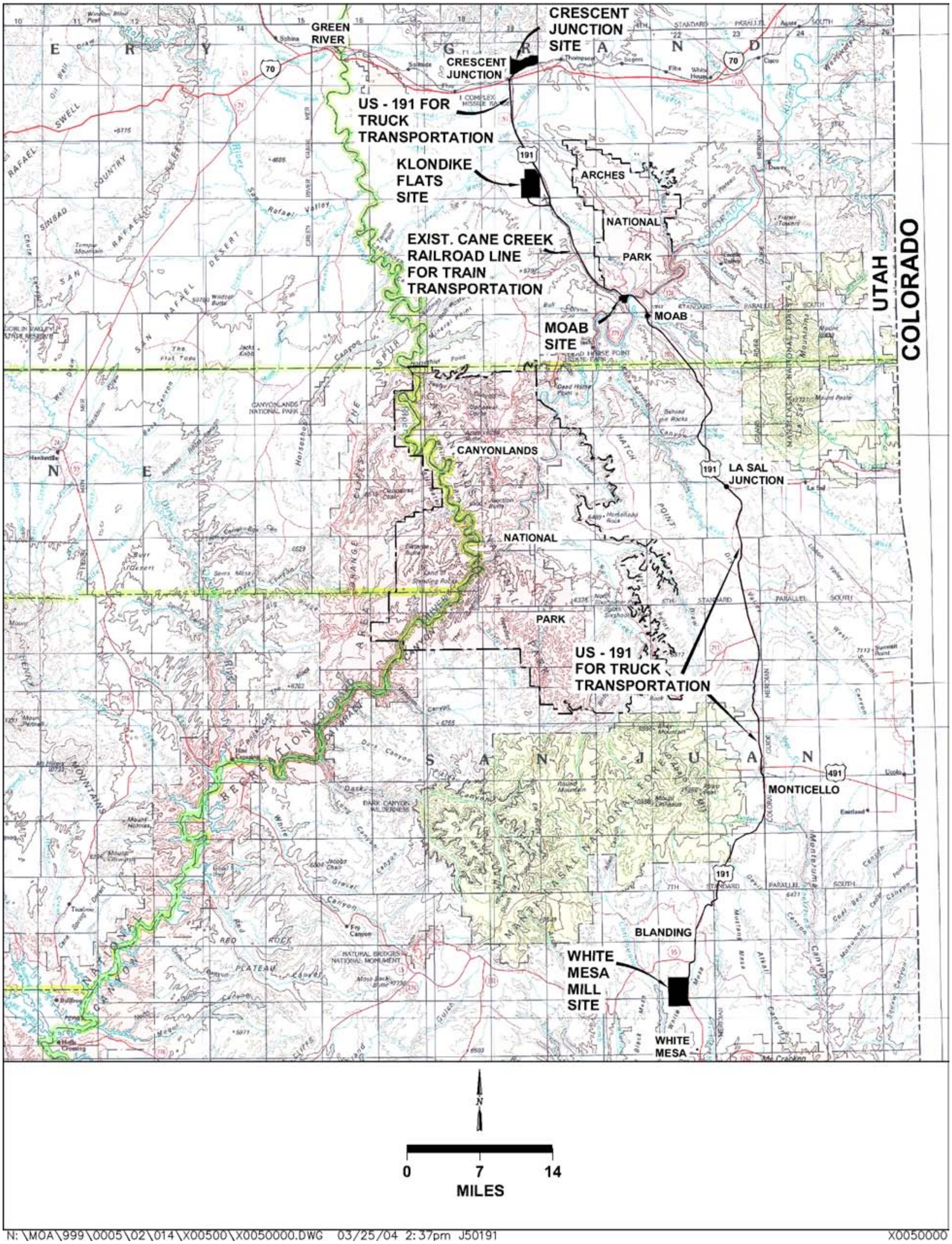

Figure 2–14. Truck and Rail Transportation Routes

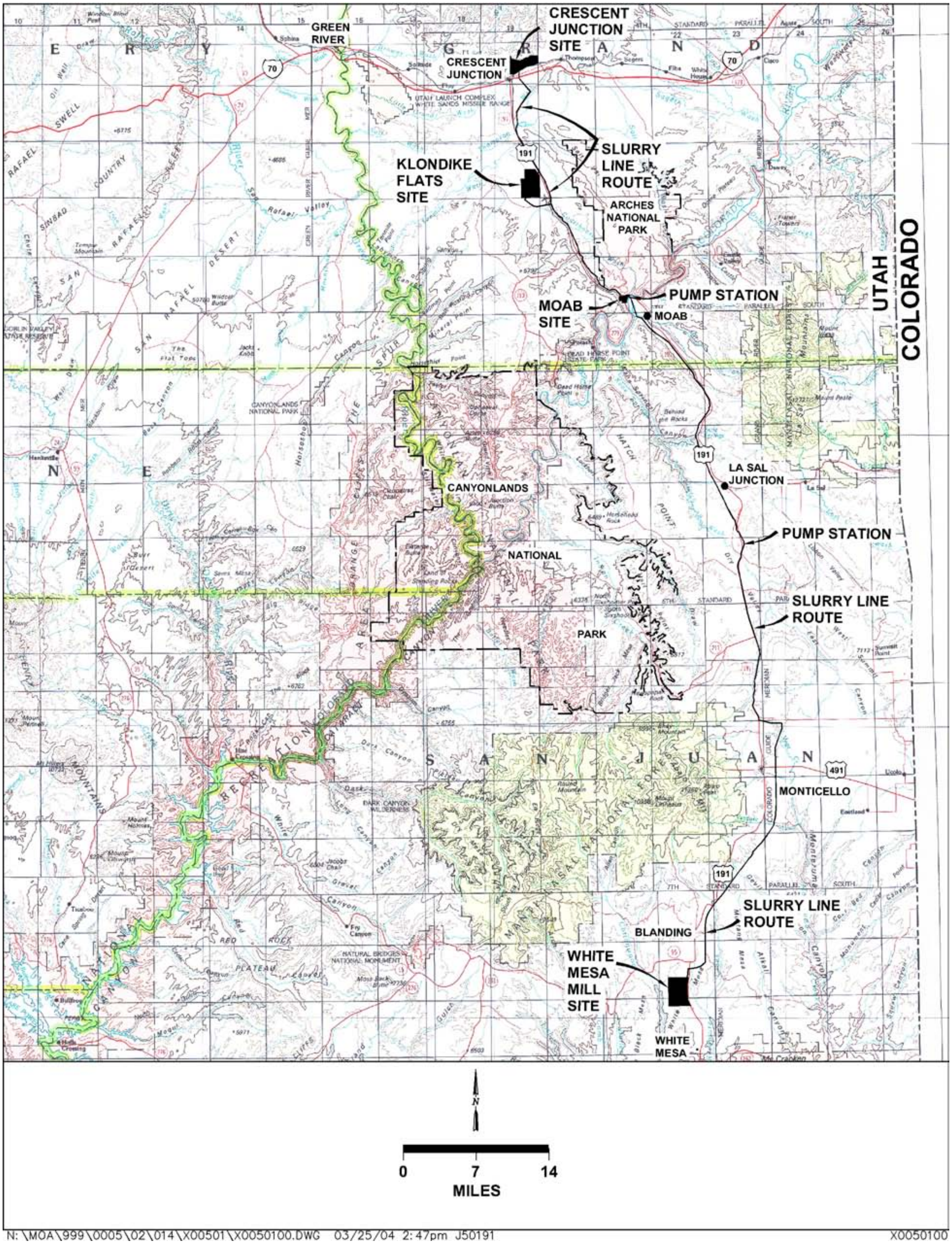

Figure 2–15. Slurry Pipeline Transportation Routes

Permits and Exemptions

The proposed 22-ton tandem trailer, hauling a total of 44 tons per truck, would require a special highway permit from UDOT. All work within UDOT rights-of-way would require an encroachment permit from UDOT Region 4. In addition, other federal, Utah, and local requirements would apply. As at other UMTRCA sites, DOE would apply for a DOT exemption to ship uranium mill tailings (see text box titled "DOT Exemption). Regardless of the exemption, DOT would require that each truck be surveyed for radioactivity prior to release from the site and that truck beds be covered to mitigate spills and prevent windblown contamination during transport. No loose radioactivity would be present on the outside of the truck. All transportation would be conducted under a transportation plan that included emergency provisions, manifesting, and specific information regarding any RCRA- or TSCA-regulated material, if applicable.

DOT Exemption

A DOT exemption, similar to that obtained for the DOE UMTRA and Monticello Projects, would allow exemption from specific DOT regulations, including

- 49 CFR 171.15 and 171.16.
- 49 CFR 172.202, .203(c)(1), .203(d), .302(a) and (b), .310, .331, .332, and Part 172 Subpart E and F (labeling and placarding).
- 49 CFR 173.22(a)(1), 173.403 only as it relates to the definition of closed transport vehicles, .427(a)(6) except for requirements stated in this exemption, .443(a).
- 49 CFR 177.817, and .843(a).

These exemptions would allow relief from certain transportation regulations pertaining to uranium and thorium mill tailings, soils, and other materials contaminated with radionuclides from uranium and thorium at the Moab site and vicinity properties. Some of the relief includes the use of closed vehicles and bulk containers without detailed analysis of the contents and with alternative requirements for hazard communication information and packaging. In addition, manifesting each truckload of tailings would not be required under the exemption, nor would labeling of contents or placarding of the truck. As long as the vehicles were protected by tarps or other means to prevent releases, they would not need to be monitored for each trip. A dedicated radioactive materials use statement would be required on the truck, and would have to be removed before the truck was thoroughly decontaminated and released according to DOE standards to haul any other material. A copy of the exemption would have to be carried in the cab of each truck hauling material under the exemption. Emergency reporting requirements are limited to DOE management when more than 1,500 pounds of material is spilled, and the information typically contained in a transportation plan is incorporated as part of the exemption document.

Load, Haul, and Dump Operations

After the tailings were processed and dried to the necessary moisture levels (see Section 2.2.1.2), the transport trucks would be loaded and the truck beds covered with tarps by an automatic tarping device. After the trucks were loaded, the exterior of the trucks would be decontaminated. The trucks would then be scanned for radioactivity and, if clean, released for highway transportation. At the disposal site, the trucks would drive directly into the disposal cell on dedicated haul roads and dump the tailings at designated locations in the cell for spreading, moisture conditioning as needed, and compaction. Figure 2–16 illustrates a typical disposal cell area, haul roads, and other major features.

After dumping, the haul trucks would be decontaminated, scanned for radioactivity, and released prior to leaving the disposal site. As shown in Figure 2–16, the disposal site would include a

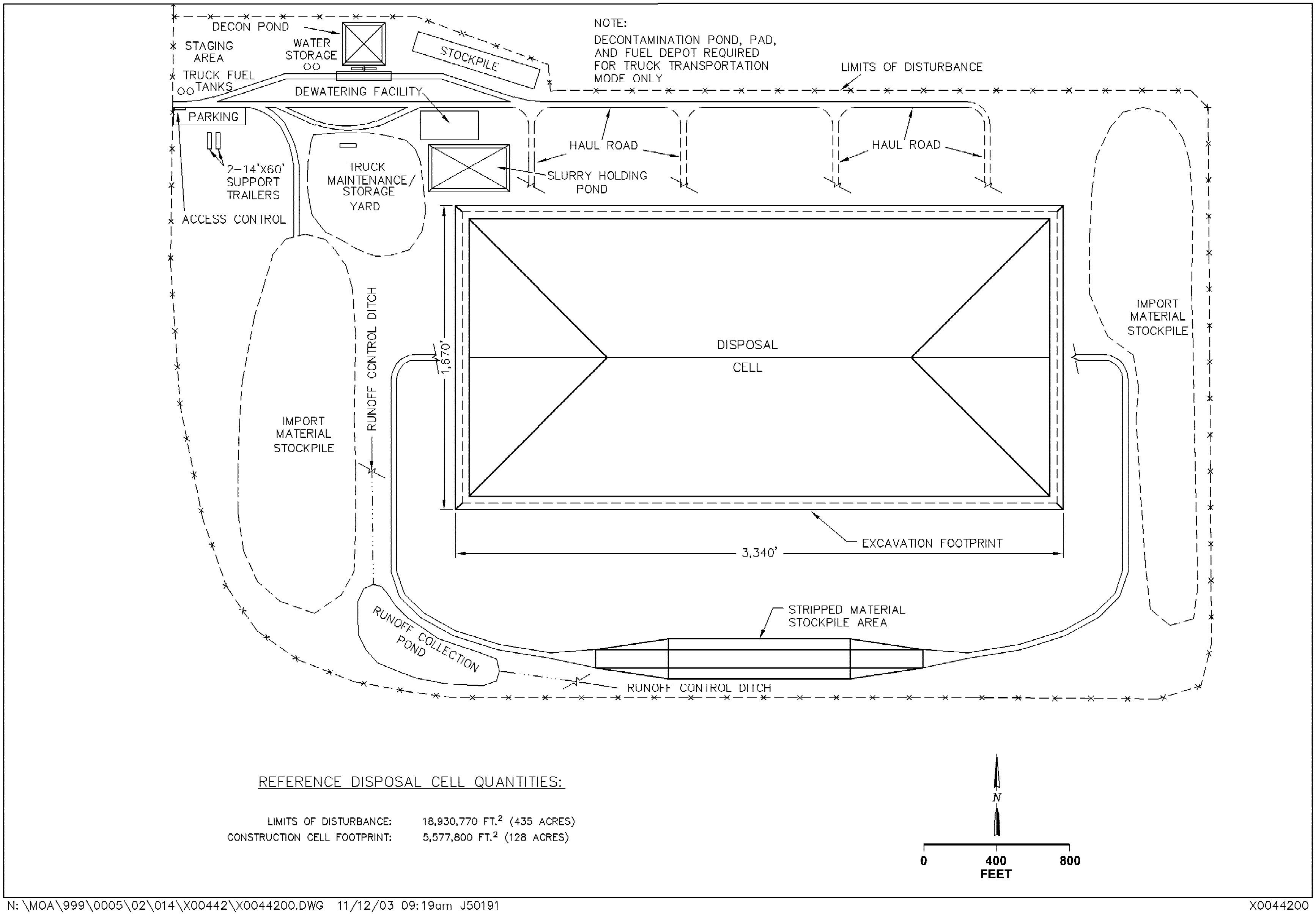

Figure 2–16. Reference Disposal Cell

truck maintenance and fuel storage area. This area would also serve as a parking yard to store one-half of the truck fleet during the off-shift and to park any backup trucks. The other half of the fleet would be stored during the off-shift at the Moab site. An office trailer would also be located at the site to support administration for the trucking service. Fuel storage tanks would range from 5,000 to 20,000 gallons, depending on the disposal cell location, and would have spill containment berms constructed around them.

Truck Maintenance and Storage Facilities at the Disposal Sites and the Moab Site

The following sections describe the transportation-related infrastructure that would be constructed and eventually reclaimed at the Moab site and the three alternative off-site disposal locations.

Moab Site Truck Transportation Infrastructure Construction and Reclamation

Figure 2–17 shows the Moab site and anticipated temporary construction infrastructure that would be required to support a truck haul. New highway access, overpass, and acceleration/deceleration lanes would be constructed for the north haul to Klondike Flats or Crescent Junction or south haul to White Mesa Mill. A new site entrance on US-191 would be built approximately halfway between the existing site entrance and Potash Road (SR-279) on the north side of the Moab site. As seen in Figure 2–17, the proposed new truck transportation infrastructure would be located within the Moab site boundary and therefore would not constitute additional land disturbance beyond the 439-acre site area assumed to be disturbed during surface remediation.

The improvements would all be temporary and would be used only for the life of the tailings haul. Design and construction criteria would meet American Association of State Highway and Transportation Officials (AASHTO) and UDOT standards, with the design life a consideration. At the end of the tailings haulage, the acceleration/deceleration lanes and overpass would be removed and reclaimed. The current US-191 access would be reestablished as the site access.

Klondike Flats Site Truck Transportation Infrastructure Construction and Reclamation

A new overpass across US-191 with a deceleration lane entering it would be constructed for north-bound trucks to access Blue Hills Road and avoid crossing the south-bound lane. The overpass would replace the existing Blue Hills Road turnoff (Figure 2–18). (Note: In Figure 2–18 and other similar figures, the insert showing a typical cell indicates comparative size only. The final location of the cell would be within the larger hatched site area and would be decided after further investigation of surface and subsurface geologic and hydrologic conditions; investigations could also include site-specific cultural or archeological surveys or other sampling.) The existing Blue Hills Road would be paved from US-191 for approximately 2 miles to the tailings pile access exit. The haul road would continue north through the bluffs and into the disposal cell area. The exact configuration of the haul road would depend on where the disposal cell was located within the Klondike Flats site.

The haul road from the highway overpass to the disposal cell would be a private road for truck traffic and cell access only. A new Blue Hills Road access for public use would be constructed south of and parallel to the existing Blue Hills Road for 2 miles. It would reconnect to the existing Blue Hills Road west of where the new haul road would turn north. Access to the new

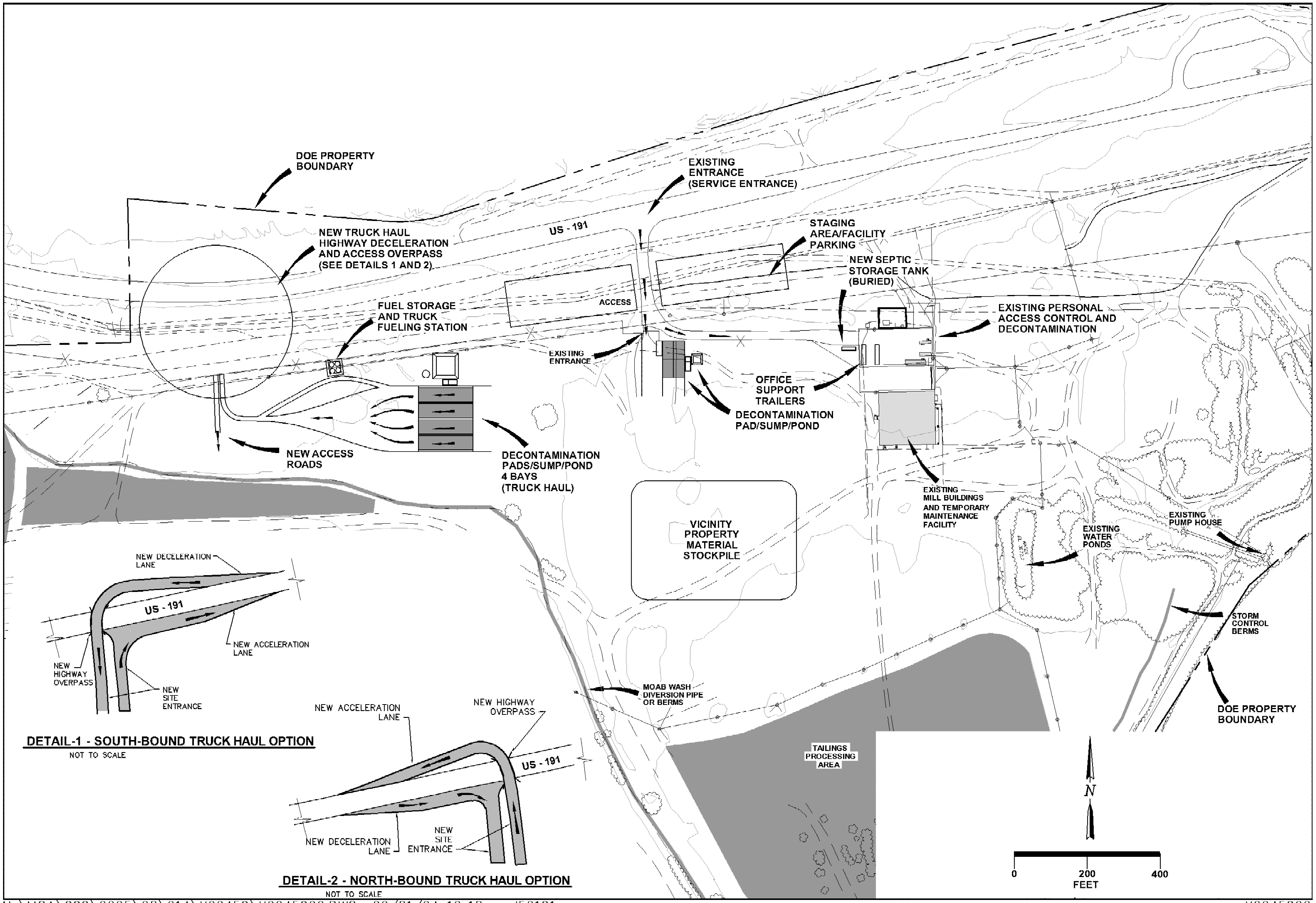

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Figure 2–17. Moab Site Temporary Construction Facilities, Off-Site Disposal Alternative

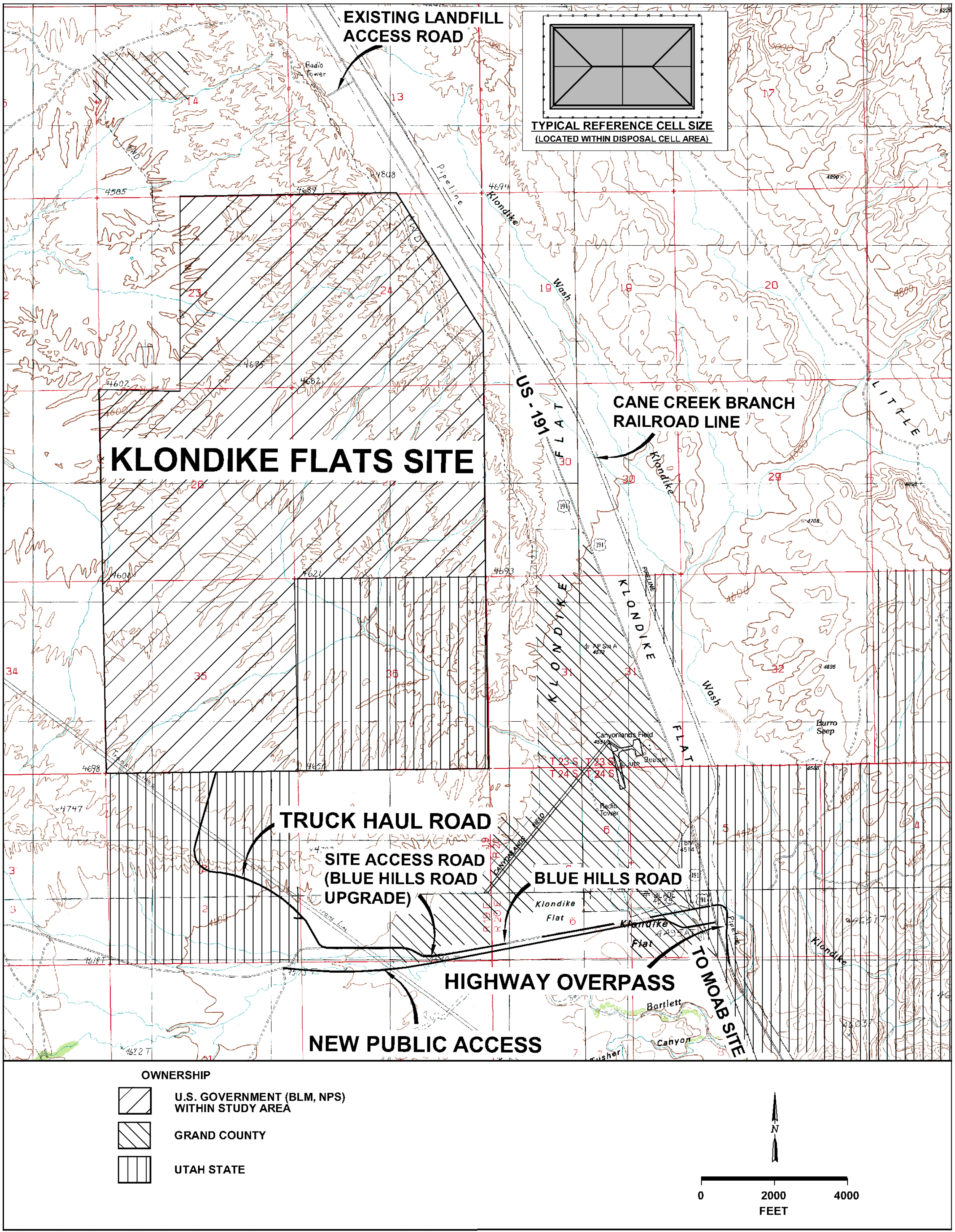

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Figure 2–18. Klondike Flats Site Truck Route Map public access Blue Hills Road would be through a new intersection with US-191 south of where the newly constructed private acceleration lane ended. The new Blue Hills Road access would be constructed to the same size and surface condition as the existing Blue Hills Road.

The acceleration lanes, deceleration lanes, and overpass would all be temporary structures to be used only for the life of the tailings haul. Design and construction criteria would meet AASHTO and UDOT standards with the design life a consideration.

At the end of the tailings haulage, the acceleration/deceleration lanes and overpass would be removed and reclaimed. The 2 miles of haul road that is currently the Blue Hills Road would remain paved, and the existing intersection with US-191 would be reconstructed, reestablishing Blue Hills Road to its former public use. The newly constructed Blue Hills Road would be regraded and reclaimed. The new haul road from the existing Blue Hills Road to the disposal cell would remain in place to provide future cell access for inspections.

Crescent Junction Site Truck Transportation Infrastructure Construction and Reclamation

The transportation trucks would use existing US-191 to transport the tailings from the Moab site to the Crescent Junction site. Road improvements would be made from the I-70 overpass to the south side of the Union Pacific rail line (Figure 2–19). A haul road would be constructed parallel to the rail line going east approximately 1 mile, where it would turn north across the railroad tracks and continue to the disposal cell. The exact configuration of the haul road would depend on where the disposal cell was located within the Crescent Junction site.

CR-175, which is the old US-50, lies north of I-70. It parallels the Union Pacific rail line and intersects US-191 north of I-70. The county road is currently paved but would have an asphalt overlay placed on it from US-191 for approximately 1,000 ft to the east. At that point, a new haul road would be constructed north on the same alignment as the current CR-223 for approximately 1,500 ft, and a new at-grade railroad crossing would be constructed. The new haul road would leave the county road alignment and continue northeast to the final disposal cell location. The entire haul road would be paved.

After completion of the tailings haul and disposal cell site reclamation, the truck haul road would continue to be used as an access road to the disposal cell for inspections. Therefore, the haul road would not be reclaimed.

White Mesa Mill Site Truck Transportation Infrastructure Construction and Reclamation

The transportation trucks would use US-191 south of the Moab site through the city of Moab. The haul route would continue on US-191 south through the cities of Monticello and Blanding to the White Mesa Mill entrance (Figure 2–20). US-191 is also the main thoroughfare in Moab, Monticello, and Blanding. A new deceleration and right turn lane would be used for entering the White Mesa Mill site, and existing haul roads on the site would also be used to access the disposal cell. A new overpass with an acceleration lane would be constructed for trucks leaving the site and accessing US-191 north-bound to avoid crossing the highway’s south-bound lane. The overpass would be located within the vicinity of the existing White Mesa Mill access.

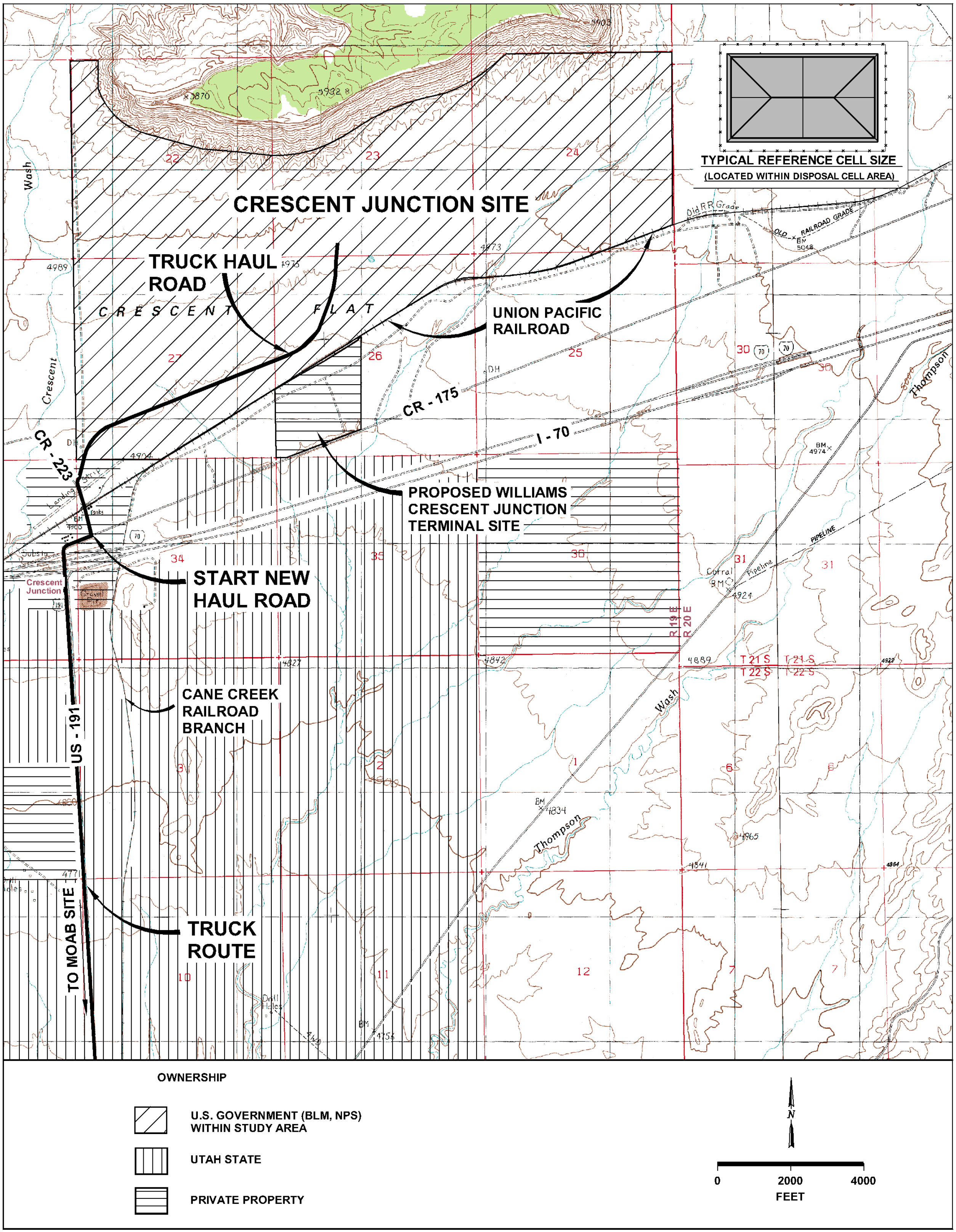

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Figure 2–19. Crescent Junction Site Truck Route Map

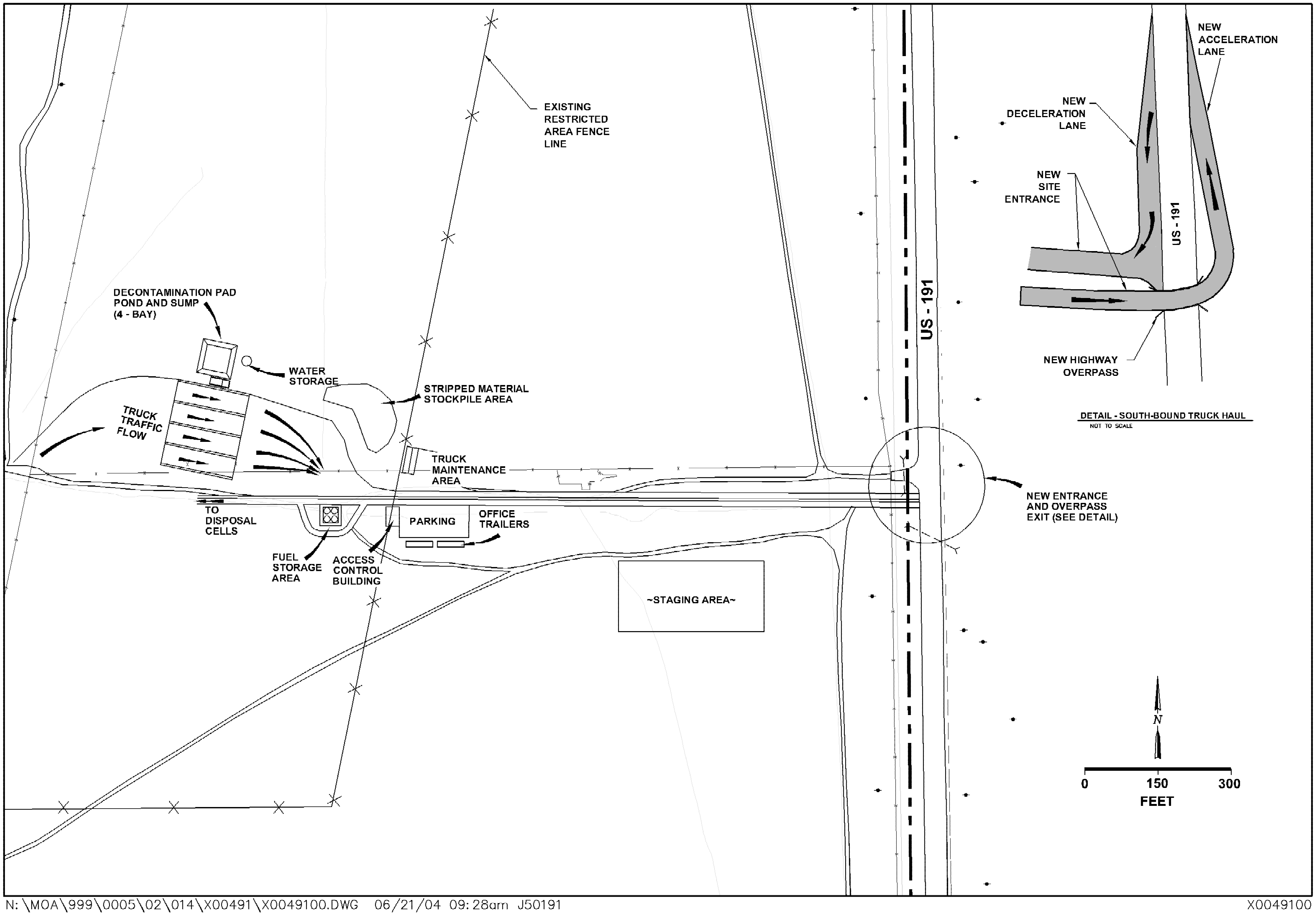

Figure 2–20. White Mesa Mill Site Temporary Construction Facilities

The overpass and acceleration lane would be temporary structures to be used only for the life of the tailings haul. Design and construction criteria would meet AASHTO and UDOT standards with the design life a consideration. At the end of the tailings haulage, the overpass and acceleration lanes would be removed and reclaimed. The current US-191 access would remain as the site access.

2.2.4.2 Rail Transportation

The existing rail line from Crescent Junction to the Moab site, called the Cane Creek Branch rail line, would be used to transport material from the Moab site to either the Klondike Flats or the Crescent Junction sites. This rail line continues south of the Moab site and dead-ends at the Potash Mine. The only current rail traffic on this line is one train per week to serve the Potash Mine. As shown in Table 2–10, if the off-site rail transport alternative were implemented, the line would carry 4 to 8 round-trips per day from the Moab site to the selected disposal site, depending on the implemented schedule. Tailings haulage would be scheduled for 6 days per week. The 7th day, when the Potash Mine train runs, would be used as a preventive maintenance day for the tailings train.

Table 2–10. Summary Logistics for Rail Transportation from the Moab Site to Two Alternative Off-Site Disposal Cell Sites

Distances/Cycles	Klondike Flats		Crescent Junction	
One-way distance—Moab site to off-load location (miles)	18		30	
Train cycle time (hours)[a]	5–6		10–12	
Train Production	**Klondike Flats**		**Crescent Junction**	
	1 Shift	**2 Shifts**	**1 Shift**	**2 Shifts**
Round-trips per day	4	8	4	8
Years of operation	3.3	1.6	3.3	1.6
Debris Production	**Klondike Flats**		**Crescent Junction**	
	1 Shift	**2 Shifts**	**1 Shift**	**2 Shifts**
Truck loads of debris shipped per day from Moab site	2	5	2	5
Total truck loads of debris shipped from Moab site	2,188	2,188	2,188	2,188
Years of operation	3.3	1.6	3.3	1.6

[a] Train cycle time for hauling a load of tailings from the Moab site to the disposal cell would depend primarily on the distance traveled. Other factors to be considered are rail grades, spur mileage (which would have a lower speed) switching, and other material-handling activities such as loading, unloading, and decontamination. Actual one-way travel times to the Klondike Flats and Crescent Junction sites are estimated at 1.5 and 3 hours, respectively.

An existing rail bed is located along the rail line at the Moab site near the tunnel entrance. A rail siding once existed there to provide rail service to the former Moab mill operations. A new 2,000-ft rail siding would be constructed on the existing rail bed and tied into the rail line with switches. The siding would be used to load tailings onto the rail haul trains, and the rail line would be used for stacking trains and for switching. Each train would consist of 30 standard-size gondola cars, each capable of carrying approximately 100 tons of material. Thus, each train would carry approximately 3,000 tons of material.

The trains would be loaded at the Moab site siding, driven to the disposal cell siding, and unloaded. Trains would then return to the Moab site siding for another load. They would be loaded by dumping material into the top by means of a conveyer and hopper system and unloaded at the disposal site by a rotary dump mechanism that would disconnect each car from the train and rotate it (flip it) to dump the material (Section 2.2.5 describes the process of unloading railcars in more detail). All loaded cars would be covered or treated with surfactants to suppress dust. Loaded cars would be decontaminated at the loadout station (Figure 2–21) before leaving Moab, and empty cars would be decontaminated before leaving the disposal site area.

DOE estimates that 35,000 yd^3 of debris from the Moab site would not be able to be transported by rail because of limitations on the size and shape of material that could be handled by the rail access conveyor (Figure 2–21). This material would be loaded onto highway trucks and hauled to the disposal cell in the same manner as tailings in the truck transportation option. Debris haulage would be spread out over the life of the project to minimize impacts.

Summary Tabulation of Rail Transportation Logistics

Table 2–10 summarizes logistics information for rail transportation from the Moab site to the proposed Klondike Flats and Crescent Junction sites and the estimated debris production for truck shipment.

DOT Requirements

General requirements for manifests, placards, emergency planning, railcar covers, and inspections would be similar to requirements for transport by truck. Other DOT requirements specific to rail transportation would be identified in the transportation plan.

Moab Site Rail Infrastructure Construction, Operations, and Reclamation

Rail Siding

The new 2,000-ft railroad siding would commence directly north of the tunnel entrance at an existing switch point where a new switch would be added. It would require new tracks but no new earthwork. Figure 2–21 shows the Moab site and infrastructure that would be constructed to support train haulage. At the completion of the rail haul, the railroad siding would be removed and all parts recycled. The switches on the main rail line would also be removed and replaced with straight track. As seen in Figure 2–21, all proposed new rail transportation infrastructure would be located within the Moab site boundary and therefore would not constitute additional land disturbance beyond the 439-acre site area assumed to be disturbed during surface remediation.

Conveyor System Construction

The conveyor system would consist of a truck dump bin with a belt feeder at the Moab site that would feed the tailings onto a stacking conveyor belt. As described in Section 2.2.1.2, tailings would be hauled to the conveyor truck dump bin after drying. The conveyor would be used to create a storage pile over belt feeders that would feed onto a conveyor belt. The conveyor belt would exit the millsite, cross SR-279, and continue up the hillside to the railroad siding. The conveyor belt would be vertically aligned to allow clearance over the highway for traffic and not interfere with the existing overhead electric power lines. The conveyor would feed directly into the top of the loadout hopper, which when full would load the railcars by gravity from bottom gates in the hopper. The conveyor system would be totally enclosed to minimize any dust emissions and to capture any spills should they occur. The existing dirt access road that starts at SR-279 and goes to the railroad siding would be upgraded with an all-weather surfacing to allow worker access. Once completed, the conveyor system would be operated by train loadout operators and maintenance mechanics. Figure 2–21 presents the location of the conveyor system, access road, and conveyor profile.

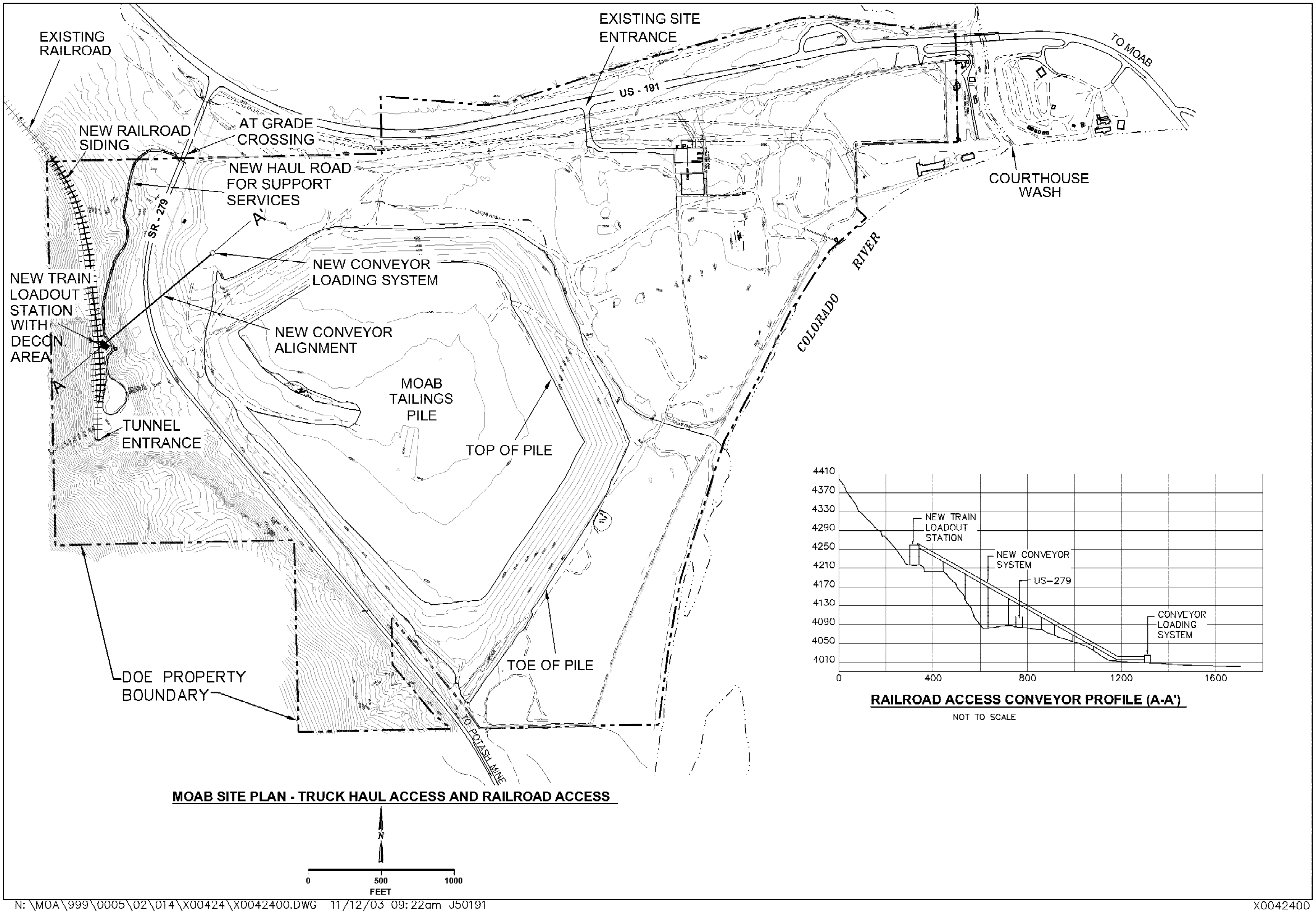

Figure 2–21. Moab Site Rail Transportation Infrastructure, Off-Site Disposal Alternative

At the completion of the rail haul, the conveyor system would be removed. The conveyor belts, belt racks, feeders, and other components in direct contact with tailings would be treated as contaminated material and disposed of at the disposal cell. Other components such as belt housings and structural steel supports would be reclaimed and salvaged as appropriate. Concrete foundations off the millsite would be demolished and disposed of at the local solid waste landfill, if uncontaminated. Concrete foundations on the millsite would be demolished and disposed of at the disposal cell, as would any contaminated rubble found off the millsite. The access roadway from SR-279 to the rail loadout station would be left in place to be used by railroad personnel for future track and tunnel inspections.

Klondike Flats Site Rail Infrastructure Construction and Reclamation

Figure 2–22 shows a conceptual plan for one possible site configuration for the infrastructure that would be constructed to support rail transportation at the Klondike Flats site. Alternate access and egress sites are possible and may be evaluated as part of the final design if this alternative were selected.

Conceptually, a new rail spur from the Cane Creek Branch railroad line would be constructed south of the Blue Hills Road turnoff. This spur would run west parallel to the south side of Blue Hills Road for approximately 1 mile, cross to the north side of the road west of the airport, and continue west parallel to the north side of Blue Hills Road for approximately another mile to a new train/truck transfer station. The spur would extend an additional 2,000 ft to allow for car stacking and would have a 2,000-ft-long rail siding constructed parallel to the rail spur at the end to allow train changeouts during operation. Support facilities for the train, such as a locomotive inspection pit, would be constructed to provide minor preventive maintenance during operations. At the transfer station would be the rotary dump, which decouples each railcar and inverts the car into a dump station for subsequent loading into trucks for final hauling and dumping into the disposal cell.

Figure 2–23 illustrates an operational rotary dump facility similar to the one proposed. The exact configuration of the rail spur and train/truck transfer station would depend on where the disposal cell was located within the Klondike Flats site.

A total of approximately 3 miles of new railroad track spur and siding would be constructed. A new switch would be placed on the Cane Creek Branch railroad line to access the spur. The new alignment would be graded, and culverts would be placed along existing washes. The track would have an at-grade crossing at Blue Hills Road. A haul road would be constructed from the rotary dump to the disposal cell. Infrastructure construction would also include the upgrade of Blue Hills Road to be used for site access. This would consist of regrading the road and making it an all-weather road by placing additional road base and a dust surfactant.

At the completion of the rail haul, the railroad switch, spur, siding, and at-grade crossing would be removed. All rail components would be salvaged. The Blue Hills Road upgrade would remain for future cell access and public access.

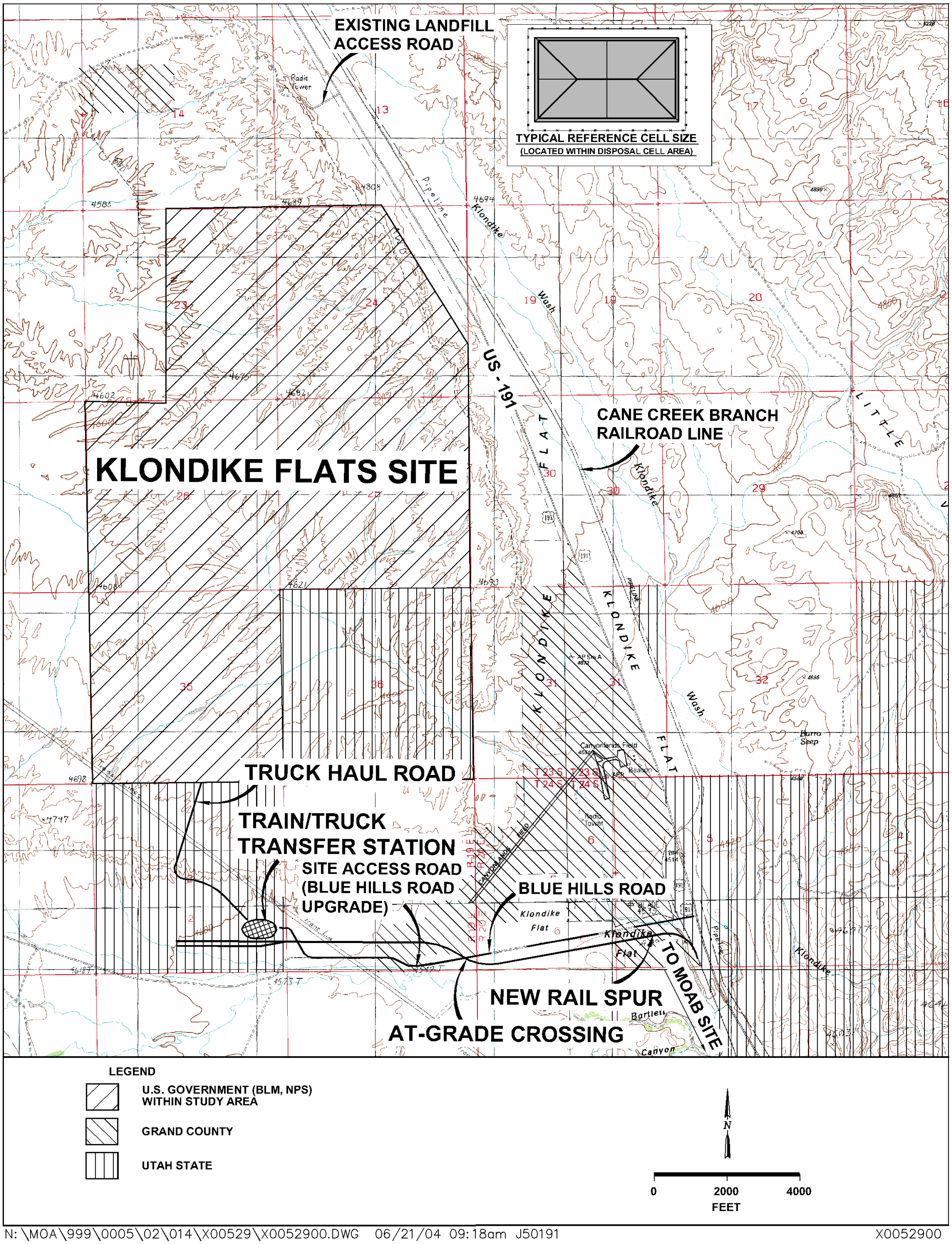

Figure 2–22. Klondike Flats Site Railroad Transportation Mode

Figure 2–23. Operational Rotary Dump Facility

Crescent Junction Rail Infrastructure Construction and Reclamation

Figure 2–24 shows a conceptual plan for one possible site configuration for the infrastructure that would be constructed to support rail transportation at the Crescent Junction site. The trains would use the Cane Creek Branch railroad line from the Moab site to Crescent Junction and then use a short stretch of the Union Pacific rail line that runs from Ogden, Utah, to Grand Junction, Colorado. The trains would then proceed east along the Ogden/Grand Junction route for approximately 1 mile, where a new track switch to a siding to the north would be constructed. The siding would be approximately 1 mile long and would end at the train/truck transfer station. The support facilities would be the same as those described for Klondike Flats. Alternate access and egress sites are possible and may be evaluated as part of the final design if this alternative were selected.

A total of approximately 2.5 miles of new railroad track spur and siding would be constructed to access the disposal cell area. A new switch would be placed on the main rail line to access the spur. The new alignment would be graded, and culverts would be placed in existing washes.

Infrastructure construction would also include constructing an access road from existing CR-175 approximately 1,000 ft east of Crescent Junction. At this point, a new access road would be constructed north on the same alignment as the current CR-223 for approximately 1,500 ft, and a new at-grade railroad crossing would be constructed. The new access road would leave the county road alignment and continue north, paralleling the new rail spur to the transfer station. The entire access road would be gravel. At the completion of the rail haul, the railroad switch, spur, and siding would be removed. All rail components would be salvaged. The access road would remain in place to provide access to the cell.

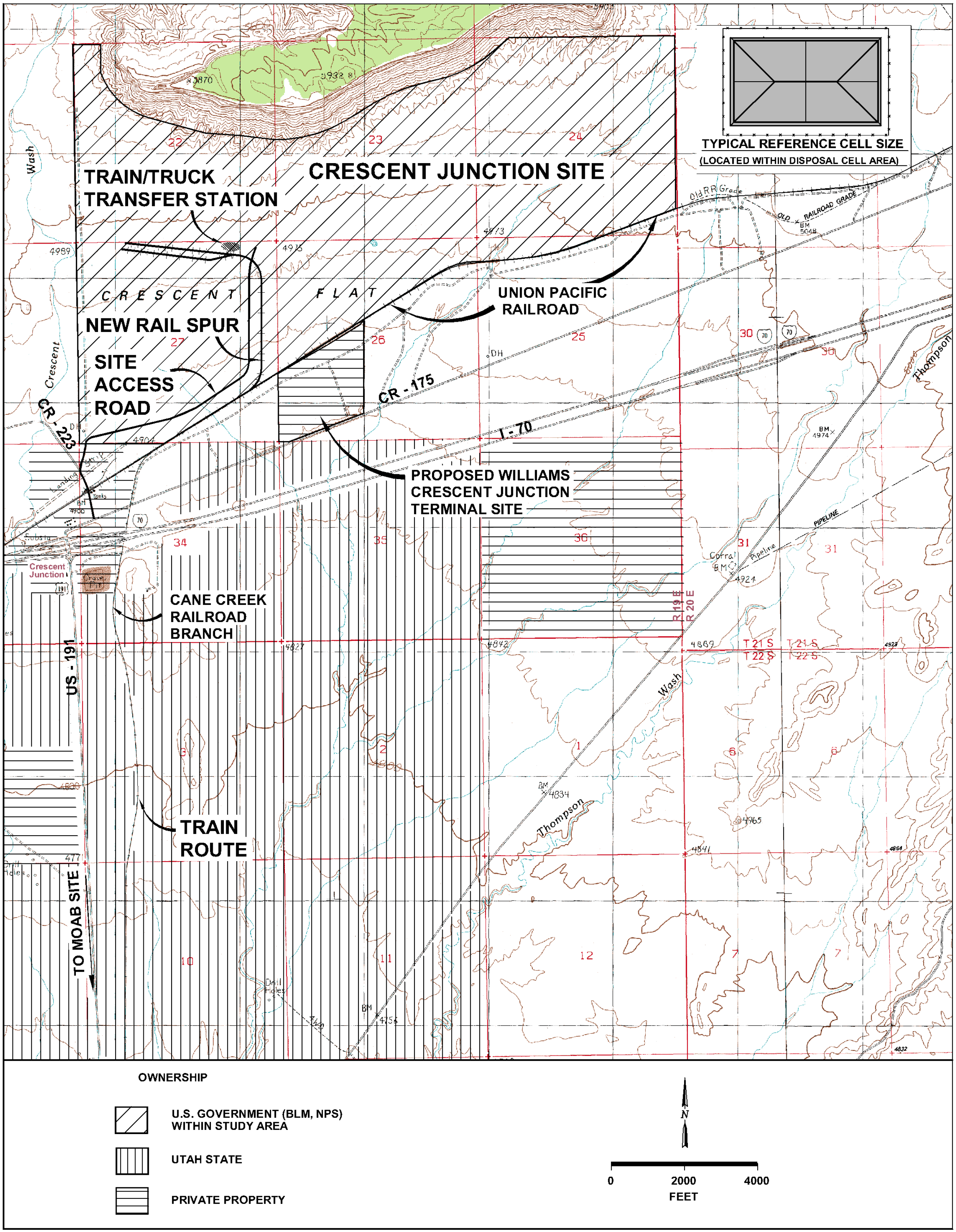

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Figure 2–24. Crescent Junction Site Railroad Transportation Mode

2.2.4.3 Slurry Pipeline Transportation

The slurry pipeline transportation mode would require the construction of a buried pipeline from the Moab site to one of the three alternative off-site disposal locations. If this option were implemented, tailings would be mixed with water (repulped) at the Moab site to form a semiliquid slurry that would be pumped through the pipeline to the disposal site.

Slurry Pipelines

Slurry pipelines have been used for over 100 years in mining operations to transport both mineral concentrates (ores) and tailings, including coal, copper, iron, phosphates, limestone, lead, zinc, nickel, bauxite, and oil sands. Commercial long-distance transportation of slurries in buried pipelines began in 1967 when the 43-mile Savage River pipeline in Tasmania began transporting iron ore concentrate. It is still operational. Since then, numerous slurry pipelines, ranging in length from a few miles to the 246-mile SAMARCO Pipeline in Brazil, have been constructed in many countries. Most of them are still operating.

At the disposal site, the slurry would be dried by means of a vacuum filtration system, and the dried residue, or filter cake, would be placed in the disposal cell. The recovered water, or filtrate, would be clarified and returned through a second pipeline to the slurry preparation area at the Moab site for reuse. Pipeline Systems, Inc., conducted a conceptual study of a slurry pipeline transportation system for the Moab site. The study (PSI 2003) is incorporated into the EIS by reference and is the primary source document for the following synopsis of the slurry pipeline option.

In general, the slurry pipeline systems for the three alternative disposal sites would be very similar except for their lengths and routes, and for one booster pump facility (shown on Figure 2–15 and in Appendix C, Map 8) that would be required for the White Mesa Mill slurry pipeline because of its length. Also, the proposed slurry transport facility at the White Mesa Mill site would require the addition of a substation transformer at the Utah Power Blanding substation and a distribution circuit upgrade from the substation to the White Mesa Mill site, if the mill is also processing uranium ore in the conventional mill circuit. The proposed intermediate slurry pump booster station would require the addition of a substation transformer at the Utah Power La Sal substation and a new approximately 3-mile power line extension to the proposed site for the pump station. A distribution circuit upgrade of the existing line from the substation to its current ending point would also be required. The slurry pipeline systems would be constructed in accordance with American National Standards Institute (ANSI) standard B31.11, *Slurry Transportation Piping Systems* (ANSI/ASME 1989), which applies to the design, construction, inspection, quality control, and security requirements of slurry piping systems, and with other applicable codes.

Pipeline Corridors

Wherever possible, the three proposed corridors would follow existing gas or oil pipeline rights-of-way or road rights-of-way. For each of the three corridors, the slurry pipeline and return water pipeline would be buried in the same trench. Figure 2–15 illustrates the three proposed pipeline corridors, and the following subsections provide detailed descriptions of them. Figure 2–25, Figure 2–26, and Figure 2–27 illustrate the details of the pipelines' final approach to the three alternate disposal cell areas. Figure 2–28 illustrates the approximate locations of the proposed slurry pipeline facilities at the Moab site.

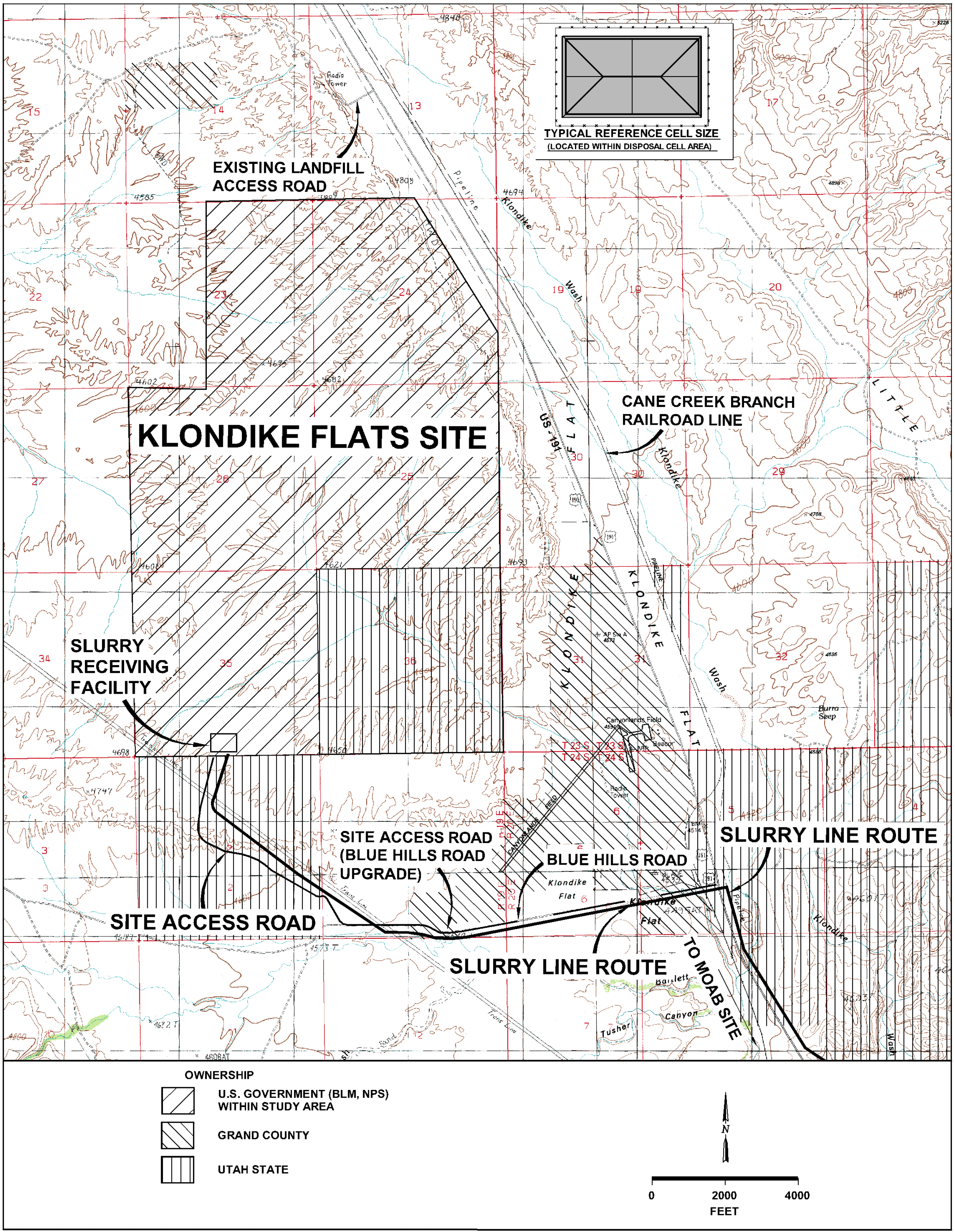

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Figure 2–25. Klondike Flats Site Slurry Pipeline Transportation Mode

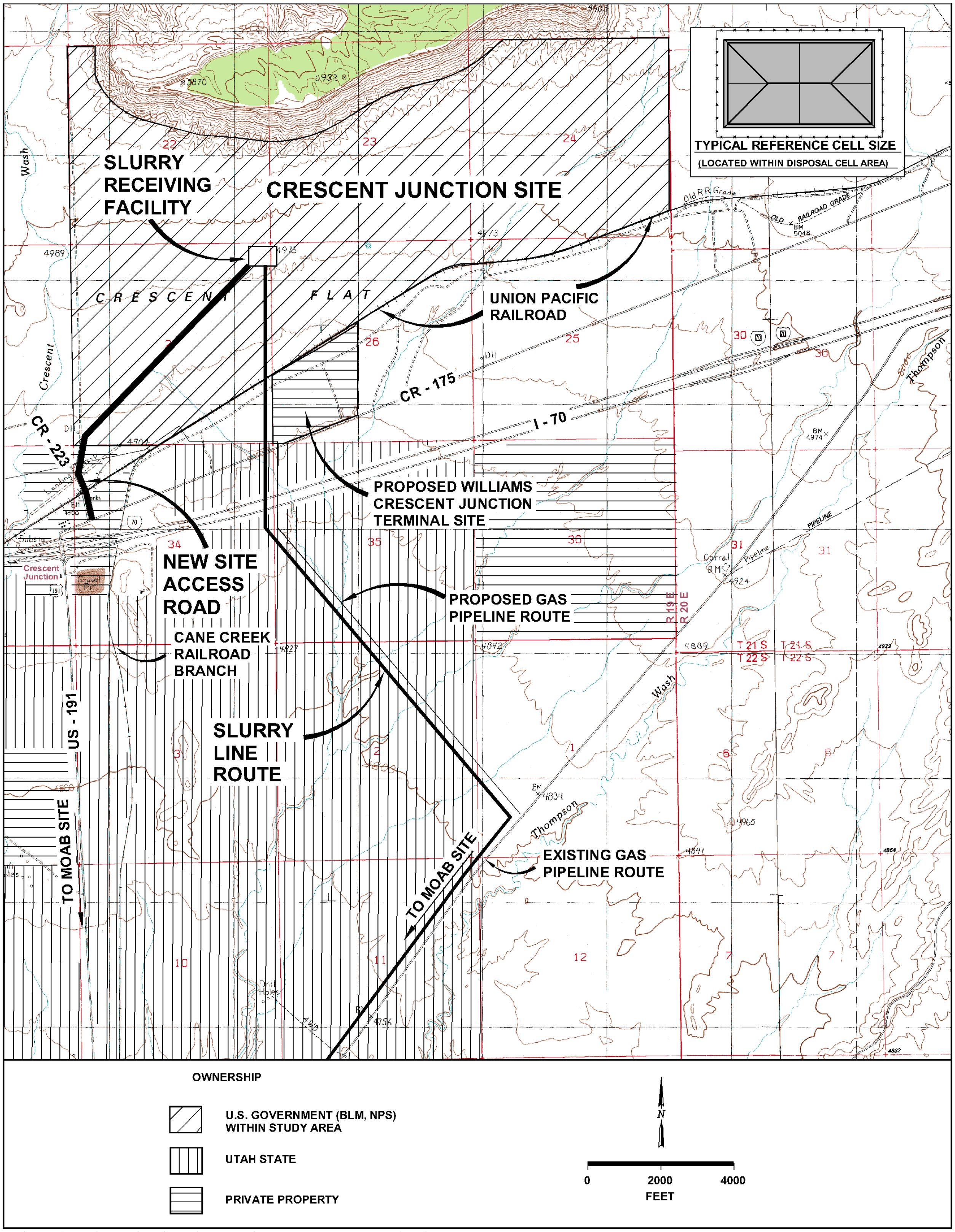

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Figure 2–26. Crescent Junction Site Slurry Pipeline Transportation Mode

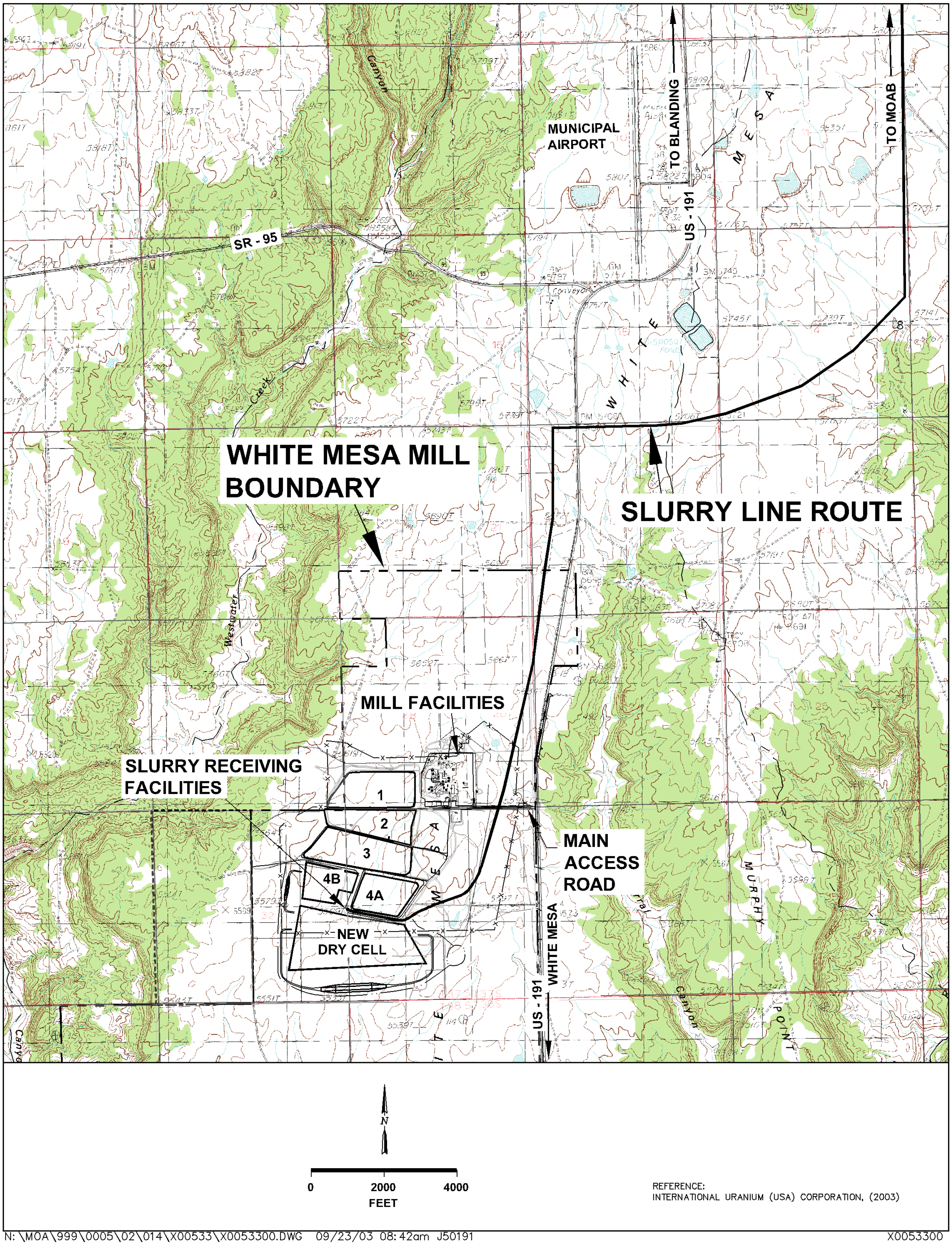

Figure 2–27. White Mesa Mill Site Slurry Pipeline Transportation Mode

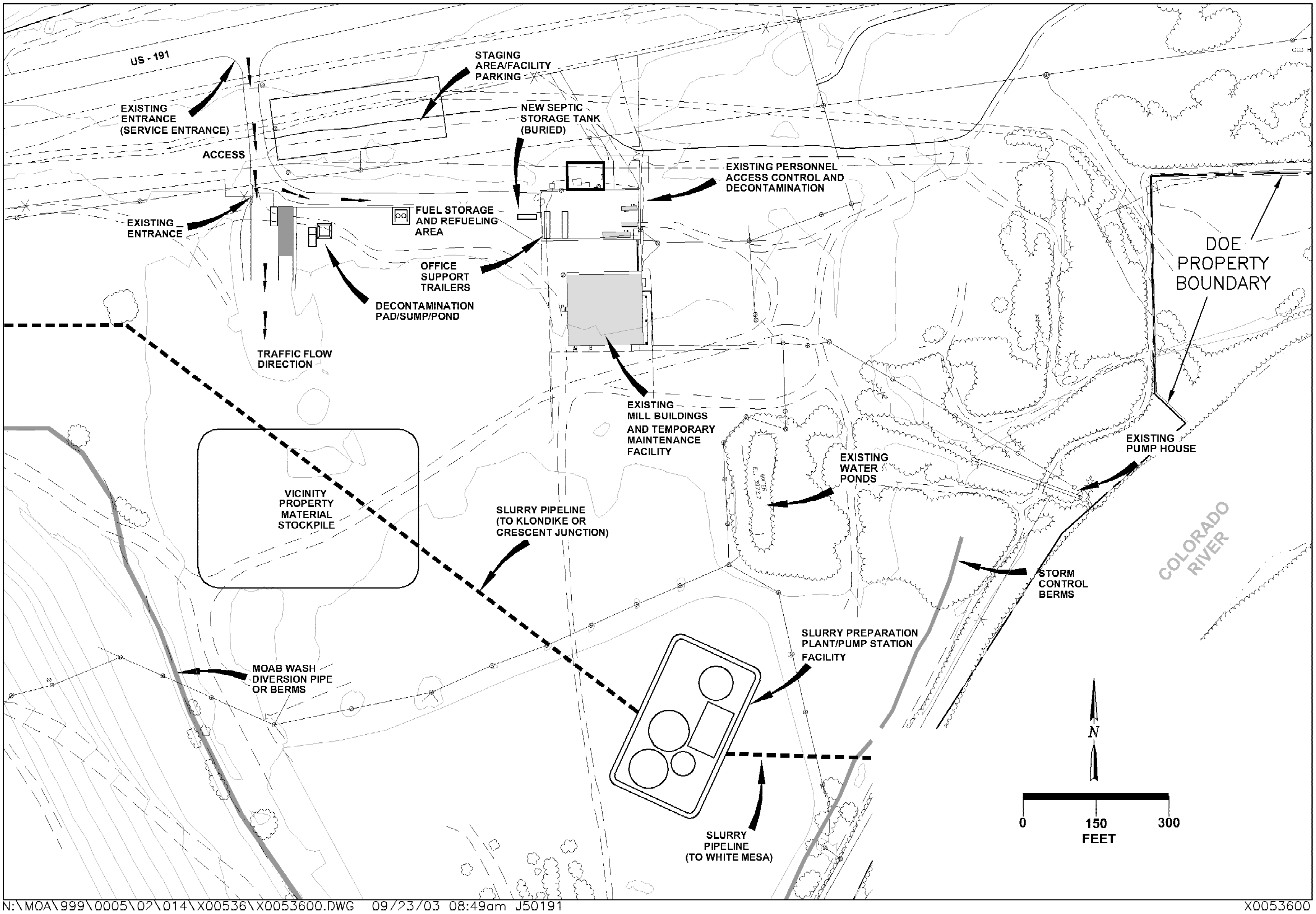

Figure 2–28. Locations of Proposed Slurry Pipeline Facilities at the Moab Site

Moab to Klondike Flats Corridor

The slurry pipeline would leave the site south of US-191. The line would parallel the highway south of Moab Wash and cross under the highway 200 ft west of the wash. From that point near the old Arches National Park entrance, it would be buried under the old state highway. The route diverges from the existing US-191 alignment about 1.5 miles north of the existing Arches National Park entrance, then reconverges with US-191 approximately 1 mile south of the SR-313 turnoff. The route north from there could parallel either the existing highway right-of-way or the Williams Gas Pipeline, which is parallel to the highway. This corridor would need to cross under US-191 twice (by boring) and under Courthouse and Moab Washes and also cross one other unnamed wash by either boring or trenching. The route is characterized by rocky areas and sandy/clay sections. The length of the pipeline route for this option would be approximately 18.8 miles. See Maps 3 and 4 of Appendix C for more detailed route information.

Moab to Crescent Junction Corridor

The corridor to Crescent Junction would be the same as the corridor to Klondike Flats until that corridor deviates from the US-191 corridor and heads west towards the disposal site at Klondike Flats. The Crescent Junction corridor would continue north, paralleling the highway and the existing Williams Pipeline corridor. Approximately 4.5 miles south of I-70, the pipeline would parallel the Williams Pipeline, which heads northeast along the county road that is also a cutoff to the town of Thompson. After 4.2 miles, the pipeline would parallel a new pipeline segment that will be installed heading north to the new Williams Pipeline Corporation proposed loadout facility located north of I-70, east of Crescent Junction. In addition to the crossings cited above for the Klondike Flats corridor, the Crescent Junction corridor would also have to be bored under I-70 and under the Union Pacific Railroad. The length of the corridor from Moab to Crescent Junction would be approximately 33.7 miles. See Maps 1 through 4 of Appendix C for more detailed route information.

Moab to White Mesa Mill Corridor

Three operating gas pipelines currently exist along the proposed Moab to White Mesa Mill corridor: Northwest Pipeline (25-inch diameter), Rocky Mountain Pipeline (10-inch diameter) and Mid-American Pipeline (16-inch diameter). The White Mesa Mill corridor would leave the Moab site and run east for about 350 ft, then cross under the Colorado River. A directionally drilled, cased bore is proposed for passing under the river because it offers the highest degree of protection against pipeline damage or leaking. The existing gas pipelines were installed using this technique to avoid affecting the river, local wildlife habitat, and the residential areas of Moab. After crossing the river, the corridor would follow the existing gas pipeline right-of-way, passing around Moab along the base of the cliffs to the southwest of town. The topography along the route southwest of Moab is undulating. Soil and vegetation are sandy loam and sagebrush. After passing around Moab, the corridor would continue following the gas pipeline right-of-way along the west side of US-191.

Approximately 15 miles from the mainline pump station (PS1), which would be located on the Moab site, the corridor would depart from the US-191 right-of-way and head southwest cross-country to avoid steep canyons in the rolling, rocky terrain. This section of the corridor is characterized by weathered sandstones, rocky sandy loam, and sagebrush. The corridor would run cross-country along an oil pipeline right-of-way. This rocky section is approximately

15 miles long. At approximately 30 miles from PS1, the corridor would cross US-191 near Lopez Arch to the east side of the highway. At this location, the terrain changes from rocky rolling hills to relatively flat sandy loam and sagebrush terrain. The proposed booster pump station (PS2) would be located approximately 31.5 miles from PS1.

The corridor would depart from the gas pipeline right-of-way south of PS2 (see Map 8 in Appendix C) and proceed along the east side of US-191 (parallel to the gas pipelines). South of PS2, the terrain is generally flat with average slopes less than 2 percent up to the high point of the corridor, which is approximately 51 miles from the Moab site at an elevation of 6,970 ft above sea level. After reaching this high point, the corridor would proceed east off US-191 for 2 miles to join an existing gas pipeline right-of-way and would pass 2 miles east of the Monticello downtown area, approximately at pipeline milepost 58. From Monticello, the corridor would follow the Blanding gas pipeline right-of-way, a cross-country pipeline route that runs parallel to US-191. The Blanding gas pipeline route joins the US-191 right-of-way at Recapture Dam. The corridor would have to cross Recapture Creek just downstream of the dam and proceed parallel to US-191. The pipeline would diverge from the highway right-of-way just north of Blanding and head south, passing about 1 mile east of the center of Blanding. It would continue south along local unpaved roads or cross-country. The terrain in this area is flat with sandy loam soil, sagebrush, and farmland. Approximately 3 miles south of Blanding, the corridor would turn west and cross US-191 near the Blanding wastewater treatment plant and continue another 3 miles along the west side of US-191 to the White Mesa Mill terminal station. The length for this corridor would be approximately 88.7 miles, of which 60 miles, or about two-thirds, would be on existing gas pipeline rights-of-way; the remainder would use a combination of public and private road that does not currently contain pipeline right-of-way.

Table 2–11 summarizes the general and construction characteristics of the three proposed pipeline corridors.

Table 2–11. Summary of Pipeline Corridor Characteristics

	White Mesa Mill	Klondike Flats	Crescent Junction
General Characteristics	**Length in Miles**		
Total corridor length	88.7	18.8	33.7
Rock: weathered sandstone	20	7.0	26.6
Soil: sandy loam/clay and sagebrush	66.7	11.8	7.0
Crossings (roads and streams)	1	0.10	0.15
Special Construction Characteristics	**Length in Feet**		
Directional drilled crossings	3,500	300	300
Road bores (highway)	500	200	400
Aerial crossings	500	0	0
Stream crossings (buried)	900	100	100

System Specifications

Regardless of the corridor that would be selected, the slurry pipeline system would be designed to meet the operational parameters shown in Table 2–12.

Table 2–12. Slurry Pipeline System Parameters

Design Life	4 years
Facility operation hours	24 hours per day 7 days per week 365 days/year
Facility overall availability	90 percent
Dry solids throughput	373 short tons per hour
Pipeline slurry concentration	50 percent by weight
Solids specific gravity	2.78
Slurry pipeline flow rate	2,031 gallons per minute (gpm)
Slurry top size	20 mesh (0.03 inch)
Dried solids (filter cake) moisture	15–20 percent by weight
Recycled water flow rate	1,172 gpm less loss from evaporation and dust control measures.
Makeup water flow rate	409 gpm

System Descriptions, Facilities, and Operations

The slurry pipeline system would comprise four major subsystems or facilities: (1) the slurry preparation plant, (2) the mainline slurry system, (3) the terminal station, and (4) the recycle water system. Each of these would be supported by integrated control and monitoring, safety, telecommunications, and electrical systems.

Slurry Preparation Plant

The slurry preparation plant would be located in the tailings pile area of the Moab site and would be common to all three corridors. The primary function of the plant would be to repulp the tailings, regrind oversized tailings, and deliver the required 20-mesh (0.03-inch) slurry to the mainline pump station (PS1). Figure 2–29 illustrates the slurry preparation plant's process flow.

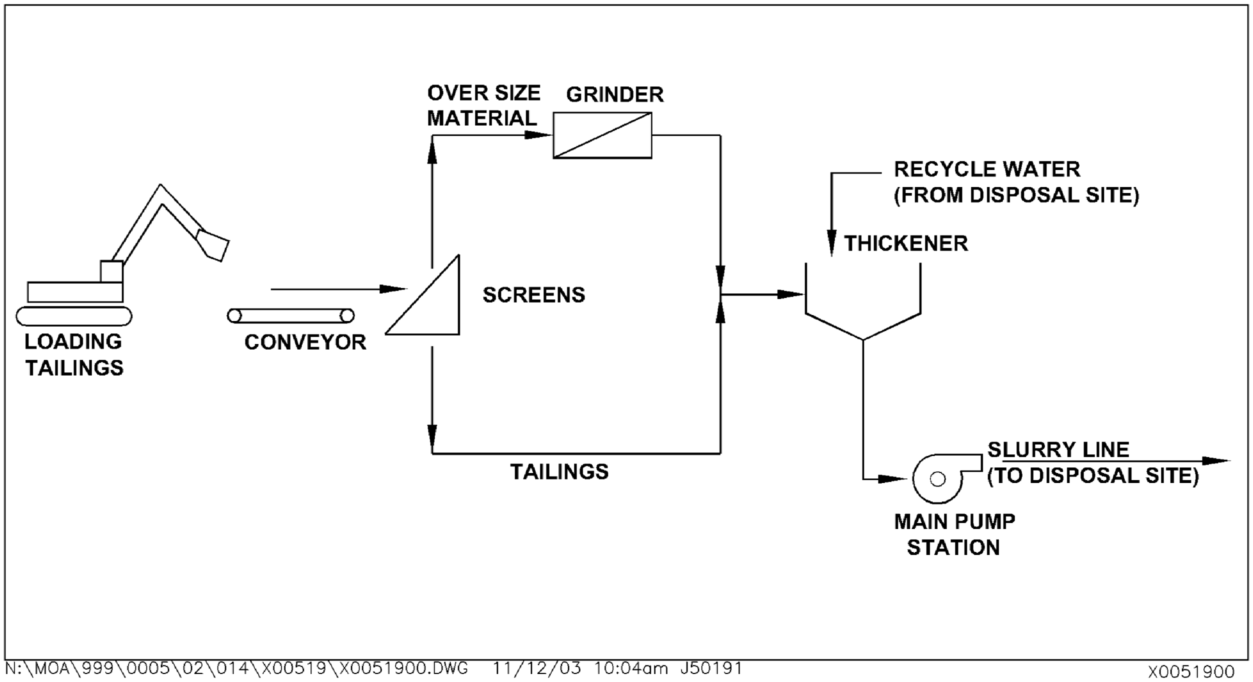

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Figure 2–29. Slurry Preparation Plant Process Flow Diagram

Tailings would be excavated as described in Section 2.2.1.2 and delivered to the slurry preparation plant by conveyor, where they would be freed of debris, sized, and amended with water to form a slurry that would be thickened to a 50-percent solids concentration and pumped to the mainline slurry system. Sieved-out material would be milled and reprocessed. Large debris would be removed for truck transport.

Mainline Slurry System

The mainline slurry system would pump the slurry from the Moab site to a terminal at the off-site disposal location. It would comprise (1) a main pump station, which would be common to all three disposal terminal alternatives; (2) a booster pump station, which would be used only if the White Mesa Mill off-site disposal alternative were implemented, (3) a 12-inch-diameter steel pipeline; and (4) one or two pressure monitoring stations. Table 2–13 summarizes the mainline pump operating characteristics.

Table 2–13. Mainline Slurry Pump Characteristics

Slurry Pipeline Corridor	Maximum Mainline Pump Flow Rate (gpm)	Mainline Pump Discharge Pressure (pounds per square inch)	No. of Pump Stations	Total Horsepower
Moab site–White Mesa Mill	2,153	2,800	2	8,276
Moab site–Klondike Flats	2,153	1,200	1	1,773
Moab site–Crescent Junction	2,153	2,000	1	2,956

gpm = gallons per minute

Terminal Station

At the terminal station, the incoming slurry would be dewatered by vacuum filtration. The suction would produce a filter cake with approximately 15- to 20-percent moisture that would be disposed of in the disposal cell. The filtrate (recovered water) would be diverted to a double-lined holding pond or a wet cell, clarified, and pumped back to the slurry preparation plant through the recycle water pipeline. Even if dewatering operations were temporarily down, pipeline operations at White Mesa Mill could continue for weeks (operations at the other sites could continue for several hours) by using the station’s wet cell to receive and temporarily store incoming slurry. In the event of a shutdown, the system would be able to be restarted without significant delay. The filter plant process flow diagram is illustrated in Figure 2–30.

Recycle Water System

The recycle water system would return approximately 80 percent of the slurry water to the Moab site for reuse. Due to some losses of water in the slurry preparation plant, filtering plant, and holding pond, approximately 400 gallons per minute (gpm) of additional (makeup) water would be required at the Moab site either from the Colorado River or from the terminal site, if makeup water were available at the terminal site. Makeup water would be available at the White Mesa Mill site, but the Klondike Flats and Crescent Junction sites would both require installation of new wells. Table 2–14 summarizes the mainline recycle pump operating characteristics.

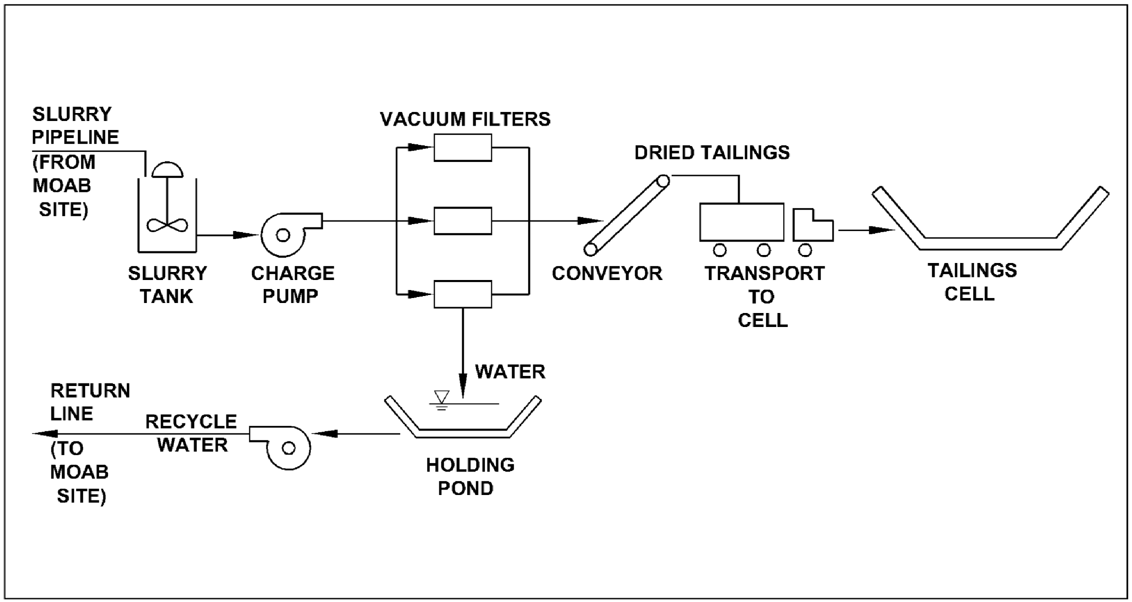

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Figure 2–30. Filter Plant Process Flow Diagram

Table 2–14. Mainline Recycle Water Pump System Characteristics

Recycle Water Pipeline Corridor	Flow Rate (gpm)	Discharge Pressure (pounds per square inch)	No. of Pump Stations	Total Horsepower
Moab site–White Mesa Mill	1,172	940	1	918
Moab site–Klondike Flats	1,172	380	1	371
Moab site–Crescent Junction	1,172	640	1	625

Facility Footprints

Table 2–15 gives the estimated square footage requirements for the proposed facilities.

Table 2–15. Facility Land Use Requirements (Footprints)

Facility/Location	Footprint (ft^2)
Moab (common to all site alternatives)	67,000
Booster pump station (White Mesa Mill alternative only)	16,500
Terminal (common to all site alternatives)	40,625

Control/Monitoring and Safety Systems

Control and Monitoring

The slurry pipeline system would be controlled and monitored from a control room at the Moab site, which would be manned constantly. Control room operators/dispatchers would be alerted automatically if abnormal or emergency conditions, such as off-specification slurry, a leak, or a plug in the pipeline, were to occur. System control would be automatic in the steady-state mode. Operator intervention would be required only during process upsets, shutdowns, and restarts. For the White Mesa Mill corridor, isolation valves would be included at both sides of the Colorado River to minimize the possibility of slurry entering the river if a leak were to occur.

Safety

- *Leak Detection and Management*—The pipeline would contain only noncompressible, nonflammable, semiliquid slurry that would not pose an explosion or fire hazard. However, high-pressure slurry could be aggressively abrasive if a leak were to occur. The pipeline would be continuously monitored by a leak detection system. This system would provide operating data for the Supervisory Control and Data Acquisition (SCADA) system via a fiber optic telecommunication system. Flow rate, pressure, and density would be monitored at various points along the pipeline. A pressure monitoring station (two for the White Mesa Mill corridor) with a pressure transmitter powered by a solar panel or other power source would be installed. The objective of the leak detection system would be to detect leaks within 2 to 10 minutes of occurrence (depending on the size and the location of the leak), predict their location, and issue warnings to operators. If there were an indication of a leak, an inspection team would be dispatched. DOE's estimated theoretical spill volume for a pipeline leak is 0.65 to 1.3 yd^3 during the sensing period and 4 yd^3 after the system is shut down. The total spill volume for a leak is expected to be less than 5.2 yd^3 (PSI 2003).
- *Overpressurization Protection*—The pipeline and equipment would be protected from overpressurization by several levels of protection, including proven operating procedures, use of SCADA system software, electrical or hardware interlocks or control loops, and mechanical pressure-relieving devices.
- *Rupture Contingency Plan*—In the unlikely event of a pipeline rupture, installed systems would warn the operator with a prompt to consider activating an emergency shutdown sequence if the data appear valid. A break would result in some slurry loss. Repairs and cleanup, including lining repairs for short sections, could be made in a matter of a few days to 2 weeks.
- *Buried Pipeline*—Although the pipeline could be installed above ground and operated safely, DOE proposes to bury it in order to minimize conflicts with the public and also to prevent punctures from causes such as vehicles and gunshots.

Additional design techniques and safety factors would be applied for all special design points (e.g., thicker steel pipe wall at the river crossing). In areas of potentially severe erosion, design provisions would be based on maximum predicted flood events.

Post-Operational Activities

Post-operational activities would depend on DOE's ultimate decision on the fate of the pipeline. Some commentors have suggested that upon completion of slurry transportation activities the pipeline could be retrofitted for irrigation or other uses. However, any decision on such a future use would be predicated first on a decision that the use would be appropriate and second that a radiological release of the pipeline would be feasible and acceptable. These decisions could not be made until slurry transportation was complete. If DOE decided that other pipeline uses were not appropriate or feasible, upon completion of pipeline slurry operations, DOE would dig up the buried pipelines, compact them, and dispose of them in the disposal cell. The disturbed pipeline right-of-way would then be reclaimed and revegetated.

2.2.5 Construction and Operations at the Off-Site Disposal Locations

This section describes construction and operations at the off-site disposal locations. These activities would be essentially identical for the proposed Klondike Flats and Crescent Junction sites. Consequently, Section 2.2.5.1 describes activities for these two sites in terms of a "reference cell" that applies to both sites. The proposed cell design for the White Mesa Mill site is somewhat different because it is based on IUC's proposed design (IUC 2003). It is discussed separately in Section 2.2.5.2. For the purpose of describing these activities, the following sections address five main elements: (1) site preparation, infrastructure development, and control, (2) disposal cell construction, (3) tailings placement operations, (4) disposal cell cover construction, and (5) site reclamation.

2.2.5.1 Reference Disposal Cell

Figure 2–16 is a reference disposal cell site plan illustrating the major site features and approximate locations of temporary areas and facilities that would be used under the truck or slurry pipeline transportation alternative. Under the rail transportation alternative, the decontamination facility, worker access control, parking, fuel storage, and some stockpile areas would be located next to the train transfer point rather than adjacent to the disposal cell.

Site Preparation, Infrastructure Development, and Controls

Access Roads

The disposal cell would require new roads throughout the site to control the flow of traffic, allow access to material deliveries, and allow access to and from the contaminated haul road. DOE estimates that approximately 3,500 ft of contaminated and clean access roads combined would be required. New access roads would be 30 ft wide with a compacted gravel surface. Gravel road would be treated with dust control surfactant to reduce the need for water-consuming dust control measures.

Storm Water Control and Management

There are no major drainage channels currently entering any of the three alternative sites. Storm water management controls would be regulated under the Utah Pollutant Discharge Elimination System General Permit for storm water discharges from construction activities. Normal storm water control requirements generally are designed to control a reference storm event of a 25-year magnitude. Runoff ponds and ditches would be constructed at the transportation transfer station and the disposal cell to divert storm water away from facilities and operational areas. Hay bales and silt fences would be constructed to control sediment transport.

Radiological Controls

Radiological controls and decontamination procedures at the disposal cell would be functionally and operationally similar to those described in Section 2.1.1.1 and 2.2.1.1. One central access control location would be designated at either the disposal cell area entrance or the train/truck transfer station entrance for site radiological control as shown in Figure 2–16 (truck or pipeline transportation) and Figure 2–31 (rail transportation).

For the truck haul and slurry pipeline transportation alternatives, the contamination area boundary would encompass the disposal cell area and supporting construction facilities but would exclude the office trailer and parking lot areas. For the rail haul transportation alternative, the contamination area boundary would encompass the train/truck transfer station, the

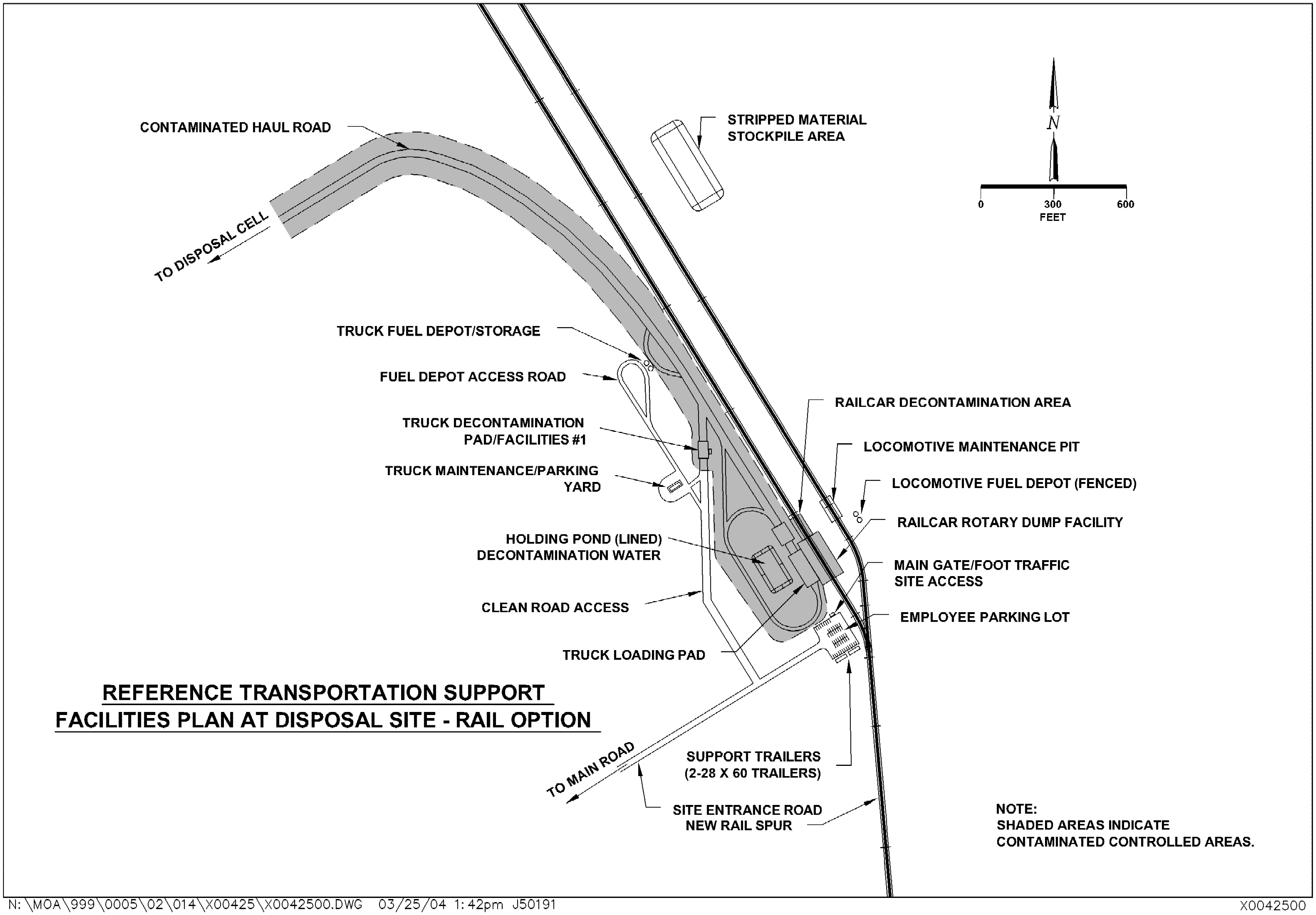


Figure 2–31. Transportation Facilities Plan, Rail Transportation

contaminated haul road from the transfer station to the disposal cell, and the disposal cell area but would exclude the office trailer and parking lot areas at the transfer station. Contamination control fencing would separate contaminated and uncontaminated areas at the transfer station and delineate the cell perimeter and both sides of the 2-mile haul road.

Water Storage Towers

Water storage towers would be placed at the disposal site and used to store water for nonpotable use such as soil compaction and dust control. Water from the Colorado River (allocated under existing water rights held by DOE, which authorize 3 cfs consumptive use) would be taken from the Moab site water storage ponds, loaded onto tanker trucks, and transported to the off-site disposal location, where it would be transferred into off-site storage towers (or possibly ponds).

Temporary Field Offices

The temporary field offices would be similar to those described in Sections 2.1.1.1 and 2.2.1.1 except that estimated discharge to the sanitary holding tank would be approximately 4,000 gallons per day. Potable water supply to the site would be locally supplied and delivered in portable, trailer-mounted water storage tanks and plumbed into the office units where appropriate. The offices would be located as illustrated in Figure 2–16 (truck or pipeline transportation) or Figure 2–31 (rail transportation).

Staging and Vehicle Maintenance Area

A staging area and a vehicle maintenance area would be constructed for storage of incidental construction materials and equipment and for on-site vehicle maintenance. Construction materials and equipment would require approximately 1 acre of open field for storage and would not require physical structures. The maintenance area would include construction of a portable structure (pole and canvas, 30 by 100 ft, dirt floor) to fully enclose excavation equipment requiring major equipment maintenance.

Fuel Storage and Refueling Area

Fuel would be supplied by local vendors and stored on the site. A central delivery point would be used to transfer the fuel to on-site 20,000-gallon fuel storage tanks. Multiple tanks would be located at both the Moab site and the off-site disposal location to accommodate fuel consumption requirements. Tank volumes would be sufficient to provide 1 week of demand. Refueling would require construction of a spill containment structure to safeguard the environment in the event of a spill. Vehicles and equipment would refuel as needed without exiting the contamination area under strict refueling plan guidelines. The areas would be located as illustrated in Figure 2–16 (truck or pipeline transportation) or Figure 2–31 (rail transportation).

Train/Truck Transfer Facility

For the rail transportation option only, a temporary train/truck transfer facility would be constructed to transfer tailings from the railcars to haul trucks. Figure 2–31 presents the overall plan for this transfer facility. It would consist of the rail spur and two sidings to allow train switchouts, a rotary bin to rotate and dump the railcars, a railcar decontamination station, a locomotive inspection pit, and a train fueling station. This area would also include support facilities for off-road haul truck maintenance and fueling and other site support facilities previously described, including field offices, equipment decontamination facilities, employee parking lots, and personnel radiological access control module.

Railcar Unloading and Decontamination

Gondola railcars delivering tailings to the train/truck transfer station would be guided into an open structure containing the rotary dump facility. The facility would consist of the rotary dump mechanism and a concrete bin directly below it to receive the dumped material. The train would approach the facility, and a car would be positioned in the center of the rotary dump. The railcar would be disconnected from the rest of the train. The rotary mechanism would connect to the car and then rotate it approximately 135 degrees to empty the car contents into the lower-level concrete bin (see Figure 2–23). The tailings would then be picked up by front-end loaders and loaded into haul trucks.

After dumping, the rotary mechanism would set the railcar upright, and the railcar would be reattached to the train. The train would pull the car forward into the decontamination area. Another full railcar would be positioned in the rotary dump, and the dumping process would be repeated. While the next car was unloaded, the previously unloaded car would be decontaminated. Its exterior would be decontaminated using high-pressure water hoses to remove visible contamination. Decontamination water would be captured below the decontamination pad in a process similar to that at the truck/equipment decontamination facility. It would flow through piping to a double-lined decontamination pond for reuse. Although most of the water would be recycled, some would be lost through evaporation. All decontamination wastewater remaining at the end of operations would be used for either moisture conditioning and compaction of cell materials or for dust control inside the cell construction area and would not be discharged to the ground water or surface water system. After decontamination, the railcar would be inspected, decontaminated again if necessary, and released. This process would be repeated for all cars until the entire train was emptied and decontaminated. It would then return to the Moab site for reloading. The unloading facility would include a rail siding adjacent to the track used for unloading. The additional siding would be used to stack a waiting train and for switching out trains to avoid track conflict.

Contaminated Haul Road to Disposal Cell

The rail transportation option would also require construction of a 30-ft-wide gravel-surfaced haul road from the transfer station to the disposal site; the length of the haul road would depend on the exact location of the disposal cell. The Crescent Junction haul road could be 1,000 to 8,000 ft long, and the Klondike Flats haul road could be 6,000 to 12,000 ft long. Haul trucks would deliver the tailings to the disposal cell. Stripping operations would remove and stockpile approximately 400 yd^3 of topsoil material strategically along the roadway alignment. The alignment would be finish-graded and would receive a 12-inch layer of compacted roadbase. Dust control surfactants would be applied.

Disposal Cell Construction

Topsoil Stripping and Stockpiling

The reference disposal cell footprint is a 3,340- by 1,670-ft rectangle on a relatively flat surface. Stripping operations would remove approximately 12 inches of topsoil from the cell footprint, haul road, stockpile areas, runoff collection pond, and runoff ditches; the estimated volume of stripped topsoil would be 234,000 yd^3. The stripped topsoil would be stockpiled for subsequent use in the final cover. Concurrently with topsoil stripping, runoff ponds and ditches would be constructed and water trucks would provide dust control as needed.

Excavation

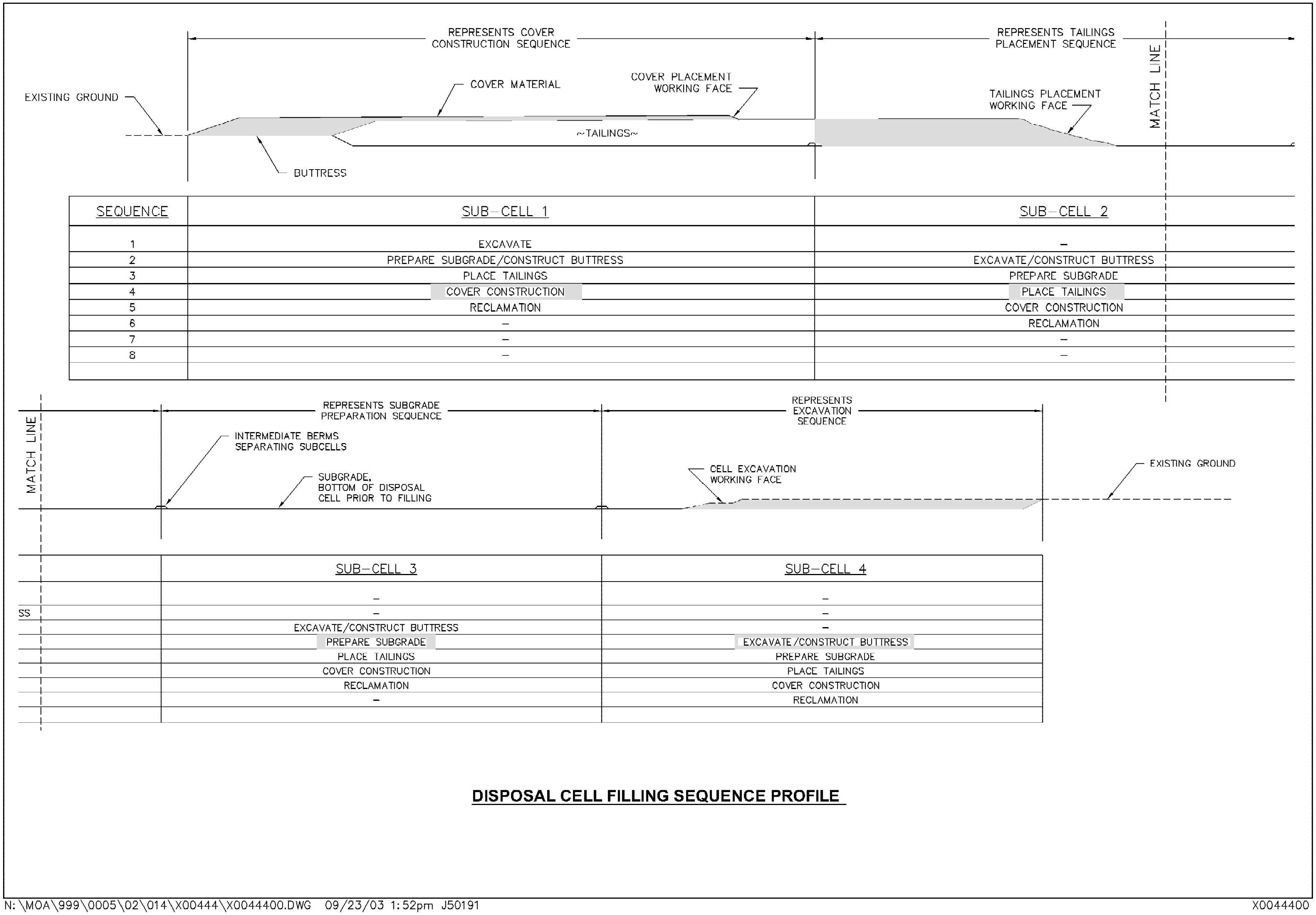
The total volume of excavation would be approximately 3.5 million yd^3. Cell excavation would proceed sequentially in four relatively equal "subcell" areas. The cell would be excavated to a nominal depth of approximately 18 ft below grade, although the as-built dimensions could vary when the final location was chosen and actual site grade conditions were evaluated. The final cell configurations would also extend 29 ft above grade. The below-grade walls of the cell would slope inward at a 2H:1V slope. Excavated material would be hauled, dumped, and spread around the perimeter of the subcell to accommodate construction of the buttress as the excavation progressed. As material was delivered to the buttress area, soil compaction equipment would compact the buttress material.

Upon completion of subcell 1, excavation of subcell 2 would begin (Figure 2–32). A separation berm between subcells would serve as a haul route into the cell for the tailings filling operations. The excavation process would proceed in a similar manner until subcell 4 was complete. Additional cell volume above the estimated required size could be necessary to accommodate volumes of tailings that were underestimated or unaccounted for. Throughout excavation operations, a survey crew would maintain grade control, soil testing technicians would provide testing information for compaction and moisture control, and water trucks would provide dust control and soil moisture control support.

Subgrade Preparation

When excavation operations for subcell 1 were complete, subgrade preparations (that is, preparing the base of the cell to receive tailings) would commence. On the basis of past knowledge and the known geologic characteristics of the disposal site areas, DOE assumes that the subgrade materials would meet permeability requirements (see Appendix B) and that low-permeability additions to the existing soils would not be necessary. However, if testing were to prove otherwise, mitigating measures such as addition of bentonite to the subgrade soils would be employed. The subgrade surface preparation would consist of scarifying to a depth of 12 inches, moisture-conditioning to optimum moisture content (i.e., to achieve optimum compaction), processing the moisture and bentonite into the soil, and compacting the surface to its maximum density. Once subgrade grading and compaction requirements for subcell 1 were satisfactorily met, tailings placement would begin in subcell 1, and the subgrade preparation crew would move to subcell 2 to repeat the subgrade preparation operation. This sequence is illustrated in Figure 2–32.

Water from rainfall or construction activities in the individual cells would be collected in a lined sump to minimize seepage and conveyed from the cell for use in moisture conditioning or dust control. The lined sump would be removed before cell closure.



SEQUENCE	SUB-CELL 1	SUB-CELL 2	SUB-CELL 3	SUB-CELL 4
1	EXCAVATE	–	–	–
2	PREPARE SUBGRADE/CONSTRUCT BUTTRESS	EXCAVATE/CONSTRUCT BUTTRESS	–	–
3	PLACE TAILINGS	PREPARE SUBGRADE	EXCAVATE/CONSTRUCT BUTTRESS	–
4	COVER CONSTRUCTION	PLACE TAILINGS	PREPARE SUBGRADE	EXCAVATE/CONSTRUCT BUTTRESS
5	RECLAMATION	COVER CONSTRUCTION	PLACE TAILINGS	PREPARE SUBGRADE
6	–	RECLAMATION	COVER CONSTRUCTION	PLACE TAILINGS
7	–	–	RECLAMATION	COVER CONSTRUCTION
8	–	–	–	RECLAMATION

Figure 2–32. Disposal Cell Filling Sequence Profile

Tailings Placement and Compaction

Haul trucks would arrive at the disposal site by (1) direct haul from the Moab site, or (2) haul from the train/transfer station, or (3) haul from the slurry pipeline dewatering facility. The trucks would dump the tailings, dozers would spread the tailings to the precompaction thickness of 12 inches, and compaction equipment would compact them.

Optimum moisture content refers to the amount of moisture in the tailings that would allow the maximum control over compaction (e.g., sufficient moisture to lubricate the mineral grains). DOE assumes that the moisture content of the tailings arriving in the cell would be at or near its optimum for disposal in the cell, and that little, if any, processing would be required. However, in the event wetting or drying were needed, water trucks and tractors with disc harrow attachments would be employed to achieve the requisite moisture level.

Tailings would be loaded to an average above-grade depth of approximately 30 ft (Figure 2–33). When the loading of subcell 1 was complete, cover construction operations could commence. The tailings placement process would proceed sequentially until subcell 4 was complete to final grades.

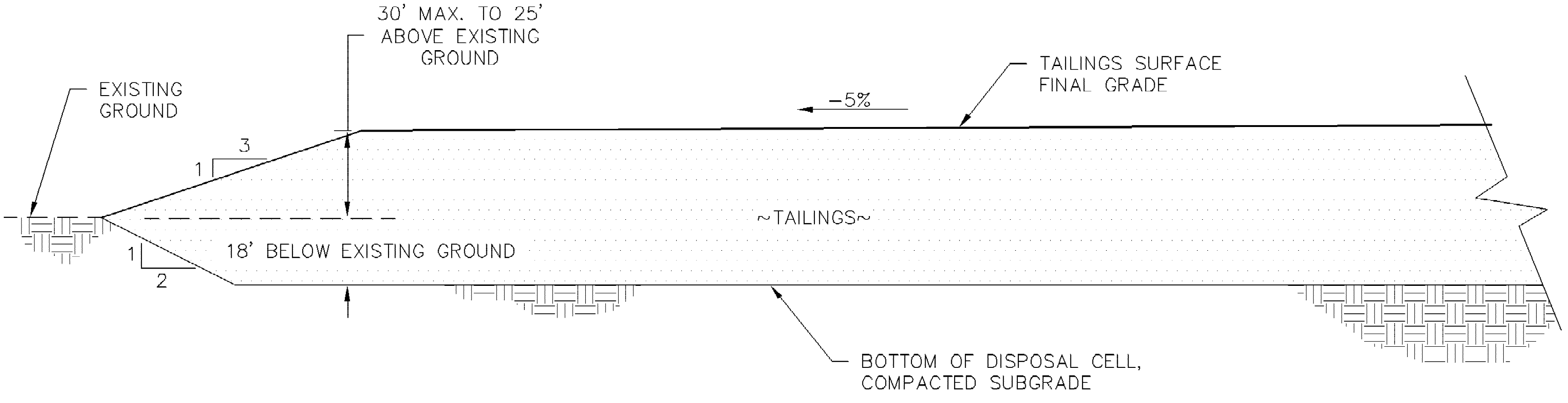
Disposal Cell Cover Construction

The technical basis, as well as the basic types and thicknesses of cover construction materials for the reference off-site cover, would be similar to those previously described for the cover proposed for the Moab site under the on-site disposal alternative in Sections 2.1.1.3 and 2.1.3.1, and in Appendix B. However, the reference cell cover would be larger in overall area because of the configurational differences of the off-site cell and the Moab site tailings pile and because, in contrast to the Moab site cover, the off-site cover would overlie the buttress as well as the emplaced tailings. Also, only the vegetated erosion protection (riprap mixed with soil) would extend over the clean-fill buttress.

Borrow materials and excavated soil for constructing the buttress and cover would be delivered or stockpiled on the disposal cell site during the cell excavation and tailings placement operations. Cover construction would commence in subcell 1 of the disposal cell after tailings placement was complete and placement operations had moved into subcell 2. The final cover footprint would require an additional surface area of 63 acres of disturbance outside the disposal cell footprint. The total depth of the finished cover over the tailings would be 6 ft, and the total height of the completed cell would be up to 35 ft above grade. Figure 2–34 illustrates the reference cell cover and cover layer surface dimensions. The following subsections describe the amounts and placement of cover materials (see Figure 2–35).

Radon/Infiltration Barrier

Approximately 294,000 yd^3 of radon/infiltration barrier material stockpiled on the site would be transported to the cell area and emplaced on the tailings in three loose lifts, or stages, that would be sequentially compacted to a final required 1.5-ft thickness and reference density. The final placement would be graded to finish-grading specifications. If necessary, water would be added to achieve optimum moisture content for compacting.



NOTE:
COVER MATERIAL NOT SHOWN.

TYPICAL CELL SECTION

SCALE: 1" = 50.0'

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Figure 2–33. Disposal Cell, Typical Section

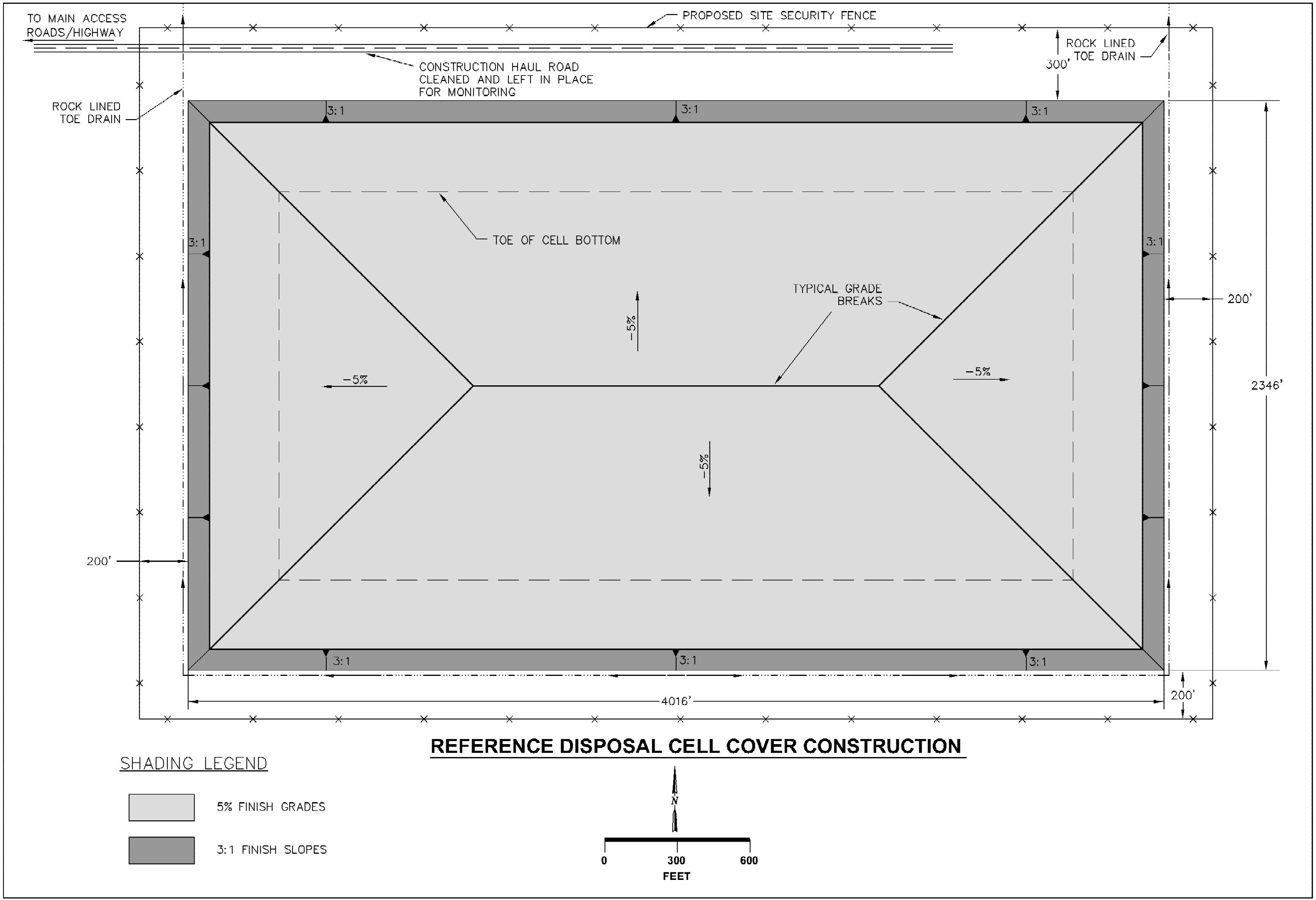


Figure 2–34. Reference Disposal Cell Cover Construction

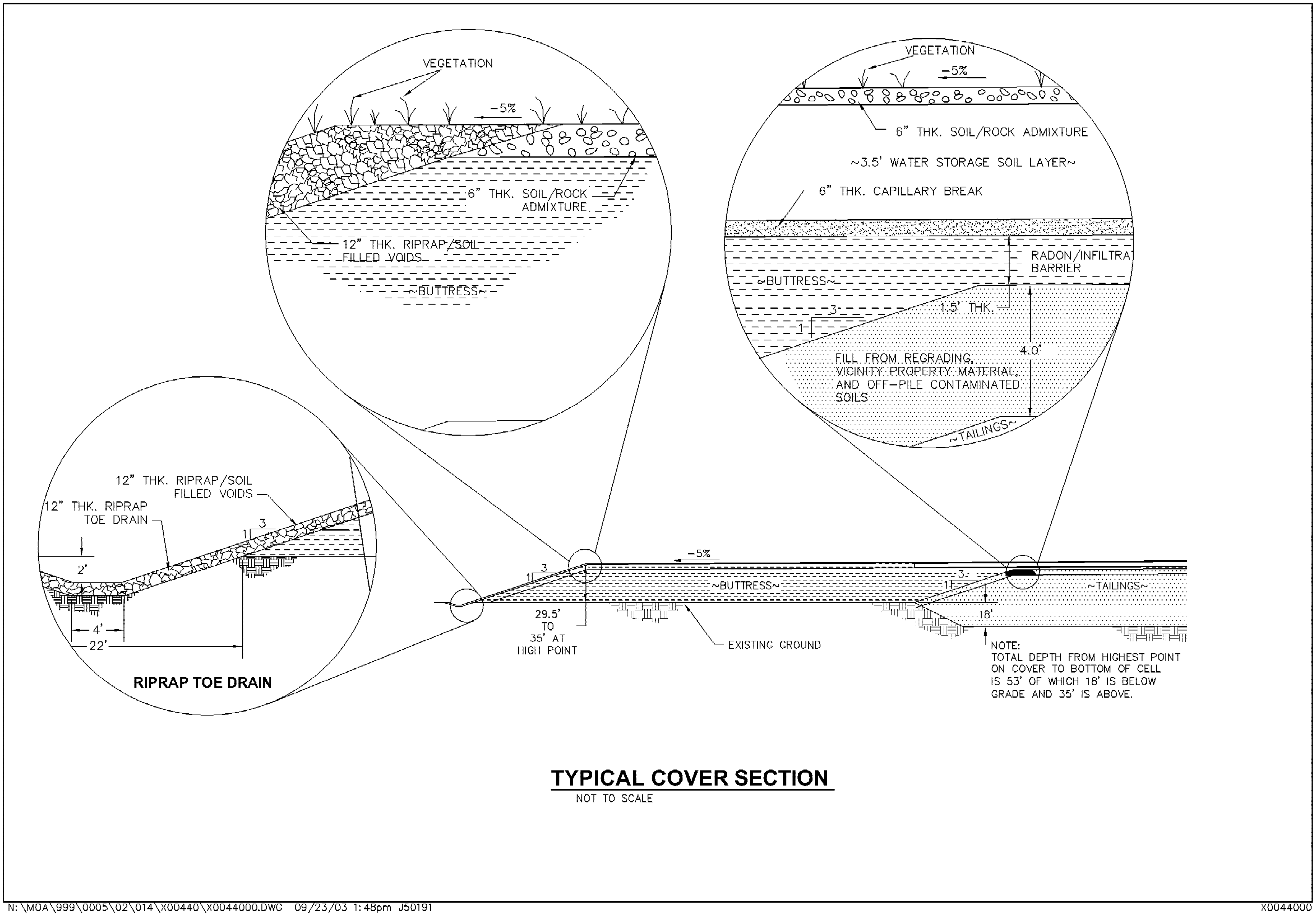


Figure 2–35. Reference Disposal Cell—Typical Cover Section

Coarse-Sand/Fine-Gravel Capillary Break

The capillary break layer would be approximately 215,750 yd^3 of a selected blend of coarse sands and fine gravels. The material would be transported from the stockpile area to the cover placement area and dumped. It would then be spread and compacted to a depth of 6 inches. The material would be compacted in its natural moisture state and would have no moisture content or density requirements.

Fine-Grained (Water Storage) Soil Layer

The fine-grained soil layer would be approximately 1.1 million yd^3 of a borrow material that would be imported and stockpiled on site. The material would be spread to a loose depth of 3.5 ft. It would have no moisture content or maximum density placement requirements.

Soil/Rock Admixture Layer

The soil/rock admixture layer would consist of approximately 154,000 yd^3 of borrow material, of which 20 percent would be riprap no greater that 12 inches in diameter. It would be spread to a final loose depth of 6 inches and would have no moisture content or maximum density placement requirements. Once satisfactory depths and mixture ratio were achieved, a tractor and disc harrow would blend the two soil types.

Side Slope Riprap/Soil-Filled Voids Layer

The riprap/soil-filled voids layer would consist of approximately 43,000 yd^3 of borrow material, of which 20 percent would be riprap no greater that 12 inches in diameter. The riprap would be placed to a final depth of 12 inches and would have no moisture content or maximum density placement requirements. Once satisfactory depths were achieved, soil would be placed over the riprap to fill voids. A tractor and chain/blanket mat would pass over the soil to work the material into the voids. Areas that received a surplus of soil would require hand raking to achieve uniform placement.

Site Reclamation

Before the last portion of the cover was emplaced, removal of contaminated facilities and contaminated areas of temporary construction facilities would begin. Noncontaminated temporary facilities such as office trailers, access roads, and employee parking lots would remain until the end of cell cover placement.

All disturbed areas within the contaminated site boundary would be verified to meet cleanup standards prior to cell closure and backfill. Any contaminated material would be excavated and placed in the disposal cell. Areas of surface disturbance caused by construction activities outside the disposal cell final footprint and permanent drainage ditches, such as areas that supported construction of haul and access roads, construction facilities, construction materials, and cover material stockpiles, would be rough-graded and backfilled with the remaining topsoil stockpiled from stripping operations. The topsoil would be excavated from the stockpile area, transported to these areas, dumped, and graded in preparation for final reclamation. Impermeable membrane liners used in decontamination ponds, storm water control ponds, and slurry operations would be removed and disposed of in the disposal cell. The ponds would be backfilled to original grades prior to final reclamation.

All remaining structures and facilities used for cell construction and loading, including buildings, trailers, fuel storage areas, concrete slabs, water towers, and all elements of the transportation infrastructures, would be disassembled and either disposed of in the cell, salvaged, or properly disposed of in accordance with applicable federal, state, and local requirements.

The disposal cell site would be completely fenced with standard 6-ft-high chain-link security fencing with a three-strand barbed wire top and gated at the access road. The proposed fence area is illustrated in Figure 2–34. Final reclamation activities would be implemented at the cell disposal area and transportation facility area and would consist of seeding with native or adapted plant species.

2.2.5.2 White Mesa Mill Disposal Cell

The design and specifications proposed for the White Mesa Mill site are somewhat different from those proposed for the Klondike Flats and Crescent Junction sites because they are based on an unsolicited proposal submitted to DOE by IUC (IUC 2003). This cover approach reflects an alternative design that is more typical of UMTRCA Title II uranium mill tailings reclamation and is similar to that proposed in NRC's 1999 EIS (NRC 1999). A brief description of the White Mesa Mill cover design is included in Appendix B. DOE has reviewed the design and has determined it to be reasonable at the conceptual level. This section describes the activities that would occur if the IUC proposal were implemented. The conceptual design is strictly intended to establish a reasonable basis for evaluating environmental impacts associated with this component of site remediation and reclamation. This assumed design is not intended to commit DOE to any specific cover design.

IUC proposes to dispose of contaminated materials from the Moab site and vicinity properties at its White Mesa Mill site, assuming it received a license amendment from the State of Utah for its current operations there. 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.) If the IUC White Mesa Mill were selected as the final disposal site for the Moab tailings, the proposed changes to IUC disposal capacity and engineering design would require prior UDEQ approval and issuance of a State Construction Permit and possibly a modification of a State Groundwater Quality Discharge Permit. The *Utah Administrative Code* R313-24-4(1)(b) requires the White Mesa Mill site to comply with state requirements for ground water protection. Details regarding appropriate engineering design, construction requirements, operational mandates, monitoring needs, and closure stipulations would be determined by UDEQ at that time. Disposal of the Moab tailings at White Mesa Mill would be performed under a reclamation plan approved by the State of Utah. Because IUC's cells and reclamation plans would be state-approved, DOE assumes that they would meet all applicable state and federal regulations. IUC would be responsible for all material, design, and performance compliance issues concerning disposal operations, cell construction, and cover performance. Tailings placement would be performed under IUC's direction by either IUC personnel or by an outside contractor. IUC would oversee the outside contractor and would be responsible for quality assurance/quality control to ensure that all design and performance specifications were met.

Tailings would be transported approximately 85 miles to the White Mesa Mill site by either truck or slurry as described in Section 2.2.4. Under the slurry transport option, IUC would take ownership of the Moab site tailings at the entrance to the slurry pipeline system. If the tailings were trucked, DOE would retain ownership until they were received at the White Mesa Mill site.

Summary of IUC's White Mesa Mill Disposal Cell Construction and Operations Proposal

Figure 2–36 illustrates the general layout of the IUC's proposed wet and dry cell, and Figure 2–37 is a schematic cross-section. The cell would be approximately 18 ft below grade. Dimensions would depend on the final cell location and configuration, which would be based on actual site grade conditions. The interior cell sideslopes below grade would be constructed at 3H:1V. Excavation operations would remove subgrade materials to the final depth of the cell, which would have a 12-inch compacted clay liner. Excess excavated material would be delivered to the buttress area, where soil compaction equipment would compact it to form the cell buttress. The cell buttress would have 5H:1V exterior slopes. After the starter cell was filled, excavation and tailings placement would proceed sequentially as previously described for the Klondike Flats and Crescent Junction cells. Maximum cell dimensions would be approximately 3,500 by 1,800 ft, creating a disposal cell approximately 145 acres in area. Final cell size would be determined by the final quantity of tailings placed.

If the tailings were delivered by slurry pipeline, they would be processed as described in Section 2.2.4 and placed in a 30-acre "starter" dry cell that would be constructed for initial storage. Fluids not immediately repiped to Moab would be stored in a "wet" cell for later use as makeup water. The wet cell would have a geosynthetic high density polyethylene liner (Figure 2–38).

Truck-transported tailings or dried slurry materials from interim storage would be placed in the cell using conventional earth-moving construction techniques. In the case of truck-transported materials, the highway trucks would dump their loads, and front-end loaders would transfer tailings to off-highway (on-site) trucks for delivery to the dry cell. Deposited tailings would be bladed to a depth of 6 to 9 inches prior to compaction to 90 percent of maximum dry density. A water truck would provide water for dust control or for any moisture necessary for compaction. Dry cell placement would be continuous as excavation and preparation of cell capacity progressed ahead of tailings placement.

A survey crew would maintain grade control throughout the excavation operation. Soil testing technicians would provide information for compaction and moisture control. Water trucks would operate in tandem with the construction operations to provide dust control during excavation operations and soil moisture control for construction of the buttress.

Approximately 35,000 yd^3 of debris are believed to exist in the Moab site. Debris would be transported by truck to White Mesa Mill for placement in the dry cell. Before leaving the site, trucks would be scanned for radioactive contamination and decontaminated at a wash facility operated by the mill. DOE estimates that approximately 2,200 truckloads of debris would be shipped.

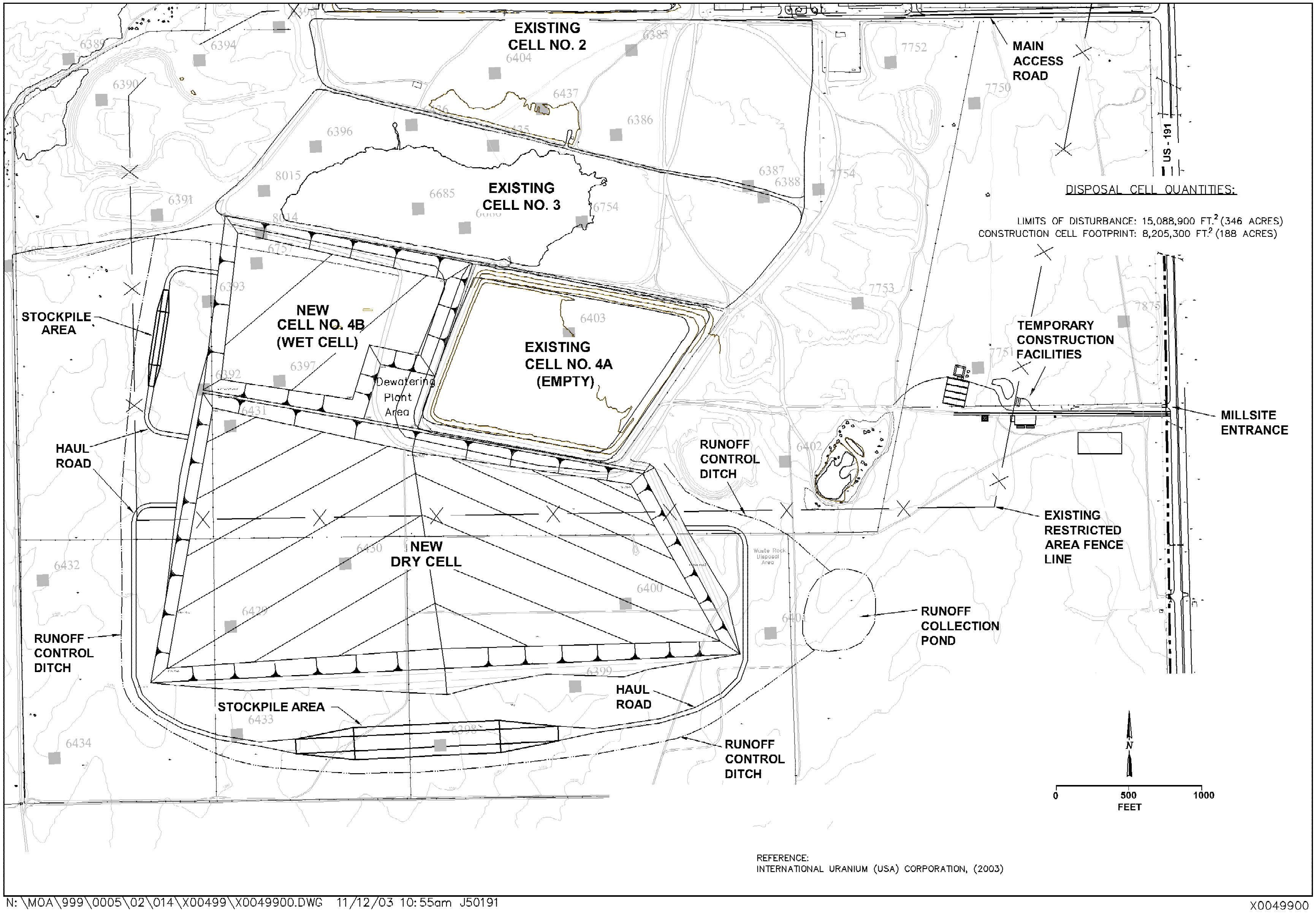
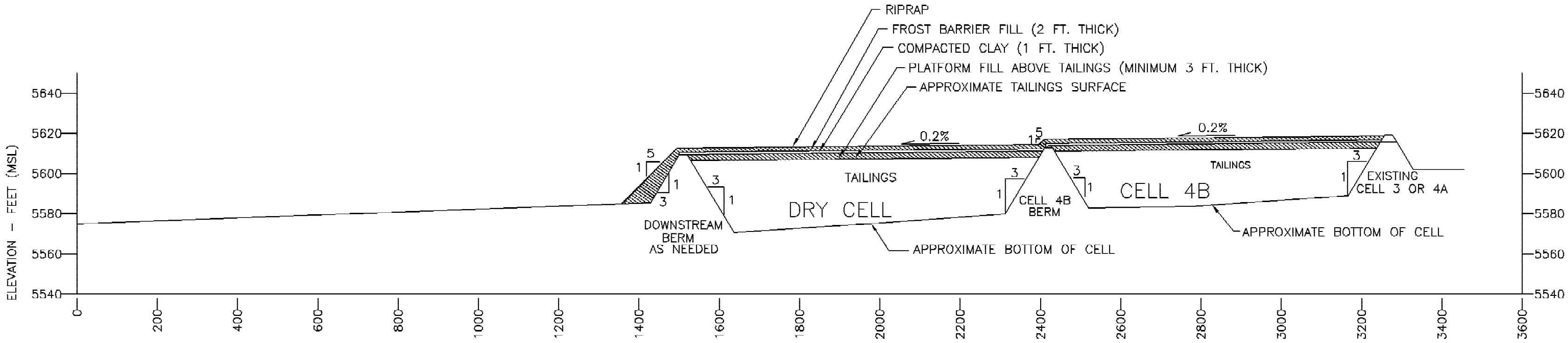


Figure 2–36. White Mesa Mill Disposal Cell Plan



CROSS SECTION (WITH COVER ON CELLS 4B AND DRY CELL)

NOTES:

1. EXISTING GROUND SURFACES SHALL BE REGRADED TO CONSTRUCT THE COVER WITH A FINAL SURFACE THAT IS CONSISTENT WITH THE RECLAMATION COVER GRADING PLAN.

REFERENCE:
INTERNATIONAL URANIUM (USA) CORPORATION, (2003)

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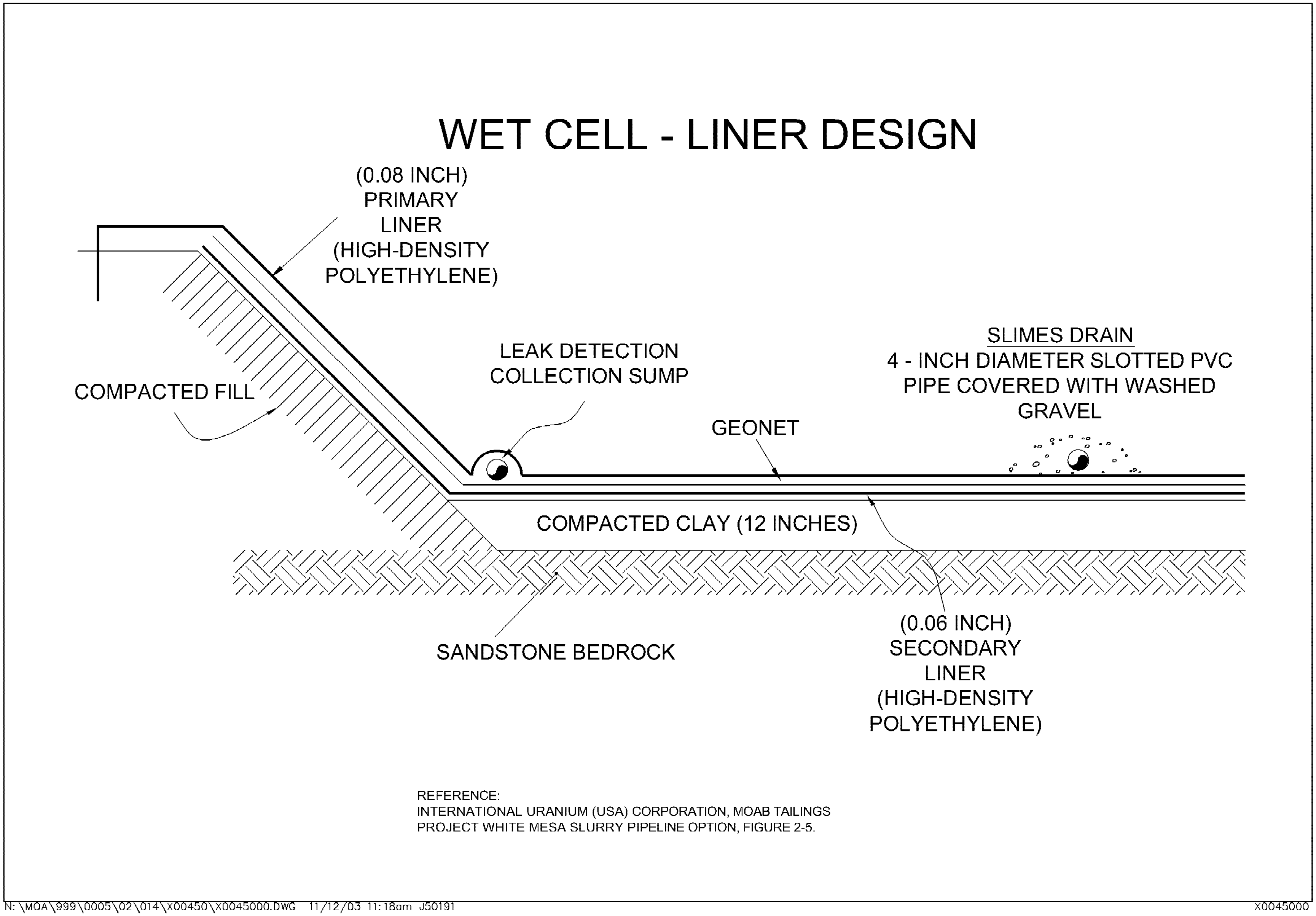
Figure 2–37. White Mesa Mill Disposal Cell Cross-Section



REFERENCE:
INTERNATIONAL URANIUM (USA) CORPORATION, MOAB TAILINGS PROJECT WHITE MESA SLURRY PIPELINE OPTION, FIGURE 2-5.

Figure 2–38. White Mesa Mill Wet Cell Liner Design

Summary of IUC's White Mesa Disposal Cell Cover Proposal

Figure 2–39 illustrates details (materials and thicknesses) of a typical reclamation cover that IUC proposes to construct. This proposed cover differs somewhat from the cover previously described for the reference cell but is typical of other NRC-approved covers for private licenses.

Components of the final top cover from the top down would consist of erosion protection riprap, a frost barrier, a compacted clay radon barrier, and a platform fill layer directly over the tailings. The side slope cover would consist of random fill covered by riprap. On-site borrow is available for all material except the riprap. Quarries located north of Blanding, approximately 8 miles from the White Mesa Mill site, would be used as the riprap source. Placement of these layers would be similar to that previously described for the reference cell. The materials would be stockpiled near the cell, then emplaced and compacted using standard construction equipment and techniques.

2.2.6 Monitoring and Maintenance

After completion of tailings placement and site reclamation, monitoring and maintenance of an off-site disposal cell at any of the three proposed locations would be in accordance with the Long-Term Surveillance and Maintenance Plan approved by NRC. Drainage areas and other areas susceptible to erosion would be inspected and repaired as needed.

Monitoring and maintenance procedures for the reference off-site disposal cell and the White Mesa Mill off-site disposal cell would be similar but not identical. An example of how monitoring and maintenance at the White Mesa Mill disposal cell would differ from the reference cell would be the need to manage storm water and internal infiltration drainage from upslope disposal cells at the White Mesa Mill site. There are no preexisting upslope cells with the reference cell design. Another example would be the need to operate and monitor the liner, drains, and leak detection system that would ostensibly be left in place in cell 4B at the White Mesa Mill site. This type of drainage system would not be used with the reference cell design.

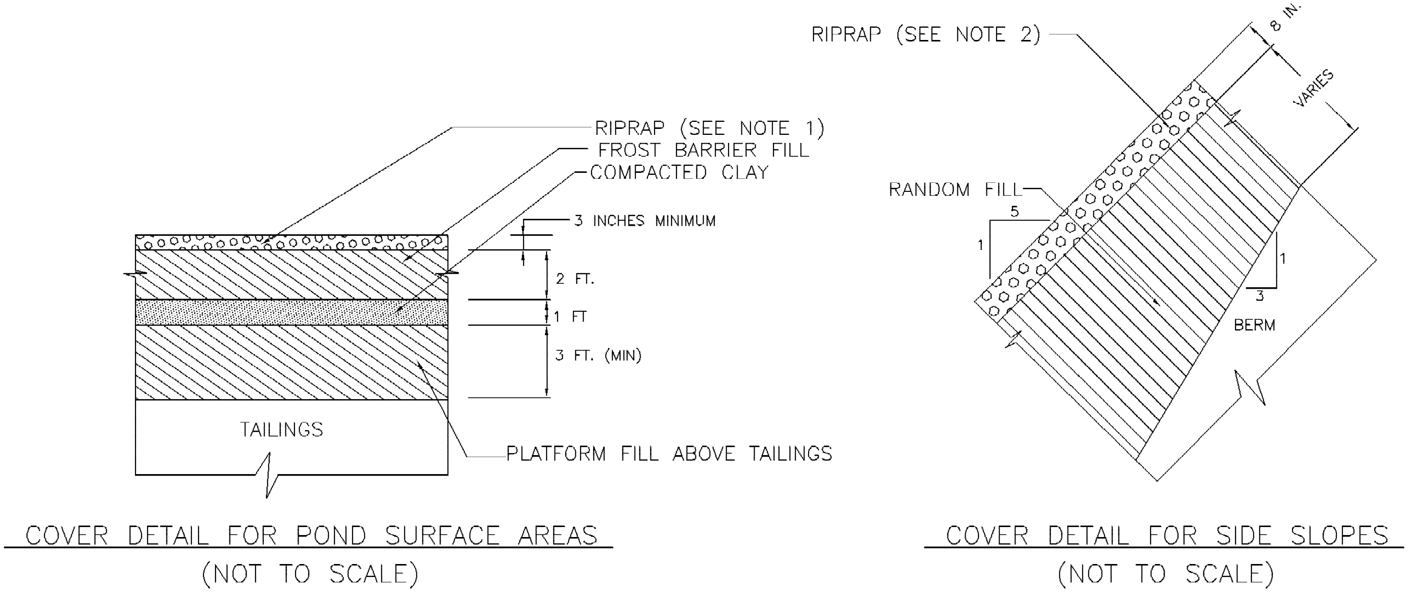
2.2.7 Resource Requirements

This section describe DOE's estimate of the major resource requirements for the off-site disposal alternative.

2.2.7.1 Labor

Table 2–16 through Table 2–18 show the estimated average annual labor requirements. In all cases, the labor category "Site Support" represents construction oversight personnel employed by the Technical Assistance Contractor for DOE.

Off-site disposal would require construction labor to be performed at the Moab site, vicinity properties, borrow areas, and the selected disposal cell site. It would also require transportation-related labor. DOE's estimates of the average annual labor requirements for construction-related activities for the Moab site, vicinity properties, borrow areas, and the selected disposal cell would be the same for all three modes of transportation. In general, single numbers in Table 2–16 through Table 2–18 indicate the labor for a single 12-hour shift working 7 days a week, 350 days a year. A double-shift schedule would require 67 to 100 percent more total work force to accomplish the same work. Where dual numbers are shown in the tables, they indicate the labor required for a single 12-hour shift (lower number) versus a double 10-hour shift schedule.



NOTES:

1. RIPRAP PLACED ON THE TOP OF COVER WILL CONSIST OF ROCK WITH D50 MINIMUM OF 3 INCHES.
2. RIPRAP PLACED ON THE SIDE SLOPES OF COVER WILL CONSIST OF ROCK WITH D50 MINIMUM OF 3.5 INCHES.

REFERENCE:
INTERNATIONAL URANIUM (USA) CORPORATION, (2003)

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Figure 2–39. White Mesa Mill Typical Reclamation Cover

Table 2–16. Average Annual Labor Requirements—Truck Transportation

Labor Category	**Construction Labor**				**Transportation Labor**		
	Moab Site	**Vicinity Properties**	**Borrow Areas**	**Disposal Cell**	**Klondike Flats**	**Crescent Junction**	**White Mesa Mill**
Equipment Operators	25	6	7	28	–	–	–
Site Support	19	4	3	16	9–18	9–18	10–20
Truck Drivers	1	3	2–10	8	34–61	50–87	109–192
General Labor	22	10	10	18	–	–	–
Mechanics	–	–	–	–	3–5	4–7	8–17
Total Average Workforce	**67**	**23**	**22–30**	**70**	**46–84**	**63–112**	**127–229**

Table 2–17. Average Annual Labor Requirements—Rail Transportation

Labor Category	**Construction Labor**				**Transportation Labor**	
	Moab Site	**Vicinity Properties**	**Borrow Areas**	**Disposal Cell**	**Klondike Flats**	**Crescent Junction**
Equipment Operators	25	6	7	28	–	–
Site Support	19	4	3	16	–	–
Truck Drivers	1	3	2–10	8	3–6	3–6
General Labor	22	10	10	18	–	–
Conveyor Operators/Crew	–	–	–	–	6–10	6–10
Train Engineer	–	–	–	–	9–14	17–28
Train Maint. Crew	–	–	–	–	1	1
Total Average Workforce	**67**	**23**	**22–30**	**70**	**19–31**	**27–45**

Table 2–18. Average Annual Labor Requirements—Slurry Pipeline Transportation

Labor Category	**Construction Labor**				**Transportation Labor**		
	Moab Site	**Vicinity Properties**	**Borrow Areas**	**Disposal Cell**	**Klondike Flats**	**Crescent Junction**	**White Mesa Mill**
Equipment Operators	25	6	7	28	–	–	–
Site Support	19	4	3	16	4	4	4
Truck Drivers	1	3	2–10	8	3–6	3–6	3–6
General Labor	22	10	10	18	–	–	–
System Operators	–	–	–	–	21	21	25
Pipeline Construction	–	–	–		250	330	502
	–	–	–	–	–	–	–
Total Average Workforce	**67**	**23**	**22–30**	**70**	**28–31**[a]	**28–31**[a]	**32–35**[a]

[a] Excludes pipeline construction labor. The duration of pipeline labor would be 9 months for White Mesa Mill, 7 months for Crescent Junction, and 6 months for Klondike Flats, and its labor requirements are not included in annual averages.

2.2.7.2 *Equipment*

Table 2–19 through Table 2–21 represent average annual equipment requirements for the off-site disposal alternative. Off-site disposal would require construction equipment at the Moab site, vicinity properties, borrow areas, and the selected disposal site. It would also require transportation-related equipment. (For the pipeline option, transportation-related equipment is considered to include pipeline construction equipment.) DOE’s estimates of the average annual equipment requirements for construction-related activities for the Moab site, vicinity properties, borrow areas, and the selected disposal cell are the same for all three modes of transportation.

Table 2–19. Average Annual Equipment Requirements—Truck Transportation Mode

Equipment Type	**Construction Equipment**				**Transportation Equipment**		
	Moab Site	**Vicinity Properties**	**Borrow Areas**	**Disposal Cell**	**Klondike Flats**	**Crescent Junction**	**White Mesa Mill**
Tractor	2	–	–	1	–	–	–
Backhoe	1	1	1	2	–	–	–
Grader	1	–	1	2	–	–	–
Trackhoe	1	–	–	1	–	–	–
Front-end loader	2	1	1	2	–	–	–
End dump truck	–	1	–	1	–	–	–
Water truck	1	1	1	2	–	–	–
Crane	1	–	–	–	–	–	–
21 yd^3 scrapers	3	–	1	6	–	–	–
Dozer	3	–	1	2	–	–	–
Sheepfoot compactor	1	–	–	2	–	–	–
Pickup truck	4	2	1	4	–	–	–
Welding rig	1	–	–	–	–	–	–
Skidsteer	–	2	–	1	–	–	–
16 yd^3 drag line	2	–	–	–	–	–	–
Tandum trucks per shift	–	–	1–7	3	24–26	36–37	78–82
Total	**23**	**8**	**8–14**	**29**	**24–26**	**36–37**	**78–82**

Table 2–20. Average Annual Equipment Requirements—Rail Transportation Mode

Equipment Type	**Construction Equipment**				**Transportation Equipment**	
	Moab Site	**Vicinity Properties**	**Borrow Areas**	**Disposal Cell**	**Klondike Flats**	**Crescent Junction**
Tractor	2	–	–	1	–	–
Backhoe	1	1	1	2	–	–
Grader	1	–	1	2	–	–
Trackhoe	1	–	–	1	–	–
Front-end loader	2	1	1	2	–	–
End dump truck	–	1	–	1	–	–
Water truck	1	1	1	2	–	–
Crane	1	–	–	–	–	–
21 yd^3 scrapers	3	–	1	6	–	–
Dozer	3	–	1	2	–	–
Sheepfoot compactor	1	–	–	2	–	–
Pickup truck	4	2	1	4	–	–
Welding rig	1	–	–		–	–
Skidsteer	–	2	–	1	–	–
16 yd^3 drag line	2	–	–	–	–	–
Tandum trucks	–	–	1–7 (per shift)	3		
Tandum trucks (debris haul)	–	–	–	–	2–5	2–5
Trains per shift	–	–	–	–	2	4
Total	**23**	**8**	**8–14**	**29**	**4–7**	**6–9**

Table 2–21. Average Annual Equipment Requirements—Slurry Pipeline Transportation Mode

Equipment Type	**Construction Equipment**				**Transportation Equipment**		
	Moab Site	**Vicinity Properties**	**Borrow Areas**	**Disposal Cell**	**Klondike Flats**	**Crescent Junction**	**White Mesa Mill**
Tractor	2	–	–	1	–	–	–
Backhoe	1	1	1	2			
Grader	1	–	1	2	1	1	2
Trackhoe	1	–	–	1	2	4	10
Front-end loader	2	1	1	2	1	2	4
End dump truck	–	1	–	1	1	2	4
Water truck	1	1	1	2	1	1	1
Crane	1	–	–	–			
21 yd^3 scrapers	3	–	1	6			
Dozer	3	–	1	2	8	7	18
Sheepfoot compactor	1	–	–	2	–	–	–
Pickup truck	4	2	1	4	17	18	27
Welding rig	1	–	–	–			
Skidsteer	–	2	–	1			
16 yd^3 drag line	2	–	–	–	–	–	–
Tandum trucks	–	–	1–7 (per shift)	3	–	–	–
Tandum trucks (debris haul)	–	–	–	–	2–5	2–5	2–5
Flatbed truck	–	–	–	–	1	2	5
Crane	–	–	–	–	1	1	1
Side boom crane	–	–	–	–	2	3	8
Trencher	–	–	–	–	1	1	2
Total	**23**	**8**	**8–14**	**29**	**38–41**	**44–47**	**84–87**

2.2.7.3 Land Disturbance

Table 2–22 summarizes DOE's estimates of the acres of land that would be disturbed under the off-site disposal alternatives. These disturbances include those that would result from remediation of the Moab site and vicinity properties, disposal cell construction at off-site locations, construction of transportation infrastructures, and excavation of borrow material. Estimates of required volumes of borrow material are shown in Table 2–7. The final area of land disturbed at borrow areas would vary depending on the final selection of borrow areas (see Table 2–6) and the depth to which borrow soils could be extracted. The values shown for disturbances to borrow areas in Table 2–22 represent DOE's estimate of the maximum disturbance.

2.2.7.4 Fuel

Table 2–23 summarizes DOE's estimates of the fuel consumption for the three off-site disposal alternatives and modes of transportation.

2.2.7.5 Water

The discussion of potable and nonpotable water uses in Section 2.1.5.5 also applies to the off-site disposal alternative. Table 2–24 shows the estimated nonpotable water consumption for the three transportation modes for all three off-site disposal locations. It is assumed that DOE's Colorado River water rights would supply nonpotable water for the Klondike Flats and Crescent Junction off-site disposal alternatives and part of the White Mesa Mill site needs. The remainder of nonpotable water needed for the White Mesa Mill site would be supplied from water rights to Recapture Reservoir or deep wells at the millsite. Rail and truck transportation options show a range of usage based on one 12-hour shift or two 10-hour shifts. To the extent that Colorado River water use exceeds USF&WS protective limits, DOE would mitigate the unavoidable adverse impact with negotiated water depletion payments.

Table 2–22. Estimated Maximum Acres of Disturbed Land for the Off-Site Disposal Alternatives

Location/Activity	Alternative							
	Klondike Flats			Crescent Junction			White Mesa Mill	
	Truck	Rail	Slurry	Truck	Rail	Slurry	Truck	Slurry
Moab Site	439	439	439	439	439	439	439	439
Vicinity Properties[a]	6	6	6	6	6	6	6	6
Borrow Areas								
Cover soils	400	400	400	400	400	400	0[b]	0[b]
Moab reclamation soils	152	152	152	152	152	152	152	152
Radon barrier soil	138	138	138	138	138	138	12	12
Other	NA	NA	NA	NA	NA	NA	10[c]	10[c]
Pipeline Construction[d]	NA	NA	85	NA	NA	164	NA	430
Disposal Cell Area								
Cell Construction Area[e]	435	420	435	435	420	435	346	346
Overpass/ Haul or Access Roads for Truck Transport	40	NA	24	13	NA	11	2	NA
Rail Infrastructure[f]	NA	69	NA	NA	57	NA	NA	NA
Total	**1,610**	**1,624**	**1,679**	**1,583**	**1,612**	**1,745**	**967**	**1,395**

[a] Assumes average disturbances of 2,500 ft^2 to 98 properties.
[b] Excavated material would be used as cover soil.
[c] Blanding riprap.
[d] Assumes disturbance to a 40-foot right-of-way.
[e] New cell footprint and adjacent construction and support areas.
[f] New rail spurs, truck/train transfer station, and haul road to cell.

Table 2–23. Estimated Annual Fuel Consumption for the Off-Site Disposal Alternatives (thousands of gallons)

Alternative							
Klondike Flats			Crescent Junction			White Mesa Mill	
Truck[a]	Rail[a]	Slurry[b]	Truck[a]	Rail[a]	Slurry[b]	Truck[a]	Slurry[b]
2,336–4,314	2,053–3,232	1,798	2,712–4,873	2,187–3,657	1,798	4,032–6,827	1,469

[a] Two figures indicate annual averages for one 12-hour shift (lower value) and two 10-hour shifts (higher value).
[b] For the slurry pipeline alternative, despite its longer pipeline length, the White Mesa Mill fuel consumption is less than that for Klondike Flats or Crescent Junction because of significantly lower distances for hauling borrow materials at White Mesa Mill. Similarly, Klondike Flats and Crescent Junction consumptions are the same for the slurry pipeline alternative because differences in borrow material haul distances offset the differences in pipeline length for these two alternatives.

Table 2–24. Estimated Annual Nonpotable Water Consumption

Transportation Option	Total Project Water Consumption (acre-feet)	Average Annual Water Consumption (acre-feet)
Rail	635–710	130–235
Truck	700–775	135–240
Slurry Pipeline	3,470	730

Table 2–25 shows the estimated potable water consumption for the three transportation modes for all three off-site disposal location locations. Consumption rates are based on the 12-hour shift and use an average of the labor required for the different transportation options. If the double 10-hour shift were selected, consumption rates would increase by 67 percent but would apply for the shorter construction duration.

Table 2–25. Potable Water Consumption Rates

Transportation Option	Average Daily Water Consumption Rate (gallons)
Rail	7,500
Truck	9,000
Slurry Pipeline	6,600

2.2.7.6 *Solid Waste Disposal*

Approximately 2,080 yd^3 of solid waste per year would be generated at the combined Moab and Klondike Flats, Crescent Junction, or White Mesa Mill sites for the off-site disposal alternatives. The solid waste from the Moab, Klondike Flats, or Crescent Junction sites would be disposed of in the Grand County landfill. The solid waste from the White Mesa Mill site would be disposed of in tailings cells that currently exist at the site or in the new tailings disposal cell constructed for Moab site contaminated materials.

2.2.7.7 *Sanitary Waste Disposal*

Table 2–26 shows the estimated maximum weekly sanitary waste generation for the three transportation modes for all three off-site disposal locations. The estimated volumes are based on the 12-hour shift and use an average of the labor required for the different transportation options. If the double 10-hour shift were selected, the volume generated weekly would increase by 67 percent but would apply for the shorter construction duration. Septic holding tanks would be placed at both the Moab site and the off-site disposal location; some portable toilets would be used to provide sanitary waste service. Both the septic tanks and the portable toilets would be pumped out routinely, and the waste would be disposed of at the city of Moab sewage treatment plant for the Klondike Flats or Crescent Junction off-site disposal alternatives or at the city of Blanding sewage treatment plant for the White Mesa Mill off-site disposal alternative. White Mesa Mill also has an on-site State-approved leach field system that has adequately managed sanitary waste generated by up to 140 workers during past operations.

Table 2–26. Sanitary Waste Generated

Disposal Option	Maximum Weekly Generation (gallons)
Rail	15,000
Truck	21,000
Slurry Pipeline	15,400

2.2.7.8 Electric Power

Table 2–27 shows DOE's estimate of the power demands at the Moab site and at the three potential off-site disposal locations for the three transportation modes. In general, the major demands would be:

- Field office trailers.
- Office and parking lot security lighting.
- River pump station (at Moab).
- Decontamination water sprays and recycle pumps.
- Train transfer station (rail transportation).
- Pipeline slurry system (pipeline transportation).

Table 2–27. Estimated Maximum Average Annual Electric Power Demand (kVA)
For the Off-Site Disposal Alternative

Transportation Mode	**Location**			
	Moab Site	**Klondike Flats Site**	**Crescent Junction Site**	**White Mesa Mill Site**
Truck	600	300	300	300
Rail	700	600	600	–
Pipeline	–	2,500 (terminal)	2,800 (terminal)	3,100 (terminal)
To Klondike Flats	3,400			4,800 (booster)
To Crescent Junction	4,800			
To White Mesa Mill	6,100			

2.3 Ground Water at the Moab Site

Section 2.3.1 provides background on the ground water standards, contaminants of concern, and the compliance strategy selection process. This includes remediation goals for the ground water, and the relationship with existing interim actions. Section 2.3.2 discusses the proposed ground water remediation, including remediation options and time frames, and the predicted contaminant concentrations as a result of active remediation. It also discusses the predicted outcome of the ground water No Action alternative. Section 2.3.3 discusses ground water remediation uncertainties.

2.3.1 Background

The uppermost aquifer at the Moab site occurs in unconsolidated Quaternary alluvial material deposited on older bedrock units in the basin that forms Moab Valley. Although the quality of this aquifer has been adversely affected by uranium processing activities at the site, it does not represent a potential source of drinking water. However, discharge of contaminated ground water from this aquifer has resulted in elevated concentrations of ammonia and other site-related constituents in the Colorado River. While the contaminants do not pose unacceptable risk to humans, they do exceed levels considered to be protective of aquatic life. Therefore, the 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.

Contamination in the ground water at the Moab site is regulated by EPA standards in 40 CFR 192. Moab site remediation must comply with Subpart A standards for ground water protection and Subpart B standards for cleanup of residual ground water contamination. Subpart C provides guidance for implementing methods and procedures to reasonably ensure that standards of Subpart B are met.

DOE's proposed action for ground water cleanup was developed using the framework described in the UMTRA Ground Water Project PEIS (DOE 1996a). This framework uses a stepwise, risk-based approach for selecting a compliance strategy and is based on site-specific characteristics. The following discussion describes the PEIS framework, identifies the overall compliance strategy using this framework, and summarizes the long-term monitoring program. A more detailed description of the PEIS compliance strategy selection process is presented in the *Site Observational Work Plan for the Moab, Utah, Site* (SOWP) (DOE 2003b).

A detailed remedial action plan would be developed following issuance of the ROD and would contain action-specific design information. However, the treatment technologies summarized in this EIS, supported by the results of site characterization studies and ground water flow and transport modeling (DOE 2003b), provide a reasonable range of scope and requirements for ground water actions to meet the requirements of 40 CFR 192. The analyses of these actions in this EIS provide sufficient information for decision-making under NEPA.

2.3.1.1 EPA Ground Water Standards

Ground water remediation actions to meet the EPA standards for inactive uranium-ore processing sites (40 CFR 192) are selected first by determining the appropriate standards for the site, then by identifying a compliance strategy that can meet the standards. Several different ground water standards could apply to the Moab site. These include background concentrations, maximum concentration limits (MCLs) (EPA ground water standards in 40 CFR 192), alternate concentration limits (ACLs), and supplemental standards (see 40 CFR 192 for definitions); applicable standards depend on site-specific cleanup objectives and conditions. Potential strategies for achieving these standards include no remediation, natural flushing with institutional controls, natural flushing with institutional controls in combination with active remediation, and active remediation alone.

At UMTRCA sites, EPA standards must be met in the uppermost aquifer, which is most likely to be affected by uranium-ore processing activities. The uppermost aquifer at the Moab site contains a highly saline (salty) water, often referred to as brine, which can be as thick as 400 ft, overlain with a thin layer of less salty water. Because ground water in the major portion of the uppermost aquifer has a TDS content exceeding 10,000 mg/L, the aquifer meets the definition of a limited-use aquifer as described in EPA's *Guidelines for Ground-Water Classification Under the EPA Ground-Water Protection Strategy* (EPA 1988).

Ground Water Compliance Strategies

No remediation means that no ground water remediation is necessary because ground water contaminant 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 necessary 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.

Under the requirements of 40 CFR 192 Subpart C, the uppermost aquifer meets the criteria to apply supplemental standards based on limited-use ground water. Supplemental standards are regulatory standards that may be applied when the concentration of certain constituents (in this case, TDS) exceeds the normally applicable standards (e.g., MCLs; see 40 CFR 192, Subpart C for further explanation) for reasons unrelated to site contamination. The use of supplemental standards must be protective of human health and the environment. Therefore, remediation of the uppermost aquifer to meet ground water or drinking water standards is not required because a limited-use aquifer is not likely to be developed as a public drinking water source. Instead, at sites with limited-use ground water, the supplemental standards require management of contamination due to tailings in a manner that ensures protection of human health and the environment from that contamination. This means that if site-related contamination could cause an adverse effect on a drinking water aquifer or on a connected surface water body, management of contamination would be necessary to protect these resources.

Because no drinking water aquifer is affected by site-related contamination, ground water remediation focuses on protecting surface water resources for beneficial use. Risk calculations show that risks to human health would be very low for all probable uses, even using conservative assumptions (see Appendix D of this EIS). However, contaminant concentrations in surface water exceed aquatic criteria for five site-related constituents. Consequently, the compliance strategy focuses on protecting ecological receptors (i.e., endangered fish) and achieving compliance goals (i.e., surface water standards) in the surface water.

2.3.1.2 Contaminants of Potential Concern

Concentrations of some site-related contaminants in ground water at the Moab site are above appropriate standards or benchmarks for protection of aquatic organisms in surface water. A thorough screening of contaminants is provided in Appendix A2. The screening process identified five contaminants of potential concern: ammonia, copper, manganese, sulfate, and uranium. Modeling of the tailings' long-term seepage indicates that seepage rates will decrease 25-fold from the current rate of approximately 20 gpm (Figure 6−3, Table 6−3 of the SOWP [DOE 2003b]) to the predicted long-term flux of 0.8 gpm. This 25-fold decrease in volumetric and contaminant mass flux from the tailings, coupled with the 10-fold average dilution of ground water observed in surface water concentrations (DOE 2005b), is anticipated to result in decreases in contaminant surface water concentrations to levels below aquatic benchmark values and appropriate water quality standards without any geochemical transformations beyond simple dilution. For example, the maximum detected copper concentrations in surface water adjacent to the site range from 5 to 14 mg/L; while the Utah Water Quality Criterion is 12 mg/L. Similarly, maximum detected manganese concentrations in surface water (up to 11.5 mg/L) exceed the aquatic benchmark value for protection of aquatic organisms of approximately 0.01 mg/L in only five locations, and natural manganese background ground water concentrations of 19 to 38 mg/L have been observed. The maximum detected uranium surface water concentration is 5 mg/L, roughly 100 times the aquatic benchmark of 0.04 mg/L, and the maximum detected sulfate surface water concentration is approximately 14,000 mg/L, roughly 28 times the upper limit of background range (439 mg/L). Therefore, the resulting 250-fold decrease in future surface water concentrations predicted from decreased tailings seepage and ground water dilution through mixing with surface water provide a reasonable assurance that long-term concentrations will be protective of aquatic organisms.

However, ammonia is the key constituent driving the proposed ground water remedial action because of its high concentrations in the tailings seepage and ground water and its toxicity to aquatic organisms (EPA 1999). It is assumed that if ammonia target goals could be achieved that are acceptable for protection of aquatic life, concentrations of the other four contaminants of potential concern would also be protective. Even though the geochemical behavior of the other contaminants of potential concern differs from that of ammonia, it is anticipated that concentrations of these constituents would decrease to protective levels in the same time frame that it would take for ammonia to reach protective levels because their concentrations are less elevated above applicable remediation criteria (e.g., surface water standards), the contaminants are less widespread, or they occur at elevated concentrations less frequently. For this reason, ammonia is the focus of the following discussion.

National ambient water quality criteria (AWQC) for the protection of aquatic life have been established for ammonia (EPA 1999). The State of Utah is in the process of adopting these criteria as state surface water quality standards. AWQC have been identified that are protective of both acute and chronic exposures. Acute criteria vary with pH; chronic criteria are both pH- and temperature-dependent. Chronic aquatic criteria represent the low end of the potential concentration range for protection of aquatic species from ammonia toxicity; the majority of chronic values fall in the range of 0.6 to 1.2 mg/L ammonia (total as N) based on site-specific pH conditions (EPA 1999). Acute criteria represent the higher end of the concentration range; the majority of acute values fall within the range of 3 to 6 mg/L. Therefore, it is DOE’s position that concentrations of ammonia (total as N) in surface water in the 0.6- to 6-mg/L range would be fully protective of aquatic life.

If ground water quality met surface water standards, then discharge of ground water to the surface should not result in exceedances of those standards unless some other process (e.g., evaporation) increased contaminant concentrations in surface water. However, establishing the low end of the protective range as the ground water target goal is probably not necessary to achieve compliance with surface water standards. Available data regarding interaction of ground water and surface water indicate that concentrations of most constituents decrease significantly as ground water discharges to and mixes with surface water (a 10-fold decrease is observed on average [DOE 2003b]). In general, more recent data collected by DOE since the SOWP confirm, with a few exceptions, that a 10-

Cleanup Terminology

Ammonia Concentrations—Where concentrations of ammonia are referred to in the text, these are expressed as *total ammonia as nitrogen (N)*. The numbers represent all forms of ammonia (e.g., NH_3, NH_4) converted to reflect only the nitrogen component in them.

Federal Ambient Water Quality Criteria (AWQC) for Ammonia—Numerical concentrations of ammonia (total as N) that are protective of aquatic life in surface water. Chronic exposure concentrations vary with both temperature and pH of the waters. Acute exposure concentrations vary only with pH of the waters. AWQC are only guidelines but can be adopted by states as enforceable standards.

Utah Surface Water Standards—State standards for protection of water quality of surface waters of the state. The standard designates appropriate uses of specific surface water bodies and provides numerical and narrative standards for those designated uses. The State of Utah is in the process of adopting federal AWQC for ammonia as the numerical standards for this constituent.

Remediation Objective—The desired condition that should result when remediation of the site is completed. For the Moab site, the remediation objective would be to meet state surface water quality standards for ammonia (both chronic and acute) in surface water where appropriate. The applicable standard for a given location is dependent on temperature and pH and the presence or absence of a mixing zone, as specified in the state standards.

Target Goal—As used in this document, the target goal for ammonia in ground water is the concentration that DOE has determined would meet the remediation objective in surface water. As explained in the text, meeting a target goal of approximately 3 mg/L ammonia (total as N) in ground water would result in compliance with Utah surface water standards for ammonia in surface water.

fold dilution factor occurs where the ground water plume is discharging adjacent to the river shoreline. In background locations where elevated ammonia from the Paradox Formation is discharging to the surface water, the 10-fold dilution factor may not apply. This more recent calculation set, *Ground Water/Surface Water Interaction for the Moab, Utah, Site* (DOE 2005b), also provides a more detailed evaluation of the transfer mechanism between ground water and backwater areas.

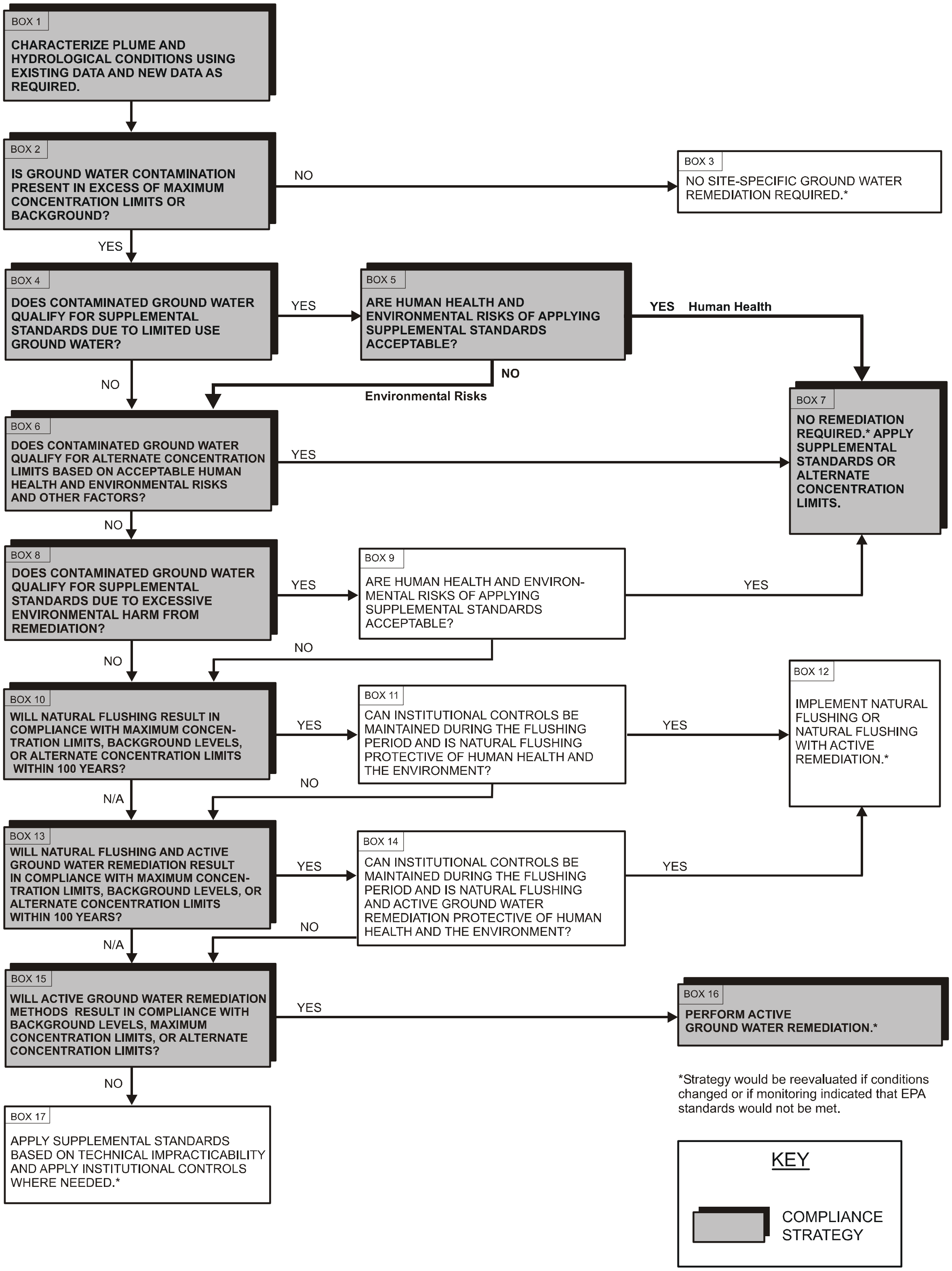
Consequently, there is a reasonable assurance that protective surface water concentrations could be achieved by meeting less conservative goals than chronic standards in ground water. The target goal of 3 mg/L in ground water (the low end of the reasonable acute range) is anticipated to provide adequate surface water protection. The 3-mg/L concentration represents a 2- to 3-order-of-magnitude decrease in the center of the ammonia plume and would be expected to result in a corresponding decrease in surface water. On the basis of sampling data presented in the SOWP (DOE 2003b), it appears that if a concentration of 3 mg/L ammonia could be achieved everywhere in surface water, approximately 99 percent of the locations sampled in the past would comply with the acute criteria, and given the 10-fold dilution factor, the chronic criteria would also be met outside the mixing zone. The 10-fold dilution factor is conservative, and a higher ground water concentration may also achieve compliance with surface water standards, although at a lower confidence level. Coupled with the average 10-fold dilution and the tendency for ammonia to volatilize, 3 mg/L in ground water is anticipated to result in compliance with both acute and chronic ammonia standards in the river adjacent to the site. Therefore, DOE proposes to use the 3-mg/L concentration of ammonia as a target goal for evaluating ground water cleanup options. However, the ultimate remediation objective would still be to meet all applicable ammonia standards in surface water.

2.3.1.3 Compliance Strategy Selection Process

Using the PEIS framework shown in Figure 2–40 and site-specific data collected through site characterization and analysis, DOE has evaluated compliance strategies for Moab site ground water. Table 2–28 summarizes the compliance strategy selection process for the Moab site, which is based on the current understanding of the site and cleanup objectives.

The PEIS framework, as presented in Figure 2–40, and the site-specific conditions of the Moab site presented in Chapter 3.0 indicate that a “no remediation” compliance strategy and the application of supplemental standards to ground water is appropriate for protection of human health. However it may not be protective of the environment (i.e., endangered species). Therefore, active remediation is proposed for both the on-site and off-site surface disposal alternatives until natural processes have reduced ground water contaminant concentrations to acceptable risk levels for discharge to surface water.

Section 2.3.2 discusses proposed active remediation approaches that may be implemented to meet the cleanup and long-term protection requirements, independent of surface reclamation. The final determination of the most appropriate technologies and method for ground water treatment would require a more detailed characterization and engineering analysis.



*Strategy would be reevaluated if conditions changed or if monitoring indicated that EPA standards would not be met.

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Figure 2–40. PEIS Compliance Strategy Selection Process

Table 2–28. Summary of Compliance Strategy Selection Process

Box (Figure 2–40)	Action or Question	Result or Decision
1	Characterize plume and hydrological conditions.	The most recent conceptual model of the site is described in the SOWP (DOE 2003b) based on characterization activities conducted by DOE in 2002 and 2003. **Move to Box 2.**
2	Is ground water contamination present in excess of 40 CFR 192 MCLs or background concentrations?	**Yes:** Maximum ground water concentrations of arsenic, cadmium, molybdenum, nitrate, radium, selenium, uranium, and gross alpha exceed the 40 CFR 192 MCLs or Safe Drinking Water Act standards at one or more monitoring points. Levels of other constituents such as ammonia and sulfate are elevated compared with background and exceed risk-based concentrations. **Move to Box 4.**
4	Does contaminated ground water qualify for supplemental standards due to a classification of limited-use ground water?	**Yes:** The uppermost aquifer is predominantly composed of brine with concentrations of TDS in excess of 10,000 mg/L, which meets one of the criteria for limited-use ground water (40 CFR 192 and EPA 1988). EPA (1988) also indicates that “the entire ground-water unit being classified does not necessarily have to meet Class III [limited-use] untreatable criteria, but a major volume would.” The major volume of the uppermost aquifer meets limited-use criteria. **Move to Box 5.**
5	Are human health and environmental risks of applying supplemental standards acceptable?	<u>Human Health Risks</u>: **Yes** Ground water is not reasonably considered to be a potential drinking water source because of its limited-use designation, and this use of water does not need to be considered further. Initial human health risk assessment results indicate that there are no unacceptable human health risks associated with uses of ground water other than drinking water (e.g., irrigation) and probable uses of hydraulically connected surface water (mainly recreational use). Therefore, protection of human health does not require any cleanup of ground water. For human health, no remediation required. Apply supplemental standards. **Move to Box 7.** (Note: Remainder of compliance strategy selection is focused on environmental risks.) <u>Environmental Risks:</u> **No** Toxicity tests conducted on fish using site-influenced ground water and surface water indicate that there is a potential for adverse effects to aquatic life (USGS 2002). Federal criteria for protection of aquatic life have been exceeded for ammonia. Concentrations of other constituents in surface water are elevated above background levels (e.g., uranium, sulfate). **Move to Box 6.**
6	Does contaminated ground water qualify for ACLs based on acceptable environmental risks and other factors?	**Not applicable.** Ground water qualifies for supplemental standards. Only surface water concentrations need to be addressed. **Move to Box 8.**
8	Does contaminated ground water qualify for supplemental standards due to excessive environmental harm from remediation?	**No: Move to Box 10.**

Table 2–28. Summary of Compliance Strategy Selection Process (continued)

Box (Figure 2–40)	Action or Question	Result or Decision
10	Would natural flushing result in compliance with MCLs, background concentrations, or ACLs within 100 years?	**Not applicable.** Ground water qualifies for supplemental standards. Only surface water concentrations need to be addressed. **Move to Box 13.**
13	Would natural flushing and active ground water remediation result in compliance with MCLs, background concentrations, or ACLs within 100 years?	**Not applicable.** Ground water qualifies for supplemental standards. Only surface water concentrations need to be addressed. **Move to Box 15.**
15	Would active ground water remediation methods result in compliance with background concentrations, MCLs, or ACLs?	**Yes:** Active remediation of ground water to control discharge to surface water can achieve surface water remediation goals until natural processes have reduced ground water concentrations to acceptable levels for discharge to surface water. **Move to Box 16.**
16	Perform active ground water remediation.	This is the compliance strategy identified by the PEIS framework.

2.3.1.4 *Initial and Interim Actions Related to the Proposed Action*

DOE, upon accepting responsibility for the Moab site, initiated consultations with USF&WS. On the basis of these consultations, and after reviewing historical surface water quality studies and data, DOE and USF&WS agreed that an elevated concentration of site-related ground water contaminants (primarily ammonia) reaching the Colorado River posed immediate risk to endangered fish and designated critical habitat.

On April 30, 2002, USF&WS concurred with DOE’s decision to implement an initial action, followed by an interim action. The goal of the initial action was to dilute ammonia concentrations at the ground water–surface water interface in areas that presented the greatest potential for fish to be present, when backwater habitat has developed. It was estimated that backwater habitat would most likely be present from June through August at flows of 5,000 to 15,000 cfs. The action focused on the segment of the Colorado River from Moab Wash extending approximately 800 ft downriver, which contributes the highest concentrations of contaminants to the river. The system was designed to withdraw fresh water upstream of the site and pump it through a distribution system to backwater areas. Because of low flows, the system was not installed in 2003. The system was installed and tested in 2004, but because of low river flows caused by a continuing drought, the targeted backwater areas never held water, and the system could not be fully implemented.

The goal of the interim action is to extract contaminated ground water near the Colorado River, thereby reducing the amount of contamination reaching the river. DOE funded, designed, and implemented the system (Phase I) in 2003, which included 10 extraction wells aligned parallel to the Colorado River. The system is designed to withdraw ground water at the rate of approximately 30 gpm and pump it to an evaporation pond on top of the existing tailings pile. On April 4, 2004, USF&WS concurred with DOE’s decision to construct a land-applied sprinkler system designed to increase evaporation rates. The system was installed in the existing evaporation pond area. In July 2004, DOE installed an additional 10 extraction wells (Phase II) near the first 10 wells to increase the rate of ground water extraction and to test the effects of freshwater injection on surface water concentrations. If the interim actions are successful, a reduction in contaminant concentrations in surface water could be observed significantly sooner than the 10-year maximum time frame predicted under the proposed action.

2.3.2 Proposed Ground Water Action

This section presents the potential ground water actions for both the on-site and off-site tailings disposal alternatives and provides the basis for assessing the impacts of these actions. This section also discusses ground water remediation objectives. Section 2.3.2.1 discusses ground water remediation options. Section 2.3.2.2 discusses time frames for implementation (i.e., pre-remediation period) of active remediation. Section 2.3.2.3 discusses construction and operational requirements. Section 2.3.2.4 discusses the active remediation target goals and time frames for remediation and compares the proposed ground water action to the No Action alternative.

The focus of active remediation would be on preventing ground water discharge to potentially sensitive surface water areas, as opposed to accelerating mass removal from the aquifer, though it is expected that the remediation should enhance the cleanup process. DOE’s proposed action for ground water at the Moab site would be to design and implement an active remediation system and also apply ground water supplemental standards. These actions would be in addition to the initial and interim actions (described above) that have already been implemented. Ground water remediation would be implemented under both the on-site and off-site tailings disposal alternatives. It would be designed to intercept contaminated ground water that is currently discharging into the nearshore area of the Colorado River, which is designated critical habitat for endangered fish species. The proposed action would, at a minimum, meet the protective surface water criteria. It is possible that effects of the interim action and the proposed action may achieve background surface water quality conditions in less than the estimated 10 years after the ROD. The system would be operated until ground water contaminant concentrations have decreased to levels that would no longer present a risk to aquatic species. The duration of active remediation is predicted to be 75 years for the off-site disposal alternative and 80 years for the on-site disposal alternative (DOE 2003b).

Because selection and design of the actual extraction and treatment system have not yet begun, the proposed action cannot be described precisely. Therefore, the following descriptions address the scope of ground water extraction, treatment, and associated effluent discharge alternatives as if the remediation action were the one with the greatest potential for impact. In this way, DOE intends to bound the range of potential forms the proposed action could take and, consequently, the range of potential impacts from their implementation. These estimates are based on experience at other UMTRCA sites. Estimates based on those sites have been scaled up to accommodate the larger scope of the Moab site remediation. Where appropriate, distinctions are made between the construction/implementation phase of the proposed action and the operation/maintenance phase, because the scope, activities, and potential impacts from these two distinct periods would be substantially different.

2.3.2.1 Ground Water Remediation Options

Potential technologies for ground water treatment were prescreened to determine which remediation methods would be most feasible (DOE 2003b). In situ as well as ex situ methods were considered.

Active ground water remediation would be accomplished using one of, or a combination of, the options described below. All proposed remediation options would occur within the area of historical millsite activities and areas requiring surface remediation. Figure 2–41 shows the area of proposed ground water remediation.

Remediation would include the following options:

- Ground water extraction, treatment, and disposal
- Ground water extraction and deep well injection (without treatment)
- In situ ground water treatment
- Clean water application

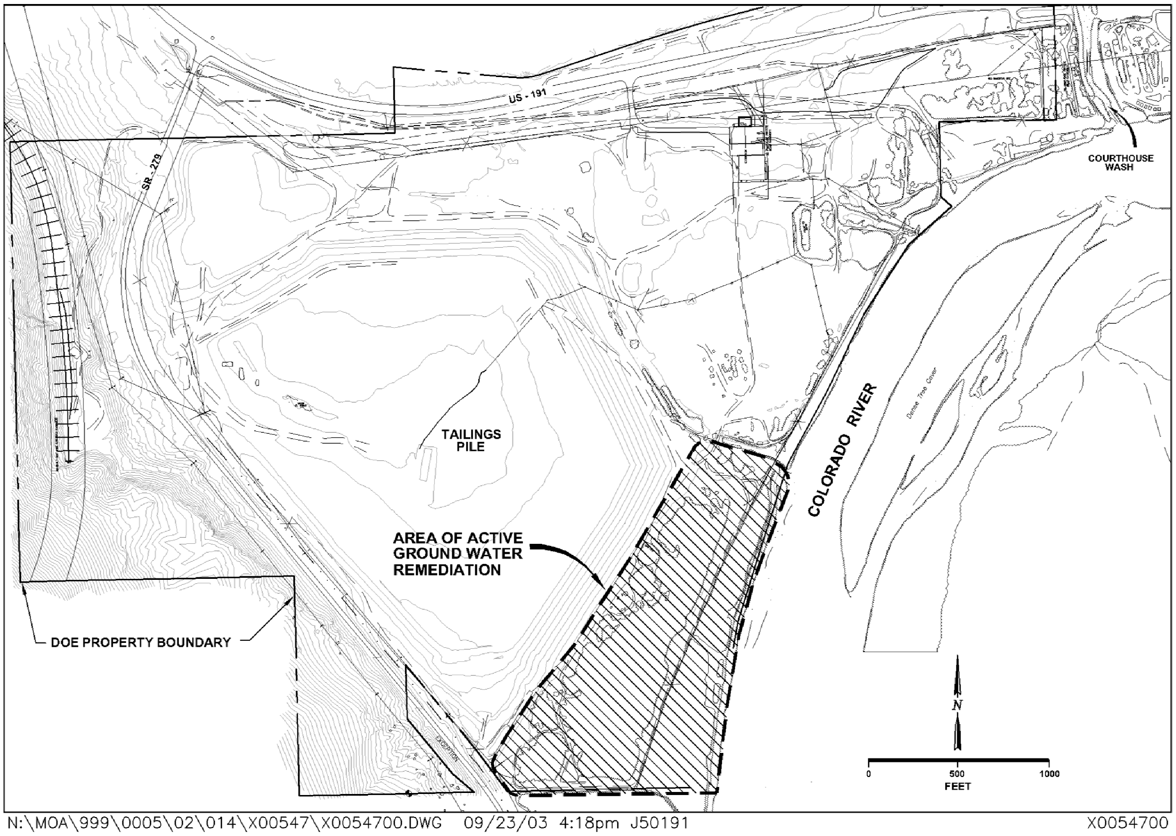


Figure 2–41. Area of Proposed Active Ground Water Remediation

<u>Ground Water Extraction, Treatment, and Disposal</u>

Ground Water Extraction: The two proposed methods for extracting contaminated ground water are extraction wells or interception trenches.

If extraction wells were used, between 50 and 150 wells would be installed to depths of up to 50 ft using conventional drilling equipment. This design would allow for extracting up to 150 gpm of contaminated ground water. The water would be pumped from the wells to a treatment collection point (e.g., evaporation pond) via subsurface piping. The system would be installed between the current tailings pile location and the Colorado River to intercept the plume before it discharged to the river and would require up to 50 acres of land for the duration of ground water remediation. The proposed locations (Figure 2–41) are within the area of historical site disturbances and areas requiring remediation of contaminated soils. It is expected that the system would be installed after any remediation of surface soils required in these areas. It is possible that some extraction wells would need to be installed adjacent to the river in areas northeast of the tailings pile in the vicinity of the old millsite.

If shallow trenches were used, they would be constructed to intercept shallow ground water, which would be piped via shallow subsurface piping to a collection point for treatment (e.g., evaporation pond). This design would allow for extracting up to 150 gpm of contaminated ground water. It is estimated that the system would require from 1,500 to 2,000 lineal ft of trenches and could affect up to 50 acres of land for the duration of ground water remediation. The proposed locations are within the area of historical site disturbances, and areas requiring remediation of contaminated soils.

Treatment Options: DOE has screened potential treatment technologies that would be applicable for treatment of ammonia and other contaminants of concern (DOE 2003b). The treatment options and technologies described below are meant to bound the range of viable possibilities. All treatment options would require construction of infrastructure. The level of treatment would depend largely on the selected method of effluent discharge. Therefore, specific treatment goals could not be established until the specific discharge method(s) were selected. The treatment goals would have to consider risk analysis and regulatory requirements.

Additional testing, characterization, or pilot studies may be required before the optimum system could be selected and designed. This level of design would be developed in the remedial action mentioned in Section 2.3.1, following publication of the ROD. The SOWP (DOE 2003b) presents more detailed descriptions of the processes and discusses the screening process for the following treatment options.

- Standard evaporation
- Enhanced evaporation
- Distillation
- Ammonia stripping
- Ammonia recovery
- Chemical oxidation
- Zero-valent iron
- Ion exchange
- Membrane separation
- Sulfate coagulation

Because evaporation is a primary treatment consideration and is also considered a disposal option, it is included in more detail. Evaporation treats extracted ground water by allowing the water to evaporate due to the dry conditions of the site and warm temperatures during part of the year. Influent rates to the ponds would match the rate of natural evaporation. Nonvolatile contaminants would be contained and allowed to concentrate, which would require provisions for disposal of the accumulated solids. Evaporation could also be used to treat concentrated wastewater from treatment processes such as distillation and ion-exchange that produce a wastewater stream. Passive evaporation would not require any mixing after disposal in the ponds. If it were determined that concentrations would present a risk to avian or terrestrial species, a wildlife management plan would be submitted to USF&WS, as further discussed in Appendix A1 (the Biological Assessment).

Solar evaporation would consist of putting the water into large, double-lined ponds built into the floodplain and designed to withstand a 100-year flood. Without enhanced methods, the pond or ponds would need to be of sufficient size that evaporation rates could keep up with extraction rates and complete remediation in a reasonable time frame. Pond areas could range up to 40 acres and include a total of 60 acres of land that would need to be disturbed. This would also require some type of small support facility. Devices such as spray nozzles could enhance evaporation rates considerably.

Disposal Options: If ground water were treated by a method other than evaporation, the treated water would require disposal by one of the following methods:

- Discharge to surface water
- Shallow injection
- Deep well injection

The Colorado River is a boundary to the Moab site, and it would be the natural repository of the site ground water if effluent were discharged to surface water. Because of water quality standards and designation as critical habitat for endangered fish, it is likely that this option would require extensive water treatment for all contaminants of concern. If discharge to the river was considered a viable alternative for dealing with treatment effluent, appropriate permits would need to be obtained from the State, and compliance with conditions such as discharge rates and effluent composition would be required.

If shallow injection were selected, injection wells would be used to return the treated ground water directly back into the alluvial aquifer. Treated ground water could potentially be used to recharge the aquifer at different points to allow manipulation of hydraulic gradients. This could facilitate extraction of the lower quality water and accelerate removal of the contaminant source. This option would require treatment of ammonia.

If deep well injection were selected, treated ground water would be disposed of by deep well injection into the Leadville Formation, Paradox Formation, or deep brine aquifer. Ground water hydrology beneath the site includes a deep salt formation called the Paradox Formation overlain by a deep aquifer with a high salt concentration (brine water). This method would likely require an underground injection control permit from the State of Utah.

<u>Ground Water Extraction and Deep Well Injection (without treatment)</u>

If this option were selected, ground water would be extracted using a system and infrastructure similar to that described above, and untreated water would be pumped into a geologically isolated zone. This option would likely require an underground injection control permit from the State of Utah and concurrence from NRC.

<u>In Situ Remediation</u>

If this option were selected, it would include some form of bioremediation, including phytoremediation (use of deep-rooted plants that extract certain contaminants from ground water through root uptake). This option would require minimal infrastructure and could require state or federal permits, depending on the method of bioremediation.

Clean Water Application

Another aspect of the active remediation system could involve some form of application of clean water to dilute ammonia concentrations in the backwater areas along the Colorado River that may have potentially suitable habitat for endangered fish. This would likely take either or both of two configurations. The first configuration would consist of diverting uncontaminated water from the Colorado River through a screened intake at the nearest location just upstream of Moab Wash. A water delivery system consisting of a pump and aboveground piping would redistribute the water to the backwater areas along a section of the sandbar of up to 1,200 ft beginning just south of Moab Wash. Flow meters and valves would be used to measure and control the rate of upstream river water released at each distribution point to minimize turbidity and velocities. The components and operation would be similar to the 1,360-gpm system originally planned as an initial action for the sandbar area adjacent to the site (DOE 2002b) or some alternative system design.

A variation of the clean water application could consist of using injection wells or an infiltration trench to deliver uncontaminated river water indirectly to the backwater areas. For this second configuration, clean water would be collected from the Colorado River and pumped to the site water storage ponds to control suspended sediment and prevent system clogging. The storage pond water would then be introduced to the shallow ground water system by a series of injection wells or infiltration trenches located along the bank adjacent to the backwater areas. The clean water would enter the backwater areas by bank discharge of ground water to provide dilution of ammonia concentrations. This clean water application system could also be combined with the extraction wells discussed earlier to control drawdown and minimize the potential for brine upconing. For this case, up to 150 gpm of uncontaminated river water would be needed to balance the amount of plume water extracted.

2.3.2.2 Implementation of Ground Water Remediation

DOE estimates that design, procurement, testing, construction, and implementation of an active ground water remediation system would be complete within 5 years of issuance of the ROD (Figure 2–42). Design criteria and specifications would depend upon whether the on-site or off-site alternative was selected for tailings disposal.

Following the start of system operation, DOE estimates that as much as an additional 5 years (Figure 2–42) could be required to reduce concentrations of contaminants in the surface water to levels that are protective of aquatic species in the Colorado River, if protective levels were not already achieved as a result of interim actions. However, it is possible that considerably less time could be required to reach protective levels. The period of construction and implementation is considered the pre-remediation period.

2.3.2.3 Construction and Operational Requirements

Number of Workers and Duration of Work

The greatest numbers of workers would be required during the initial construction of the remediation system. Construction of the system would include installing an extraction system and constructing a treatment system. Construction of a distillation system would probably be the most labor-intensive water treatment option and require the greatest diversity of workers because

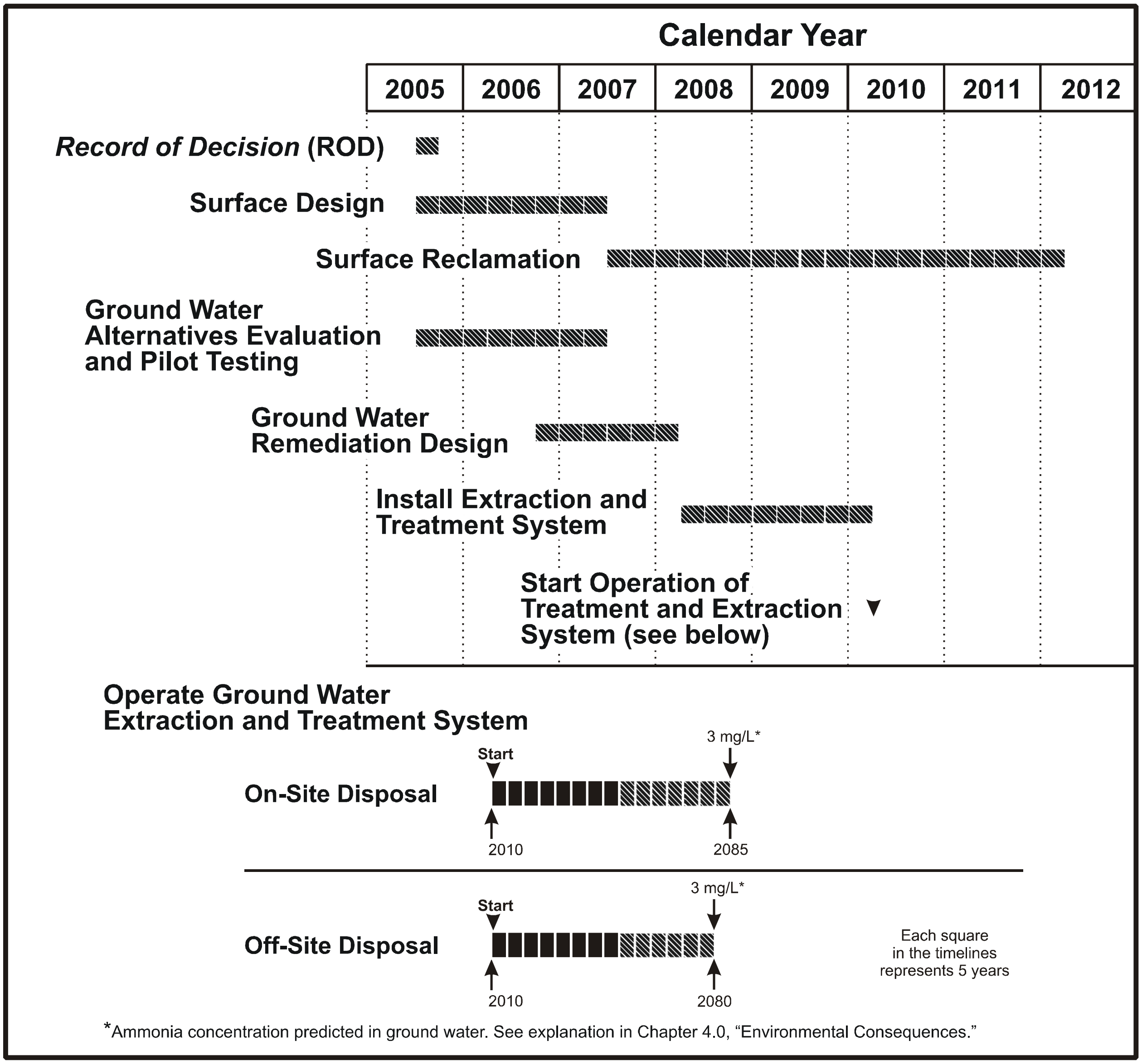


Figure 2–42. Estimated Ground Water Remediation Schedule

of the complexity of the system. After the system construction was complete, routine operation and periodic maintenance and monitoring would be required until remediation goals were met. If the treatment process produced a solid waste stream, such as a sludge produced from residual brines generated during distillation, transportation to an off-site disposal facility could be required.

Required workers would include construction workers, operators, engineers, electricians, plumbers, and administrative support.

- Number of workers for construction: 25 to 50; duration: 12 months
- Number of workers for operation: 2 to 6; duration: 80 years (on-site disposal) and 75 years (off-site disposal)

If the initial action discussed in Section 2.3.1.4 were needed to dilute river water during installation of the active system, it could be started almost immediately. Construction of the active system would not start until surface remediation was completed in the location where the system would be installed.

Number and Types of Equipment

Installation of an extraction system would require either conventional drill rigs for the wells or heavy equipment (e.g., backhoes) for construction of trenches. If ground water treatment were required, a treatment plant would need to be constructed with infrastructure to meet the operational requirements of the treatment system. The technology requiring the greatest amount of equipment for construction would be installation of an evaporation pond system because of the large amount of excavation required. Typical construction and earth-moving equipment would be required. Additional considerations include air emission controls, holding tanks, water lines, electrical lines, chemical storage areas, and pumps. After construction, the only equipment required for continued operations would likely be pickup trucks.

Equipment estimates are based on construction of an evaporation pond at a similar UMTRCA site near Tuba City, Arizona. Table 2–29 provides estimated equipment requirements for a scaled-up 40-acre evaporation pond at the Moab site to manage the estimated 150-gpm ground water extraction rate.

Table 2–29. Estimated Equipment Requirements

Equipment	No. of Equipment
Tractor	2
Drill rig for wells	1
Trackhoe for trenches	1
Backhoe	2
Grader	2
Front-end loader	1
End dump truck	1
Water truck	2
Scrapers (21 yd^3)	4
Dozer	2
Sheepfoot compactors	2
Smooth drum roller	1
Pickup	2
Skidsteer	1

Wastes Generated and Waste Management Requirements

Depending on the way extracted ground water would be treated and managed, different waste streams could be generated. Some of these waste streams would require some form of additional management, whereas others would be lost naturally to the atmosphere or subsurface. For example, if evaporation were the selected method for addressing ground water remediation, contaminated ground water would be discharged to an evaporation pond. Some constituents, such as ammonia, would volatilize to the atmosphere in the form of air emissions. The water in the pond would evaporate, and dissolved solids would eventually accumulate and be left as a residual sludge that would require waste management. Depending on combinations of technologies selected, different combinations of wastes would be generated, requiring different management techniques. Minimization of liquid wastes would result in more solids to manage. Different treatment options would result in varying amounts of secondary solids.

Regardless of the active method selected, is it assumed that any remediation system would need to accommodate a feed rate of 150 gpm of contaminated water. The average influent stream water composition would be roughly 1,000 mg/L ammonia, 7 mg/L uranium, and 20,000 mg/L TDS. Because ammonia is volatile, its release could result in air emissions; the dissolved solids would end up in solid form by removal of water through the remediation process.

Air Emissions. Operation of an evaporation pond, particularly spray evaporation, or an ammonia-stripping treatment technology would probably be the alternatives with the highest air emissions. Emission control devices on treatment plants could probably control emissions for some treatment methods. Residuals from these control systems would then require subsequent disposal. Control of emissions from an evaporation pond would not be feasible. However, the pond could be designed and operated to minimize impacts on surrounding areas.

Water Effluents. It is assumed that the same volume of extracted ground water would need to be handled regardless of the remedial system selected. However, resulting water effluents from that system would be of varying quality and would require different methods of handling. For deep injection and evaporation, extracted ground water would go directly to its final disposal with no intermediate steps. Water effluents produced as a result of some treatment process could require no special handling, as in the case of treated water that is produced through distillation, or may require some additional management method (such as the residual brine from distillation). Additional studies could be required if water effluents would be used for land application so that soils were not adversely affected.

Waste Solids. Solids generated from ground water remediation would mostly include sludges derived from processes employing precipitation and evaporation, or RRM or filters used in flow-through media processes. Both distillation and evaporation would concentrate dissolved solids and would probably produce the most concentrated waste solids. Larger volumes of lower-concentration wastes could be produced by use of flow-through processes. An estimated 6,600 tons per year of RRM waste would be generated, assuming all of the 20,000 mg/L TDS in the treatment stream would be recovered at a treatment capacity of 150 gpm. These RRM wastes would need to be disposed of at a low-level waste disposal site or at an UMTRCA disposal cell.

Land Use Requirements

The greatest requirements for land use would probably be associated with the evaporation alternative. A sufficiently large pond would need to be constructed to achieve evaporation rates that could keep up with extraction rates and complete remediation in a reasonable time frame. Estimated pond areas range up to 40 acres, and a total of 60 acres of land would need to be disturbed. Any active remediation alternative would require some type of support facility, but this would be expected to be minor and would probably be located in already disturbed areas. If land application of treated water were selected as the preferred effluent disposal alternative, sufficient land would need to be reserved for this purpose with a delivery system installed to transport and deliver the effluents (piping and sprinkler heads). A similar land farming alternative for an UMTRCA site in Monument Valley, Arizona, was estimated to require approximately 30 acres to handle 80 gpm of water; extraction rates at the Moab site are estimated to be a maximum of 150 gpm. If treated effluents resulted in a proportional volume of water requiring land application, land use requirements would probably be less than 60 acres. However, unlike under the evaporation alternative, this land could serve other beneficial purposes.

Natural Resource Requirements

Power consumption needs for a distillation unit would be the highest required for ground water remediation. Based on operation of a distillation unit at Tuba City, Arizona, an UMTRCA site similar to the Moab site, it is estimated that the maximum electrical power demand would be approximately 600 kVA. The capacity of the existing distribution system circuit at the Moab site would support this demand. An estimate of diesel fuel consumption for construction of an evaporation pond is shown in Table 2–30.

Table 2–30. Estimated Diesel Fuel Consumption for Evaporation Pond Construction (12-month period)

Equipment Type	Number of Equipment Total Project	Consumption (gallons per hour)	Consumption (gallons per year per piece)
CAT Ag. tractor (Challenger 55)	2	9	54,000
CAT 420D backhoe	2	3	18,000
CAT 140H grader	2	6	36,000
CAT 9880G front-end loader	1	13	39,000
12 yd^3 end dump	1	3	9,000
4000 gal. capacity water truck	2	3	18,000
CAT 621G 21 yd^3 scrapers	4	11	132,000
CAT D8R dozer	2	9	54,000
CAT 825G soil compactors	2	15	90,000
CAT CS533D drum roller	1	4	12,000
Pickup truck	2	1	6,000
CAT 248 skidsteer loader	1	3	9,000
		Total Diesel Fuel Consumption	477,000

Construction Materials (e.g., building materials, piping, pumps)

For an evaporation pond for ground water remediation, construction materials for a berm would come from clean, on-site materials. If the decision were made to implement some form of interim action in the potential habitat areas of the river before the active remediation system was fully operational, water could be extracted using the existing pumping system upgradient of the site and discharged to the potential habitat areas adjacent to the site. If application of fresh river water were implemented as an interim measure, DOE estimates that 50 to 500 gpm of river water would be withdrawn and used for this purpose. Almost all the water withdrawn would be returned to the river in fish habitat areas. The interim action would continue only until active ground water remediation began–that is, for a period of 4 to 5 years or less after issuance of the ROD.

2.3.2.4 Active Remediation Operations

The active remediation system would begin to extract and treat ground water within 10 years of the ROD and would continue for 75 to 80 years (depending on whether an off-site or on-site surface remediation alternative were implemented) to maintain surface water quality goals. This is the predicted time to allow natural processes to diminish the contaminant sources to the point that maximum ground water concentrations adjacent to the river meet the target goals (Figure 2–43). Contaminant concentrations in the ground water are thus predicted to be at acceptable risk levels prior to entry into the Colorado River within 10 years of the ROD. Active remediation would cease only after ground water and surface water monitoring confirmed that long-term remediation goals were achieved. The 3-mg/L target goal is a reasonably conservative ground water goal that should result in ammonia compliance in surface water given the uncertainties involved in predicting contaminant behavior. These uncertainties associated with the success of active remediation are discussed further in Section 2.3.3. Ground water and surface water would be monitored for any alternative that is selected to assess the progress of the active remediation system in achieving long-term remediation objectives and verifying predicted concentrations.

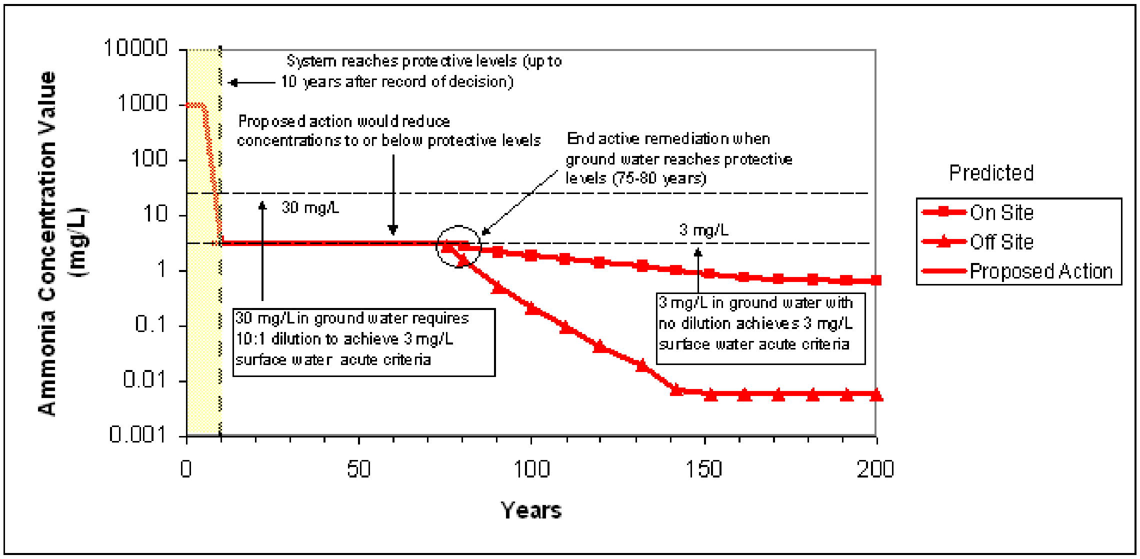


Figure 2–43. Predicted Maximum Ammonia Concentrations in Ground Water for Active Remediation

Table 2–31 summarizes the predicted schedule for meeting the target goal of 3-mg/L *in ground water* based on ground water modeling results (using base case assumptions). Ground water modeling results indicate that ground water ammonia concentrations would slowly decline through time under all remedial scenarios and under the No Action alternative. The on-site disposal alternative is predicted to meet the 3-mg/L target goal in approximately 80 years. The off-site disposal alternative is predicted to meet the 3-mg/L target goal in approximately 75 years. According to modeling results for the on-site disposal alternative, the lowest achievable ground water concentrations of ammonia would be less than 0.7 mg/L in 200 years at steady-state. For the off-site disposal alternative, the ground water concentrations of ammonia would reach the most stringent calculated chronic ammonia State of Utah standard for the site (0.2 mg/L) in 100 years and eventually decline to background levels in 150 years.

Table 2–31. Schedule for Meeting Ground Water Target Remediation Goals

Post-ROD Project Phase	**Remediation Target Goals Achieved**	
	On-site Alternative	**Off-site Alternatives**
Pre-remediation (within 10 years of the ROD)	No	No
Remediation—on-site disposal (within 80 years of the ROD)	Yes	NA
Remediation—off-site disposal (within 75 years of the ROD)	NA	Yes
Post-remediation	Yes	Yes

Higher ground water concentrations, such as those resulting from the No Action alternative, could comply with surface water standards, albeit at a lower confidence level.

The lowest concentration achievable under the No Action alternative is 6 mg/L; therefore, this alternative would not meet the 3-mg/L target goal. Figure 2–44 shows the ammonia concentrations over time for the No Action alternative.

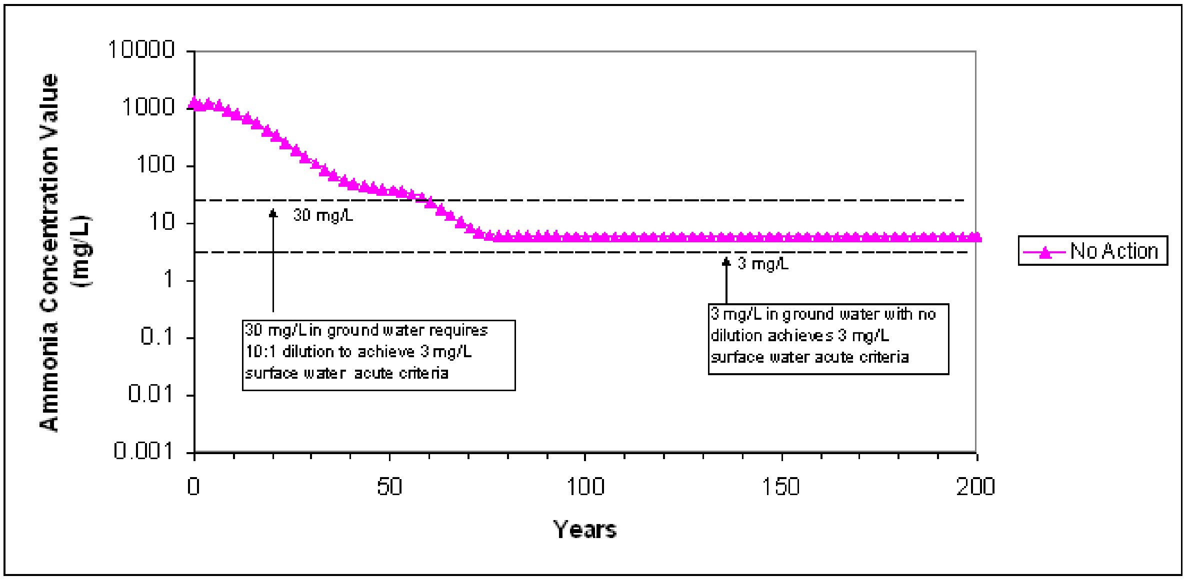


Figure 2–44. Predicted Maximum Ammonia Concentrations in Ground Water for No Action

2.3.3 Uncertainties

DOE does not have a quantitative estimate of uncertainty associated with modeling predictions estimating the time for ground water concentrations to reach target goals that are protective of aquatic species. The uncertainties can be grouped into the following general categories:

- Future changes in the status of threatened and endangered species.
- Future changes in AWQC.
- Uncertainties in concentrations predicted by the ground water model.

- Uncertainties in the time to achieve the target goal predicted by the ground water model.
- Change in concentrations of contaminants associated with ground water discharge to surface water (i.e., application of a dilution factor).

This analysis of uncertainties focuses on the goal of achieving concentrations of contaminants in the river that are protective of threatened and endangered fish species. According to the recovery plan for the Colorado pikeminnow (USF&WS 2002), downlisting could be achieved by 2006 and delisting by 2013. The razorback sucker could be delisted by as early as 2023 (USF&WS 2002). At that time, protection of threatened and endangered fish and critical habitat could have less significance, and less conservative remediation objectives could be applicable. Conversely, ambient water quality standards (federal or state) could be revised that affect target remediation goals.

Sections 7.3, 7.6, and 7.8 of the SOWP (DOE 2003b) discuss the sensitivity of the ground water flow and transport model to specific modeling input parameters as well as modeling uncertainty. Specifically, transport parameters (e.g., tailings seepage concentration and the natural degradation of ammonia in the subsurface) were found to have a much greater impact on predicted concentrations than did flow parameters (e.g., hydraulic conductivity and effective porosity). The sensitivity analysis performed indicates that perturbing the key transport parameters from the calibrated values could result in either significantly higher or significantly lower contaminant concentrations in the ground water adjacent to the river; it did not indicate the probability or likelihood of any one outcome.

The variables affecting prediction accuracy are many, and the system of contaminant transport and the interaction between ground water and surface are complex, largely due to the dynamic nature of river stage and backwater area morphology. To compensate for the inherent uncertainties, DOE has assumed a conservative protective water quality goal of meeting the lowest possible acute aquatic standard (based on the range of observed pH and temperature conditions in the river) in the ground water with no consideration of dilution.

On-Site Disposal

Model predictions, supported by the site-specific data, indicate that long-term ground water concentrations adjacent to the river (0.7 mg/L ammonia for the on-site disposal alternative) would be protective for acute and chronic exposure scenarios for all but the worst-case pH and temperature conditions without any consideration of dilution from the surface waters.

Because seepage from the tailings pile represents a long-term source of ground water loading, an on-site disposal decision could result in longer-term active ground water remediation; higher concentrations of residual ground water contamination also would be expected to remain at the conclusion of the remediation time period (see Figure 2–43). The longer operational time period would also result in a corresponding increase in operational costs of the system.

Some acceleration of cleanup could be realized under the on-site disposal alternative by focused ground water remediation of the legacy plume and the ammonia flux from the brine interface. However, after the legacy plume and ammonia flux from the brine interface were depleted, the continued presence of the tailings pile source would limit the degree to which concentrations could ultimately be reduced. Uncertainties associated with model predictions for the on-site disposal alternative involve both time required to meet steady-state conditions and the question of whether the target goals (i.e., concentrations) could be met.

Off-Site Disposal

Model predictions, supported by the site-specific data, indicate that long-term ground water concentrations adjacent to the river (background concentrations for the off-site disposal alternative) would be protective for acute and chronic exposure scenarios for all but the worst-case pH and temperature conditions without any consideration of dilution from the surface waters.

No Action Alternative

It is possible that the No Action alternative would meet the target goal considering the number of uncertainties involved. For example, a factor-of-2 decrease in the 6-mg/L ammonia concentration in ground water predicted at steady state would result in meeting the 3-mg/L target goal. A factor-of-2 decrease in predicted concentrations is within the lower range of uncertainty.

It is clear that if ground water concentrations comply with remediation objectives, surface water concentrations should comply as well. Therefore, on the basis of site-specific data and a study of the site conditions, DOE has a reasonable degree of confidence that protective conditions would be met and maintained both during the operation of the remedial action (75 to 80 years) and following achievement of water quality goals. Monitoring would confirm performance to meet target concentrations.

2.4 No Action Alternative

Although DOE would not remediate contaminated materials or ground water under this alternative, DOE would likely complete tasks necessary to secure the site to minimize the potential for accidents. For example, power would be turned off and equipment would be removed. This alternative is analyzed to provide a basis for comparison to the action alternatives and is required by NEPA regulations (40 CFR 1502.14[d]).

Under the No Action alternative, DOE would not remediate on-site surface contamination, which includes the existing tailings pile, contaminated materials and buildings, and unconsolidated soils. The existing tailings pile with its interim cover would not be capped and managed in accordance with 40 CFR 192 standards; this consequence of the No Action alternative would conflict with the requirements of the Floyd D. Spence Act. In addition, no site controls or activities to protect human health or the environment would be continued or implemented. Public access to the site would be unrestricted. All site activities, including operation and maintenance activities, would cease. Vicinity properties located close to the site and near the town of Moab, including residences, commercial and industrial properties, and vacant land, would also not be remediated.

Initial and interim ground water actions would not be continued or implemented. DOE would abandon all ongoing and planned activities designed to protect endangered species and prevent discharge of contaminated ground water to the Colorado River. No further media sampling or characterization of the site would take place.

A compliance strategy for contaminated ground water beneath the site would not be developed in accordance with standards in 40 CFR 192. Contaminated ground water would discharge indefinitely to the backwater areas of the Colorado River, and ammonia concentrations would continue to exceed protective levels. No institutional controls would be implemented to restrict the use of ground water, and no long-term surveillance 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.

2.5 Alternatives Considered But Not Analyzed

This section addresses on-site and off-site alternatives, including locations, that were initially considered on the basis of preliminary assessment. However, they were eliminated from detailed evaluation for the EIS.

2.5.1 On-Site Alternatives

On-site alternatives for surface remediation that were initially considered included (1) stabilize-in-place, (2) solidification, (3) soil washing, and (4) vitrification. All but stabilize-in-place were eliminated from detailed evaluation. The rationale for elimination is discussed below.
Ground water compliance alternatives were evaluated in the SOWP (DOE 2003b), which evaluates the compliance strategies and serves as the basis for the strategy proposed in Section 2.3.

2.5.1.1 Solidification

This alternative involves adding a stabilizing reagent to a soil or sediment. The reagent fills the interstitial spaces, blocking the flow of water and other fluids into these spaces and reducing contact and leaching of contaminants. A study of polyethylene macroencapsulation conducted by DOE and Envirocare at the Envirocare site near Salt Lake City showed that this technology could be applied to reduce leachate from radioactively contaminated lead bricks.

However, a study of seven solidification/stabilization reagents for treatment of contaminated sediments at the New Bedford Harbor Superfund site in Massachusetts did not give encouraging results. Concentrations of RCRA Toxicity Characteristic Leachate Procedure metals, particularly barium, copper, and zinc, actually increased in leachate generated from a number of post-treatment samples (EPA 2001).

The current cost of the treatment system used at Envirocare (excluding the costs of the initial treatability studies that resulted in a viable technology) was estimated at \$90 to \$100 per cubic foot (ft^3) based on a demonstration performed on waste streams from 23 DOE sites (FRTR 2001). The estimated total volume of contaminated tailings and soils at the Moab site is approximately 8.9 million yd^3, or 240 million ft^3. Thus, the cost of remediating the Moab site using Envirocare macroencapsulation would be \$22 billion to \$24 billion. Macroencapsulation is inherently an ex situ process; therefore, this cost would be in addition to the cost of excavating the entire volume of contaminated tailings and soil. Because the solidified material would remain classified as RRM, it would still have to be disposed of as a radioactive waste. Additional disposal costs were not estimated because of the excessive costs associated with the treatment. Therefore, this alternative was eliminated from further assessment under this EIS.

2.5.1.2 Soil Washing

Notwithstanding the name, most soil-washing processes do not actually wash soils. Rather, they use water, sometimes combined with chemical additives, to separate contaminated soils into contaminated and clean constituents. Contaminants tend to bind to silt and clay. Soil-washing processes separate silt and clay from sand and gravel particles that constitute the bulk of most contaminated soils. The silts and clays, which contain the contaminants, must then be treated by other means before disposal. The sand and gravel can be disposed of as nonhazardous material. Soil washing, then, is a waste volume-reduction technology. It can be effective, resulting in volume reductions of as much as 90 percent.

Soil washing has been used at a number of Superfund sites, notably at the King of Prussia Technical Corporation site in 1993, where 19,200 tons of metal-contaminated soil and sludge were treated. The treated soil (sand and gravel) from the King of Prussia site met or exceeded all the treatment standards (EPA 1995).

Ashtabula, Ohio, is a DOE site where soil washing was used to treat 40,000 tons of soils commingled with depleted uranium. This application more nearly approximated true “soil washing” because it used a chemical extraction to leach the uranium from the soil. The results of this deployment appear to be mixed, although the volume reduction was nearly 98 percent (DOE 2001a).

Technical feasibility may be a serious obstacle to the use of soil washing at the Moab site. The uranium at the Moab site is chemically bound to the tailings because it occurs naturally in the ore, and the tailings are the by-product of the milling process. The uranium remaining in the tailings is that which remained bound to the substrate after the leaching process was used at the mill. It would likely be difficult to remove the uranium in a second stage of processing. Furthermore, a significant portion of the Moab tailings consists of slimes, which are difficult to handle in physical processes and do not disperse readily. The soil-washing systems used to date have relatively low capacities. The King of Prussia system operated at 25 tons per hour, so it would require 54 years to treat the Moab pile, assuming continuous operation. The Ashtabula system operated at 10 tons per hour, a rate that would require 136 years to treat the Moab pile. Pulse Technology, a private firm marketing a soil-washing technology developed with Russian aid, offers a stationary system that can process up to 90 tons per hour. This would treat the Moab pile in 15 years with no allowance for downtime. Because residual contamination would remain after soil washing, the resulting waste would still have to be managed and disposed of as radioactive waste.

Soil washing is an expensive technology. The project cost at the King of Prussia site was $7.7 million, or $401 per ton of soil (EPA 1995). The unit treatment cost at Ashtabula was estimated at $370 per ton (DOE 2001a). Either of these figures, if extrapolated to the total volume of more than 11 million tons of contaminated tailings and soils at the Moab site, results in a total treatment cost of more than $4 billion. The lowest cost suggested by EPA for soil washing is $90 per ton (DOE 2001a), equivalent to $1 billion for the Moab site. To make soil washing economically feasible at the site, the unit costs would have to be an order of magnitude lower than those reported at the other sites where that technology has been used. There is no indication that such a reduction could be achieved.

2.5.1.3 Vitrification

This treatment alternative uses electricity to heat contaminated soils to their melting points in place, then allows the melted soils to cool as glass. The high temperatures required for vitrification (quartz melts at 1,610 °C [2,930 °F]) destroys many contaminants, and contaminants that are not destroyed are encapsulated in the glass.

Vitrification has been used at a number of DOE and other sites to treat small quantities of high-level radioactive waste. It is particularly useful for treatment of high-level liquid wastes. The Savannah River (Pickett et al. 2000) and Hanford Sites (62 FR 8693–8704 [1997]) are using vitrification for this purpose. An in situ vitrification (ISV) treatment system was successfully used to treat contaminated soils and sediment at the Parsons Chemical/ETM Enterprises Superfund site (EPA 1997). Oak Ridge National Laboratory (ORNL) has successfully demonstrated a transportable vitrification system for ex situ treatment of contaminated soils (DOE 1998). An in situ pilot test at Brookhaven National Laboratory in 1996 was less successful and, as stated in the report on that test, "raised concerns about the effectiveness of ISV" (DOE 1996b).

The quantities of wastes treated by vitrification have been small compared with the volume of contaminated tailings and soils at the Moab site. The ORNL ex situ demonstration (DOE 1998) treated about 8 tons of mixed waste, and the Parsons Chemical/ETM project (EPA 1997) treated approximately 3,000 yd^3 of soils and sediment. The estimated volume of solid material at the Moab site is 8.9 million yd^3.

Partly because of the relatively small volumes treated, the reported unit costs of ISV projects have been high.

- The ISV project at the Parsons Chemical/ETM Enterprises Superfund site in Grand Ledge, Michigan, which treated approximately 3,000 yd^3 of contaminated soils and sediments in 1993 and 1994, reported a cost of $270 per cubic meter (equivalent to $353 per cubic yard).
- DOE's report on ISV reported average costs of $375 to $425 per ton for projects at Parsons, ORNL, Wasatch, and a private Superfund site.
- "High Temperature Plasma Vitrification of Geomaterials" (Mayne and Beaver 1996) reported a range of operating costs of $308 to $695 per cubic meter (equivalent to $403 to $909 per cubic yard).

The total treatment cost of the ORNL ex situ transportable vitrification system was calculated at $8 to $15 per kilogram ($18 to $33 per pound).

Applying the average of the costs of the in situ processes (excluding the ORNL ex situ transportable vitrification system) to the total volume of the tailings and contaminated soils at the Moab site yields an estimated total cost of more than $4 billion for remediation of the site using ISV. Some economy of scale would be realized in a project the size of Moab. However, the most significant cost element in a vitrification process is electricity. DOE used an estimated unit cost of $0.05 per kilowatt hour to derive the cost range for vitrification projects, and it is highly unlikely that the cost of electricity for the Moab project would be significantly lower than this value. To make vitrification economically feasible at Moab, the unit costs would have to be more than an order of magnitude lower than those reported at the other sites where that technology has been used. The consistency between the reported unit costs for the various ISV projects suggests that an order of magnitude reduction is unlikely. In addition, as with other treatment alternatives, this waste would still need to be managed and disposed of as a radioactive waste.

2.5.1.4 On-Site Relocation

Moving the pile to another location on the Moab site was considered but dismissed as an alternative. DOE is already analyzing an on-site disposal alternative and there do not appear to be any advantages offered by relocating the tailings elsewhere on the site. Any alternate locations on the Moab site would result in more of the tailings pile/disposal cell lying in the 100-year floodplain of either the Colorado River or Moab Wash, thereby increasing the risk of flooding and decreasing cell integrity. One of the major objections to the existing pile is its proximity to the residents of Moab, to the Colorado River, and to Arches National Park. Moving the cell to a different location on the Moab site would not remedy these concerns and is likely to result in the relocated cell being closer to one of these three receptors. Although a relocated on-site disposal cell could be designed with a liner, it would continue to be located directly over an aquifer that feeds the Colorado River. Potential liner failure would pose a threat of contamination of the ground water and thus the Colorado River.

2.5.1.5 Removal of Top of the Pile

Because ammonia is the primary contaminant of concern and because it appears to be concentrated in the top of the pile due to the presence of a salt layer, some commentors have suggested that an alternative disposal strategy might be to remove the top portion of the pile (for example, the top 10 ft) for off-site disposal and cap the rest of the pile in place. However, DOE does not believe such a strategy offers potential advantages sufficient to warrant full analysis. While acknowledging that a salt layer may exist in the upper part of the pile and that leaching of ammonia from this layer could result in a temporary resumption of nonprotective surface water quality, modeling suggests that the potential impacts to surface water and aquatic species from salt layer leaching would not occur for at least 1,000 years. Moreover, partial removal of the pile would be the worst alternative in terms of proliferation of sites requiring long-term monitoring and stewardship. To some degree, removal and transportation of just the top of the pile would entail all of the unavoidable adverse impacts associated with full off-site disposal but would not result in any of the benefits to be accrued at the Moab site through full off-site disposal. DOE does not believe the alternative offers any compelling benefits in terms of impact or cost.

2.5.2 Off-Site Alternatives

2.5.2.1 Off-Site Surface Locations

Several off-site locations were considered for surface disposal of contaminated materials. All sites are within the state of Utah and included the following:

- Envirocare
- ECDC
- Green River
- Box Canyon
- Rio Algom
- Cisco site
- Whipsaw Flats
- Summo Minerals Lisbon Valley

These alternate locations for surface disposal were eliminated from further consideration on the basis of the following factors:

The licensed capacity of the Envirocare site is only half of the volume of tailings at the Moab site that would require disposal. Additional capacity for the tailings would require an amendment to the existing license from the State of Utah and an environmental evaluation. In August 2004, NRC transferred licensing authority to the State of Utah for the regulation of the possession of by-product material by persons. The tailings-transport distance to the Envirocare site would be over 200 miles (170 miles farther than the Crescent Junction site). Transportation costs associated with disposal of the tailings at Envirocare would be prohibitive.

ECDC formally withdrew its site from consideration shortly after the Notice of Intent To Prepare an EIS was published. At the Green River site, the location of the Green River floodplain in the northern portion of the site would limit placement of a disposal cell to the area south of the Probable Maximum Flood (PMF [see definition in Chapter 1.0]) boundary. The site is also bounded by I-70, which would severely restrict the space available for cell construction and disposal. The Box Canyon site would be limited by several small washes formed by surface runoff at the site, and the space is limited for a tailings pile. In addition, the Box Canyon site is located in an area frequented by tourists and outdoor recreationists, making it incompatible with a tailings disposal facility.

The Rio Algom facility was not considered a viable disposal site because (1) shallow, contaminated ground water exists in the Burro Canyon aquifer, (2) the ACL application has already been submitted to NRC for approval and termination of the license, contingent on existing conditions, and (3) adjacent property has already been acquired to provide an institutional control over the site-related contamination in ground water, and it may be impractical to expand farther.

The Cisco site is located 30 miles farther from Moab than the Crescent Junction site, and transportation costs would be higher compared to those for the Klondike Flats or Crescent Junction sites. Also, the Cisco site does not offer disposal criteria that are better than those at the Klondike Flats site. The Whipsaw Flats site is close to Arches National Park, and NPS personnel have opposed this location because the disposal site would be visible from portions of Arches National Park. In addition, this site would not offer any advantages over the Klondike Flats or Crescent Junction sites and would be more difficult to access than either the Klondike Flats or Crescent Junction sites.

The Summo Minerals Lisbon Valley site was proposed by a private copper mining company who suggested that the Moab tailings could be co-deposited with copper ore heap-leach residues. The Lisbon Valley site is located roughly the same distance from Moab as the Klondike Flats site, but the hydrogeology is less favorable.

Comments received in scoping meetings suggested several other off-site alternatives or related actions. These were considered but dismissed as described in the following discussions.

Railroad to White Mesa Mill Site—DOE considered but dismissed construction of a new railroad line from the Moab site to White Mesa Mill as an alternative because of the potential for extensive environmental impacts, technical difficulty, and cost. Minimum construction costs for a new rail line are typically in the range of $1 million to $3 million per mile, depending on terrain. In areas where the grade exceeds 1 to 2 percent, the line would have to be routed to avoid these grades, thereby adding to the total mileage, or the railbed would have to be graded to 1 to 2 percent, which would add to the cost and terrestrial impacts. A railroad bridge crossing the Colorado River would be a major additional expense and would require extensive and unforeseeably complex and lengthy permitting issues and potential delays in completing the construction. Acquisition or leasing of undisturbed land, much of it privately held, would be an additional expense, as would the necessary land surveys and road crossings, and there would be no guarantees that the required land could be secured without condemnation proceedings. DOE estimates that capital construction costs of a new 90- to 100-mile railroad from the Moab site to the White Mesa Mill site would exceed $150 million, including land surveys/acquisition and track, bridge, and road crossings construction. This is almost twice the projected capital construction costs for building a pipeline. Based on these higher capital construction costs, uncertainties surrounding the permitting process, and the likelihood of significant environmental impacts, this alternative was dismissed from further consideration.

Old Mines—Disposing of the contaminated tailings in old mines was dismissed from consideration because (1) no single mine in the region had sufficient volume to contain the contaminated material from the Moab site, (2), mines are typically excavated by blasting, and consequently can be structurally and geologically unstable, and (3) old mine shafts could also be susceptible to explosions, poisonous gas, and cave-ins. The use of mines under these conditions would pose serious logistical and worker occupational safety and health concerns.

Grand County Landfill—Using the Grand County landfill or allowing Grand County to own or direct operations of the cleanup area was dismissed because the landfill is neither permitted for nor technically designed for radioactive waste.

River Rerouting—Rerouting the Colorado River away from the Moab site was dismissed as an alternative because of the broad range of adverse and irreversible environmental impacts to the Matheson Wetlands Preserve that such an undertaking would entail.

Land Use—Converting the site into a golf course was suggested but is not considered an alternative remediation action. Rather, it is a potential future land use suggestion that will be considered at a later time.

Use of Contaminated Water—Contaminated ground water could possibly be used to augment the slurry pipeline recycle makeup water requirements or, depending on schedule, to augment the nonpotable requirements for the initial pipeline slurry. However, the anticipated 150 gpm of pumped contaminated ground water would be less than 40 percent of the required 409 gpm of makeup water (see Table 2–12). If the pipeline option were implemented, the effluent discharge options discussed in Section 2.3.3 would be evaluated, and a preferred option or combination of options would be selected for more detailed technical and engineering review. Use of contaminated water to augment the slurry water requirements would be evaluated at that time.

2.5.2.2 Disposal in Mined Salt Caverns

In late 2003, DOE considered an option to dispose of the Moab mill tailings in solution-mined salt caverns either at the Moab site or off site at two potential locations. Conceptually, disposal caverns would be created by solution mining in the salt beds of the Paradox Formation beneath the Moab site or at other possible locations, such as the commercial potash mine site approximately 6 air miles downstream from Moab. This option would involve withdrawing Colorado River water for the solution mining process; the water would become saturated with salt, generating brine that would have to be disposed of by deep well injection or solar evaporation or perhaps by use in the potash mining operations. Appendix E presents DOE’s evaluation of this alternative approach.

Disposal in mined salt caverns is an unproven approach to uranium mill tailings disposal that would require immense amounts of Colorado River water (approximately 1,700 gpm of fresh water, roughly 880 million gallons per year or 73 million gallons per month) for a 20-year period to perform solution mining activities. DOE does not currently own the rights to withdraw this much water, and if they could be purchased, DOE would be required to pay water depletion fees associated with compensation of existing water right holders because of impairment.

DOE's programmatic experience with the complexity of implementing a first-of-a-kind unproven disposal technique for radioactive waste indicates that implementation of this option could be 3 or 4 times as long as all other alternatives (up to a few decades to go operational, a 20-year operations time frame, and a project life cycle range of multiple decades). Technical, geological, hydrological, seismological, legal, economic, and operational uncertainties present a real potential for substantial schedule and cost growth over current estimates. More specifically, these technical and operational uncertainties include (1) the location of favorable geologic strata that could be used for disposal of the brine by deep well injection and the rate and extent that brine could be injected; (2) the location, depth, and configuration of the caverns to be solution mined in the Paradox Formation; (3) the long-term performance of salt caverns in isolating the mill tailings; (4) the private/government business model that could allow use of the salt or brine, (5) the consumption of significant quantities of Colorado River water, which may be more than is available under DOE's water rights and possibly more than what would be acceptable under the recovery program for endangered fish; (6) the high potential cost (approximately $892 million to $1.3 billion); and (7) high potential for cost growth well beyond the range identified for other alternatives.

Resolving these uncertainties sufficiently to determine whether this alternative would be technically feasible and cost-effective would require a significant investment in additional studies. Such studies would include injection well testing, subsurface characterization, salt cavern performance modeling, an assessment of legalities, and an overall system performance assessment. The studies could require several to tens of millions of dollars and many years to complete, with no guarantee that the investment would demonstrate that this alternative is technically viable or offers substantive advantages to DOE or the public relative to the other alternatives being considered. Because the available data are not sufficient to provide the basis for a decision of this magnitude, DOE would need to delay the EIS to obtain this information.

An advantage of the solution-mixed salt cavern approach is the potential for longer-term isolation and more protection than that offered by other alternatives. Other advantages are that (1) salt cavern disposal would produce the least long-term environmental impact because no surface footprint would remain at the conclusion of the disposal period, and (2) this approach provides another disposal option for contaminated ground water for 50 of the 75 to 80 years required for active ground water remediation.

However, on the basis of the evaluation of this option and review by the 12 cooperating agencies and given the technical, legal, and economic uncertainties associated with this unproven technical approach, DOE's past experience, and the potential advantages with respect to the existing alternatives and the disadvantages, DOE has concluded that this option is not "practical or feasible" and has therefore decided not to include salt cavern disposal as a reasonable alternative in the EIS.

2.6 Description and Comparison of Alternatives and Environmental Consequences

Section 2.6.1 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. It is based on the consequences, including assumptions and uncertainties, identified in detail in Chapter 4.0 of the EIS. Section 2.6.2 summarizes the potential impacts (both adverse and beneficial) to the physical, biological, socioeconomic, cultural, and infrastructure environment that could occur at the potential borrow areas. Section 2.6.3 identifies areas of uncertainty in DOE's analyses and the potential ramification of those uncertainties on decision-making. Section 2.6.4 recognizes that there are opposing views on a few issues, characterizes those opposing views, presents DOE's position on the issues, and discusses the implications of these issues to decision-making.

2.6.1 Impacts Affecting the Moab Site and Vicinity Properties, Transportation Corridors, and Off-Site Disposal Locations

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 greater for truck versus 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 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 2–45). 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.

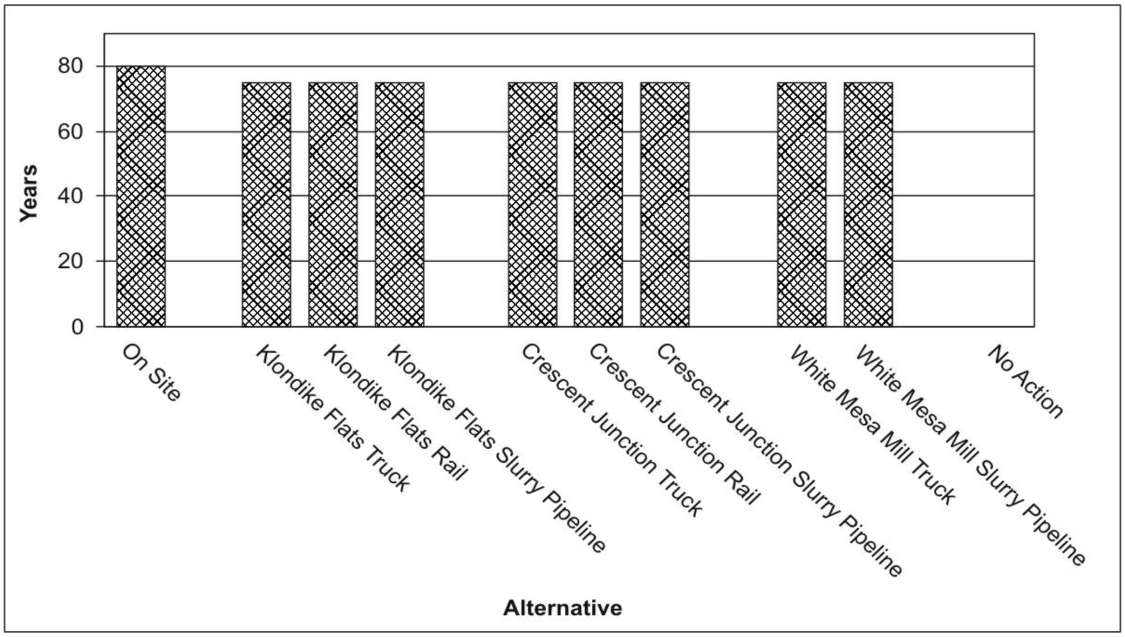


Figure 2–45. Estimated Duration of Ground Water Remediation

In the near term, DOE estimates that the proposed ground water remediation system would result in surface water quality that is protective of aquatic species in the Colorado River within 5 years after the system was implemented.

DOE also anticipates that contaminant concentrations in ground water and surface water that are protective of aquatic species in the Colorado River could be maintained, under all action alternatives, for the 200- 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, the ground water beneath the Moab site would remain contaminated, would pose an increased risk to human health, and would continue in perpetuity to discharge contaminants to the surface water at concentrations that would not be protective of aquatic species. Cursory characterization indicates a potential for a salt layer in the upper zone of the tailings pile (see Table S–1). Modeling results indicate that under the on-site disposal alternative, contaminants from such a salt layer if present in the tailings pile would reach ground water in approximately 1,100 years and would affect ground water and surface water for approximately 440 years. Because ground water treatment would have been discontinued after an estimated 80 years, surface water concentrations could revert to nonprotective levels.

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

In addition to natural subsidence described in the discussion of ground water impacts, a Colorado River 100- or 500-year flood could release additional contamination to ground water and surface water under the on-site disposal or No Action alternatives. However, under the on-site disposal alternative, the increase in ground water and river water ammonia concentrations due to floodwaters inundating the disposal cell 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.

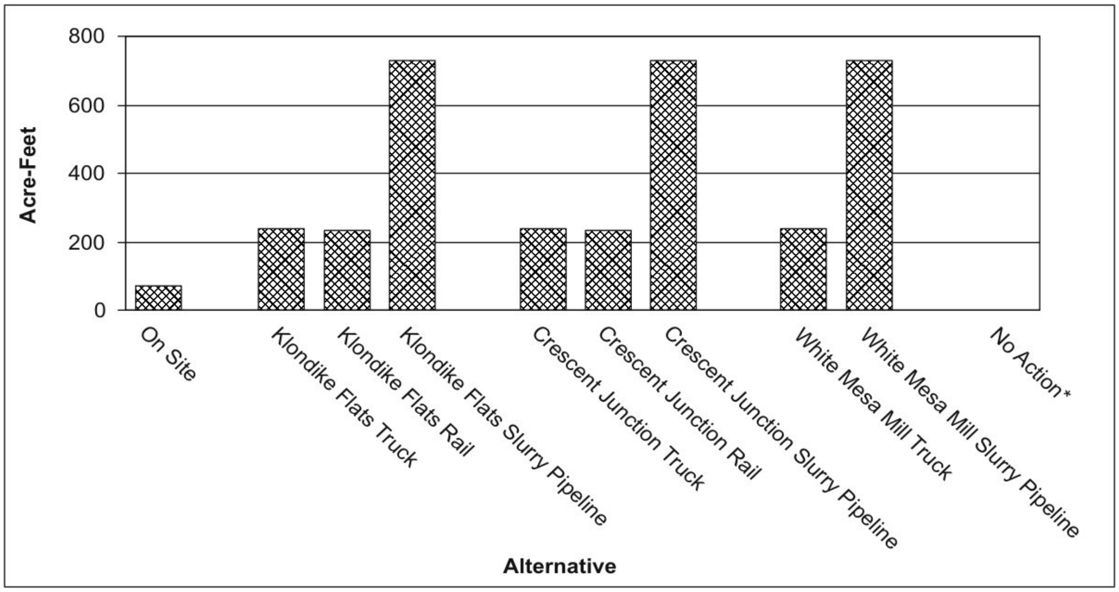
With the exception of ephemeral streams and impoundments, no surface water exists on or near any of the three off-site disposal locations.

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

In accordance with its regulations (10 CFR 1022), DOE has prepared the *Floodplain and Wetlands Assessment and Floodplain Statement of Findings for Remedial Action at the Moab Site* and 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 2–46. 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.

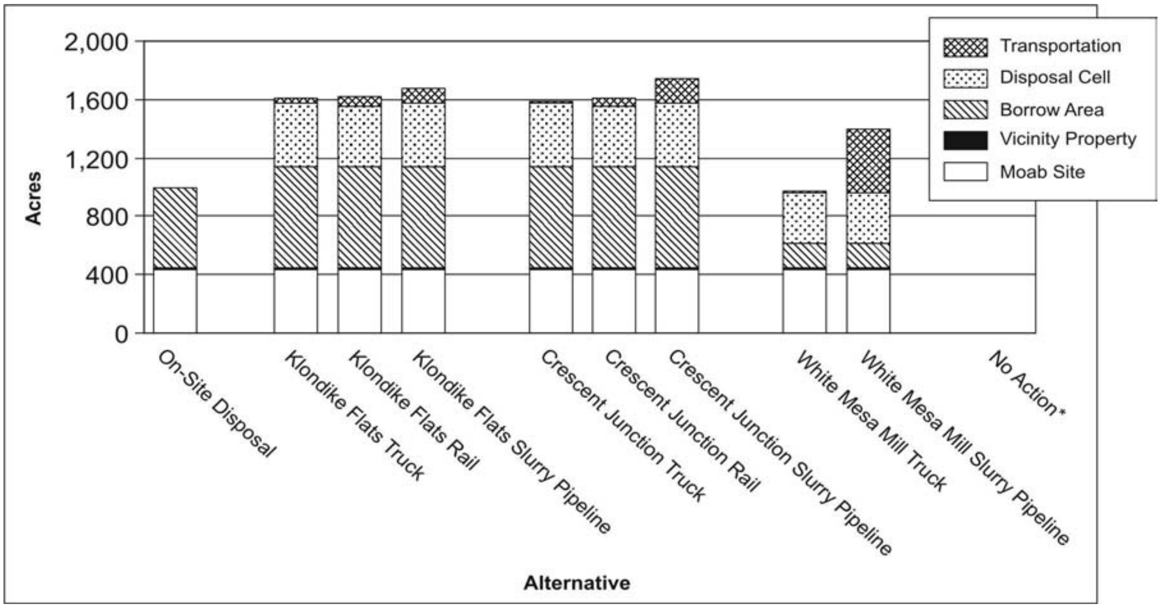
Figure 2–46. Annual Withdrawals of Colorado River Water

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 2–47 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 2–47. 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.

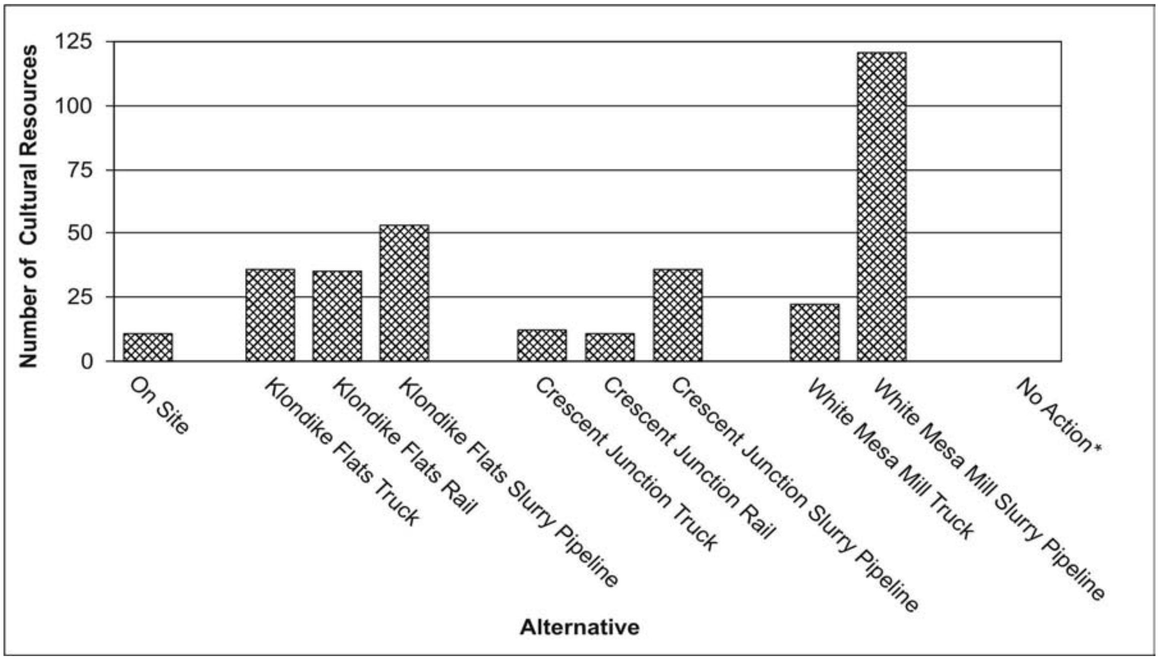
Land Use. Under any of the disposal alternatives, the land dedicated to the disposal cell would be unavailable for any other uses in perpetuity. Under off-site disposal at the Klondike Flats and Crescent Junction locations, up to 435 acres of undisturbed BLM rangeland would be dedicated to the disposal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

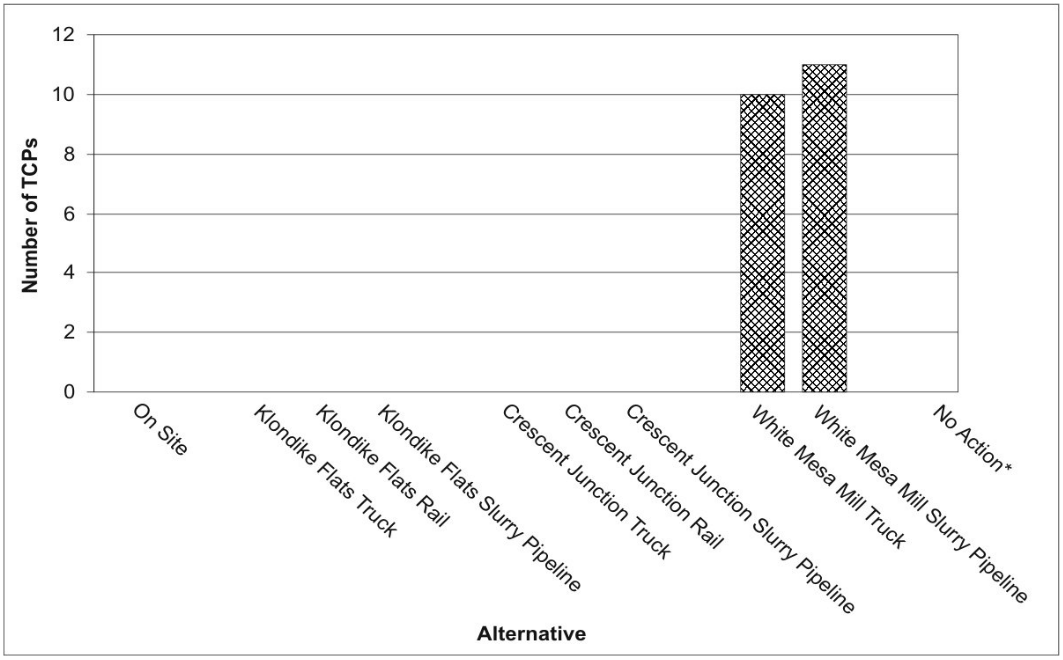
Cultural Resources. Only the Moab site and White Mesa Mill site have been field-surveyed; however, cultural resources would probably be adversely affected under all the action alternatives. The numbers of potentially affected cultural resources would vary significantly among the action alternatives (Figure 2–48). 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 2–49). (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.



*Impact would not occur under this alternative.

Figure 2–48. Maximum Number of Potentially Affected Cultural Resources



*Impact would not occur under this alternative.

Figure 2–49. Minimum Number of Potentially Affected Traditional Cultural Properties

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

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

Visual Resource Contrast Rating

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

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

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

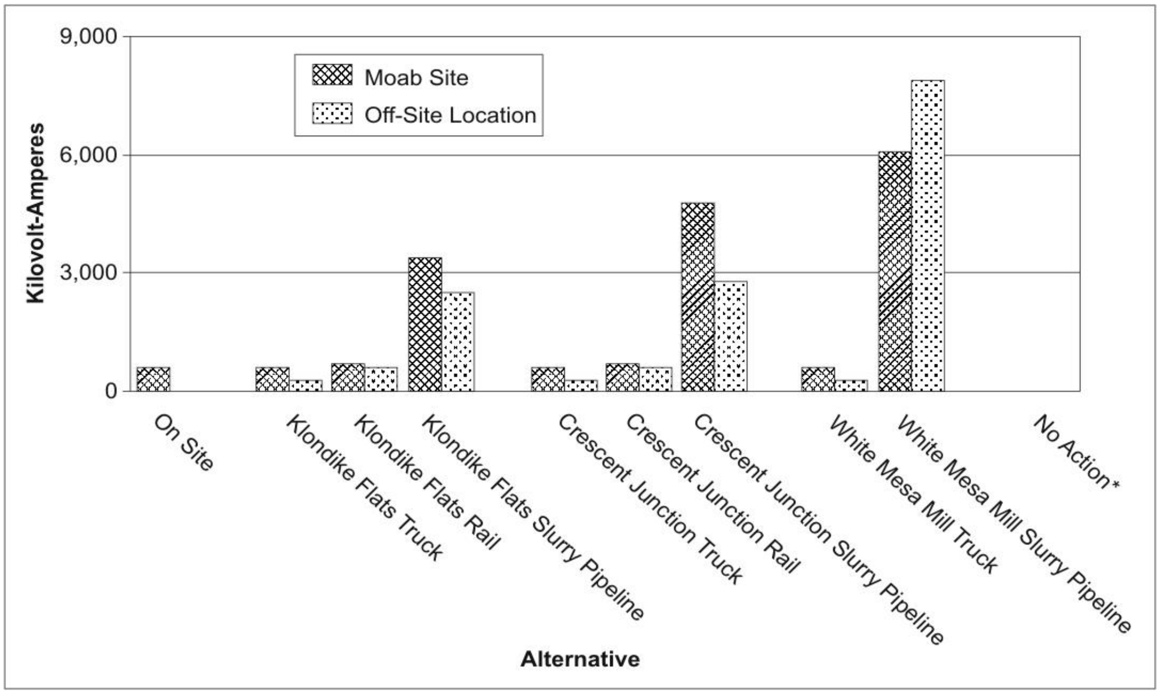
Infrastructure and Resource Requirements. Under all action alternatives, demand for electricity, potable and nonpotable water, and sewage treatment would not exceed local capacity or DOE’s withdrawal rights to Colorado River water. However, under the White Mesa Mill slurry pipeline transportation option, a booster pump station on the pipeline approximately 30 miles beyond the Moab site would be required. Powering the new pump station would require (1) adding a substation transformer at the Utah Power La Sal substation, (2) installing approximately 3 miles of new distribution line to service the booster pump station, and (3) upgrading the existing line from the La Sal substation to its current endpoint in Lisbon Valley. The required upgrade would entail modifications to line and pole configurations and capacities as necessary to accommodate the increased electric load represented by the booster pump station. A slurry pipeline to White Mesa Mill may also require a new substation transformer at Utah Power's Blanding substation and upgrades to the existing distribution line from the Blanding substation to the White Mesa Mill site. Exact upgrade requirements would be determined by the requisite detailed electrical engineering study if slurry pipeline transportation to White Mesa Mill were implemented.

Total diesel fuel consumption under the on-site disposal alternative would be 4 million to 5 million gallons. Total fuel consumption under the off-site disposal alternative would range from 12 million to 20 million gallons for truck transportation, from 10 million to 11 million gallons for rail transportation, and from 7 million to 9 million gallons for slurry pipeline transportation.

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

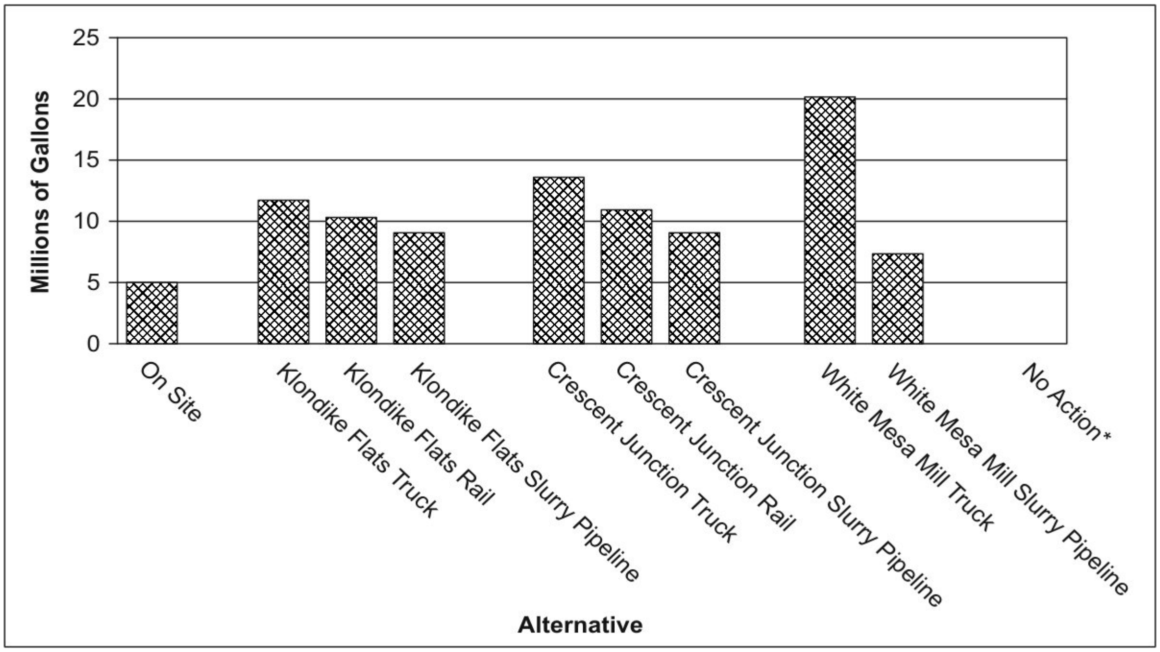
Figure 2–50 through Figure 2–54 compare the major resource and infrastructure requirements among the alternatives. These figures show that power and nonpotable water requirements would be significantly higher for the slurry pipeline alternative than for other alternatives. Fuel requirements for the White 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 RRM from treatment of contaminated ground water (Figure 2–55). 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.



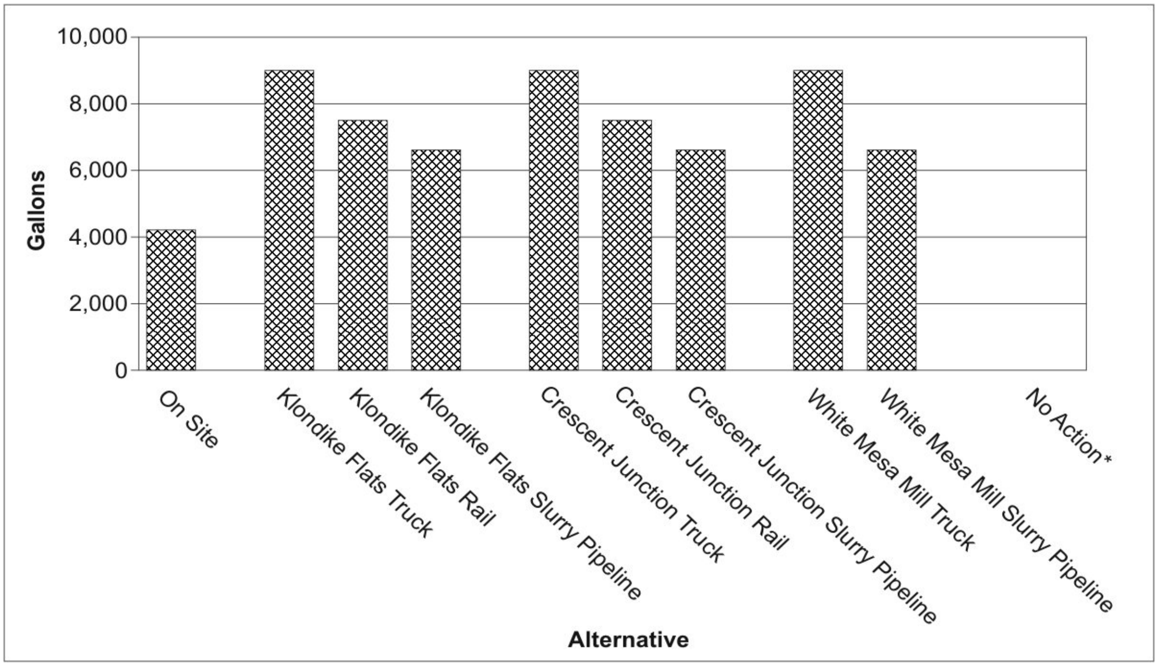
*Impact would not occur under this alternative.

Figure 2–50. Power Requirements



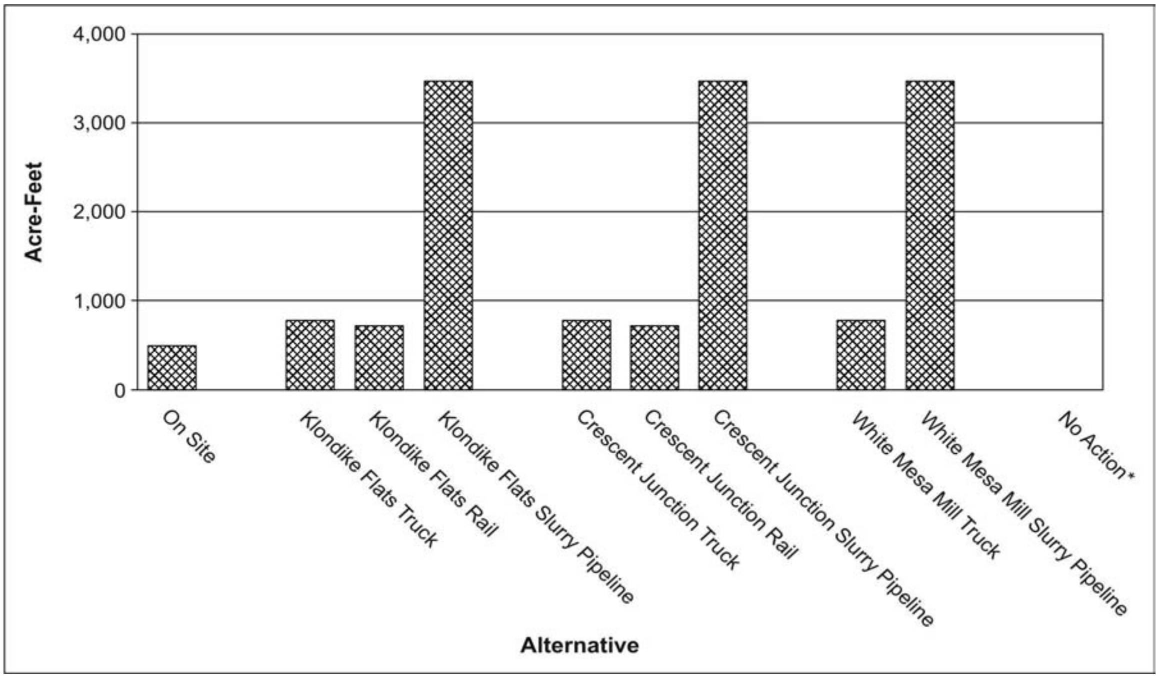
*Impact would not occur under this alternative.

Figure 2–51. Total Fuel Consumption



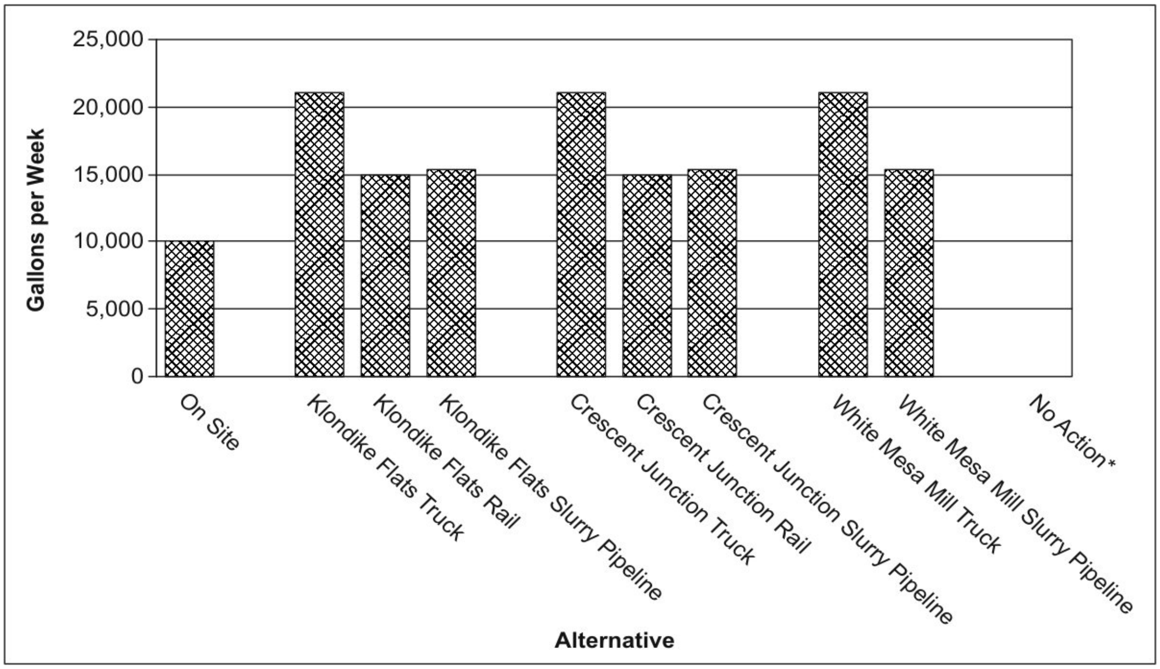
*Impact would not occur under this alternative.

Figure 2–52. Daily Potable Water Consumption



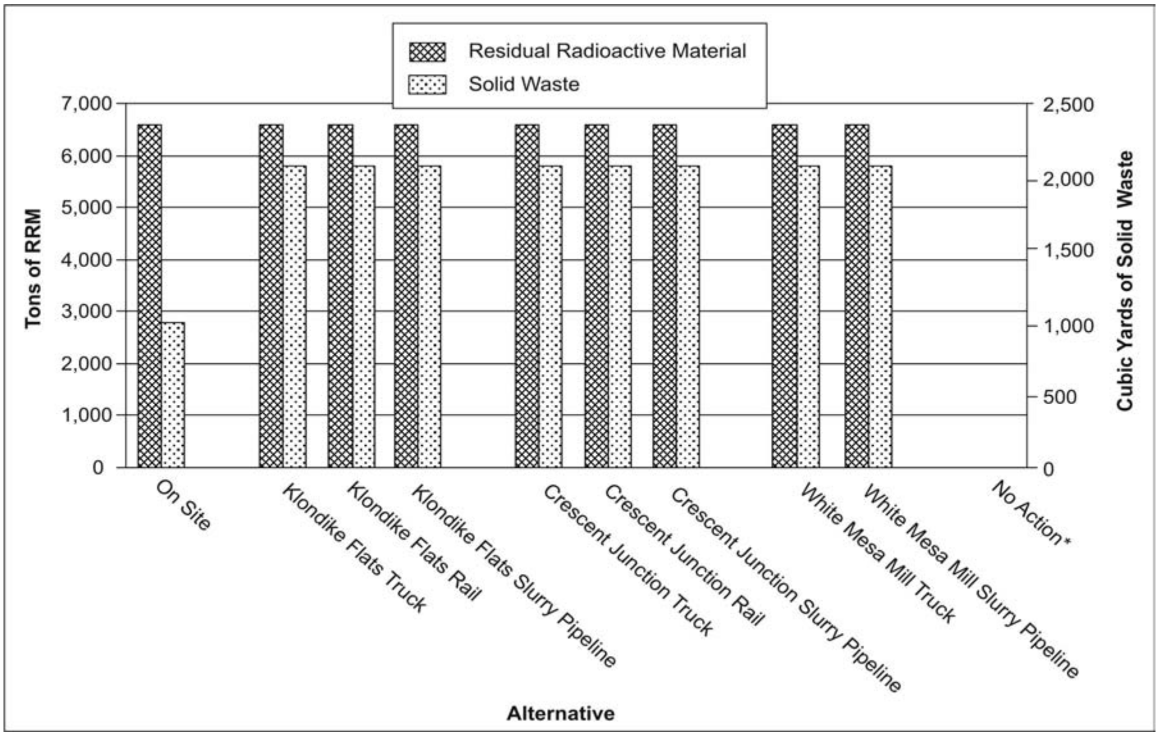
*Impact would not occur under this alternative.

Figure 2–53. Total Nonpotable Water Consumption



*Impact would not occur under this alternative.

Figure 2–54. Sanitary Waste Generation



*Impact would not occur under this alternative.

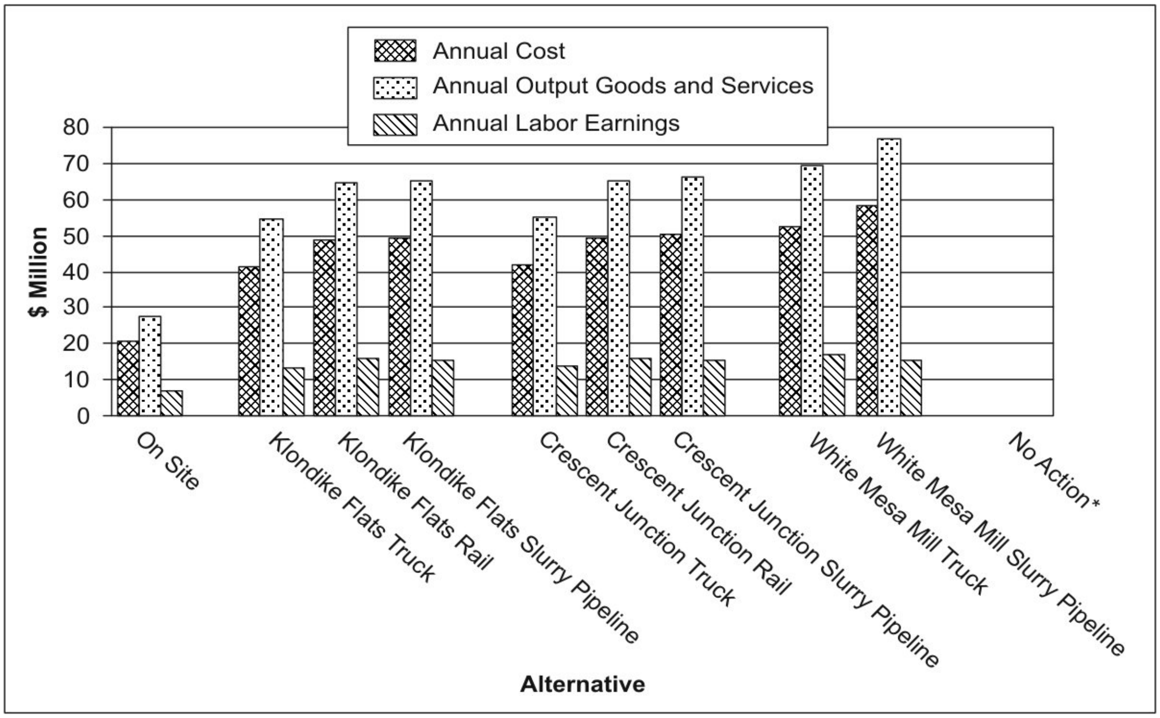
Figure 2–55. Annual Generation of RRM and Solid Waste

Socioeconomics. Figure 2–56 and Figure 2–57 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.

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 2–57). 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.

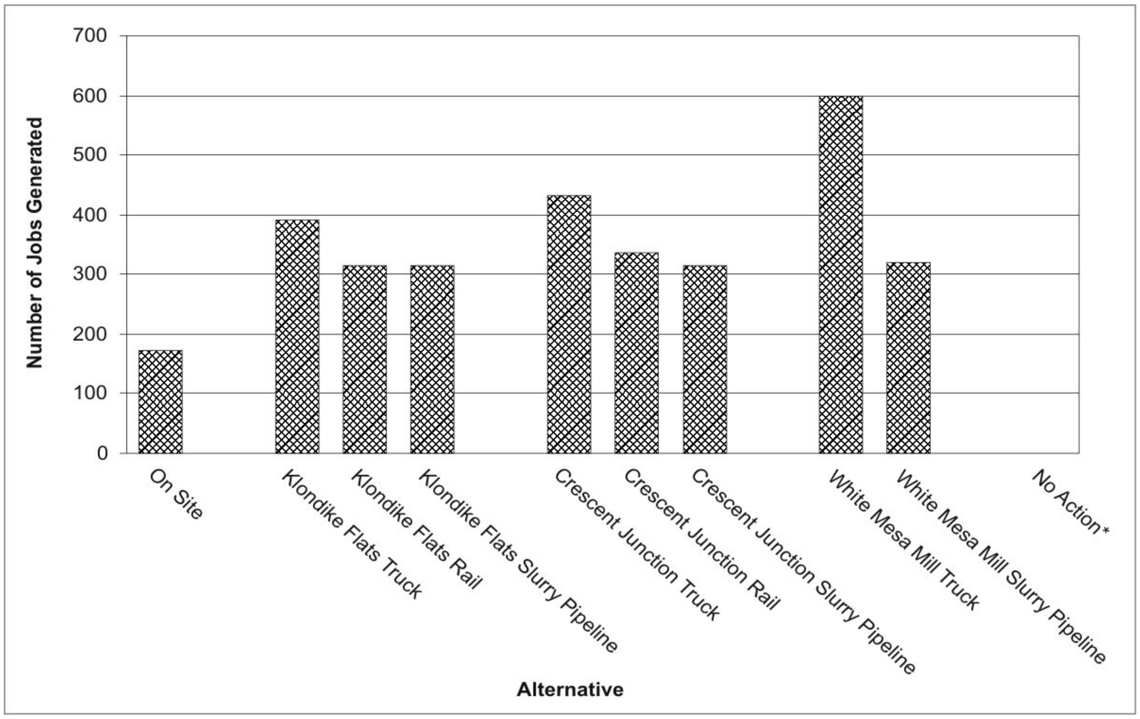
The potential socioeconomic impacts from the No Action alternative would relate to potential longer-term damages that would result from leaving the pile and contaminated materials at vicinity properties where they are in their present form. These damages would include potential adverse impacts to human 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 2–58 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.



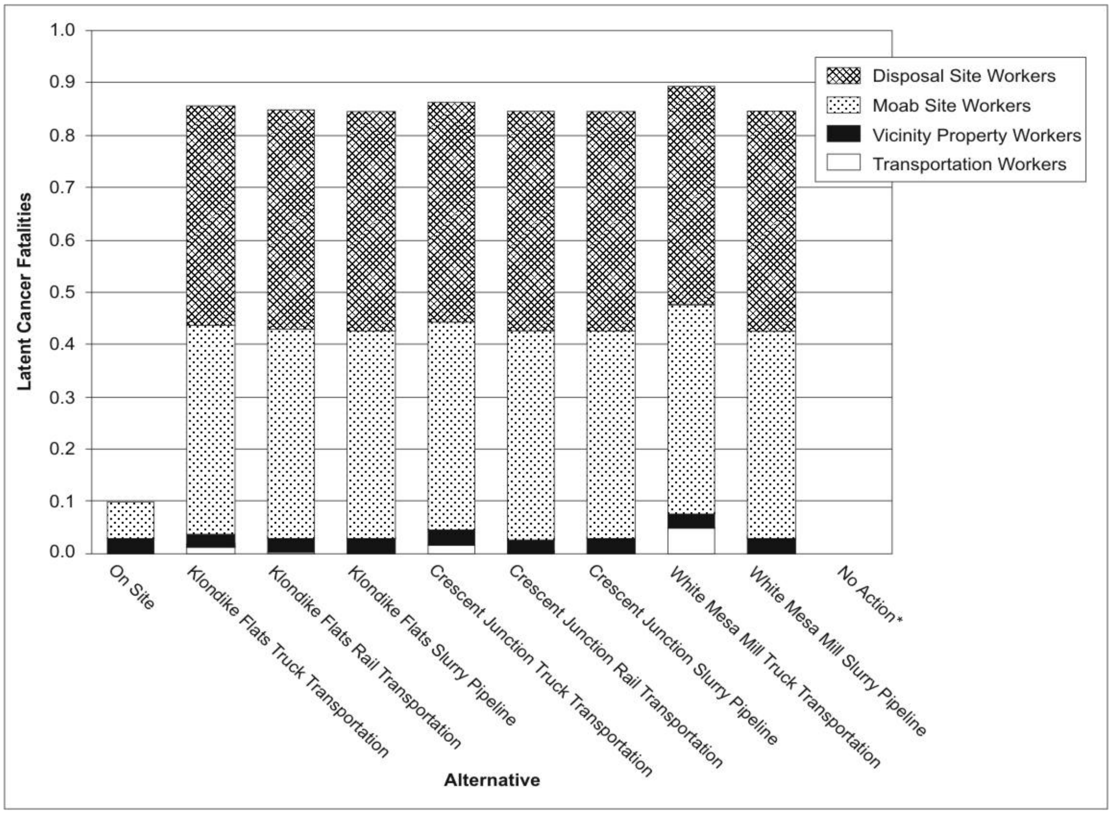
*Impact would not occur under this alternative.

Figure 2–56. Annual Costs and Benefits



*Impact would not occur under this alternative.

Figure 2–57. Generation of New Direct and Indirect Jobs



*Impact would not occur under this alternative.

Figure 2–58. Latent Cancer Fatalities Among Workers

Figure 2–59 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 2–60. Estimates of latent cancer fatalities shown for the action alternatives in Figure 2–59 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 2–59). 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.

Figure 2–60 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.

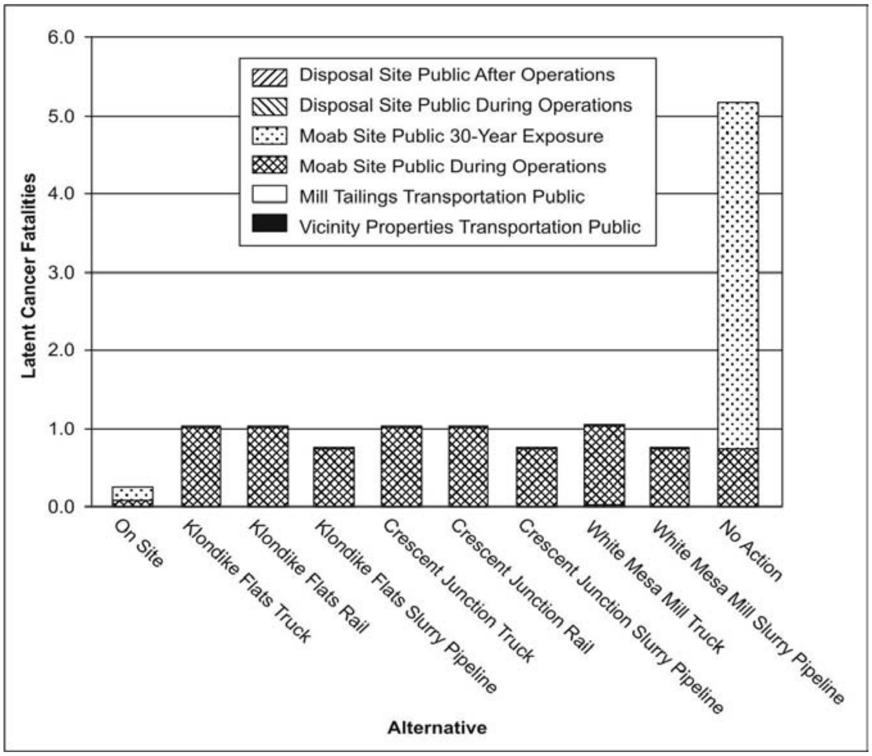
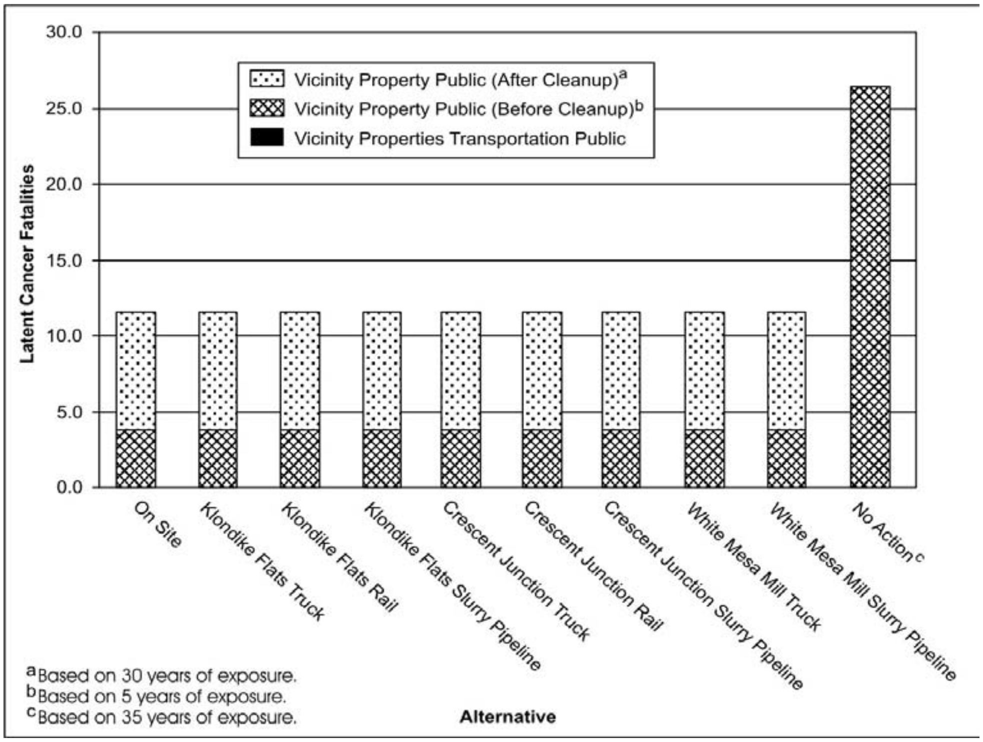


Figure 2–59. Public Latent Cancer Fatalities (Excluding Vicinity Property Exposure)



[a] Based on 30 years of exposure.
[b] Based on 5 years of exposure.
[c] Based on 35 years of exposure.

Figure 2–60. Public Latent Cancer Fatalities from Vicinity Property Exposure

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).

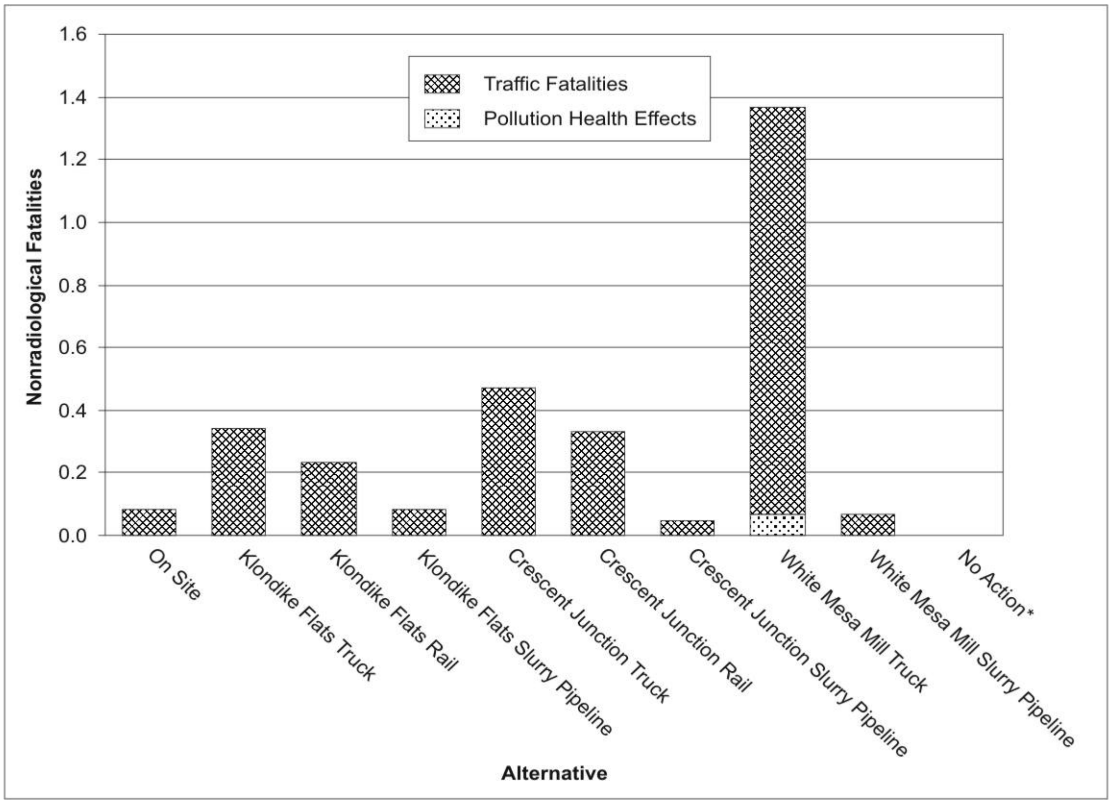
On the basis of this emission rate, after the disposal cell cover was installed the annual latent cancer fatality risk from radon for a nearby resident at any of the disposal sites is estimated to be 8.9×10^{-5} per year of exposure. As with the radioactivity in the disposal cell, the annual risk would 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.

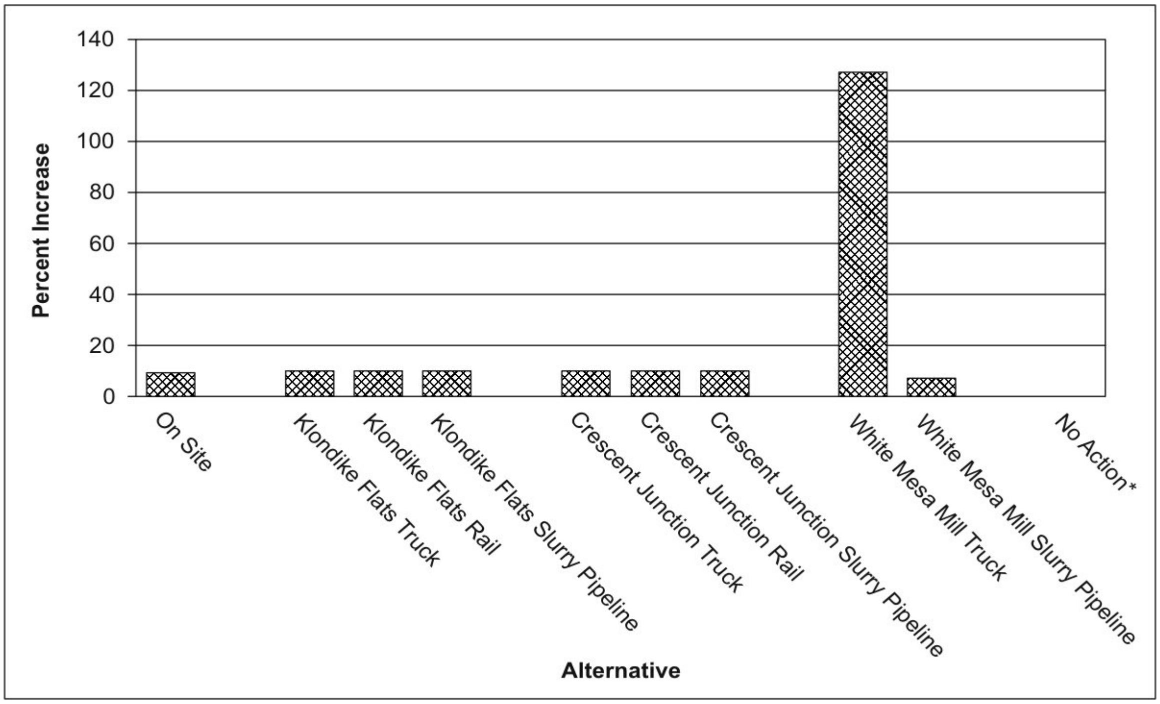
Figure 2–61 compares nonradiological fatalities predicted among members of the public due to project-related traffic accidents and to exposure to project-related nonradiological pollutants during surface remediation activities. There would be less than one-tenth of one fatality due to exposure to nonradiological pollutants (for example, exhaust emissions) under any action alternative (Figure 2–61). 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 2–62 through Figure 2–64 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 UDOT 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,



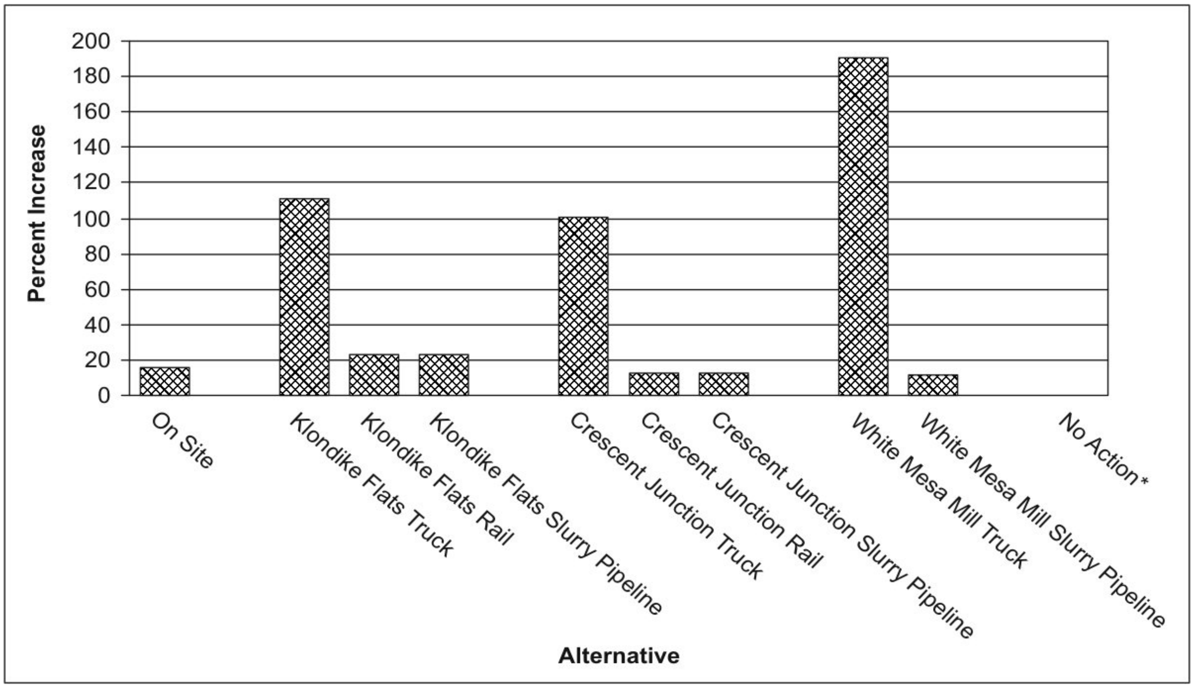
*Impact would not occur under this alternative.

Figure 2–61. Nonradiological Transportation Fatalities



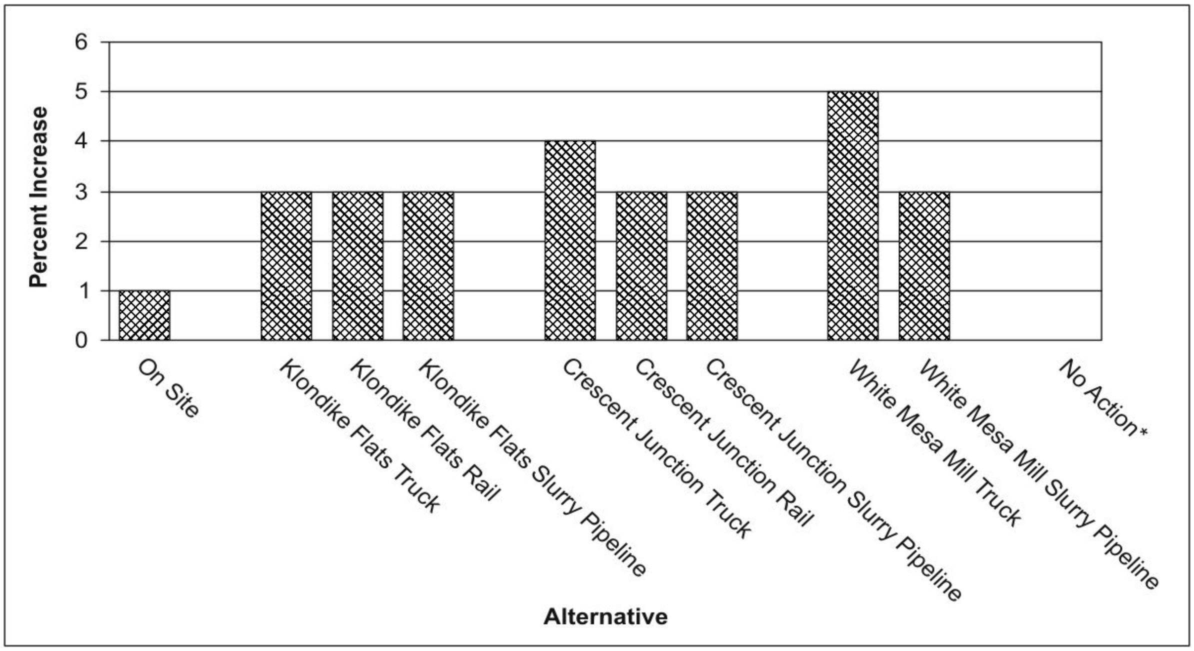
*Impact would not occur under this alternative.

Figure 2–62. Increase in Truck Traffic in Downtown Moab



*Impact would not occur under this alternative.

Figure 2–63. Increase in Truck Traffic on US-191



*Impact would not occur under this alternative.

Figure 2–64. Increase in Moab Traffic from Commuters 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 2–61, DOE estimates that less than one traffic fatality would occur for all alternatives and transportation modes with the exception of truck transportation to White Mesa Mill, for which modeling predicts that 1.3 traffic fatalities would occur.

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

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

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.

Table 2–32 compares the impacts analyzed in the EIS. In general, the information in Table 2–32 is the same as that provided in this section. The information is repeated in tabular form as an aid to readers who may wish to rapidly compare a specific impact across all alternatives.

Table 2–32. Summary and Comparison of Impacts

CATEGORY	ON-SITE DISPOSAL AT THE MOAB SITE	OFF-SITE TRANSPORTATION MODE	OFF-SITE DISPOSAL ALTERNATIVES			NO ACTION ALTERNATIVE
			KLONDIKE FLATS	CRESCENT JUNCTION	WHITE MESA MILL	
GEOLOGY AND SOILS	No seismic potential.		No seismic potential.			No seismic potential.
	Potential for subsidence and incision.		No stability hazards present.		Potential for minor geologic instabilities in areas surrounding site.	Potential for subsidence and incision.
	Sand and gravel resources below site could be unavailable for exploitation because of previous mill contamination.		Geological resources available are too deep for exploitation.		Some potential for oil deposits at deep depths; other resources too deep or sparse for exploitation.	Sand and gravel resources beneath the Moab site would remain contaminated.
	1.8 million yd^3 of soil and other borrow materials would be removed from borrow areas for use at the Moab site.		2.2 million yd^3 of soil and other borrow materials would be removed from borrow areas for use at the disposal cell site or Moab site.			No new materials would be committed to the Moab site.
	Excavation of 234,000 tons (173,000 yd^3) of contaminated site soil and backfilling with clean reclamation borrow soil to a depth of approximately 6 inches would result in a short-term increase in potential for soil erosion.		Excavation of 234,000 tons (173,000 yd^3) of contaminated site soil and backfilling with clean reclamation borrow soil to a depth of approximately 6 inches would result in a short-term increase in potential for soil erosion. Excavation and removal of the tailings pile and an estimated 2 feet of contaminated subpile soil and backfilling with clean reclamation borrow soil to a depth of approximately 6 inches would result in short-term increase in potential for soil erosion. Excavation and construction of the disposal cell, access roads, and support facilities would result in short-term increase in potential for soil erosion.			No excavation.

Table 2–32. Summary and Comparison of Impacts (continued)

CATEGORY	ON-SITE DISPOSAL AT THE MOAB SITE	OFF-SITE TRANSPORTATION MODE	OFF-SITE DISPOSAL ALTERNATIVES			NO ACTION ALTERNATIVE
			KLONDIKE FLATS	CRESCENT JUNCTION	WHITE MESA MILL	
GEOLOGY AND SOILS (cont).		Pipeline	Excavation and construction for emplacement and removal of slurry pipeline would disturb topsoil and result in short-term increase in potential for soil erosion along a pipeline corridor approximately 19 miles long.	Excavation and construction for emplacement and removal of slurry pipeline would disturb topsoil and result in short-term increase in potential for soil erosion along a pipeline corridor approximately 34 miles long.	Excavation and construction for emplacement and removal of slurry pipeline would disturb topsoil and result in short-term increase in potential for soil erosion along a pipeline corridor approximately 89 miles long.	
AIR QUALITY	PM_{10} (see definition in Chapter 10) emissions would require dust control measures.	Truck, rail, and pipeline	PM_{10} emissions would require dust control measures.			PM_{10} emissions from dust would likely exceed standards.
	Vehicle emissions would not exceed National Ambient Air Quality Standards (NAAQS).		Vehicle emissions would not exceed NAAQS.			No emissions.
	Prevention of significant deterioration (PSD) increment limits would not be exceeded.		PSD increment limits would not be exceeded.			
	Air emissions from technologies evaluated for ground water remediation would not exceed health standards for workers or the public.		Air emissions from technologies evaluated for ground water remediation would not exceed health standards for workers or the public.			

Table 2–32. Summary and Comparison of Impacts (continued)

CATEGORY	ON-SITE DISPOSAL AT THE MOAB SITE	OFF-SITE TRANSPORTATION MODE	OFF-SITE DISPOSAL ALTERNATIVES			NO ACTION ALTERNATIVE
			KLONDIKE FLATS	CRESCENT JUNCTION	WHITE MESA MILL	
GROUND WATER	Moab site ground water would remain contaminated in perpetuity, but supplemental standards would provide protection of human health.	N/A	Moab site ground water would remain contaminated for 150 more years, but supplemental standards would provide protection of human health.			Moab site ground water would remain contaminated in perpetuity and would not be protective of human health.
	Natural subsidence would result in permanent tailings contact with the ground water in 7,000 to 10,000 years.		Off-site disposal would eliminate the potential for tailings subsidence into Moab site ground water.			Natural subsidence would result in permanent tailings contact with the ground water in 7,000 to 10,000 years.
	Additional contamination from the ammonia salt layer could reach ground water within 1,100 years and could continue until 1,540 years from the present, even after completion of ground water remediation.		Travel time to underlying ground water 25,000 years.	Travel time to underlying ground water 170,000 years.	Travel time to point of exposure at surface springs 3,570 to 7,690 years.	Additional contamination from the ammonia salt layer could reach ground water within 170 years and continue until 220 years from the present.
SURFACE WATER	Colorado River flood would release additional contamination to ground water and surface water.	N/A	No potential flood events to release contaminants.			Colorado River flood event could release additional contamination to ground water and surface water.
	Active ground water remediation at Moab site required for 80 years to meet aquatic standards in the Colorado River.		Active ground water remediation at the Moab site required for 75 years to meet aquatic standards in the Colorado River.			Discharge of ground water would continue to exceed standards for protection of aquatic species in the Colorado River.
			No potential to affect surface water.			

Table 2–32. Summary and Comparison of Impacts (continued)

CATEGORY	ON-SITE DISPOSAL AT THE MOAB SITE	OFF-SITE TRANSPORTATION MODE	OFF-SITE DISPOSAL ALTERNATIVES			NO ACTION ALTERNATIVE
			KLONDIKE FLATS	CRESCENT JUNCTION	WHITE MESA MILL	
FLOODPLAINS AND WETLANDS	100- and 500-year flood events would partially inundate toe of disposal cell, possibly resulting in additional release of contaminants.	See below	Site is not within a floodplain.			100- and 500-year flood events would partially inundate toe of the tailings pile, resulting in additional release of contaminants.
	Wetlands could be contaminated in the long term.		No known wetlands are present.		Wetlands may be affected by construction.	Wetlands could be contaminated for the long term.
	Wetland areas at the Moab site adjacent to the river would be temporarily adversely affected by surface remediation.		Wetland areas at the Moab site adjacent to the river would be temporarily adversely affected by surface remediation.			Wetland areas on site would continue to be affected by surface and ground water contamination.
	Ground water remediation at the Moab site would occur within the 100- and 500-year floodplains for 80 years; surface actions would occur for less time.		Ground water remediation at the Moab site would occur within the 100- and 500-year floodplains for 75 years; surface actions would occur for less time.			No remediation actions would occur within the 100- and 500-year floodplains.
		Truck	No impacts to floodplains or wetlands expected.			
		Rail	No impacts to floodplains or wetlands expected.		N/A	
		Pipeline	No impacts to floodplains or wetlands expected.		Would cross the Colorado River, Matheson Wetlands Preserve, and many intermittent and perennial streams.	

Table 2–32. Summary and Comparison of Impacts (continued)

CATEGORY	ON-SITE DISPOSAL AT THE MOAB SITE	OFF-SITE TRANSPORTATION MODE	OFF-SITE DISPOSAL ALTERNATIVES			NO ACTION ALTERNATIVE
			KLONDIKE FLATS	CRESCENT JUNCTION	WHITE MESA MILL	
AQUATIC ECOLOGY	Potential impact at the Moab site to Colorado River aquatic species eliminated within 5 years after implementation of active ground water remediation.	See below	Potential impact at Moab site to Colorado River aquatic species eliminated within 5 years after implementation of active ground water remediation.			Potential impacts to aquatic species from releases of contaminants would continue for at least the next 100 years.
			No aquatic resources present.			
	Surface remediation at Moab could temporarily disturb up to 8,100 ft of Colorado River shoreline and affect aquatic species.		Surface remediation at the Moab site could temporarily disturb up to 8,100 ft of Colorado River shoreline and affect aquatic species.			
	Potential impact to Colorado River aquatic species from future releases from salt layer beginning in 1,100 years and continuing until 1,540 years from the present.		No potential for future impacts to the Colorado River aquatic species from future releases from salt layer.			Potential impact to the Colorado River aquatic species from future releases from salt layer beginning in 170 years and continuing until 220 years from the present.
	Water withdrawal from the Colorado River would be less than the 100 acre-feet per year deemed by USF&WS to be protective of aquatic species.	Truck	Up to 240 acre-feet of water withdrawn from the Colorado River annually would exceed the 100 acre-foot annual limit established by USF&WS as protective of aquatic species. Impact mitigated by negotiated water depletion payments.			No water withdrawals would occur from the Colorado River
		Rail	Up to 235 acre-feet of water withdrawn from the Colorado River annually would exceed the 100 acre-foot annual limit established by USF&WS as protective of aquatic species. Impact mitigated by negotiated water depletion payments.		N/A	
		Pipeline	Up to 730 acre-feet of water assumed withdrawn from the Colorado River annually would exceed the 100 acre-foot annual limit established by USF&WS as protective of aquatic species. Impact mitigated by negotiated water depletion payments.			

Table 2–32. Summary and Comparison of Impacts (continued)

CATEGORY	ON-SITE DISPOSAL AT THE MOAB SITE	OFF-SITE TRANSPORTATION MODE	OFF-SITE DISPOSAL ALTERNATIVES			NO ACTION ALTERNATIVE
			KLONDIKE FLATS	CRESCENT JUNCTION	WHITE MESA MILL	
TERRESTRIAL ECOLOGY	Surface remediation would cause the temporary loss of existing vegetation and habitat on 50 acres at the Moab site.	See below	Surface remediation would cause the temporary loss of existing vegetation and habitat on 50 acres at the Moab site.			No additional land disturbance.
	Up to 439 acres of short-term disturbance at the Moab site for disposal cell area and site remediation, but vegetation is sparse and provides poor habitat. Up to 6 acres disturbance at vicinity properties. Up to 550 acres disturbance at borrow areas. Up to 995 acres total short-term land disturbance.		Up to 439 acres of short-term disturbance at the Moab site from remediation. Up to 6 acres disturbance at vicinity properties. Up to 690 acres disturbance at borrow areas.			Animal intrusion into the pile could result in acute and/or chronic toxic effects to wildlife.
			Up to 435 acres of short-term disturbance for disposal cell area, but vegetation is sparse and provides poor habitat.		Up to 346 acres of short-term disturbance	
	Revegetation would minimize impact over the longer term.		Revegetation would minimize impact over the longer term.			
	Potential affect to endangered southwestern willow flycatcher and candidate yellow-billed cuckoo.		Potential to affect endangered black-footed ferret and bald eagle, which would be mitigated by avoidance or other measures.		Potential to affect the Gunnison sage grouse, Navajo sedge, Mexican spotted owl, and bald eagle, which would be mitigated by avoidance or other measures.	Federal- or state-listed species could be exposed to contaminants through ingestion of prey and water, incidental soil ingestion, inhalation, and dermal uptake.

Table 2–32. Summary and Comparison of Impacts (continued)

CATEGORY	**ON-SITE DISPOSAL AT THE MOAB SITE**	**OFF-SITE TRANSPORTATION MODE**	**OFF-SITE DISPOSAL ALTERNATIVES**			**NO ACTION ALTERNATIVE**
			KLONDIKE FLATS	**CRESCENT JUNCTION**	**WHITE MESA MILL**	
TERRESTRIAL ECOLOGY (cont.)	Small increase in wildlife fatalities (deer, pronghorn antelope, bighorn sheep).	Truck	Significant increase in traffic would lead to an increase in wildlife fatalities.		Significant increase in traffic would lead to an increase in wildlife fatalities.	No potential to impact wildlife from increased traffic.
	Mexican spotted owl could be affected by increase in traffic noise.				Truck route crosses migration routes for mule deer and critical range for pronghorn antelope and is in Gunnison sage grouse conservation area.	
			Up to 40 acres disturbed for transportation infrastructure Up to 1,610 acres total short-term land disturbance (all areas)	Up to 13 acres disturbed for transportation infrastructure. Up to 1,583 acres total short-term land disturbance (all areas)	Up to 2 acres disturbed for transportation infrastructure. Up to 967 acres total short-term land disturbance (all areas)	
		Rail	Intermittent noise and ground vibration could disturb wildlife.		N/A	
			Up to 69 acres disturbed for transportation infrastructure. Up to 1,624 acres total short-term land disturbance (all areas)	Up to 57 acres disturbed for transportation infrastructure. Up to 1,612 acres total short-term land disturbance (all areas)	N/A	
			Some habitat disturbance, but much is already disturbed.		N/A	

Table 2–32. Summary and Comparison of Impacts (continued)

CATEGORY	ON-SITE DISPOSAL AT THE MOAB SITE	OFF-SITE TRANSPORTATION MODE	OFF-SITE DISPOSAL ALTERNATIVES			NO ACTION ALTERNATIVE
			KLONDIKE FLATS	CRESCENT JUNCTION	WHITE MESA MILL	
TERRESTRIAL ECOLOGY (cont.)		Pipeline	Construction could disturb Mexican spotted owl, white-tailed prairie dog, black-footed ferret, ground-nesting migratory birds.		Construction could disturb Navajo sedge, black-footed ferret, Mexican spotted owl, and southwestern willow flycatcher.	
			Up to 109 acres disturbed for transportation infrastructure. Up to 1,679 acres total short-term land disturbance (all areas)	Up to 175 acres disturbed for transportation infrastructure. Up to 1,745 acres total short-term land disturbance (all areas)	Up to 430 acres disturbed for transportation infrastructure. Up to 1,395 acres total short-term land disturbance (all areas)	
LAND USE	DOE control of the Moab site would continue in perpetuity. 439 acres disturbed on Moab site remain unavailable for other uses in perpetuity.	See below	DOE use of the Moab site would continue for at least 75 years for ground water remediation activities.			Uncontrolled access to the site could result in unacceptable uses.
	Short-term land use disturbance to up to 550 acres at borrow areas.	Truck	Short-term land use disturbance to up to 1,610 acres at Klondike Flats, borrow areas, and for transportation	Short-term land use disturbance to up to 1,583 acres at Crescent Junction, borrow areas, and for transportation	Short-term land use disturbance to up to 967 acres at White Mesa Mill, borrow areas, and for transportation	
			Up to 435 acres of undisturbed BLM rangeland committed to disposal cell unavailable for other uses in perpetuity. Loss of grazing rights, loss of potential oil, gas, and mineral extraction in perpetuity. Permanent access road required for cell inspection and maintenance.		Private land, no potential for impacts to grazing or mineral extraction.	

Table 2–32. Summary and Comparison of Impacts (continued)

CATEGORY	ON-SITE DISPOSAL AT THE MOAB SITE	OFF-SITE TRANSPORTATION MODE	OFF-SITE DISPOSAL ALTERNATIVES			NO ACTION ALTERNATIVE
			KLONDIKE FLATS	CRESCENT JUNCTION	WHITE MESA MILL	
LAND USE (cont.)		Rail	Short-term land use disturbance to up to 1,624 acres at Klondike Flats, borrow areas, and for transportation	Short-term land use disturbance to up to 1,612 acres at Crescent Junction, borrow areas, and for transportation	N/A	
			Up to 420 acres of undisturbed BLM rangeland committed to disposal cell unavailable for other uses in perpetuity. Loss of grazing rights, loss of potential oil, gas, and mineral extraction in perpetuity. Permanent access road required for cell inspection and maintenance.		N/A	
		Pipeline	Short-term land use disturbance to up to 1,679 acres at Klondike Flats, borrow areas, and for transportation	Short-term land use disturbance to up to 1,745 acres at Crescent Junction, borrow areas, and for transportation	Short-term land use disturbance to up to 1,395 acres at White Mesa Mill, borrow areas, and for transportation	
			Up to 435 acres of undisturbed BLM rangeland committed to disposal cell unavailable for other uses in perpetuity.	Up to 420 acres of undisturbed BLM rangeland committed to disposal cell unavailable for other uses in perpetuity.	Up to 346 acres committed for disposal cell within IUC land previously committed to RRM disposal.	
			Permanent access road required for cell inspection and maintenance.			
			Loss of grazing rights, loss of potential oil, gas, and mineral extraction in perpetuity.		Site converts to DOE ownership upon termination of IUC license under all alternatives.	

Table 2–32. Summary and Comparison of Impacts (continued)

CATEGORY	ON-SITE DISPOSAL AT THE MOAB SITE	OFF-SITE TRANSPORTATION MODE	OFF-SITE DISPOSAL ALTERNATIVES			NO ACTION ALTERNATIVE
			KLONDIKE FLATS	CRESCENT JUNCTION	WHITE MESA MILL	
CULTURAL RESOURCES	4 to 11 cultural sites could be adversely affected at Moab site and borrow areas. Potential for traditional cultural properties is low.	See below	15 to 32 cultural sites could be adversely affected at Moab site, Klondike Flats site, and borrow areas. Potential for traditional cultural properties is low to medium.	4 to 11 cultural sites could be adversely affected at Moab site, Crescent Junction site, and borrow areas. Potential for traditional cultural properties is low.	13 to 21 cultural sites and 10 traditional cultural properties could be adversely affected at White Mesa Mill site, Moab site, and borrow areas. Mitigation for effects on traditional cultural properties would be extremely difficult and would involve numerous tribal entities.	No known cultural sites or traditional cultural properties would be disturbed.
		Truck	1 to 4 additional cultural sites could be adversely affected. Potential for traditional cultural properties is low.	1 additional cultural site could be adversely affected. Potential for traditional cultural properties is low.	1 additional cultural site could be adversely affected. Potential for traditional cultural properties is extremely high.	
		Rail	0 to 3 additional cultural sites could be adversely affected. Potential for traditional cultural properties is low.	No additional cultural sites would be adversely affected. Potential for traditional cultural properties is low.	N/A	
		Pipeline	6 to 21 additional cultural sites could be adversely affected. Potential for traditional cultural properties is medium to high.	11 to 25 additional cultural sites could be adversely affected. Potential for traditional cultural properties is low to high.	50 to 100 cultural sites and at least one known traditional cultural property could be adversely affected. Potential for additional traditional cultural properties is extremely high. Mitigation for effects on traditional cultural properties would be extremely difficult and would involve numerous tribal entities.	

Table 2–32. Summary and Comparison of Impacts (continued)

CATEGORY	ON-SITE DISPOSAL AT THE MOAB SITE	OFF-SITE TRANSPORTATION MODE	OFF-SITE DISPOSAL ALTERNATIVES			NO ACTION ALTERNATIVE
			KLONDIKE FLATS	CRESCENT JUNCTION	WHITE MESA MILL	
NOISE AND VIBRATION	Noise generated on the site would not exceed standard of 65 dBA at any receptor locations.	See below	Noise generated would not exceed 65 dBA at any receptor locations.			No additional noise or vibration would be generated.
	Small vibrations from activities at the Moab site or from truck transport could be felt near boundary of Arches National Park.		Small vibrations from activities at the Moab site, from truck or rail transport or from pipeline installation could be felt near boundary of Arches National Park.			
	Vicinity property remediation would cause temporary increase in local noise levels; noise standard could be violated within 820 ft of activity.		Vicinity property remediation would cause temporary increase in local noise levels; noise standard could be violated within 820 ft of activity.			
		Truck	No permanent residences would be affected by increase in traffic noise.	A few permanent residences could be affected by increase in traffic noise.	Residents are likely to be disturbed from tailings trucks passing through Moab, La Sal Junction, Monticello, and Blanding.	
		Rail	No residences would be affected by increase in rail noise.		N/A	
		Pipeline	No residences would be affected by operational noise.			
			Construction noise would cause short-term impacts at entrance to Arches National Park and along route.		Construction noise would cause short-term impacts along route.	
VISUAL RESOURCES	Strong to moderate adverse impacts. Visual contrasts would not be compatible with Class II objectives assigned by BLM to nearby landscapes.	See below	Strong positive impacts at the Moab site.			Moderate adverse impacts. Visual contrasts would not be compatible with Class II objectives assigned by BLM to nearby landscapes.
			Negligible to no adverse impacts.	Weak to strong adverse impacts, depending on viewing location.	Negligible to no adverse impacts.	
		Truck	Negligible to strong adverse impacts, depending on viewing location.	Negligible to moderate adverse impacts.	No adverse impacts.	
		Rail	Strong adverse impacts on Blue Hills Road.	Negligible to moderate adverse impacts.	N/A	
		Pipeline	Moderate adverse impacts to viewers on US-191.			

Table 2–32. Summary and Comparison of Impacts (continued)

CATEGORY	ON-SITE DISPOSAL AT THE MOAB SITE	OFF-SITE TRANSPORTATION MODE	OFF-SITE DISPOSAL ALTERNATIVES			NO ACTION ALTERNATIVE
			KLONDIKE FLATS	CRESCENT JUNCTION	WHITE MESA MILL	
INFRASTRUCTURE AND RESOURCE REQUIREMENTS	600 kVA electricity demand would not exceed local capacity. 4,200 gallons of potable water per day; available from Moab. Up to 70 acre-feet of nonpotable water annually (490 acre-feet total); available from DOE's Colorado River water rights. 10,000 gallons of sanitary waste per week; would not exceed Moab treatment plant capacity. Up to 5 million gallons of diesel fuel.	See below	600–3,400 kVA electricity demand at Moab site would not exceed local capacity. 300–2,500 kVA electricity demand at Klondike Flats site would not exceed local capacity.	600–4,800 kVA electricity demand at Moab site would not exceed local capacity. 300–2,800 kVA electricity demand at Crescent Junction site would not exceed local capacity.	600–6,100 kVA electricity demand at Moab site would not exceed local capacity. 300–3,100 kVA electricity demand at White Mesa Mill site would not exceed local capacity.	No additional requirements for energy, water, or sewage treatment.
		Truck	9,000 gallons of potable water per day available from Moab.		9,000 gallons of potable water per day available from existing deep wells at White Mesa Mill site.	
			Up to 240 acre-feet of nonpotable water annually (775 acre-feet total); available from DOE's Colorado River water rights.		Up to 240 acre-feet of nonpotable water annually (775 acre-feet total); available from DOE's Colorado River and IUC's Recapture Reservoir water rights.	
			21,000 gallons of sanitary waste per week would not exceed Moab treatment plant capacity.		21,000 gallons of sanitary waste per week could be met by IUC site and Blanding treatment plant capacity.	
			Approximately 11.7 million gallons of diesel fuel.	Approximately 13.6 million gallons of diesel fuel.	Approximately 20.2 million gallons of diesel fuel.	

Table 2–32. Summary and Comparison of Impacts (continued)

CATEGORY	ON-SITE DISPOSAL AT THE MOAB SITE	OFF-SITE TRANSPORTATION MODE	OFF-SITE DISPOSAL ALTERNATIVES			NO ACTION ALTERNATIVE
			KLONDIKE FLATS	CRESCENT JUNCTION	WHITE MESA MILL	
INFRASTRUCTURE AND RESOURCE REQUIREMENTS (cont.)		Rail	7,500 gallons of potable water per day available from Moab.		N/A	
			Up to 235 acre-feet of nonpotable water annually (710 acre-feet total); available from DOE's Colorado River water rights.		N/A	
			15,000 gallons of sanitary waste per week would not exceed Moab treatment plant capacity.		N/A	
			Approximately 10.3 million gallons of diesel fuel.	Approximately 10.9 million gallons of diesel fuel.	N/A	
		Pipeline	6,600 gallons of potable water per day available from Moab.		6,600 gallons of potable water per day available from existing deep wells at White Mesa Mill site.	
			Up to 730 acre-feet of nonpotable water annually (3,470 acre-feet total); available from DOE's Colorado River water rights.		Up to 730 acre-feet of nonpotable water annually (3,470 acre-feet total); available from DOE's Colorado River and IUC's Recapture Reservoir water rights.	
			15,400 gallons of sanitary waste per week would not exceed Moab treatment plant capacity.		15,400 gallons of sanitary waste per week could be met by IUC site and Blanding treatment plant capacity.	
			Approximately 9.0 million gallons of diesel fuel.		Approximately 7.3 million gallons of diesel fuel.	
			No booster pump station required.		4,800-kVA demand for pipeline booster pump under pipeline option would require: about 3 miles of new transmission lines for booster pump station and upgrade of existing lines.	

Table 2–32. Summary and Comparison of Impacts (continued)

CATEGORY	ON-SITE DISPOSAL AT THE MOAB SITE	OFF-SITE TRANSPORTATION MODE	OFF-SITE DISPOSAL ALTERNATIVES			NO ACTION ALTERNATIVE
			KLONDIKE FLATS	CRESCENT JUNCTION	WHITE MESA MILL	
WASTE MANAGEMENT	1,040 yd^3 solid waste generated annually during surface remediation; adequate capacity in local landfill.	N/A	1,040 yd^3 solid waste generated annually; adequate capacity in local landfill.		1,040 yd^3 solid waste generated annually; adequate capacity in local landfill or disposal cell.	No additional solid waste would be generated.
	6,600 tons RRM waste generated annually during 80-year Moab site ground water remediation; disposal in licensed facility.		6,600 tons RRM waste generated annually during 75-year Moab site ground water remediation; disposal in licensed facility.			
SOCIOECONOMICS	Increased workforce would tend to cause some crowding-out impacts in hotels, apartments, and campgrounds during 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.	See below	Increased workforce would tend to cause some crowding-out impacts in hotels, apartments, and campgrounds during the peak tourism season, but lower vacancy rates would be expected during the off-season as workers took up temporary accommodation in the principal two-county region of influence.		Because sufficient housing and lodging are available, an increased workforce would not cause crowding-out effects.	There would be no increase in the workforce to affect housing. Potential loss of 3–4 jobs.
	Annual cost: $20.7 million.	Truck	Annual cost: $41.3 million.	Annual cost: $41.7 million.	Annual cost: $52.5 million.	Annual cost: $0.
	Annual output of goods and services: $27.3 million.		Annual output of goods and services: $54.6 million.	Annual output of goods and services: $55 million.	Annual output of goods and services: $69.2 million.	Annual output of goods and services: $0.
	Annual labor earnings: $6.7 million.		Annual labor earnings: $13.4 million.	Annual labor earnings: $13.6 million.	Annual labor earnings: $17.1 million.	Annual labor earnings: $0.
	171 direct and indirect jobs.		391 direct and indirect jobs during surface remediation.	431 direct and indirect jobs during surface remediation.	598 direct and indirect jobs during surface remediation.	No additional jobs.

Table 2–32. Summary and Comparison of Impacts (continued)

CATEGORY	ON-SITE DISPOSAL AT THE MOAB SITE	OFF-SITE TRANSPORTATION MODE	OFF-SITE DISPOSAL ALTERNATIVES			NO ACTION ALTERNATIVE
			KLONDIKE FLATS	CRESCENT JUNCTION	WHITE MESA MILL	
SOCIOECONOMICS (cont.)		Rail	Annual cost: $49 million.	Annual cost: $49.4 million.	N/A	
			Annual output of goods and services: $64.7million.	Annual output of goods and services: $65.1 million.	N/A	
			Annual labor earnings: $15.9 million.	Annual labor earnings: $16.1 million.	N/A	
			315 direct and indirect jobs during surface remediation.	335 direct and indirect jobs during surface remediation.	N/A	
		Pipeline	Annual cost: $49.4 million.	Annual cost: $50.3 million.	Annual cost: $58.2 million.	
			Annual output of goods and services: $65.1 million.	Annual output of goods and services: $66.2 million.	Annual output of goods and services: $76.7 million.	
			Annual labor earnings: $16.1 million (year 1), $15.1 million (years 2–8).	Annual labor earnings: $16.3 million (year 1), $15.1 million (years 2–8).	Annual labor earnings: $18.9 million (year 1), $15.3 million (years 2–8).	
			335 direct and indirect jobs (year 1), 315 (years 2–8).	458 direct and indirect jobs (year 1), 315 (years 2–8).	778 direct and indirect jobs (year 1), 320 (years 2–8).	

Table 2–32. Summary and Comparison of Impacts (continued)

CATEGORY	ON-SITE DISPOSAL AT THE MOAB SITE	OFF-SITE TRANSPORTATION MODE	OFF-SITE DISPOSAL ALTERNATIVES			NO ACTION ALTERNATIVE
			KLONDIKE FLATS	CRESCENT JUNCTION	WHITE MESA MILL	
HUMAN HEALTH	Individual risk at unremediated vicinity properties 1.9 × 10^{-3} latent cancer fatalities (LCF) per year. Individual risk at remediated vicinity properties 6.6 × 10^{-4} LCF per year. Individual risk of 0.029 LCF at vicinity properties over 35 years, pre- and post-remediation.	See below	Individual risk at unremediated vicinity properties 1.9 × 10^{-3} LCF per year. Individual risk at remediated vicinity properties 6.6 × 10^{-4} LCF per year. Individual risk of 0.029 LCF at vicinity properties over 35 years, pre- and post-remediation.			Individual risk at contaminated vicinity properties 1.9 × 10^{-3} LCF per year. Individual risk of 0.067 LCF at vicinity properties over 35 years.
	Before remediation of vicinity properties, population risk of 0.76 LCF per year, or 3.8 LCF over 5 years. Population risk at remediated vicinity properties 0.26 LCF per year. Population risk at remediated vicinity properties 7.8 LCF over 30 years post-remediation period. Population risk of 12 LCF over 35 years, pre- and post-remediation.		Before remediation of vicinity properties, population risk of 0.76 LCF per year, or 3.8 LCF over 5 years. Population risk at remediated vicinity properties 0.26 LCF per year. Population risk at remediated vicinity properties 7.8 LCF over 30 years post-remediation period. Population risk of 12 LCF over 35 years, pre- and post-remediation.			Population risk at contaminated vicinity properties 0.76 LCF per year. Population risk at contaminated vicinity properties 26 LCF over 35-year period.

Table 2–32. Summary and Comparison of Impacts (continued)

CATEGORY	ON-SITE DISPOSAL AT THE MOAB SITE	OFF-SITE TRANSPORTATION MODE	OFF-SITE DISPOSAL ALTERNATIVES			NO ACTION ALTERNATIVE
			KLONDIKE FLATS	CRESCENT JUNCTION	WHITE MESA MILL	
HUMAN HEALTH (cont.)	Population risk 0.080 LCF during operations. Population risk 0.18 LCF over 30 years after operations. Individual risk of 0.026 LCF at vicinity properties over 35 years, during operations and after operations.	Truck	Population risk 1.0 LCF at Moab, and 0.011 LCF at Klondike Flats during operations. Population risk 2.8×10^{-3} LCF over 30 years at Klondike Flats after operations. Population risk of 0.014 LCF at Klondike Flats over 35 years, during operations and after operations.	Population risk 1.0 LCF at Moab, 8.3×10^{-3} LCF at Crescent Junction during operations. Population risk 2.0×10^{-3} LCF over 30 years at Crescent Junction after operations. Population risk of 0.010 LCF at Crescent Junction over 35 years, during operations and after operations.	Population risk 1.0 LCF at Moab, 0.012 LCF at White Mesa Mill during operations. Population risk 3.0×10^{-3} LCF over 30 years at White Mesa Mill after operations. Population risk of 0.015 LCF at White Mesa over 35 years, during operations and after operations.	Population risk 5.2 LCF over 35 years at Moab.
	Maximally exposed individual member of the public 1.2×10^{-3} LCF during operations. Maximally exposed individual member of the public 2.7×10^{-3} LCF over 30 years after operations. Individual risk of 3.9×10^{-3} LCF over 35 years, during operations and after operations.		Maximally exposed individual member of the public 8.8×10^{-3} LCF at Moab, 1.8×10^{-5} LCF at Klondike Flats during operations. Maximally exposed individual member of the public 4.4×10^{-6} LCF over 30 years at Klondike Flats after operations. Individual risk of 2.2×10^{-5} over 35 years at Klondike Flats, during operations and after operations.	Maximally exposed individual member of the public 8.8×10^{-3} LCF at Moab, 7.5×10^{-5} LCF at Crescent Junction during operations. Maximally exposed individual member of the public 1.8×10^{-5} LCF over 30 years at Crescent Junction after operations. Individual risk of 9.4×10^{-5} over 35 years at Crescent Junction, during operations and after operations.	Maximally exposed individual member of the public 8.8×10^{-3} LCF at Moab, 7.8×10^{-6} LCF at White Mesa Mill during operations. Maximally exposed individual member of the public 1.9×10^{-6} LCF over 30 years at White Mesa Mill after operations. Individual risk of 9.7×10^{-6} over 35 years at White Mesa, during operations and after operations.	Maximally exposed individual member of the public 0.048 LCF over 35 years at Moab.

Table 2–32. Summary and Comparison of Impacts (continued)

CATEGORY	ON-SITE DISPOSAL AT THE MOAB SITE	OFF-SITE TRANSPORTATION MODE	OFF-SITE DISPOSAL ALTERNATIVES			NO ACTION ALTERNATIVE
			KLONDIKE FLATS	CRESCENT JUNCTION	WHITE MESA MILL	
HUMAN HEALTH (cont.)	Construction-related fatalities among workers: 0.16 fatality.	Truck (cont.)	Construction-related fatalities among workers: 0.38 fatality.			
	Annual worker risk 0.038 LCF per year.		Annual worker risk 0.18 LCF per year.			
	Total worker risk 0.10 LCF.		Total worker risk: 0.85 LCF.			
	Total transportation fatalities from all sources: 0.084.		Total transportation fatalities from all sources: 0.35.	Total transportation fatalities from all sources: 0.49.	Total transportation fatalities from all sources: 1.4.	
		Rail	Population risk 1.0 LCF at Moab, 0.011 LCF at Klondike Flats during operations. Population risk 2.8×10^{-3} LCF over 30 years at Klondike Flats after operations. Population risk of 0.014 LCF at Klondike Flats over 35 years, during operations and after operations.	Population risk 1.0 LCF at Moab, 8.3×10^{-3} LCF at Crescent Junction during operations. Population risk 2.0×10^{-3} LCF over 30 years at Crescent Junction after operations. Population risk of 0.010 LCF at Crescent Junction over 35 years, during operations and after operations.	N/A	

Table 2–32. Summary and Comparison of Impacts (continued)

CATEGORY	ON-SITE DISPOSAL AT THE MOAB SITE	OFF-SITE TRANSPORTATION MODE	OFF-SITE DISPOSAL ALTERNATIVES			NO ACTION ALTERNATIVE
			KLONDIKE FLATS	CRESCENT JUNCTION	WHITE MESA MILL	
HUMAN HEALTH (cont.)		Rail (cont.)	Maximally exposed individual member of the public 8.8×10^{-3} LCF at Moab. 1.8×10^{-5} LCF at Klondike Flats during operations. Maximally exposed individual member of the public 4.4×10^{-6} LCF over 30 years at Klondike Flats after operations. Individual risk of 2.2×10^{-5} over 35 years at Klondike Flats, during operations and after operations.	Maximally exposed individual member of the public 8.8×10^{-3} LCF at Moab. 7.5×10^{-5} LCF at Crescent Junction during operations. Maximally exposed individual member of the public 1.8×10^{-5} LCF over 30 years at Crescent Junction after operations. Individual risk of 9.4×10^{-5} over 35 years at Crescent Junction, during operations and after operations.	N/A	
			Construction-related fatalities among workers: 0.39 fatality.		N/A	
			Annual worker risk: 0.18 LCF per year.		N/A	
			Total worker risk: 0.85 LCF.		N/A	
			Total transportation fatalities from all sources: 0.23.	Total transportation fatalities from all sources: 0.33.	N/A	

Table 2–32. Summary and Comparison of Impacts (continued)

CATEGORY	ON-SITE DISPOSAL AT THE MOAB SITE	OFF-SITE TRANSPORTATION MODE	OFF-SITE DISPOSAL ALTERNATIVES			NO ACTION ALTERNATIVE
			KLONDIKE FLATS	CRESCENT JUNCTION	WHITE MESA MILL	
HUMAN HEALTH (cont.)		Pipeline	Population risk 0.74 LCF at Moab, 0.011 LCF at Klondike Flats during operations. Population risk 2.8×10^{-3} LCF over 30 years at Klondike Flats after operations. Population risk of 0.014 LCF at Klondike Flats over 35 years, during operations and after operations.	Population risk 0.74 LCF at Moab, 8.3×10^{-3} LCF at Crescent Junction during operations. Population risk 2.0×10^{-3} LCF over 30 years at Crescent Junction after operations. Population risk of 0.010 LCF at Crescent Junction over 35 years, during operations and after operations.	Population risk 0.74 LCF at Moab, 0.012 LCF at White Mesa Mill during operations. Population risk 3.0×10^{-3} LCF over 30 years at White Mesa Mill after operations. Population risk of 0.015 LCF at White Mesa over 35 years, during operations and after operations.	
			Maximally exposed individual member of the public 6.9×10^{-3} LCF at Moab, 1.8×10^{-5} LCF at Klondike Flats during operations. Maximally exposed individual member of the public 4.4×10^{-6} LCF over 30 years at Klondike Flats after operations. Individual risk of 2.2×10^{-5} over 35 years at Klondike Flats, during operations and after operations.	Maximally exposed individual member of the public 6.9×10^{-3} LCF at Moab, 7.5×10^{-5} LCF at Crescent Junction during operations. Maximally exposed individual member of the public 1.8×10^{-5} LCF over 30 years at Crescent Junction after operations. Individual risk of 9.4×10^{-5} over 35 years at Crescent Junction, during operations and after operations.	Maximally exposed individual member of the public 6.9×10^{-3} LCF at Moab, 7.8×10^{-6} LCF at White Mesa Mill during operations. Maximally exposed individual member of the public 1.9×10^{-6} LCF over 30 years at White Mesa Mill after operations. Individual risk of 9.7×10^{-6} over 35 years at White Mesa, during operations and after operations.	

Table 2–32. Summary and Comparison of Impacts (continued)

CATEGORY	ON-SITE DISPOSAL AT THE MOAB SITE	OFF-SITE TRANSPORTATION MODE	OFF-SITE DISPOSAL ALTERNATIVES			NO ACTION ALTERNATIVE
			KLONDIKE FLATS	CRESCENT JUNCTION	WHITE MESA MILL	
HUMAN HEALTH (cont.)		Pipeline (cont.)	Construction-related fatalities among workers: 0.43 fatality.	Construction-related fatalities among workers: 0.47 fatality.	Construction-related fatalities among workers: 0.54 fatality.	
			Annual worker risk: 0.18 LCF per year.			
			Total worker risk: 0.85 LCF.			
			Total transportation fatalities from all sources: 0.086.	Total transportation fatalities from all sources: 0.048.	Total transportation fatalities from all sources: 0.067.	
TRAFFIC						
Estimated maximum increase in Average Annual Daily Traffic (AADT) (all vehicles) on US-191 from shipping contaminated materials.	2% (Vicinity property material)	Truck	29% (Tailings and vicinity property material)		10–29% (Tailings and vicinity property material) (Range reflects different AADT on US-191 segments between Moab and White Mesa Mill)	N/A
Estimated maximum increase in average annual daily truck traffic on US-191 from shipping contaminated materials.	6% (Vicinity property material)		95% (Tailings and vicinity property material)		65–186% (Tailings and vicinity property material) (Range reflects different AADT on US-191 segments between Moab and White Mesa Mill)	

Table 2–32. Summary and Comparison of Impacts (continued)

CATEGORY	ON-SITE DISPOSAL AT THE MOAB SITE	OFF-SITE TRANSPORTATION MODE	OFF-SITE DISPOSAL ALTERNATIVES			NO ACTION ALTERNATIVE
			KLONDIKE FLATS	CRESCENT JUNCTION	WHITE MESA MILL	
Estimated maximum increase in average annual daily truck traffic on US-191 from shipping borrow material (Increase shown for truck transport would also occur for rail and pipeline transport).	10% (All borrow materials)		16% (All borrow materials)	6% (All borrow materials)	5% (Sand, gravel and riprap shipment impacts to US-191 at White Mesa Mill.) 4% (Moab reclamation soil impacts to US 191 north of Moab site)	
Estimated maximum increase in AADT (all vehicles) on US-191 in central Moab from commuting workers (Conservatively assumes all workers commute through central Moab).	1%		3%	4%	5%	
Estimated maximum percent increase in average annual daily truck traffic on US-191 in central Moab from shipments of contaminated materials.	7% (Vicinity property material)		7% (Vicinity property material)		127% (Tailings and vicinity property material)	

Table 2–32. Summary and Comparison of Impacts (continued)

CATEGORY	ON-SITE DISPOSAL AT THE MOAB SITE	OFF-SITE TRANSPORTATION MODE	OFF-SITE DISPOSAL ALTERNATIVES			NO ACTION ALTERNATIVE
			KLONDIKE FLATS	CRESCENT JUNCTION	WHITE MESA MILL	
TRAFFIC (cont.)						
Estimated maximum percent increase in average annual daily truck traffic on US-191 in central Moab from shipments of borrow materials (increase shown for truck transport would also occur for rail and pipeline transport).	2% (Sand, gravel, and riprap)	Truck (cont.)	3% (Sand, gravel, and riprap)		0%	
Estimated maximum increase in AADT (all vehicles) on US-191 from shipping contaminated materials.		Rail	2% (Vicinity property material and oversize tailings debris)		N/A	
Estimated maximum increase in average annual daily truck traffic on US-191 from shipping contaminated materials.			7% (Vicinity property material and oversize tailings debris)		N/A	
Estimated maximum increase in AADT (all vehicles) on US-191 in central Moab from commuting workers (conservatively assumes all workers commute through Moab).			3%		N/A	
Estimated maximum increase in average annual daily truck traffic on US-191 in central Moab from shipments of contaminated materials.			7% (Vicinity property material)		N/A	
Estimated maximum increase in AADT (all vehicles) on US-191 from shipping contaminated materials.		Pipeline	2% (Vicinity property material and oversize tailings debris)			

Table 2–32. Summary and Comparison of Impacts (continued)

CATEGORY	ON-SITE DISPOSAL AT THE MOAB SITE	OFF-SITE TRANSPORTATION MODE	OFF-SITE DISPOSAL ALTERNATIVES			NO ACTION ALTERNATIVE
			KLONDIKE FLATS	CRESCENT JUNCTION	WHITE MESA MILL	
TRAFFIC (cont.)						
Estimated maximum increase in average annual daily truck traffic on US-191 from shipping contaminated materials.		Pipeline (cont.)	7% (Vicinity property material and oversize tailings debris)			
Estimated maximum increase in AADT (all vehicles) on US-191 in central Moab from commuting workers (conservatively assumes all workers commute through Moab).			3%			
Estimated maximum increase in average annual daily truck traffic on US-191 in central Moab from shipments of contaminated materials.			7% (Vicinity property material)		7% (Vicinity property material and oversize tailings debris)	

Table 2–32. Summary and Comparison of Impacts (continued)

CATEGORY	ON-SITE DISPOSAL AT THE MOAB SITE	OFF-SITE TRANSPORTATION MODE	OFF-SITE DISPOSAL ALTERNATIVES			NO ACTION ALTERNATIVE
			KLONDIKE FLATS	CRESCENT JUNCTION	WHITE MESA MILL	
ENVIRONMENTAL JUSTICE	No potential for disproportionately high and adverse impacts to minority or low-income populations.	N/A	No potential for disproportionately high and adverse impacts to minority or low-income populations.		Disproportionately high and adverse impacts to minority and low-income populations would occur under this alternative as a result of unavoidable adverse impacts on potential traditional cultural properties located on and near the White Mesa Mill site, the proposed White Mesa Mill pipeline route, White Mesa Mill borrow area, and Blanding borrow area.	No potential for disproportionately high and adverse impacts to minority or low-income populations.

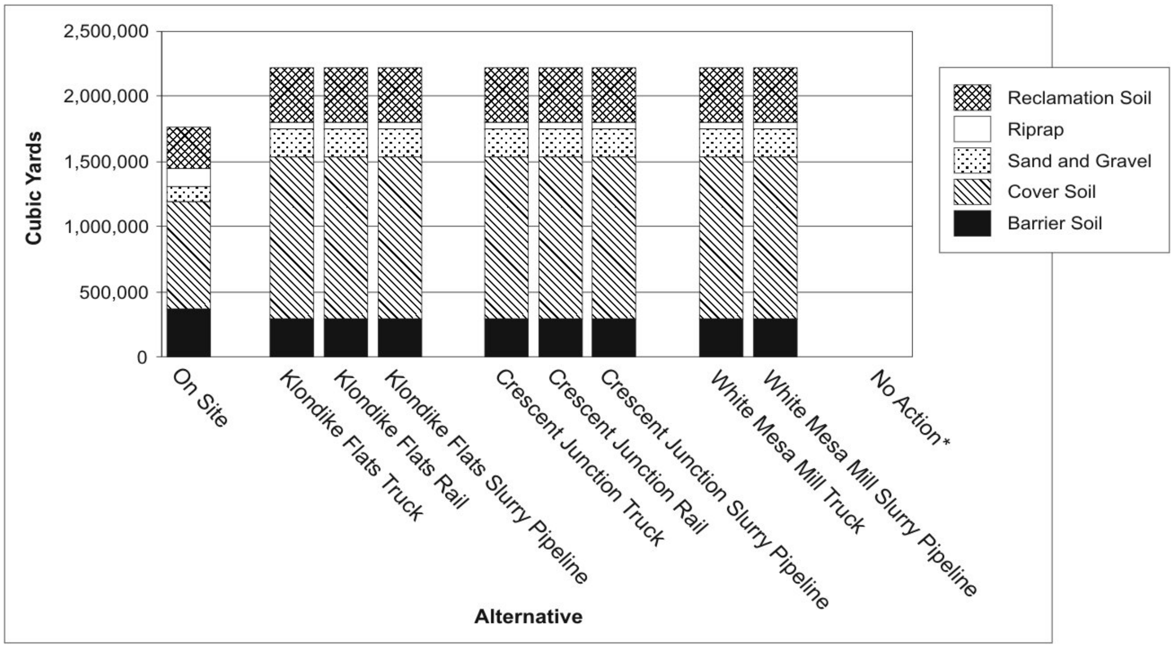
Table 2–32. Summary and Comparison of Impacts (continued)

CATEGORY	ON-SITE DISPOSAL AT THE MOAB SITE	OFF-SITE TRANSPORTATION MODE	OFF-SITE DISPOSAL ALTERNATIVES			NO ACTION ALTERNATIVE
			KLONDIKE FLATS	CRESCENT JUNCTION	WHITE MESA MILL	
ACCIDENT CONDITIONS						
DISPOSAL CELL FAILURE	Some human health risk under the residential scenario.	N/A	Site is not located on a river, does not have historical seismic activity, and is not prone to settling. Site is located away from population centers and sensitive habitats. Possibility of a failure occurring and having adverse consequences is much lower than at the Moab site.			The possibility and consequences of tailings pile failure would be the greatest under this alternative.
	Negative impacts to aquatic receptors from uranium and ammonia concentrations in Colorado River.					Negative impacts to aquatic receptors from uranium and ammonia concentrations in Colorado River.
TRANSPORTATION ACCIDENTS INVOLVING RRM	N/A	Truck	Maximally exposed individual 6.8×10^{-8} LCF, accident probability 0.06 per year.	Maximally exposed individual 6.8×10^{-8} LCF, accident probability 0.1 per year.	Maximally exposed individual 6×10^{-8} LCF, accident probability 0.3 per year.	N/A
			Population risk: 7.9×10^{-7} LCF if in a populated area; 1.2×10^{-9} LCF if in a rural area; accident probability 0.06 per year.	Population risk: 7.9×10^{-7} LCF if in a populated area; 1.2×10^{-9} LCF if in a rural area; accident probability 0.1 per year.	Population risk: 7.9×10^{-7} LCF if in a populated area; 1.2×10^{-9} LCF if in a rural area; accident probability 0.3 per year.	
		Rail	Maximally exposed individual 6.1×10^{-7} LCF, accident probability 0.3 per year.	Maximally exposed individual 6.1×10^{-7} LCF, accident probability 0.5 per year.	N/A	
			Population risk: 7.5×10^{-6} LCF if in a populated area; 1.2×10^{-8} LCF if in a rural area; accident probability 0.3 per year.	Population risk: 7.5×10^{-6} LCF if in a populated area; 1.2×10^{-8} LCF if in a rural area; accident probability 0.5 per year.		

2.6.2 Impacts Affecting Potential Borrow Areas

Although impacts to borrow areas would occur under any of the alternative actions, these impacts are discussed separately in this section 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 subsequent analyses necessary to authorize DOE to use borrow material at BLM-managed borrow areas.

All of 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 2–65). 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 2–65). Further description of impacts at borrow areas is provided in Section 4.5 and Table 4−52.



*Impact would not occur under this alternative.

Figure 2–65. Borrow Material Requirements

2.6.3 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 in 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 have developed between DOE and one or more of its cooperating agencies on issues regarding regulatory or scientific interpretation. 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. Many of the uncertainties have been identified and acknowledged in the EIS. This section delineates the major uncertainties and, to the extent possible, describes the potential consequences of them.

The uncertainties 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 to 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 DOE 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 DOE'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. Consistent with the Council on Environmental Quality requirements for incomplete or unavailable information (40 CFR 1502.22), within this EIS DOE has explicitly identified its assumptions where information may be limited, clearly indicated the methods and models used in its analyses, and evaluated the potential relevance of incomplete or unavailable information to decision-making.

Table 2–33 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.

Table 2–33. 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 assumes that for the on-site and off-site disposal alternatives, a hydraulic conductivity of 1×10^{-8} centimeters per second for the cover can be constructed and maintained for the regulatory period of performance. 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, and the hydraulic conductivity of the cover.	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 2–33. 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 2–33. Consequences of Uncertainty (continued)

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

Table 2–33. 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 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 2–33. 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 could be longer than currently projected. An augmented workforce would exacerbate commuter traffic and socioeconomic and other workforce resource demands. More extensive radiation monitoring and personnel decontamination facilities could be required. It is unlikely that this uncertainty would adversely affect ground water remediation schedules or the projected time for achieving acceptable river water quality.
8.	**Extent of Cultural Resources and Traditional Cultural Properties** The EIS acknowledges uncertainties in the number and density of potentially affected cultural resources and traditional cultural properties. It is possible that detailed surveys or traditional cultural property studies that would be conducted for the preferred alternative identified in the final EIS would identify a significantly richer cultural resource than indicated by existing, less detailed, or adjacent surveys.	Although this uncertainty affects all alternatives to some degree, the consequences would be greatest for the White Mesa Mill alternative, in particular for the White Mesa Mill slurry pipeline option. The likelihood that additional traditional cultural properties (not identified in the final EIS) would be identified after completion of site-specific surveys and studies is extremely high. Results of required cultural resource surveys and traditional cultural property studies might show that the White Mesa alternative could be more costly to implement because of the severity of impacts to newly discovered cultural resources.

Table 2–33. 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 (DOE 2003a) 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 cfs, the NRC-specified 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 2–33. 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 an insignificant impact to the surface water quality and would not require a different scope or magnitude of ground water remediation and therefore would not affect decision-making.
12.	**Future Land Use** Because of uncertainty regarding the success of surface remediation and the possible use of “off-pile” areas of the site to support ground water remediation for 75 to 80 years, DOE has assumed that the entire site would be unavailable for future uses at this time and would be retained for long-term stewardship.	The uncertainty regarding the future use of the Moab site applies to all action alternatives. Decisions on the future use of the Moab site could not be made until surface remediation was complete in 7 to 10 years, and possibly longer, following the issuance of a ROD under either the on-site or off-site disposal alternatives. Such future-use decisions would depend in large part on the success of surface remediation, a condition that cannot be known at this time. In addition, it is possible that continuing ground water remediation activities would make the site unavailable for other uses until such activities were complete in 75 to 80 years. The possible uses of the site in 75 to 80 years when ground water remediation actions would be completed are too speculative to analyze meaningfully at this time. For these reasons, future-use scenarios were not analyzed in the EIS.
13.	**Congressional Appropriations** The schedules and budgets presented in the EIS for all the action alternatives assume that Congress would appropriate the money to complete the actions in the proposed time frames.	If Congress did not appropriate the necessary money, the program would not be implemented, and the impacts described under the No Action alternative would persist. Active ground water remediation (on-site and off-site disposal alternatives) could not be implemented, and Colorado River water would remain unprotected indefinitely. Reduced or incremental appropriations could delay realization of protective river water quality until the active ground water remediation was funded and the ground water contaminant plume was intercepted and contained. If any of the activities under the off-site disposal alternative were implemented and then shut down before completion because of appropriated funds being pulled back, there could be higher human health risks to exposed populations than the EIS estimates because of their more prolonged exposure to radiation from the open Moab pile or the incomplete new disposal cell.

Table 2–33. 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 2–33. 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 2–33. 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 preliminary discussions with UDOT, 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.

2.6.4 Responsible Opposing Views

As a result of input developed in the public comment process and consultations with the 12 cooperating agencies, DOE has identified three general topics on which there exist responsible opposing views to DOE's position regarding the remediation alternatives for the Moab site: river migration, contaminated ground water flow under the river to the Matheson Wetlands Preserve, and the appropriate compliance standard for aquatic species in the river. Sections 2.6.4.1 through 2.6.4.3 summarize the responsible opposing views on these topics, DOE's positions on these topics, and the implications for the alternatives should DOE's views prove to be incorrect.

2.6.4.1 Responsible Opposing Views on River Migration

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

- *USGS Study*. In a recent study (USGS 2005), the USGS used a multidimensional hydrodynamic model to explore the hydraulic conditions of the existing channel geometry and three hypothetical channel scouring geometries under 100-year (97,600 cfs), 500-year (120,000 cfs), and PMF (300,000 cfs) discharge conditions. Water surface elevations, velocity distributions, and shear-stress distributions were predicted for each discharge and each channel geometry. The report states that "...predicted main-channel bed stress values indicate substantial transport of medium-sized gravels for the simulations conducted with the existing channel geometry. Transport of coarse sands was predicted near the tailings for the 100-year discharge, and fine gravel transport was predicted in this region for the PMF discharge." Overbank shear stresses are greatest for the hypothetical 25-ft scour channel geometry. The State of Utah and others have interpreted the results of this study to indicate that substantial potential for erosion of the riverbank adjacent to the tailings pile exists and that this potential poses a sufficient threat and uncertainty to warrant relocation of the tailings to a more geologically stable location.
- *Interpretation of Historical Documents*. Dr. John Dohrenwend questioned DOE's interpretation of the 80-year history documented by historical maps and aerial photographs. A particular concern was that the photographs were not properly registered or interpreted. Dr. Dohrenwend's interpretation was that if the images were properly registered or evaluated, they would show that the Colorado River is not migrating south and east away from the tailings pile, but rather to the north and west, toward the pile. Comment 429 in EIS Volume III, "Comment Responses," presents the complete text of Dr. Dohrenwend's opposing view.
- *Significance of Flows into the River*. Dr. John Dohrenwend raised the issue of the significance of Courthouse Wash and Moab Wash on the movement of the Colorado River. Dr. Dohrenwend and others suggested that flows from Courthouse Wash have deposited sediments on the south side of the Colorado River channel and, therefore, have actively contributed to the northward migration of the river channel, not southward and eastward as indicated in the EIS.

- *Interpretation of Data*. DOE's interpretation of available well log and borehole data was called into question. Dr. John Dohrenwend and the State of Utah interpreted the available data to indicate that the valley fill is not thickest and deepest south of the present location of the river channel, but rather beneath or perhaps as much as several hundred feet north of the present river channel. Therefore, the commentors maintained, there is no reason to suppose that continuing subsidence of the valley floor would cause the river channel to migrate away from the tailings pile. The opposing interpretation is that if the thickest and deepest valley fill deposits mark the position of maximum valley subsidence, there would instead be strong reason to suppose that continuing subsidence could cause the river to move closer to the pile.

  Dr. Dohrenwend also challenged DOE's interpretation of available subsurface data. He interpreted these data to show that conditions directly beneath the tailings pile are much more complex than presented in the EIS. The opposing interpretation is that the data indicate localized subsidence of the valley floor and that the subsidence must be considered as a possible and potentially serious geologic hazard. Moreover, a comparison of surface and subsurface data along the northern margin of Moab Valley between Courthouse Wash and the millsite suggests the possibility that localized subsidence or extremely deep channel scour has occurred in this area sometime during the past 45,000 years.
- *Dissolution of Salt Layers*. Dr. John Dohrenwend raised the issue of the dissolution of the salt layers (Paradox Formation) beneath Moab Valley. Dr. Dohrenwend maintains that dissolution of the salt layers is causing slow subsidence of the alluvial fill within the valley. In his interpretation, the Colorado River and its local tributaries deliver far more sediment to the valley floor than could ever be accommodated by the valley's slow subsidence. Therefore, ongoing deposition by the Colorado River and by Mill Creek and Pack Creek are the principal processes controlling the surficial geology and geomorphology of Moab Valley.

Commentors agreed with the EIS characterization that the geometry and position of ancient Colorado River gravels buried beneath the surface of Moab Valley clearly show that the Colorado River has shifted back and forth across the mill and tailings site in the recent geologic past. However, they interpret these data to mean that the river is therefore likely to traverse the site again in the near future.

The issue of recent flooding in the St. George and Santa Clara regions of Utah was also presented. The commentors interpreted these recent flood events on other drainages in Utah as demonstrations of the swift and immense force of floodwater in the desert. Some commentors have indicated that the unanticipated results of these occurrences demonstrate mankind's inability to adequately predict or engineer and plan for such impacts and that this potential poses a sufficient threat and uncertainty to warrant relocation of the tailings to a more geologically stable location.

In summary, commentors suggested that scientific evidence exists indicating flaws in DOE's interpretation concerning the suitability of the Moab millsite for the long-term disposal of the uranium mill tailings and associated waste. They maintain that the Colorado River channel has migrated both toward and away from the Moab millsite in the past 80 years and that it could do so in the future. The overall concern expressed by commentors is that the EIS has mischaracterized the available data and that the dynamic and often unpredictable nature of the river system and the inevitable migration of the river toward the site over geologic time make on-site disposal an inappropriate alternative. Their view is that under this alternative the potential impacts of river migration would pose unacceptable risks to a multitude of local and downstream users, as well as the ecological receptors of the Colorado River corridor.

DOE's Position on River Migration

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

- Historical evidence of river migration (e.g., aerial photographs, historical topographic and property survey maps) indicates that the river has remained stable to moderately stable for the last 120 years, suggesting that catastrophic rapid channel migration is unlikely and indicating that all floods have dissipated by overflow into the Matheson Wetlands Preserve. Significant movement of the right bank (tailings side) has not occurred in the historical time frame.

- Sediment input from Courthouse Wash and Moab Wash has created an alluvial fan upon which the tailings impoundment is constructed. Both washes have delivered significant quantities of sediment in the past and will continue to do so into the future unless profound changes occur in the watersheds. Sediment deposition has pushed the river channel south into Moab Valley.

- The current location of the Colorado River is approximately 1,100 ft south of the terrace formed at the confluence of Courthouse Wash and the Colorado River, suggesting that the river has moved south since the time the terrace gravels were deposited. Geologic mapping by the Utah Geologic Survey has dated this terrace as late Pleistocene, and this date is supported by correlation of soil profiles. The terrace age provides an indication of the length of time in the past the river channel was at that location and was flowing with a velocity high enough to transport and erode gravels. This finding indicates that the right riverbank has been stable for the last 30,000 years.

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

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

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

Implications of Opposing Views on River Migration

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

The impacts to public health and the environment, should the river migrate toward the disposal cell catastrophically, is addressed in Section 4.1.17 of the EIS.

2.6.4.2 Responsible Opposing Views on Contaminant Flow Under the River

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

Values of equivalent freshwater head (EFH) were calculated by Gardner and Solomon (2003) at nine wells screened in brine at a common elevation of 3,904 ft above mean sea level. The calculations were performed using measured water levels at the wells and estimated TDS concentrations in the well columns at the common elevation. The resulting EFH values were plotted on a map of the area and contoured using a 1.6-ft contour interval. Contours of equal potential indicated ground water movement to the south-southeast; Gardner and Solomon infer that ground water on the project side of the river has the capacity to flow under the river toward the Matheson Wetlands Preserve. They also concluded that the sub-riverbed flow occurs within highly permeable basin fill consisting of very coarse sands and gravels, which are commonly observed on both sides of the river at a depth of about 16 to 23 ft below ground surface.

A map of posted uranium concentrations in ground water at five wells on the project side of the river and 14 wells southeast of the river (Gardner and Solomon 2003) suggested that uranium concentrations in wells along the river's east bank and in and near the Matheson Wetlands Preserve were derived from contaminated ground water on the Moab site. The explanation given for this connection was that ground water flows below the riverbed from the project site to the wetlands area in the very coarse basin fill sediments found in both areas. The study presented two cross-sections showing measured uranium levels in selected monitor wells on either side of the river as support for the possible transport of uranium from one area to the other.

Two cross-sections by Gardner and Solomon (2003) containing measured oxygen isotope ($\delta^{18}O$) ratios did not conform to DOE's conceptual model of ground water flow at the Colorado River, which hypothesizes that the river itself or an area close to its east bank acts as a ground water divide. Such a divide would likely result in more negative $\delta^{18}O$ ratios (compared to standard mean ocean water ratios) with depth in the ground water system near the river. However, Gardner and Solomon pointed out that less negative $\delta^{18}O$ ratios are observed below more negative ratios just to the southeast of the river. From this observation, the authors concluded that ground water from the project site with less negative $\delta^{18}O$ ratios migrates to deeper ground water below the Matheson Wetlands Preserve.

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

DOE's Position on Contaminant Flow Under the River

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

The unique salinity conditions observed in ground water in the study area are attributed to the river's natural tendency to act as a site of regional discharge. Very saline water to brine is observed on both banks of the river at about the elevation of the riverbed. DOE views this phenomenon as a form of saltwater upconing that is similar to the upconing that would occur below a well that withdraws relatively fresh ground water above a saline zone. A natural source for the brine in the Moab study area is the dissolution of evaporite sediments that make up the Paradox Formation, which appears to subcrop hundreds of feet below the riverbed.

Information supporting this conceptual model includes flow potential data on both sides of and near the river. A significant upward component of flow was observed in these types of data collected at the project site for the SOWP (DOE 2003b). Steep upward gradients are also indicated in the data collected from three deep boreholes drilled just east of the river for the Gardner and Solomon (2003) study. From prominent studies of regional ground water flow over brine sources, it can be deduced that such upward gradients are expected in the vicinity of a site of ground water discharge. These studies also demonstrate that ground water velocities in the brine are very small and explain how relatively fast-moving fresh water above the brine moves mostly laterally to the site of discharge (e.g., a river). In effect, the brine at the discharge site acts as a barrier to ground water flow, thus limiting flow from one of its sides to the other. In a similar manner, DOE's conceptual model of ground water flow envisions shallow water converging toward the Colorado River from both the northwest and southeast and postulates that brine does not flow below the river from one side to the other.

From the available data and corresponding flow assessments, DOE concludes that ground water contamination does not migrate under the river from the project site to the Matheson Wetlands Preserve. The occurrence of ammonia (as nitrogen) concentrations in the 3- to 5-mg/L range measured just to the southeast of the river can be explained by the natural upconing of briny water in the vicinity of the river, not the result of sub-riverbed flow. Accordingly, DOE believes that the project site poses no potential human health risk on the east side of the river and that the site does not affect ecological receptors east of the river.

A review of measured ammonia concentrations in wells located close to the river but on its east side indicates that these ammonia levels have a high probability of being naturally caused. Ammonia levels in wells screened within uncontaminated brine near the river are typically in the 3- to 4.5-mg/L range, which is the same range observed in ground water on the river's east side. In addition, oil and gas wells drilled into the Paradox Formation in the vicinity of Moab Valley have encountered brine with ammonia concentrations as high as 1,330 mg/L.

Implications of Opposing Views on Contaminant Flow Under the River

If significant contaminant mass has flowed and continues to flow beneath the river eastward toward the Matheson Wetlands Preserve, contaminant concentrations would increase in the ground water in these areas. The existing concentrations of ammonia, uranium, sulfate, and chloride on the east side of the river are all within the range of natural background. It is not clear that future contaminant migration to the east side of the river would cause a significant health risk to the public or the environment. Because of the naturally high concentrations of TDS, chloride, and sulfate in all but the shallowest waters on the east side of the river (TDS below 3 to 14 feet is between 40,000 and 124,000 mg/L), the incremental addition of contaminants from the Moab site would not reasonably result in a significant increase in risk to receptors, given the poor ambient water quality and lack of exposure pathway. However, in the extreme case, additional ground water remedial action could be required to address the deeper contamination on both sides of the river. This could involve installing additional ground water monitor and extraction wells and implementing additional ground water treatment capabilities for many decades. Should this be required, implementation of these measures could cause (1) additional temporary surface disturbance on the tailings side and on the east side of the river within the floodplain, (2) additional water treatment waste generation for decades, and (3) the consumption of additional utilities. Consumption of water in the treatment process may have depletion impacts on recharge to the river commensurate with the extraction and treatment requirements of the system.

However, the current water quality of all but the upper few feet of the several-hundred-foot-thick aquifer on the east side of the river, like that on the west (tailings) side of the river, is an order of magnitude worse than any potential use criteria (more than 80,000 mg/L TDS—more than twice the salinity of sea water). Due to the naturally high salinity of the ground water on the east side of the river it is not used for drinking water, irrigation, or livestock watering. Therefore, there is no limited use of the aquifer on the east side of the river.

2.6.4.3 Responsible Opposing Views on the Appropriate Compliance Standard

The State of Utah and others presented opposing views regarding DOE's target cleanup goal for ground water of 3 mg/L ammonia (as nitrogen). The opposing view is that the ground water cleanup goal for ammonia should be the chronic AWQC for ammonia rather than the acute standard. These criteria vary depending on pH and temperature, but a value of 0.6 mg/L was shown in the SOWP (DOE 2003b) to be applicable for the vast majority of surface water conditions. The commentors maintain that the 0.6-mg/L ammonia goal must be met in ground water to ensure that it can also be met in quiet backwater areas that serve as endangered fish habitat. Their interpretation disagrees with DOE's interpretation that ground water discharging to the surface will undergo dilution by a factor of 10 or more. The high standard deviation associated with the average dilution factor is cited as evidence that there is no statistical basis for DOE's assumed dilution factor. Their view contends that DOE's analysis was based on data collected for purposes other than estimation of a dilution factor and that a much more rigorous sampling is required before a defensible dilution factor can be established. Commentors further argued that unless DOE better understands the geochemical behavior of ammonia as it is transferred from ground water to surface water, DOE has no choice but to apply the 0.6-mg/L criterion as a conservative interim cleanup goal.

Finally, the State of Utah questions DOE's conclusion that only 80 years of active ground water remediation would be required to meet remediation goals. This view is predicated on doubts that DOE's application of a 3-mg/L ammonia cleanup goal would be protective because of dilution of ground water as it discharges to the surface. The opposing view indicates that at least 200 years would be required to achieve the 0.6-mg/L level based on DOE's contaminant transport model. Also, the State of Utah maintains that the State can enforce the appropriate protective criteria in ground water.

DOE's Position on the Appropriate Compliance Standard

DOE has established the target cleanup goal for ammonia in ground water based on the national AWQC, considerable study of ground water and surface water data, and direct consultation with the USF&WS. These data were collected expressly to determine the validity of the conceptual site model presented in the SOWP and to better understand ground water-surface water interactions and the effect of discharge of ground water to the Colorado River. Results of these evaluations were presented in the SOWP (DOE 2003b), the *Fall 2004 Performance Assessment of the Ground Water Interim Action Well Fields* (DOE 2005a), the *Ground Water/Surface Water Interaction for the Moab, Utah, Site* (DOE 2005b), and the *Performance of the Ground Water Interim Action Injection System at the Configuration 2 Well Field* (DOE 2005c). Also, the USF&WS has since prepared a Biological Opinion, which concurs that the target cleanup goal for ammonia in ground water is reasonable. In its Biological Opinion, the USF&WS indicates that additional studies are required as a reasonable and prudent measure to increase confidence for this target goal.

Specifically, DOE's use of the 3.0-mg/L acute ammonia-nitrogen standard as a ground water cleanup goal is based on the national AWQC. The acute criterion is a function of water pH, and the chronic criterion is a function of water temperature and pH. The national criteria documentation does not recommend using an average temperature and pH to calculate a single applicable value for the standards, but rather a range of standards that may apply under observed pH and temperature conditions. Chronic aquatic criteria represent the low end of the potential concentration range for protection of aquatic species from ammonia toxicity. The majority of chronic values measured in the surface water at the Moab site range from 0.6 to 1.2 mg/L ammonia (total as N) based on site-specific pH conditions. Acute criteria represent the higher end of the concentration range; the majority of acute values measured in the surface water range from 3 to 6 mg/L based on site-specific temperature and pH conditions. Therefore, it is DOE's position that ammonia concentrations (total as N) in surface water in the 0.6- to 6-mg/L range would be fully protective of aquatic life.

As discussed in Section 2.3.1.2, if ammonia concentrations in the ground water met the surface water standards, then discharge of ground water to the surface should not result in exceedances of those standards unless some other process (e.g., evaporation) increased contaminant concentrations in surface water. However, establishing the lowest end of the protective range as the ground water cleanup goal is not considered necessary to achieve compliance with surface water standards. Available data regarding interaction of ground water and surface water indicate that concentrations of constituents generally decrease significantly as ground water discharges to and mixes with surface water (at least a 10-fold decrease was noted [DOE 2003b, Section 5.6.6]). In general, more recent data collected by DOE since the SOWP confirm, with a few exceptions, that a 10-fold dilution factor occurs where the ground water plume is discharging adjacent to the river shoreline. In background locations where elevated ammonia from the Paradox Formation is discharging to the surface water, the 10-fold dilution factor may not apply. This more recent calculation set, *Ground Water/Surface Water Interaction for the Moab, Utah, Site* (DOE 2005b), also provides a more detailed evaluation of the transfer mechanism between ground water and backwater areas.

Implications of Opposing Views on the Appropriate Compliance Standard

If the State’s view prevailed, the proposed action for ground water remediation would change only in the duration for which the system would be operated. It is expected that the proposed ground water action would mitigate all impacts to the river within 10 years of implementation and would be operated for 75 years to meet the 3-mg/L ammonia target cleanup goal. Should the target cleanup goal be 0.6 mg/L, the proposed ground water action may need to be operated for at least 200 years. If this were the case, a commensurate increase in annual operation and maintenance costs, generated wastes, and water resource impacts would result for the additional period of operation. Although DOE would commit to completing its cleanup responsibilities in this case, DOE cannot now reasonably assure continued maintenance of active ground water remediation for a time period of 200 years or more. Section 2.6.3 discusses the uncertainty regarding achieving these cleanup goals.

2.7 Other Decision-Making Factors

2.7.1 Areas of Controversy

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

One area of controversy involves the ground water remediation standard to be applied. Based on its calculations, DOE has concluded that protection for aquatic species would be achieved at total ammonia concentrations in surface water of 3 mg/L (acute criteria) and 0.6 mg/L (chronic criteria that assumes dilution within a mixing zone). The USF&WS agrees with DOE that the target goal of 3 mg/L (acute criteria) in ground water that DOE has selected would be protective of aquatic species in the Colorado River.

However, UDEQ disagrees with DOE's selection of the acute standard and has stated that the chronic standard (0.6 mg/L) should be applied to ground water. The consequences of the State's position could lengthen the duration of ground water remediation and are discussed in more detail in Section 2.6.3, "Consequences of Uncertainty," and Section 2.6.4, "Responsible Opposing Views."

There are also some areas of technical disagreement regarding long-term site risks. These risks are associated with uncertainties in processes potentially occurring over hundreds or thousands of years that are not amenable to short-term resolution. For example, professional differences of opinion with the State of Utah on river migration and transport of contaminants under the Colorado River to the Matheson Wetlands Preserve can be resolved with certainty only through long-term monitoring. The potential consequences of these differing opinions with regard to environmental impacts are discussed in Sections 2.6.3 and 2.6.4. 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 on 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.

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.

2.7.2 National Academy of Sciences Review

The Floyd D. Spence Act required that a remediation plan be prepared to evaluate the costs, benefits, and risks associated with various remediation alternatives, including “removal or treatment of radioactive or other hazardous materials at the site, ground water restoration, and long-term management of residual contaminants.” The Act further stipulated that the draft plan be presented to NAS for review. NAS was directed to provide “technical advice, assistance, and recommendations” for remediation of the Moab site. Under the Act, the Secretary of Energy is required to consider NAS comments before making a final recommendation on the remedy. If the Secretary prepares a remediation plan that is not consistent with the recommendations of the NAS, the Secretary must submit to Congress a report explaining the reasons for deviating from the NAS recommendations.

The *Preliminary Plan for Remediation* (DOE 2001b) was completed in October 2001 and forwarded to NAS. The National Research Council, the chief operating arm of NAS, formed a committee of expert volunteers to review the draft plan and provide technical advice and recommendations for a remedy at the Moab site. The committee held a fact-gathering meeting in Moab on January 14–15, 2002; this meeting included a session for public input. The committee completed its report on June 11, 2002, and conducted a public meeting in Moab and released the report on the same date.

The NAS report concluded that existing scientific and technical data were insufficient to support a decision. Specifically, the committee provided four principal reasons for not selecting a remedial action alternative at the time the report was issued.

The first reason stated that “The pile, the Moab site, and alternative sites for a relocated disposal cell have not been characterized adequately.” Since preparation of the *Preliminary Plan for Remediation*, additional characterization of the tailings pile and the Moab site, which was not available at the time of the NAS review, has been completed and is presented in the SOWP (DOE 2003b). In addition, numerous other reports have been acquired or generated by DOE that are cited as references throughout this EIS and that provide sufficient characterization of the three off-site alternatives to support the analyses in this EIS and future DOE decision-making.

The second reason stated that “Options for implementing the two primary remediation alternatives have not all been identified or sufficiently well defined.” More detailed and complete options for implementing the two primary remediation alternatives, stabilize-in-place or off-site disposal, have been identified and defined in the EIS. For example, three off-site alternatives have been added to the scope of this EIS where, in contrast, the *Preliminary Plan for Remediation* only considered one off-site alternative in any detail. Pre-conceptual facilities configurations, transportation scenarios, and labor and resource requirements have all been defined and presented to support comparative impacts analysis. DOE is confident that the configuration and definition of all the alternatives is much more robust that originally presented in the *Preliminary Plan for Remediation* and sufficient to support sound decision-making. For this reason, the final EIS also serves as the final PFR.

The third reason stated that "Risks, costs, and benefits of the major alternatives have not been adequately characterized and estimated." Human and ecological risks, long- and short-term environmental impacts, costs, and benefits of the major alternatives, which were not completely developed in the *Preliminary Plan for Remediation*, have been fully developed and evaluated in the EIS. These include assessment of potential impacts of catastrophic failure of the disposal cell for the on-site stabilization alternative should DOE's conclusions regarding river migration prove to be incorrect.

The fourth reason stated that "Long-term management implications for each option have not been described." The scope and costs of the long-term stewardship requirements associated with each option have been more fully developed and evaluated in the EIS. Included in this evaluation are the long-term ground water remedial action costs and long-term stewardship costs for annual surveillance and maintenance. The impacts of catastrophic failure should long-term surveillance and engineering controls fail are also included in the EIS to support informed decision-making.

NAS also advised that decisions involving risk management should involve stakeholders from the earliest phases of defining the problem through the final decision. NAS noted that involving the public has particular value at Moab because of the anticipated long duration of the cleanup. To date, DOE's efforts toward public involvement have included public scoping meetings, periodic project update public briefings, publication of project documents on a project website, and presentations to city council meetings. DOE has also included federal and state agencies along with cities, towns, counties, and tribes as cooperating agencies in the development of the EIS through briefings, data submittals to cooperating agencies, and reviews of preliminary drafts. Section 1.6 presents a discussion of these activities and the differing opinions expressed by the cooperating agencies.

In addition, the National Research Council committee recommended further study and evaluation of a wide range of technical areas before DOE makes decisions on the remediation of the Moab site. Table 2–34 presents a summary of these recommendations. NAS did not provide a recommendation on a disposal alternative. Since the issuance of the NAS report, DOE has integrated the NAS recommendations for further study into ongoing site investigations and has used this new knowledge in the analyses performed for this EIS.

NAS has confirmed that its role in the Moab project ended with the issuance of its report, that NAS met its responsibilities under the Act, and that unless directed by Congress, NAS will not be reviewing the EIS (NAS 2004). DOE has considered NAS findings and recommendations in developing this EIS. Specifically, Table 2–34 lists key NAS recommendations, DOE's proposed resolution to findings and recommendations, and the chapter and section of the EIS in which they are addressed.

Table 2–34. Key NAS Recommendations for Assessing Remedial Action Alternatives for the Moab Site

Recommendation	Proposed Resolution	EIS Chapter/Section
Use bounding analysis to frame the major issues.	Incorporate bounding analysis throughout the EIS.	All sections
Evaluate the impacts of a potential failure of the tailings pile.	Include an evaluation of catastrophic failure of a disposal cell at the Moab site.	Chapter 4.0, Section 4.1.17, "Disposal Cell Failure from Natural Phenomena"
Rely on the experience gained from previous DOE projects and the UMTRA Project.	Use overall experience and lessons learned from DOE's uranium mill tailings cleanup programs, especially construction of uranium mill tailings disposal cells, annual inspections of disposal cells, and cleanup of UMTRA Project vicinity properties.	Chapter 2.0, Sections 2.1.1, "Construction and Operations at the Moab Site," 2.1.2, "Characterization and Remediation of Vicinity Properties," 2.1.5, "Resource Requirements"; Chapter 4.0, sections titled "Construction and Operations Impacts at the Moab Site," "Impacts from Characterization and Remediation of Vicinity Properties," "Monitoring and Maintenance Impacts"; and Appendix B, "Assumed Disposal Cell Cover Conceptual Design and Construction."
Improve the understanding of the potential performance of the disposal cell.	Conduct a more detailed evaluation of physical conditions at the proposed disposal sites with respect to geology, soils, climate and meteorology, ground water, and surface water; design a disposal cell that would perform satisfactorily under worst-case conditions at the proposed sites.	Chapter 3.0, Geology—Sections 3.1.1, 3.2.1, 3.3.1, 3.4.1; Soils—Sections 3.1.2, 3.2.2, 3.3.2, 3.4.2; Climate and Meteorology—Sections 3.1.5, 3.2.3, 3.3.4, 3.4.4; Ground Water—Sections 3.1.6, 3.2.4, 3.3.5, 3.4.5; Surface Water—Sections 3.1.7, 3.2.5, 3.3.6, 3.4.6; Appendix B, "Assumed Disposal Cell Cover Conceptual Design and Construction."
Evaluate impacts from institutional controls, including failure.	Evaluate institutional controls with respect to risk to workers and members of the public exposed to contaminants at the proposed disposal sites.	Chapter 4.0, "Human Health"—Sections 4.1.15, 4.2.15, 4.3.15, 4.4.15, 4.1.17, "Disposal Cell Failure from Natural Phenomena"; Appendix D, "Human Health."
Refine the initial cost estimates for the major alternatives.	Provide more detailed cost estimates in 2003 dollars.	Chapter 2.0, Section 2.7.3, "Costs"; Chapter 4.0, "Socioeconomics"—Sections 4.1.14, 4.2.14, 4.3.14, 4.4.14.
Examine the effectiveness of long-term management.	Prepare a risk assessment to evaluate several aspects of the two major alternatives—cap in place and off-site disposal.	Chapter 4.0, "Human Health"—Sections 4.1.15, 4.2.15, 4.3.15, 4.4.15, 4.1.17, "Disposal Cell Failure from Natural Phenomena"; Appendix D, "Human Health."

2.7.3 Costs

To support future decision-making, DOE has estimated the costs of the alternatives analyzed in the EIS (Table 2–35). The estimates, which are in 2003 dollars, include the total costs for surface remediation, ground water remediation, and long-term surveillance and monitoring of the disposal cell. The estimates assume that ground water remediation and long-term surveillance and monitoring would continue for 80 years under the on-site disposal alternative and for 75 years under the off-site disposal alternative, although DOE acknowledges that up to $35,000 in annual costs for disposal cell surveillance and monitoring could continue in perpetuity. The estimates assume implementation of a single work shift schedule; however, the estimates would be essentially the same if a double work shift were implemented because a double shift would not involve overtime costs, but only a compressed schedule for completing the same work. The cost estimate accuracy, as defined by ANSI and the Association for the Advancement of Cost Engineering, is a budget estimate and is expected to fall within the range of –15 percent to +30 percent. However, DOE acknowledges that additional uncertainties, such as land acquisition and impact mitigation costs, are inherent in these estimates. Since the draft EIS, DOE has refined the cost estimates for the Crescent Junction rail alternative. The expected value (mid-range) is now $578 million.

Table 2–35. Estimated Lifetime Cost of Analyzed Disposal Alternatives (in millions of dollars)

Remedial Action Component	Stabilize In Place	Klondike Flats			Crescent Junction			White Mesa	
		Truck	**Rail**	**Pipeline**	**Truck**	**Rail**	**Pipeline**	**Truck**	**Pipeline**
Site Characterization	$1.6	$1.6	$1.6	$1.6	$1.6	$1.6	$1.6	$1.6	$1.6
Env. Health & Safety/NEPA	$6.4	$16.8	$17.1	$9.7	$16.8	$17.1	$9.7	$16.8	$5.7
Remedial Action Design	$2.0	$2.0	$2.0	$4.8	$2.0	$2.0	$6.0	$2.0	$7.1
Site Acquisition	NA	NA	NA	NA	NA	NA	NA	NA	NA
Remedial Action Field Management	$9.9	$9.6	$9.6	$9.6	$9.6	$9.6	$9.6	$9.6	$6.6
Site Preparation	$1.7	$35.2	$40.4	$76.2	$31.8	$40.9	$86.3	$31.5	$103.0
Tailings Handling	$4.7	$110.6	$158.1	$131.8	$126.1	$169.6	$133.8	$198.9	$171.0
Cover Material	$41.0	$38.9	$38.9	$38.9	$30.3	$30.3	$30.3	$29.9	$28.2
Erosion Protection	$6.0	$4.1	$4.1	$4.1	$4.3	$4.3	$4.3	$3.4	$3.5
Site Restoration	$7.4	$6.0	$7.0	$7.1	$5.7	$6.7	$8.5	$12.6	$17.0
All Other Construction Costs[a]	$48.8	$54.6	$56.7	$54.7	$54.6	$56.7	$54.7	$54.9	$59.0
Surveillance & Maintenance (Including Ground Water O&M)	$75.3	$69.9	$69.9	$69.9	$69.9	$69.9	$69.9	$69.9	$69.9
Subtotal	**$204.7**	**$349.4**	**$405.3**	**$408.4**	**$352.7**	**$408.6**	**$414.6**	**$431.1**	**$472.6**
Vicinity Property Design	$1.0	$1.0	$1.0	$1.0	$1.0	$1.0	$1.0	$1.0	$1.0
Vicinity Property Construction	$9.2	$9.2	$9.2	$9.2	$9.2	$9.2	$9.2	$9.2	$9.2
Technical Assistance Contract Project Management	$11.3	$10.6	$10.6	$10.6	$10.6	$10.6	$10.6	$10.6	$10.6
Total	**$226.1**	**$370.2**	**$426.1**	**$429.2**	**$373.5**	**$429.4**	**$435.4**	**$451.9**	**$493.4**
Contingency @ 10%	$22.6	$37.0	$42.6	$42.9	$37.3	$42.9	$43.5	$45.2	$49.3
Grand Total[b]	**$248.8**	**$407.2**	**$468.7**	**$472.1**	**$410.8**	**$472.3**[c]	**$479.0**	**$497.1**	**$542.7**

[a] Costs include other pre-remediation and remediation expenditures for surface actions as well as ground water characterization, design, and initial construction not normally included with UMTRCA surface remediation.

[b] Costs do not include pre-ROD activities (e.g., EIS, pre-ROD site maintenance, and interim actions).

[c] Most recent estimate (post-draft EIS) is $578 million (mid range-expected value).

2.7.3.1 On-Site Versus Off-Site Disposal Alternative Comparison

Depending on the off-site disposal cell location and mode of transportation, off-site disposal would cost approximately 63 to 118 percent more than on-site disposal. In absolute terms, off-site disposal would cost approximately $158 million to $294 million more than on-site disposal, depending on the off-site disposal location and mode of transportation.

2.7.3.2 Off-Site Transportation Options Comparison

Among the three transportation options, truck haul would be the least expensive and slurry pipeline the most expensive. The cost difference between rail and slurry pipeline would be less than 2 percent. Truck transportation would cost approximately 10 to 15 percent less than either rail or slurry pipeline.

2.7.3.3 Off-Site Disposal Cell Locations Comparison

The costs for off-site disposal at the Klondike Flats and Crescent Junction sites would be comparable, differing less than 2 percent regardless of the mode of transportation. Consistent with this, the estimates indicate that transport distance is not a key factor in cost for the off-site disposal alternatives. The approximate ratio of the distances of the Klondike Flats, Crescent Junction, and White Mesa Mill sites from the Moab site is 1:1.7:4.7. However, despite the almost 5 times longer distance to White Mesa Mill, truck transportation would cost only 22 percent more for the White Mesa Mill site than for the Klondike Flats site, and slurry transportation would cost only 15 percent more. Nonetheless, the absolute increase in cost under the White Mesa Mill off-site disposal alternative would be substantial. Compared to the cost to ship to the Klondike Flats site, shipping to the White Mesa Mill site would cost $90 million more for truck transport and $71 million more for pipeline transport. In contrast, the absolute increase in cost for the Crescent Junction site over the Klondike Flats site would be only about $3 million to $7 million, depending on the mode of transportation.

2.8 References

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