NUREG–1531

Draft
Environmental Impact Statement
Related to Reclamation of the Uranium Mill Tailings at the Atlas Site, Moab, Utah

Source Material License No. SUA 917
Docket No. 40–3453
Atlas Corporation

U.S. Nuclear Regulatory Commission

Office of Nuclear Material Safety and Safeguards

January 1996

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ABSTRACT

This Draft Environmental Impact Statement (DEIS) has been prepared by the Nuclear Regulatory Commission (NRC), Office of Nuclear Material Safety and Safeguards, to address potential environmental impacts associated with a request by Atlas Corporation to amend its existing NRC License No. SUA-917 to reclaim an existing uranium mill tailings pile near Moab, Utah. The proposed reclamation would allow Atlas to (1) reclaim the tailings pile for permanent disposal and long-term custodial care by a government agency in its current location on the Moab site, (2) prepare the 162-ha (400-acre) Moab site for site closure, and (3) relinquish responsibility of the site after having its NRC license terminated. The DEIS describes and evaluates (1) the purpose of and need for the proposed action, (2) alternatives considered, (3) potentially affected environmental resources, (4) environmental consequences of the proposed action, and (5) costs and benefits associated with reclamation alternatives. Public and agency comments on this DEIS will be considered in the Final Environmental Impact Statement.

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SUMMARY AND CONCLUSIONS

This Draft Environmental Impact Statement (DEIS) has been prepared under the direction of the staff of the U.S. Nuclear Regulatory Commission (NRC) and issued by the Commission's Office of Nuclear Material Safety and Safeguards (NMSS). The National Park Service is a Cooperating Agency.

1. This action is administrative, involving a licensing decision in response to a license amendment request from Atlas Corporation, Denver, Colorado. Atlas proposes to reclaim an existing uranium mill tailings pile on the Atlas site near Moab, Utah, and has requested an amendment of its existing NRC License No. SUA-917 to allow this reclamation. The Atlas mill no longer operates and is currently being dismantled, and the nearby 9.52-million-metric-ton (10.5-million-ton), 52.6-ha (130-acre), uranium mill tailings pile needs to be stabilized for long-term disposal. The license amendment requested by Atlas would allow Atlas to (1) reclaim the tailings pile for permanent disposal and long-term custodial care by a government agency in its current location on the Moab site, (2) prepare the 162-ha (400-acre) Moab site for site closure, and (3) depart the site after having its NRC license terminated.

   Under the Atlas proposal, the side slopes of the pile would be reduced to 30% [i.e., 0.9 m (3 ft) vertical per 3 m (10 ft) horizontal] or less to minimize effects of erosion and possible earthquakes. Also, an earth and rock cover system would be installed over the pile to minimize radon escape, infiltration of rain water into the tailings, infiltration of tailings contaminants into groundwater, and tailings erosion potentially caused by surface runoff and flooding of the Colorado River and a nearby ephemeral stream known as Moab Wash. Earth and cover materials would likely be obtained from several possible borrow sites, including two sites for crushed bedrock in Castle Valley, an area for rounded cobble in Spanish Valley southeast of Moab, and an area for clay near the Canyonlands Airport northwest of Moab.

   This DEIS also considers the alternative of transporting the Atlas tailings to an alternate site for permanent disposal. Potential impacts of the alternative of tailings transport by rail and disposal at the Plateau site, about 29 km (18 miles) northwest of Moab, are considered in detail, and other alternate sites are briefly identified.

2. Concerns and alternatives are addressed in this DEIS, and additional public and agency comments will be considered in the Final Environmental Impact Statement (FEIS). NRC has also prepared a draft Technical Evaluation Report (TER) that evaluates the technical adequacy of Atlas's proposed design for tailings pile reclamation. Thus, the draft TER focuses on engineering aspects of the Atlas proposal and its compliance with Appendix A to 10 CFR Part 40, whereas this DEIS focuses on the environmental aspects. The draft TER is also being made available for public comment.

3. Concerns receiving special attention are summarized in Section 1.5, "Scoping Results and Scope of this Environmental Impact Statement." The concerns were expressed by the public and several local, state, and federal agencies. The major categories of concern were that

   a. Reclamation of tailings should be consistent with NRC policy and regulations and prior NRC actions involving tailings reclamation, and should provide maximum protection of public health and the environment;

b. The chemical and physical composition of the tailings should be well described;
c. Over the long term, earthquakes and the frequent flushing of the tailings base by flood waters could compromise pile stability;
d. The environmental impact statement (EIS) should provide a comprehensive technical and cost-benefit analysis of alternatives, including the use of the best and most recent information;
e. Tailings should be transported to an alternate site for permanent disposal, to protect the Moab area and to allow future commercial use of the Atlas site;
f. Tailings leachates enter the groundwater and the Colorado River, having an adverse impact on water quality and aquatic biota;
g. The tailings pile would impact recreation, tourism, and the local economy; and
h. A failure of the tailings pile would impact the Colorado River, resulting in contamination and impacts on the environment and downstream water users.

4. For the reclamation of tailings, the following alternatives are considered:

   a. Alternative of no action: This alternative—under which Atlas would cease operations involving environmental control of the tailings, and NRC would make no licensing decision—is not legally or environmentally acceptable;
   b. The Atlas proposal (i.e., reclamation for permanent disposal on the Atlas site);
   c. Disposal of the tailings at an alternate site, including consideration of
      - the Plateau site as the primary alternate site, with tailings transport by rail, and
      - tailings transport alternatives (rail, truck, slurry pipeline).

5. Based on the evaluations in this DEIS, if a license amendment approves tailings reclamation on the Atlas site, the licensee will be required to conform to the following conditions in addition to any requirements in the TER:

   a. A plan to minimize emissions of fugitive dust during reclamation shall be submitted for NRC approval (Section 4.1.3);
   b. A spill prevention and control plan and an erosion control plan applicable to the Atlas site and borrow areas shall be submitted for NRC approval (Section 4.5.4); and
   c. A borrow transport plan shall be submitted for NRC approval to minimize impacts on socioeconomics and recreation (Section 4.7.1.3).

6. The potential environmental consequences of the Atlas proposal and the Plateau site alternative are summarized below. The summary includes consideration of a hypothetical, maximum tailings pile failure in which 20% of the tailings pile enters the Colorado River during a hypothetical flood. However, the tailings pile would not be expected to fail because it would be designed to withstand earthquake and flooding conditions anticipated at the Atlas site.

   a. Fugitive dust and vehicle emissions would add to existing levels of air pollutants in the region, which are in compliance with national ambient air quality standards (NAAQS). Fugitive dust during reclamation would not be expected to cause exceedances of NAAQS. No other source of air pollutants has been identified that would cause a significant impact in combination with the Atlas proposal or the Plateau site alternative. Long-term releases of air pollutants after reclamation at either the Atlas site or Plateau site would be very small and would not cause exceedance of air quality standards.

b. No long-term land use change would result from the Atlas proposal, with the exception of several acres in Castle Valley that may be converted to quarries to supply rock riprap. Because the tailings pile would continue to occupy a portion of the Atlas site under the Atlas proposal, future commercial use of roughly half of the site would be precluded. The Plateau site alternative would allow unrestricted use of the entire Atlas site after completion of reclamation. The Plateau site alternative would also result in the loss of an area of a few hundred acres of grazing land, which is a very small fraction of the extensive lands available for grazing in the region. The deposition of tailings onto downstream lands after the hypothetical tailings pile failure would add to any existing level of contamination that may have resulted from deposition of existing contaminants in the river during previous floods. The increase in contamination should be too slight to have any appreciable long-term impact on land uses along the river.

c. The increased use of water during reclamation under the Atlas proposal or the Plateau site alternative could cause a slight increase in the total groundwater use in the Moab area. Although groundwater consumption in the Moab area has gradually increased over the years, shortages have not occurred and are not expected. If tailings reclamation were done at the Atlas site, tailings leachates would continue to enter the alluvial aquifer at the Atlas site. No significant use of groundwater from this aquifer in the vicinity of Moab is anticipated in the foreseeable future. Under the Plateau site alternative, tailings leachates would no longer enter the alluvial aquifer at the Atlas site. No impact to groundwater would be anticipated at the Plateau site, because a clay liner would be installed beneath the tailings, and no viable supply of groundwater has been identified there.

d. Any hydrological impact associated with the tailings reclamation at the Atlas site or the Plateau site would be negligible. Some surface water for dust control would be obtained from a contractor or the city of Moab. No water use would occur for the Atlas proposal or the Plateau site alternative after reclamation is completed. Several additional acres (e.g., 1.2 ha or 3 acres) of 100-year floodplain would be occupied by the tailings pile as a result of tailings reclamation on the Atlas site; this use of floodplain would have negligible hydrologic impact, although a permit from the U.S. Corps of Engineers would be required. Most floodplain in the area has been protected by the establishment of the Moab Marsh Preserve. No floodplain is present at the Plateau site.

e. Surface runoff associated with operations under both the Atlas proposal and Plateau site alternative could temporarily add to existing levels of impacts on surface water quality in the Colorado River. With adequate controls, this cumulative, temporary impact would be expected to be negligible. After reclamation under the Atlas proposal, tailings leachates would continue to enter the Colorado River and have a small, generally undetectable impact on surface water quality. The greatest potential for impact would occur during periods of low flow in the river when the tailings contribution to flow would be fractionally larger than during high flows. At the Plateau site, a clay liner beneath the tailings would restrict the escape of tailings leachates, thus preventing impacts to a nearby ephemeral wash and the Colorado River, which is far downstream. The hypothetical tailings pile failure at the Atlas site would have a relatively large, short-term impact (e.g., several weeks) and a small, long-term impact on water quality, which would likely be undetectable after a short time period (e.g., months to several years) after the failure. Over the long term, the tailings contaminants would be virtually completely dominated by the large amount of existing contaminants continually transported by the river.

f. Aquatic biota would be affected by any changes in surface water quality resulting from the Atlas proposal or the Plateau site alternative. During reclamation operations, erosion control measures would be applied to prevent the occurrence of appreciable impact. After reclamation under the Atlas proposal, tailings leachates would continue to add slightly to existing contaminants in the river, potentially having a minor impact on aquatic biota. The Plateau site alternative would eliminate the potential for impact on aquatic biota. The hypothetical tailings pile failure should have negligible impact on water quality and aquatic biota.

g. A small loss (e.g., 2 ha or 5 acres) of terrestrial habitat at the Atlas site would occur under the Atlas proposal, and habitats at borrow areas would be temporarily disturbed. A portion of this habitat is tamarisk wetland, which is of limited importantance to wetland wildlife. The Plateau site alternative would result in the loss of a few hundred acres of sparse vegetation that supports low numbers of wildlife. No threatened or endangered plant or animal is likely to be affected under either the Atlas proposal or Plateau site alternative. No reduction in habitat or wildlife populations numbers would be anticipated in the event of the hypothetical tailings pile failure.

h. Reclamation of the tailings pile at either the existing Atlas site or the Plateau site would result in a slight, short-term increase in employment and population in the Moab area. This increase could add slightly to the effects of the increased population in the area during the primary tourist season. However, the Moab area should be able to absorb the increased population with no significant adverse impact. No impact on historic or cultural resources is anticipated under either alternative. The transport of borrow material by truck would add to existing traffic, have some adverse and beneficial impacts on business in Moab, and increase the potential for traffic accidents. Under the Plateau site alternative, the 7 to 12 years of moving the tailings pile and contaminated soils by rail could create a temporary adverse aesthetic impact. Because truck transport of borrow material (Atlas proposal) and mill debris (Plateau site alternative) in the Moab area would be relatively short term and would be conducted primarily during the winter season, truck traffic associated with the Atlas proposal or Plateau site alternative would not be expected to produce a significant impact. The hypothetical tailings pile failure would cause some temporary economic impact. Because of a lack of impact on water quality, tailings pile failure would not be expected to produce a significant economic impact related to surface water use.

i. Doses to the maximally exposed individual (a resident adjacent to the Atlas site) and to the surrounding population were estimated based on computer modeling results and on actual measurements at the Atlas tailings pile and at other tailings piles. Impacts during reclamation of the tailings pile would be dominated by radon daughters (86%) rather than particulates (14%). After reclamation, essentially no release of radioactive particulates would occur, and radon releases would be reduced to less than the NRC limit of 0.74 $Bq/m^2/s$ (20 $pCi/m^2/s$). Dose to the maximally exposed individual from particulates and radon daughters during reclamation would be an estimated 0.78 mSv/yr (78 mrem/yr), which is below the NRC limit of 1 mSv/yr (100 mrem/yr). During reclamation, the total annual dose to the Moab population would be less than 0.052 person Sv (5.2 person rem) compared to a total natural background dose of about 18 person Sv (1800 person rem). After reclamation the doses to the maximally exposed individual and the Moab population would be 0.02 mSv/yr (2.0 mrem/yr) and 8×10^{-4} person Sv per year (0.08 person rem per year), respectively. Under expected working conditions, doses to reclamation workers on the tailings pile would be expected to be less than 0.01 Sv/yr (1 rem/yr). For the Plateau site alternative, annual doses during removal of the tailings would be about the same as the reclamation doses for the Atlas proposal, but the doses would last up to 7 years longer. A risk analysis conducted for transport of the tailings by rail to the Plateau site indicated that no acute fatalities would occur and that the number of latent cancer fatalities would not exceed 6.44×10^{-5} for the railroad crew or 1.50×10^{-4} for the general public.

j. The analysis of costs and benefits associated with reclamation alternatives indicates that the Atlas proposal would cost significantly less ($11 to $17 million) than would the Plateau site alternative ($60 to $110 million). Both options would result in benefits from releasing land at the Atlas site for unrestricted use.

7. Based on the evaluations in this DEIS, the NRC staff's preliminary conclusion is that the Atlas proposal (i.e., reclamation for permanent disposal on the Atlas site), with the conditions identified in item 5, is acceptable with respect to environmental costs and benefits.

ACRONYMS AND ABBREVIATIONS

ACL	alternate concentration limit
ALARA	as low as reasonably achievable
amsl	above mean sea level
Atlas	Atlas Corporation
ATV	all terrain vehicle
BLM	Bureau of Land Management
Bq	Becquerel
°C	degrees Celsius
CEQ	Council on Environmental Quality
CFR	Code of Federal Regulations
cfs	cubic feet per second
Ci	curies
cm	centimeter
CO	carbon monoxide
db(A)	decibels on the A-weighted scale
DEIS	draft environmental impact statement
DOE	U.S. Department of Energy
EA	environmental assessment
EIS	environmental impact statement
EPA	U.S. Environmental Protection Agency
°F	degrees Fahrenheit
FEIS	final environmental impact statement
FEMA	Federal Emergency Management Agency
FONSI	finding of no significant impact
FR	Federal Register
ft	feet
FWS	U.S. Fish and Wildlife Service
g	strength of earth's gravitational field (acceleration of 980•cm sec^{-2})
GEIS	generic environmental impact statement
gpd	gallons per day
gpm	gallons per minute
ha	hectare
HF	hypothetical flood
Hg	mercury
hp	horsepower
hr	hour
ISC	Industrial Source Complex
kg	kilogram
km	kilometer
kV	kilovolt
L	liter
LCF	latent cancer fatalities
LPG	liquid petroleum gas
Lpm	liters per minute
LTSP	long-term surveillance plan
m	meter

m^3	cubic meter
m^3/s	cubic meter per second
MCE	maximum credible earthquake
MCL	maximum concentration limit
MEI	maximally exposed individual
MeV	million electron volts
mg	milligram
Mgd	million gallons per day
ml	millilier
min	minute
M_L	Richter magnitudes
MP	milepost
mph	miles per hour
mrem	millirem
mSv	milli-Sievert (100 millirems)
μCi	microcuries
μg	micrograms
NAAQS	National Ambient Air Quality Standards
NCRP	National Council for Radiation Protection and Measurements
NEPA	National Environmental Policy Act of 1969
NESHAP	National Emission Standards for Hazardous Air Pollutants
NMSS	Office of Nuclear Material Safety and Safeguards
NO_2	nitrogen dioxide
NOI	notice of intent
NPDES	National Pollutant Discharge Elimination System
NPS	National Park Service
NRC	U.S. Nuclear Regulatory Commission
O_3	ozone
ORNL	Oak Ridge National Laboratory
Pb	lead
$pCi/m^2/s$	picocuries per square meter per second
pCi/g	picocuries per gram
PCPI	per capita personal income
PGA	peak ground acceleration
pH	a measure of hydrogen ion concentration (acid/basic)
PM-10	particulate matter less than 10 microns in diameter
PMF	probable maximum flood
POC	point-of-compliance
ppm	parts per million
PSD	prevention of significant deterioration
Publ. L.	public law
s	second
SO_2	sulfur dioxide
SO_4	sulfate
SPCC	spill prevention, control, and countermeasures
spp.	species
TDS	total dissolved solids
TER	Technical Evaluation Report
TPI	total personal income

TSP	total suspended particles
UDNR	Utah Department of Natural Resources
UDOT	Utah Department of Transportation
U_3O_8	uranium oxide
UMTRCA	Uranium Mill Tailings Radiation Control Act of 1978
UMTRAP	Uranium Mill Tailings Radiation Control Act Program
USC	United States Code
USGS	U.S. Geological Survey
VMT	vehicle miles traveled
V_2O_5	vanadium oxide
WL	working level
yd^3	cubic yard
yr	year

FOREWORD

This Draft Environmental Impact Statement addresses the administrative action and potential environmental consequences of authorizing Atlas Corporation to reclaim an existing uranium mill tailings pile on Atlas property near Moab, Utah. Atlas would conduct reclamation activities in compliance with an amendment to its existing License No. SUA-917 issued by the U.S. Nuclear Regulatory Commission (NRC).

Any interested party may submit comments on this report for consideration by the NRC. To be certain of consideration, comments on this report must be received by the date published in the *Federal Register* Notice announcing availability of the DEIS. Comments received after the due date will be considered to the extent practicable. Comments should be sent to:

Chief, High-Level Waste and Uranium Recovery Projects Branch
Division of Waste Management
Office of Nuclear Material Safety and Safeguards
Mail Stop TWFN 7J-9
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555
Telephone (301) 415-6643

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This Draft Environmental Impact Statement (DEIS) has been prepared by the U.S. Nuclear Regulatory Commission (NRC), Office of Nuclear Material Safety and Safeguards with the assistance of Oak Ridge National Laboratory. The National Park Service (NPS), U.S. Department of Interior has served as a cooperating agency in the preparation of this DEIS. In this role, the NPS has provided information to the preparers of the DEIS, has submitted comments on a preliminary draft of the report, and has assisted in defining proposed sampling protocols for the collection of additional information on water quality and aquatic biota. The Bureau of Land Management, U.S. Department of Interior, which had originally been designated a cooperating agency, withdrew because of a lack of a defined role in the project. In preparing the DEIS, the staff relied heavily on information provided by Atlas Corporation in its application for license amendment, on information provided by federal, state, and local government agencies, and from other individuals and organizations that had special knowledge of environmental resources and related activities relevant to the proposed action.

1. PURPOSE AND NEED FOR ACTION

1.1 INTRODUCTION

1.1.1 The Federal Proposed Action

This Draft Environmental Impact Statement (DEIS) has been prepared in support of a Federal licensing decision to be made by the U.S. Nuclear Regulatory Commission (NRC), in accordance with the National Environmental Policy Act of 1969 (NEPA). The decision is whether or not to approve Atlas Corporation's request for a license amendment approving its proposed reclamation plan for on-site disposal of uranium mill tailings on the Atlas site near Moab, Utah. The decision will be made after completion of the Final Environmental Impact Statement (FEIS), which will provide an environmental evaluation of the Atlas proposal and alternatives to the Atlas proposal. NRC has prepared a draft Technical Evaluation Report (TER) that evaluates the technical adequacy of Atlas's proposed design for tailings pile reclamation (NRC 1996). The draft TER focuses on engineering aspects of Atlas's proposal, whereas this DEIS focuses on the environmental issues. The draft TER will be made available for public comment. Atlas Corporation's request is hereafter referred to as the Atlas proposal. In the preparation of this DEIS, NRC is the lead agency, while the National Park Service (NPS) is a cooperating agency.

1.1.2 The Atlas Proposal

Atlas Corporation (Atlas) has applied to the NRC for an amendment to its existing NRC License No. SUA-917 covering the Atlas uranium mill and associated activities at the Atlas site located along the Colorado River near Moab, Utah (Fig. 1.1-1). The mill no longer operates and is currently being dismantled. The nearby 9.5-million-metric-ton (10.5-million-ton), 52.6-ha (130-acre), uranium mill tailings pile needs to be reclaimed for long-term disposal. The license amendment requested by Atlas would allow Atlas to (1) reclaim (stabilize) the tailings pile for permanent disposal in its current location on the Moab site; (2) discontinue its responsibility for the tailings, which would then be under long-term custodial care by a government agency—probably the U.S. Department of Energy (DOE); and (3) prepare the 162-ha (400-acre) site for site closure. Atlas has submitted to NRC detailed tailings reclamation plans and environmental data in support of its amendment request. In accordance with Federal regulations, NRC must determine whether or not the Atlas proposal would comply with the requirements of Appendix A of 10 CFR Part 40 as discussed in Section 1.4 of this DEIS.

Under the Atlas proposal to reclaim the tailings pile in its current location, the side slopes of the pile would be reduced to 30% [i.e., 0.9 m (3 ft) vertical per 3 m (10 ft) horizontal] or less to minimize effects of erosion and possible earthquakes. Also, an earth and rock cover system would be installed over the pile to minimize radon escape, infiltration of rain water into the tailings, infiltration of tailings contaminants into groundwater, and tailings erosion potentially caused by surface runoff and flooding of the Colorado River and a nearby ephemeral channel known as Moab Wash. Earth and cover materials would likely be obtained from several possible borrow sites (Plateau site, cobble area, and bedrock area shown in Fig. 1.1-1).

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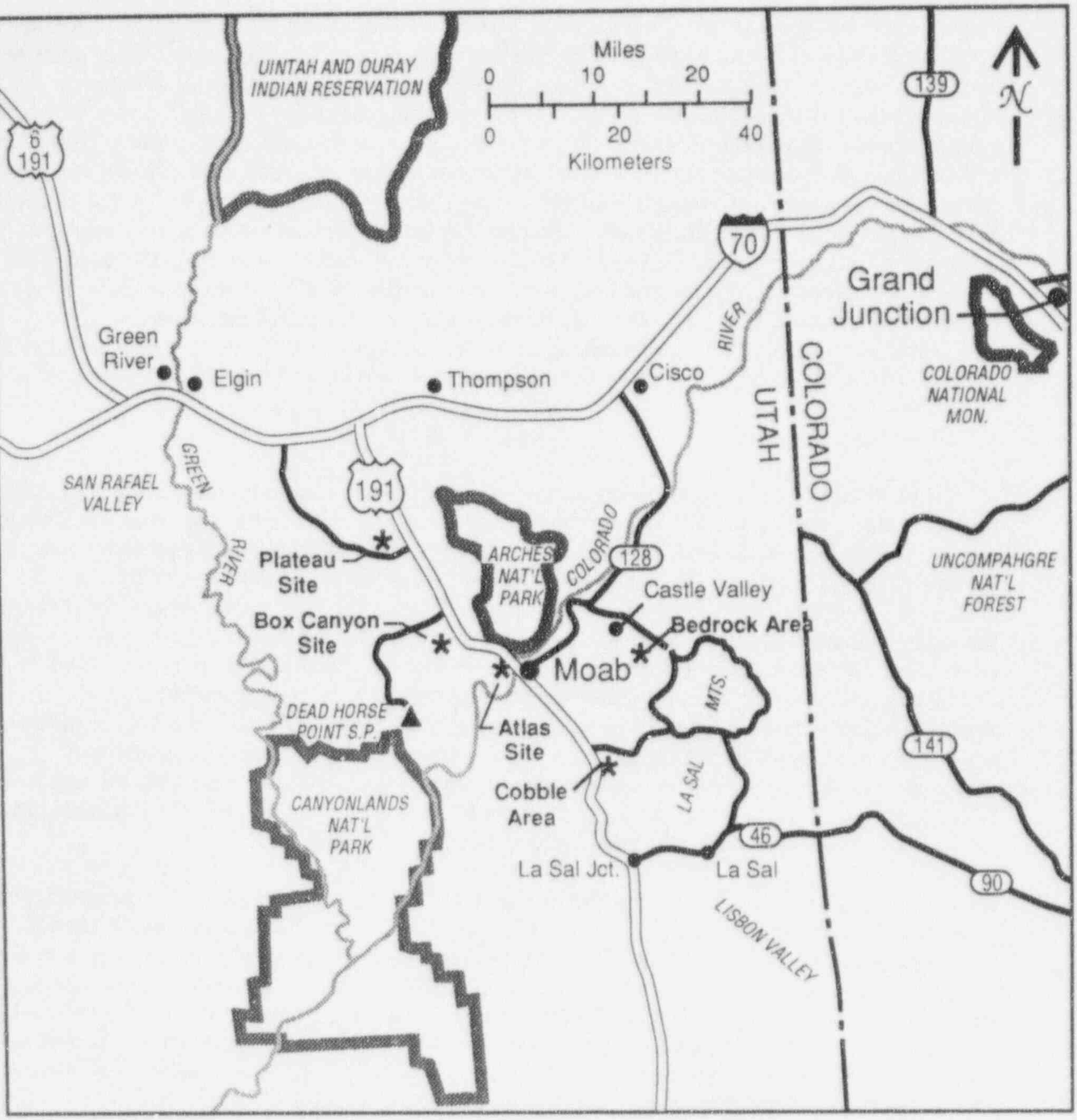

Figure 1.1-1. Regional Location of the Atlas Corporation Site Near Moab, Utah.

1.1.3 Alternatives

Disposal of tailings at the Moab site has become an issue, primarily because the site is on the Colorado River floodplain and is near the town of Moab and Arches National Park. In 1979, when the FEIS for the operation of the Moab Uranium Mill was published (NRC 1979), the majority of agency and public comments supported the continued operation of the mill, and disposal of the tailings at an alternate site was not an issue (Appendix A in NRC 1979). During the scoping process (Section 1.3) for this DEIS, however, several government agencies and members of the public proposed that the tailings be transported to an alternate site for disposal. Several possible alternate sites were identified during scoping and subsequent discussions with agencies and individuals. At this environmental stage in the licensing process, NRC will not select a specific alternate site and determine that the tailings must be moved to this site. Rather, NRC is focused on determining whether the Atlas proposal is acceptable and whether the Atlas site is environmentally acceptable for tailings disposal. To support this determination, this DEIS compares the Atlas proposal with an alternative of tailings disposal at one of the best, if not the best, alternate sites identified to date. This alternative was selected based on the scoping process for this DEIS, discussions with other agencies and individuals, an NRC site visit, and other information. This alternative involves transport of the tailings by rail to the Plateau site located approximately 29 km (18 miles) northwest of the town of Moab (Fig. 1.1-1).

Under the no-action alternative, NRC would make no licensing decision, and Atlas would cease operations involving management of the tailings. Because this alternative would not comply with regulations and is not environmentally acceptable, it is not evaluated in detail in this DEIS.

1.2 PURPOSE AND NEED FOR ACTION

In accordance with the Uranium Mill Tailings Radiation Control Act of 1978, as amended (Pub. L. 95-604) and with NRC regulations (Section 1.4), NRC is required to act upon the license amendment request from Atlas Corporation. The purpose of NRC's licensing action is to determine whether Atlas has acceptably demonstrated that its proposal meets the requirements of Appendix A to 10 CFR Part 40 and whether the Moab site is environmentally acceptable for tailings disposal.

The Atlas uranium mill ceased operations in 1984 and is being dismantled. The tailings must be reclaimed adequately for long-term stability. Escape of hazardous substances into the surrounding environs must be minimized to the extent feasible. To abandon the tailings pile at this time with no further environmental control (i.e., the no-action alternative) is not legally or environmentally acceptable.

The mill tailings pile contains high-volume, low-activity materials and elements that could be hazardous to the environment and public health. These substances are currently escaping the tailings pile at low rates. Tailings leachates are slowly diffusing downward into groundwater, some of which moves horizontally and enters the Colorado River. Radioactive radon gas slowly escapes the tailings pile and enters the air, and strong winds may blow tailings dust into the air although an interim cover has been placed on the tailings. To minimize environmental contamination, Atlas has conducted a number of environmental control and corrective action programs, and additional environmental protection measures are needed for long-term tailings disposal.

The purpose of the tailings-reclamation action (either the Atlas proposal or an alternative action) considered by this DEIS is to minimize the potential for environmental and public health impact posed by the existing tailings pile. This purpose can be satisfied only by appropriate reclamation of the tailings pile, either at the Moab site or an alternate site.

1.3 HISTORY AND CURRENT STATUS OF THE MOAB MILL FACILITY AND OPERATIONS

The Atlas Moab Mill is located on the west bank of the Colorado River about 4.8 km (3 miles) northwest of Moab. The property and facilities were originally owned by the Uranium Reduction Company that was acquired by Atlas Corporation in 1962. Atlas owns approximately 162 ha (400 acres) including the approximately 81 ha (200 acres) on which the mill and tailings are located. Atlas activities at the Moab Mill site are covered by the NRC Source Material License SUA-917, which was renewed in 1988. The mill ceased ore milling operations in 1984. The principal Atlas and NRC documents supporting the source material license are listed in Appendix B.

Initial tailings pond construction was completed in 1956, and with the exceptions of brief periods, tailings were disposed in the pond continuously from initial start-up in October 1956 until the mill ceased operating and was placed on standby status in 1984. The tailings pile has been maintained since that date under various conditions of the Atlas Source Material License. The pile has five embankments that were raised to the present elevation of 1237 m (4058 ft) above mean sea level (amsl) after the 1979 license renewal. A 5.5-m (18-ft) raise in embankment elevation to a projected final elevation of 1242 m (4076 ft) was reviewed and approved under License Amendment No. 7 dated June 30, 1982. However, the embankment raise was never initiated, because the added capacity was not needed when the mill subsequently entered a long-term shutdown status.

During early operations, Atlas utilized an acid leach process for uranium milling. During this period, lime was added to the mill tailings to help neutralize the tailings. In 1961, an alkaline leach process was initiated. In 1967, a new acid leach circuit was installed and, for a period of time, both the acid circuit and an alkaline circuit were operated. From 1982 through 1984, only an acid leach process was used with no neutralization of process water because a recycle process was in use.

The 1982–84 phase of operations appears to have resulted in increased metals mobilization as a result of the lower pH of the water and tailings associated with the acid leach circuit. As a result of the increased groundwater contamination, NRC required Atlas to initiate a compliance monitoring and corrective action program by July 1990. A revised program was prepared by Atlas and found acceptable with modification. The program was made mandatory by license conditions 17 and 55. The program included the establishment of groundwater quality standards, point-of-compliance wells, a background well, sampling frequency, groundwater sampling points, selected constituents for which the groundwater was to be analyzed, and enhanced drying of the tailings. Wells were drilled into the tailings to pump water to an evaporation pond on the top of the tailings pile. Pumping ceased in early 1994 because of lack of water in the tailings. The projected date for completion of all groundwater corrective actions is December 1998, as specified in license condition no. 55.

To collect water draining from the embankments, two sump pits were excavated in the 1980s, one on the northeast side of the pile and the other at the south end of the pile. Pumps were installed to collect the seepage water and pump it to an evaporation pond on top of the tailings pile. Water has not collected in the pits for several years, and the pumps were subsequently removed. NRC amended Atlas's license to allow disposal of radioactive contaminated solid waste in the south sump pit.

Atlas has conducted cleanup of windblown tailings and other contaminated soils in several areas on the site. These areas were along the west side of state highway 279, between the tailings pile and the highway, an area northwest of the tailings pile, and an area of about 2.8 ha (7 acres) southeast of the tailings pile. Cleanup involved excavating the windblown tailings and contaminated soils and placing them on the tailings pile.

1.4 FEDERAL AND STATE AUTHORITIES, REGULATIONS, AND PERMITS

Title II of the Uranium Mill Tailings Radiation Control Act of 1978, as amended, authorized the NRC to enforce decontamination, decommissioning, and reclamation standards on new licenses or relicensing actions for uranium mill and mill tailings sites. NRC regulations in Appendix A to 10 CFR Part 40 establish criteria for the technical aspects, finance, ownership, and long-term site surveillance relating to the siting, operation, decontamination, decommissioning, and reclamation of uranium milling facilities. Each site-specific licensing decision is to be based on the criteria, taking into account public health and safety and the environment. A summary list of the criteria is provided in Appendix C of this DEIS.

Flexibility is provided in the criteria to allow achievement of an optimum tailings disposal program on a site-specific basis. Licensees may propose alternatives to the criteria, but protection of the public must be equivalent to or better than that required by the existing criteria. NRC licensing decisions that would require certain more costly reclamation practices to minimize environmental impacts or meet "reasonably achievable" criteria must consider the state of the technology and the economic costs compared to the benefits.

In the case of the Atlas proposal for tailings reclamation at the Moab site, NRC staff review the licensee's proposed design and cover materials for the reclaimed tailings pile and independently determine whether the licensee has acceptably demonstrated that its proposal would meet the applicable criteria. Current NRC independent reviews of reclamation designs and materials in terms of the Appendix A criteria are detailed in the draft TER for the Moab site. Regulations state that NRC will approve a reclamation plan proposed by a licensee if the NRC-evaluation documented in the draft TER demonstrates compliance with the Appendix A criteria.

As part of compliance with Appendix A of 10 CFR Part 40, the licensee may propose alternate concentration limits (ACLs) as groundwater protection standards that present no significant hazard to the environment and public health. NRC regulations state that an ACL will be approved if NRC, after considering practicable corrective actions, determines that the proposed ACL is as low as reasonably achievable and that the constituent will not pose a substantial present or potential hazard to human health or the environment as long as the ACL is not exceeded. Before approving ACLs, NRC must consider numerous factors that are listed in Appendix A to 10 CFR Part 40.

The Atlas proposal would require a number of permits, licenses, or approvals from various agencies in addition to the NRC (listed in Table 1.4-1).

NRC regulations in 10 CFR Part 20 Subpart D specify radiation dose limits for individual members of the public during reclamation. No unrestricted area may have a radiation level that would result in a dose from external sources to an individual exceeding 0.02 mSv (0.002 rem) in an hour, 0.5 mSv (0.05 rem) in a year, or a total effective dose equivalent of 1 mSv (0.10 rem) in a year. The licensee is required to perform monitoring or calculations needed to demonstrate compliance.

The Utah Department of Environmental Quality has jurisdiction concurrent with NRC over non-radiological groundwater constituents.

1.5 SCOPING RESULTS AND SCOPE OF THIS ENVIRONMENTAL IMPACT STATEMENT

1.5.1 The Scoping Process and Results

In July 1993, NRC staff issued an environmental assessment (EA) evaluating the licensee's revised reclamation plan for on-site disposal of mill tailings. Also in July 1993, the NRC published a finding of no significant impact (FONSI) in the *Federal Register* in anticipation of approving the revised reclamation plan. NRC received more than 20 letters opposing the proposed action and wanting additional evaluation and consideration of issues. As a result, NRC rescinded the FONSI by a *Federal Register* notice in October 1993, decided to prepare an Environmental Impact Statement (EIS), and requested additional information from Atlas to support NRC's technical and environmental evaluation of the Atlas proposal.

Table 1.4-1. Applicable Permits, Licenses, and Approvals

Permits, licenses, or approvals	Granting or approving authority	Status
Approval for disposal of nonradiological demolition solid wastes (i.e., roofing, lumber, blocks, brick, metal, etc.)	State of Utah and local authority	Approvals will be pursued upon identification of waste types, estimated quantities, and disposal site selection
Approval for disposal of domestic or municipal-type solid wastes (i.e., paper, garbage, glass, etc.)	State of Utah and local authority	Approvals to be obtained
Approval for disposal of miscellaneous nonradiological "hazardous" and/or "problem" solid waste (i.e., oils, grease, solvents, polychlorinated biphenyls, caustics, etc.)	Environmental Protection Agency (EPA), State, and/or local authority	Approvals will be pursued upon identification of waste types, estimated quantities, and disposal site selection
Section 404 (dredge and fill permit)	U.S. Army Corps of Engineers	To be obtained
401 Certification (dredge and fill permit)	State of Utah	Undetermined at present
Approval for excavation of borrow materials	State of Utah	Undetermined at present
Historical clearance	State Historic Preservation Officer	Clearance to be secured
	Advisory Council on Historic Preservation	Need not expected
Threatened and endangered species consultation	U.S. Fish and Wildlife Service (Department of Interior)	Biological Assessment submitted; consultation continuing
National Pollution Discharge Elimination System permit	EPA Region VIII	Permit application will be submitted, if applicable, following finalization of design and mitigation plans
Approval of plans and specifications for water pollution control facilities	Utah Department of Environmental Quality	To be submitted as applicable following finalization of design and mitigation plans

The scoping process for this DEIS was conducted in accordance with 10 CFR Part 51, which contains the NRC requirements for implementing the regulations of the Council on Environmental Quality (CEQ) under NEPA. On March 30, 1994, the NRC published in the *Federal Register* (59 FR 14912) a notice of intent (NOI) to prepare an EIS for the proposed reclamation of tailings and to conduct scoping for the EIS. The alternatives identified in the NOI were (1) on-site reclamation (the licensee's proposal), (2) off-site disposal at an alternate site, and (3) no action. A public scoping meeting was held at Starr Hall in Moab, Utah, on April 14, 1994. About 43 people (not including people who represented government agencies) attended the meeting, and 8 persons gave oral comments. The NRC also invited the public and interested agencies, organizations, and individuals to submit their written suggestions and comments by May 13, 1994, for consideration in the EIS process.

A brief summary of the scoping results is provided here, and a more detailed summary is presented in Appendix D. Several commenters stated that the licensee's proposed reclamation plans for the tailings were inadequate and that reclamation at the Moab site would be inconsistent with NRC policy provided in Appendix A to 10 CFR Part 40. Major issues raised in the scoping process included effects of flooding and earthquakes on the tailings pile, possible pile failure resulting in the spilling of tailings into the Colorado River and impacts on downstream water use, leaching of tailings contaminants into groundwater and the river, transport of rock riprap from Castle Valley, and impacts on tourism and the local economy.

Most commenters wanted the tailings transported to an alternate site and the Moab site cleaned up to allow future commercial use of the site. The alternative favored by the commenters was transport of the tailings by rail and disposal at the Plateau site about 29 km (18 miles) northwest of Moab. Many commenters wanted a thorough cost-benefit comparison of alternatives and the Atlas proposal. Upon completion of the scoping process NRC determined that the EIS would consider all of the environmental and socioeconomic issues raised during the scoping period, although some issues would receive more extensive treatment than others because of their complexity or importance. NRC also indicated determined that the issues of tailings pile stability and safety would be addressed primarily in the TER rather than in this DEIS.

1.5.2 Scope of this Environmental Impact Statement

This DEIS focuses on the potential environmental impacts and environmental suitability of tailings disposal (with subsequent site closure) at the Moab site and an alternate site, whereas the adequacy and safety of Atlas's proposed design of the tailings pile is addressed in the draft TER (NRC 1996). This DEIS has been prepared in compliance with NEPA, the CEQ regulations for implementing the procedural provisions of NEPA (40 CFR Parts 1500–1508), and NRC's NEPA regulations (10 CFR Part 51). This DEIS is being made available to agencies and the public, whose comments will be considered in the FEIS.

This DEIS compares in detail the Atlas proposal with the alternative of tailings disposal at an alternate site (the Plateau site). Other alternate sites are analyzed in less detail. However, the selection of an alternate site for actual disposal of the Atlas tailings is not within the scope of this

DEIS. Should NRC not approve the Atlas proposed on-site reclamation plan, additional environmental evaluation would be required for any alternate plan.

Neither the Atlas proposal nor the alternative of tailings disposal at the Plateau site has an approved cover design. Each cover would be designed and evaluated based on appropriate parameters applicable to the top 3 m (10 ft) of tailings being covered, and such that all pertinent design criteria would be satisfied. For instance, the cover would have to restrict the flux of radon gas from the tailings to no more than 20 picocuries per square meter per second such that the protection of the public was not compromised. Minor differences in preliminary cover design appearing in this DEIS would be completely resolved prior to approval of the final design and before construction. The evaluation of environmental impacts presented in this DEIS has been performed such that they would not be contradicted by minor changes engineered into the final design of either cover. Any cost differences would not be expected to be significant in relation to the total costs.

2. ALTERNATIVES INCLUDING THE PROPOSED ACTION

2.1 THE ATLAS CORPORATION PROPOSAL

2.1.1 Overview

The partially below-grade tailings pile is about 0.8 km (0.5 mile) in diameter and rises to an elevation of 1237 m (4058 ft) amsl. The height of the pile is about 27 m (90 ft) above the surface of the river terrace, which is approximately 1210 m (3970 ft) amsl at the side of the pile nearest the river. The pile is located 3.7 km (2.3 miles) northwest of Moab and occupies about 53 ha (130 acres) of land about 230 m (750 ft) from the Colorado River (Figure 2.1-1). It consists of an outer compacted embankment of coarse tailings and an inner impoundment of both coarse and fine tailings. An interim cover of uncontaminated earth covers the tailings. The amount of tailings is estimated to total 9.5 million metric tons (10.5 million tons). The water content of the tailings was reduced to the extent feasible by pumping water from wells in the tailings and discharging the water into a pond at the top of the pile. The pumping was stopped in early 1994. Moab Wash, an ephemeral stream channel, is located along the north and northeast sides of the tailings pile, while State Highway 279 and a bluff border the southwest side of the pile. Under the Atlas proposal, the tailings pile would be reclaimed at its current location. Rock riprap and clay required for covering the pile would be transported by truck to the site from several possible borrow areas, which have tentatively been located southeast of the town of Castle Valley (riprap), southeast of Moab in Spanish Valley (riprap), and on the Plateau site (clay) northwest of the Atlas site.

2.1.2 Tailings Disposal on the Atlas Site

2.1.2.1 Final Structure and Characteristics of the Reclaimed Tailings Pile

Pile Design. The pile design has not been finalized and details will change as a result of the licensing review process. The design information provided in this DEIS may differ somewhat from the final design, but these differences are unlikely to affect the analysis of impacts or the license conditions discussed in this DEIS.

As generally proposed by Atlas, the reclaimed tailings pile at the Moab site (Figure 2.1-1) would be approximately 0.8 km (0.5 mile) in diameter and 27 m (94 ft) high at its highest point near the river. It would have sloped sides and a concave upper surface with drainage ditches (Figure 2.1-2). The pile would contain about 9.5 million metric tons (10.5 million tons) of tailings. In addition, miscellaneous materials, including debris from mill decommissioning, would be disposed adjacent to the pile's southeastern edge. Atlas proposed that the currently relatively steep slopes on the sides of the pile would be reduced to 30% (i.e., 0.9 m (3 ft) vertical per 3 m (10 ft) horizontal) except at the eastern sides of the pile facing the river, where the slopes would be 10%. The top and sides of the pile would be covered with rock riprap layers. The elevation at the base of the pile is about 1210 m (3970 ft) amsl, and the highest spots on the outer rim of the reclaimed pile would be about 1238 m (4062 ft) amsl.

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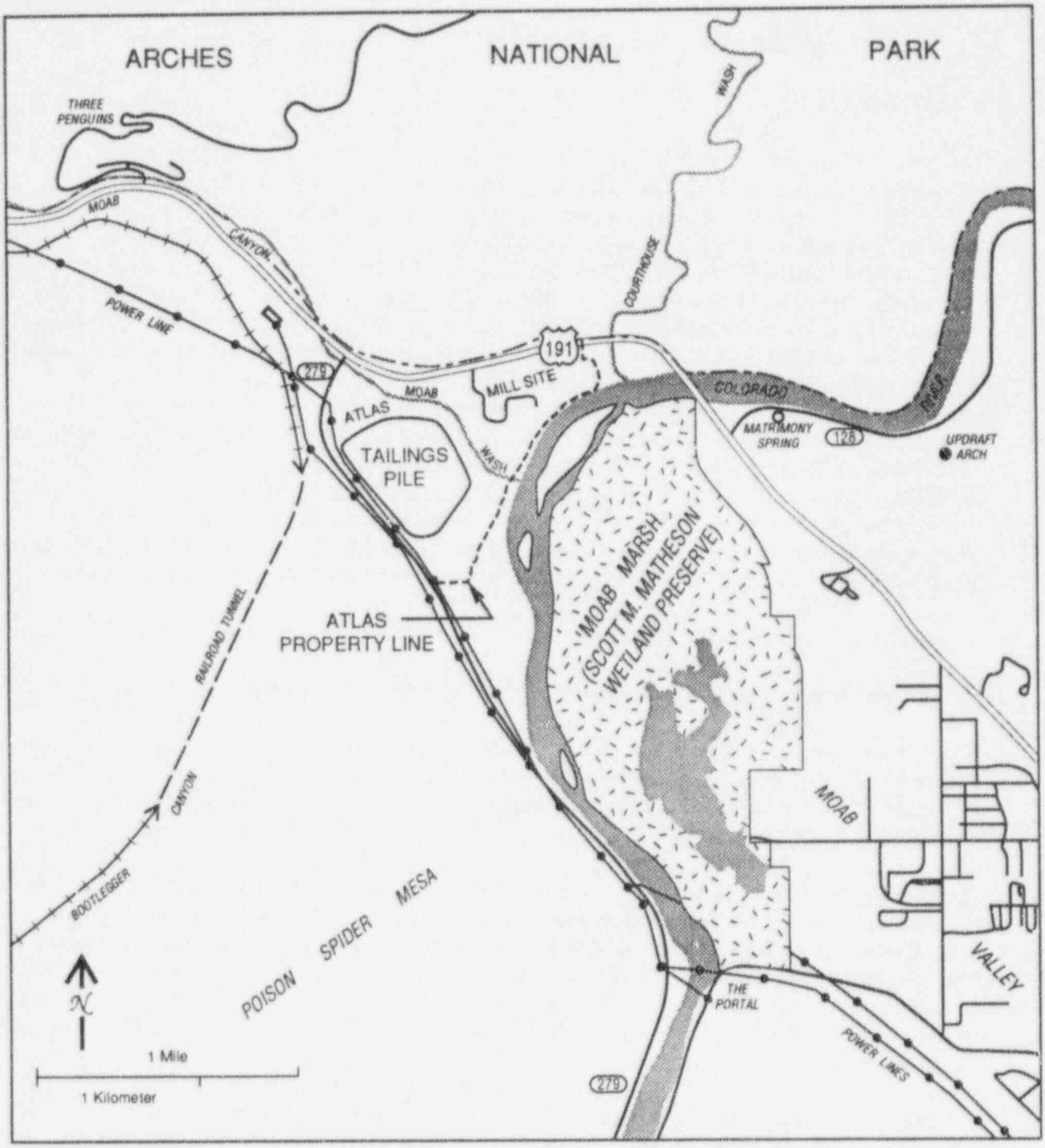

Figure 2.1-1. The Atlas Corporation Site and Uranium Mill Tailings Pile at Moab, Utah.

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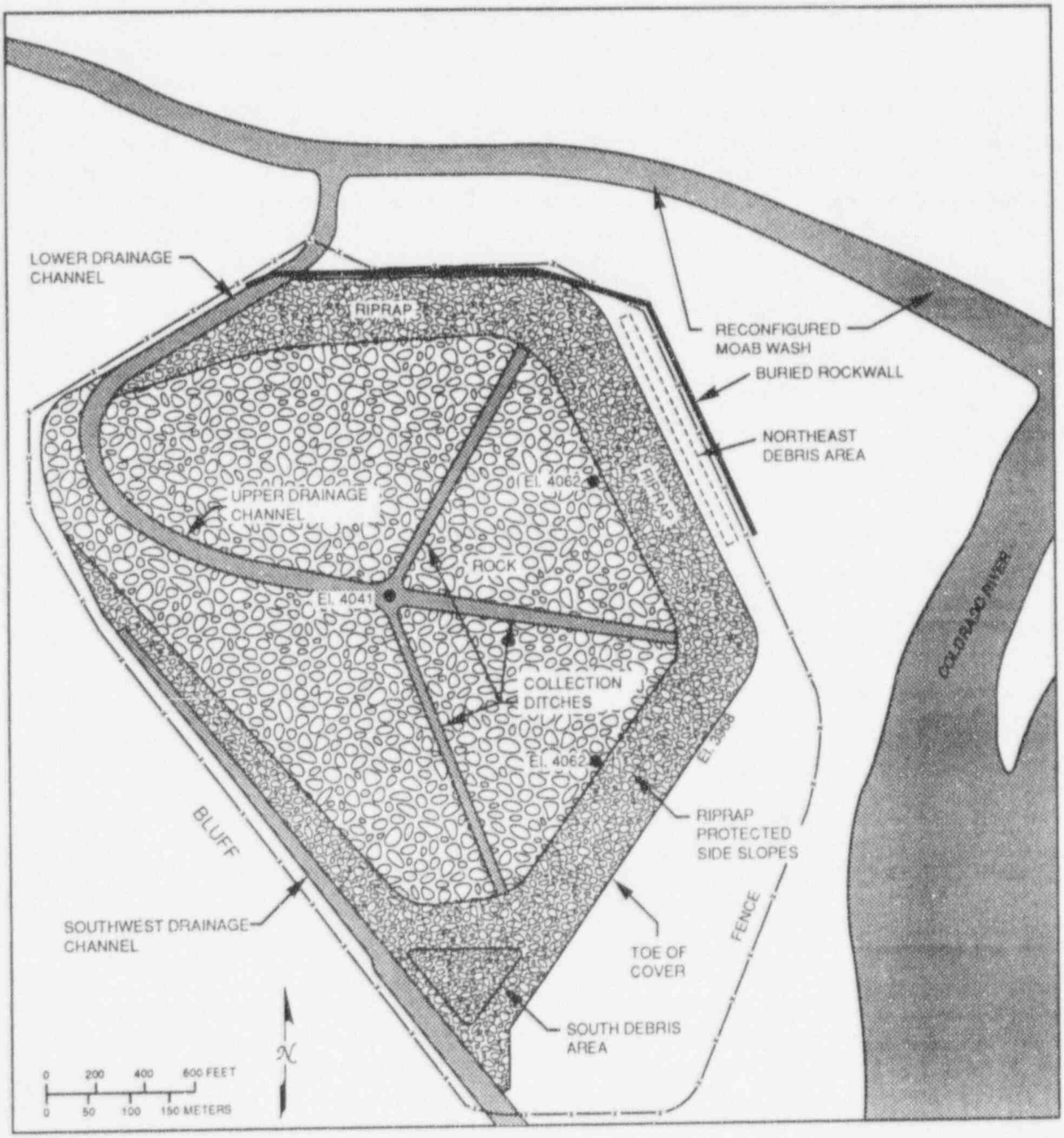

Figure 2.1-2. Proposed Surface Structure and Drainage for the Reclaimed Tailings Pile. El. = elevation in ft (divide by 3.281 to obtain meters). *Source*: Atlas (June 1992).

The reclaimed pile would be designed to minimize erosion, infiltration of rain water into the tailings, and the release of radon gas. The pile would be designed to withstand the probable maximum precipitation event and the probable maximum flood (PMF) event. Rock for riprap would have acceptable durability to withstand the forces of weathering. The design would comply with Criterion 6 of 10 CFR Part 40, Appendix A, which states that the design must provide reasonable assurance of control of radiological hazards to be effective for 1000 years to the extent reasonably achievable and, in any case, for 200 years. The layers of the reclaimed pile, from the bottom upward, would include the tailings layer and a cover system (Table 2.1-1 and Figure 2.1-3).

Table 2.1-1. The Proposed Cover Profile Over Coarse Tailings, Fine Tailings, and Embankments[a]

	Over coarse tailings	Over fine tailings	On embankments
(bottom)	Low-grade ore from the mill area—15 cm (6 inches)	Regraded coarse tailings—2.1 m (7 ft) minimum	Regraded coarse tailings
	Affected soil—41 cm (16 inches)	Affected soil—41 cm (16 inches) minimum[b]	Sandy soil—2.1 m (7 ft) minimum
	Compacted clay—20 cm (8 inches) minimum	Compacted clay—30 cm (12 inches) minimum	Filter layer—variable thickness
	Sandy soil—23 cm (9 inches)	Sandy soil—23 cm (9 inches) minimum	
(top)	Rock—variable thickness	Rock—variable thickness	Rock—variable thickness

[a]Draft Technical Evaluation Report (NRC 1996).

[b]Affected soil is soil that must be removed from the mill area and outlying areas to meet cleanup standards. Ore is waste rock-like material that was mined and transported to the mill. All indicated thicknesses of layers are minimums.

The cover system would provide a minimum of 94 cm (37 inches) of cover above the tailings on the tops and sides of the cell. Generally, the cover would include a layer of affected soil from the mill area and outlying areas directly over the tailings, then a clay layer (radon barrier), a layer of sandy soil, and a surface layer of riprap. The embankment would not have a clay layer. If necessary to meet surface contour requirements, fill material may be placed in certain low areas over the coarse tailings prior to placing the cover system. The radon barrier would consist of suitable material to minimize both the escape of radon and infiltration of rain water. The rock, which would be at least 10 cm (4 inches) thick, would protect against erosion and restrict the intrusion of vegetation and burrowing animals into the radon barrier. Tailings include both coarse and fine tailings, with the latter having higher radiation levels. As shown in Table 2.1-1, a thicker

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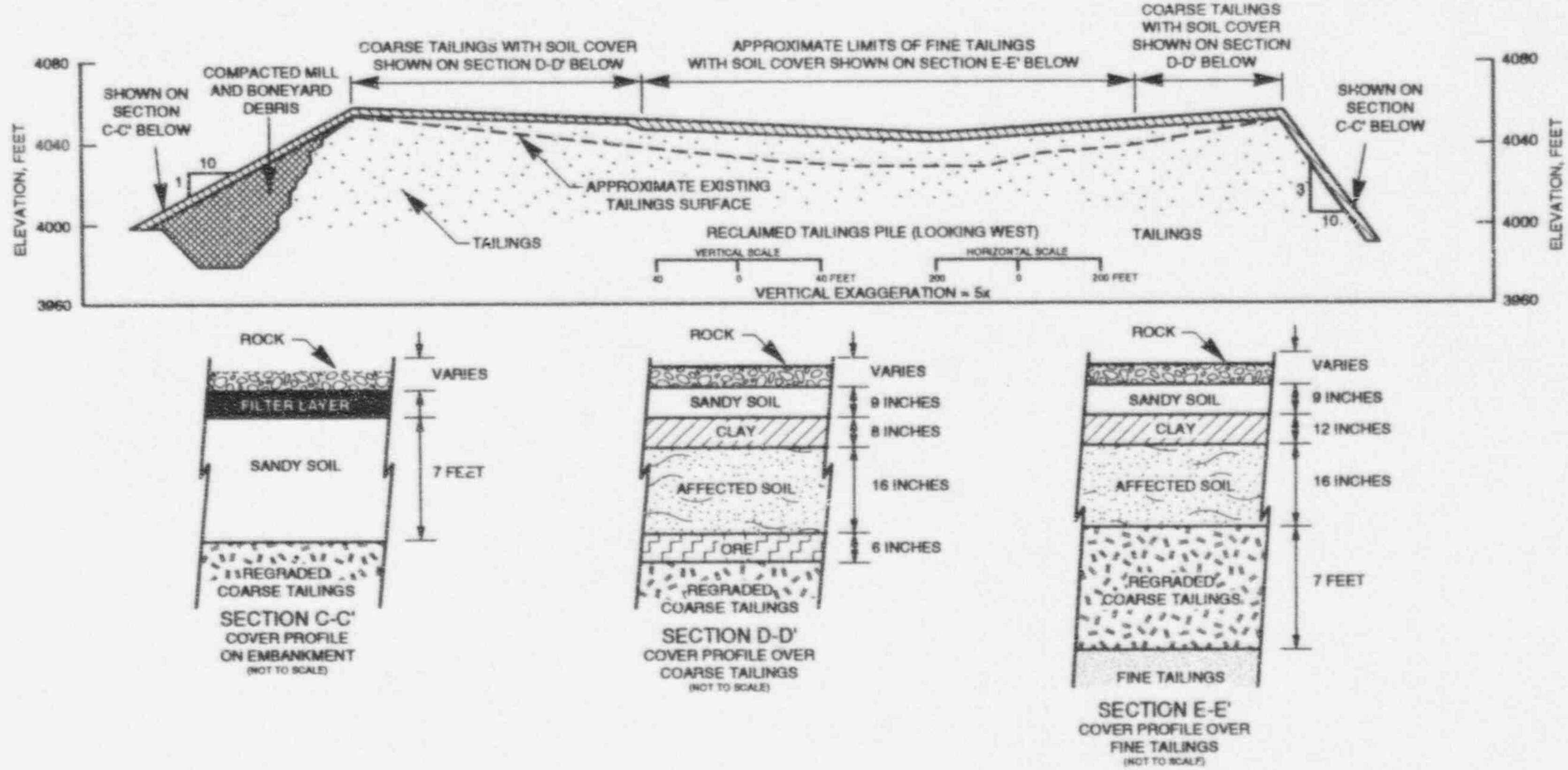

Figure 2.1-3. Proposed Interior Structure of the Reclaimed Tailings Pile. *Source*: Atlas (June 1992). The view is toward the west.

cover system over fine tailings would be required to meet radon emission limits. The placement of coarse tailings over any fine tailings currently at the surface is proposed.

The relatively flat top of the pile would be sloped slightly downward toward the middle and toward the northwest to promote collection of surface runoff and drainage to Moab Wash. Surface runoff on the top of the pile would flow to several collection ditches that would direct rainwater to a channel leading from the top of the pile to Moab Wash (Figure 2.1-3). Another ditch would be constructed between the bluff and the southwest slope of the tailings pile to convey runoff toward the Colorado River. All ditches would be protected with riprap and one or more layers of gravel under the riprap. The gravel layers are needed in the ditches to provide additional protection against erosion of the underlying soil material during runoff events. In the vicinity of the tailings pile, Moab Wash would be relocated farther away from the pile to minimize flooding effects on the pile.

At the toes (bases) of the side slopes, the riprap would be extended a minimum of 0.9 m (3 ft) beneath the earth surface to provide extra protection against flood erosion. Riprap would be extended 2.4 m (8 ft) below the surface at the outlets of the drainage ditches to prevent erosion (headcutting) of the outlets. In addition, the NRC could require any additional protection determined to be necessary as a condition of plan approval.

The sizes of riprap that would be used would be appropriate for erosion protection based on slope and exposure to runoff. The sizes of riprap that are proposed by Atlas are shown in Table 2.1-2; subject to a final detailed analysis of flows, these sizes may change slightly.

Characteristics of the Tailings. The majority of the ore for the Atlas Mill came from the Big Indian Uranium District approximately 129 km (80 miles) to the southeast. The ore was primarily a sandstone with minor amounts of carbonate. Other ores came from small private mines in other districts. Ore was trucked to the mill and ground to a sufficiently fine consistency to allow the most efficient chemical reactions for extraction of uranium. During early operations, Atlas utilized an acid leach process for uranium milling. During this period, lime was added to the mill tailings to help in neutralization of the tailings. In 1961 an alkaline leach process was initiated. A new acid leach circuit was installed in 1967, and both acid and alkaline circuits were operated. Only the acid leach process was used from 1982 through 1984, with no neutralization of process water because a water recycle process was in use.

After milling, the waste slurries from both circuits were combined and pumped to the tailings pile. The embankment consists of compacted coarse tailings (sands), whereas the impoundment has both fine tailings (slimes) and coarse tailings. Some unmilled ore is also present.

In 1987, as part of an independent assessment of the characteristics of the tailings, NRC obtained samples of the tailings liquid to identify hazardous organic and inorganic constituents. Of the 132 organic constituents sampled, most had concentrations of 0.01 mg/L (ppm) or less, and all had concentrations less than 0.051 mg/L. Concentrations of inorganic constituents are shown in Table 2.1-3. A composite analysis of the tailings by Atlas determined that the average radium

Table 2.1-2. Riprap Sizes and Thickness[a]

Location/Feature	D50[b] cm (inches)	Layer Thickness cm (inches)
Upper top slope	3.3 (1.3	10.2 (4)
Lower top slope	7.6 (3.0)	15.2 (6)
Side slope (3V:10H)	11.2 (4.4)	22.9 (9)
Moab Wash buried rock wall	11.2 (4.4)	22.9 (9)
Collection ditches	11.2 (4.4)	22.9 (9)
Upper impoundment drainage channel	11.2 (4.4)	22.9 (9)
Moab Wash buried rock wall	22.9 (9)	34.3 (13.5)
Southwest drainage channel	22.9 (9)	34.3 (13.5)
Apron along Colorado River	28.4 (11.2)	76 (30)
Southwest drainage channel	28.4 (11.2)	43 (17)
Southwest drainage channel	44.2 (17.4)	66 (26)
Lower impoundment drainage channel	44.2 (17.4)	66 (26)
Lower southwest drainage channel	70.1 (27.6)	132 (52)

[a]*Source*: Draft Technical Evaluation Report (NRC 1996).
[b]D50 median stone size.

Table 2.1-3. Chemical composition of tailings liquid at the Atlas site, Moab, Utah[a]

	Total (mg/L)[b]	Dissolved (mg/L)
Silver (Ag)	<1.2	<0.5
Aluminum (Al)	435	325
Arsenic (As)	2.7	1.4
Boron (B)	<2.0	<0.8
Barium (Ba)	<0.5	0.22
Beryllium (Be)	0.14	0.10
Calcium (Ca)	265	220
Cadmium (Cd)	0.48	0.36
Chlorine (Cl)	NR	390
Cobalt (Co)	1.4	0.96
Carbonate (CO_3)	NR	<5.0
Chromium (Cr)	1.5	1.0
Copper (Cu)	11	8.1
Cyanide (total)	NR	0.004
Fluorine (F)	NR	<100
Iron (Fe)	585	460
Gallium (Ga)	<7.5	<3.0
HCO_3	NR	<5.0
Lithium (Li)	<5.0	2.9
Magnesium (Mg)	505	365
Manganese (Mn)	27	21
Molybdenum (Mo)	<1.0	0.46
Sodium (Na2)	1700	1300
Ammonia (NH_3)	NR	2275
Nickel (Ni)	<1.5	0.85
Nitrite (NO_2)	NR	<100
Nitrate (NO_3)	NR	<500
Phosphorus (P)	<7.5	4.1
Lead (Pb)	<5.0	<2.0
pH (pH units)	NA	2.17
Phosphate (PO_4)	NR	<500
Antimony (Sb)	<5.0	<2.0
Selenium (Se)	<5.0	<2.0
Silicon (Si)	7.1	18
Tin (Sn)	<1.2	<0.5
Sulfate (SO_4)	NR	28,000
Strontium (Sr)	3.6	2.7
Sulfide	NR	<5.0
Titanium (Ti)	0.54	0.46
Total dissolved solids	NA	23,350
Total suspended solids	NA	7.5
Uranium	17.4	6.5
Vanadium (V)	52	39
Zinc (Zn)	55.6	4.3
Zirconium (Zr)	<0.5	<0.2
PB-210 (pCi/L)	891	851
Radium (pCi/L)	533	NR
Thorium-230 (pCi/L)	39,150	37,800

[a]Units are milligrams per liter (mg/L or ppm) except where indicated as pico-Curies per liter (pCi/L). NA = not applicable; NR = not reported. Values are averages of two samples collected in 1987 at different locations in the tailings pile.
[b]The total includes suspended solids as well as dissolved.
Source: EnecoTech (1988).

activities were as follows: slimes—47 Becquerels per gram (Bq/g) [1275 picocuries per gram (pCi/g)]; sands—8.9 Bq/g (241 pCi/g); and ore—7.9 Bq/g (213 pCi/g).

2.1.2.2 On-Site Construction and Operations During the Reclamation Process

The primary activities on the site during reclamation would be the grading and earth hauling required to reconfigure Moab Wash, the grading required to contour the surface of the tailings pile and the cover system, and operation of earth-hauling vehicles and trucks providing cover materials from borrow areas and hauling mill debris to the debris disposal sites at the southern and northeastern edges of the tailings pile. Earthwork would occur mainly from May to September when weather conditions are favorable. No new buildings would be constructed. An existing building would provide the needed facilities for workers.

2.1.2.3 Monitoring and Maintenance of the Tailings Pile

Surveys and monitoring of the tailings pile itself as proposed by the licensee are described in this section, whereas monitoring to detect impacts on air quality, water quality, etc., is discussed in Section 4.

Pre-Reclamation Characterization and Monitoring. Test borings were made at six locations on the tailings pile in 1992 to characterize the chemical and physical characteristics of the tailings. Thirty-six samples were collected and grouped into three material types—ore, coarse tailings, and fine tailings. Three composite samples were taken from each of the three groups and tested for specific gravity, radium activity, emanation coefficient, diffusion coefficient, density, moisture, gradation, Atterberg limits, and capillary moisture relationships.

Prior to placing the cover system over the tailings, a system of monuments would be installed to detect any settling of the tailings. Each monument would consist of a 1.9-cm- (0.75-inch-) diameter metal rod welded to a 61-cm (24-inch) by 61-cm (24-inch) base plate. The rods would extend 15 cm (6 inches) above the final cover system. Before placing the cover system, monitoring would be conducted to ensure that sufficient settling of the tailings had occurred. Because differential settling could adversely affect the cover system, monitoring would continue during cover placement to detect any adverse settling that would require correction.

During Reclamation. The same type of monitoring as conducted previously would continue during the reclamation process. No additional monitoring requirements are anticipated.

Post-Reclamation. Once Atlas completes the reclamation, the agency that would assume responsibility for the tailings pile would prepare a long-term surveillance plan (LTSP) and submit it to NRC for approval. Upon NRC approval of the LTSP, NRC would terminate the Atlas license (No. SUA-917) and approve transfer of ownership of the tailings pile to the United States or the state of Utah, at the option of the state (Appendix A to 10 CFR Part 40) subject to a general license issued under 10 CFR Part 40.28 for custody and long-term care of byproduct material disposal sites. At a minimum, the responsible agency would be required to conduct annual site inspections to determine the need, if any, for monitoring and/or maintenance of the reclaimed tailings pile (Criterion 12, Appendix A to 10 CFR Part 40).

2.1.3 Borrow Areas and Transport of Borrow Materials

Required borrow materials include rock riprap, clay, and sand. Sand would be obtained from various areas on the Atlas site. Rock and clay would be obtained from remote borrow areas and transported to the Atlas site primarily during the winter months when tourist traffic is reduced. Rock would consist of crushed bedrock and rounded alluvial cobble obtained from several sources (Figures. 1.1-1 and 2.1-4). Bedrock would likely be obtained from two quarries near the town of Castle Valley. One quarry would likely be in T25S, R23E, Section 22; the location of the other possible quarry has not yet been determined. Cobble would be collected from the earth surface in a contiguous area of 15.5 km^2 (6 square miles) about 13 km (8 miles) southeast of the center of Moab (T27S, R23E, Sections 7, 8, 17, and 18; and T27S, R22E, Sections 1 and 12). The licensee would probably contract commercial firms to obtain and deliver the rock. About half of the rock would be cobble and half would be crushed bedrock.

The transport route for the cobble would be U.S. 191 through Moab, and that for the bedrock would be past the town of Castle Valley and then on State Highway 128 to the Atlas site. Rock would be transported by 18-metric-ton (20-ton) trucks at an approximate rate of 10 to 12 trucks per hour during daylight hours.

Clay for the tailings pile cover would be obtained and transported by truck from the Plateau site on Klondike Flat about 23 km (14 miles) northwest of the mill tailings site. Atlas currently has a lease from the state of Utah to obtain clay from a 65-ha (160-acre) portion of the Plateau site. The transport route leaving the borrow area would be along the dirt road leading to U.S. 191 and then southeast along U.S. 191 to the Atlas site.

2.1.4 Schedules for Reclamation and Employment

Interim cover placement to provide for control of tailings pending reclamation was completed in November 1995. It was started in August 1989 and completed in phases as the pond in the center of the pile dried up. Installation of the final cover system would begin at an appropriate time after the NEPA process is completed and after NRC has made a determination of the acceptability of the Atlas proposal being addressed by this DEIS. Atlas proposes to perform reclamation in five 15-week phases starting once they have obtained required approvals. Approximately 30 weeks would be devoted to the transport and placement of clay and rock material. The remaining 45 weeks would be devoted to earthwork. The truck transport of clay and rock would be conducted primarily during the winter, when tourist traffic is reduced. A small number of existing Atlas employees (e.g., <10) would continue working at the Moab site during reclamation. Atlas would obtain a small number of other reclamation workers from contractors. The average number of workers at peak periods of activity is estimated to be about 25.

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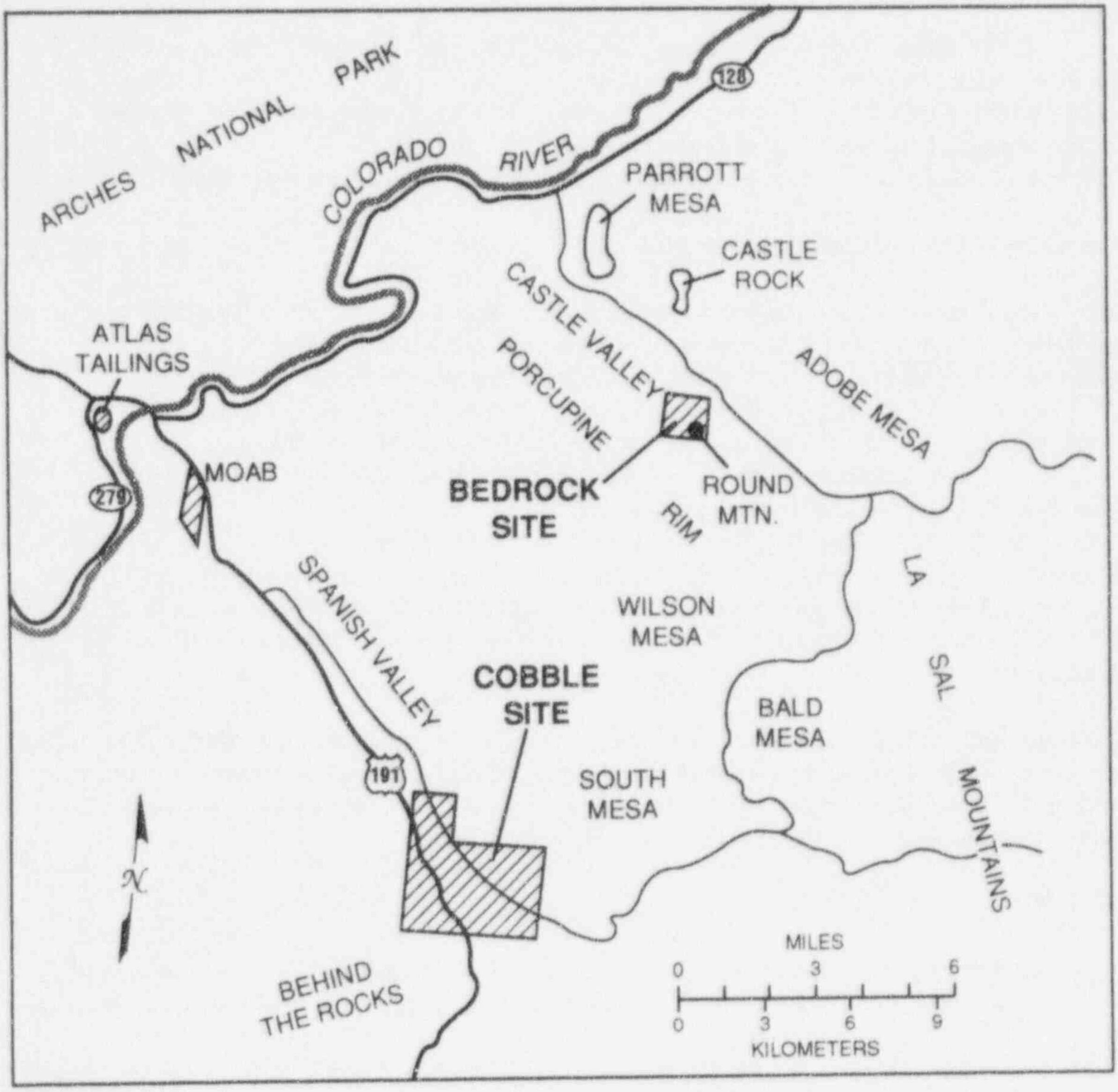

Figure 2.1-4. Locations of Possible Borrow Areas for Rock.

2.1.5 Natural Resource Requirements

Natural resources that would be required for reclamation include the following:

- about 272,000 metric tons (300,000 tons) of rock (about 50% crushed bedrock and 50% rounded alluvial cobble) (CESC 1993);
- about 56,000 m^3 (73,300 yd^3) of clay from the Plateau site, as estimated by the licensee;
- an undetermined amount of sand from the Moab site; and
- vehicle fuel (diesel fuel and gasoline) from a contractor (quantity not estimated).

2.1.6 Emissions, Discharges, and Solid Wastes

Emissions to the air during reclamation would include vehicle exhausts, radon from the tailings, external gamma radiation, and dusts raised by vehicles and wind. After reclamation, exhaust emissions would be eliminated, radon releases would be maintained below an average of 0.74 Becquerels per square meter per second ($Bq/m^2/sec$) [20 picocuries per square meter per second (20 $pCi/m^2/s$)] from the surface as required by Criterion 6 of Appendix A to 10 CFR Part 40, direct gamma radiation exposures to the public would be indistinguishable from background levels, and particulate releases would be eliminated.

The only anticipated liquid discharge from the tailings is tailings leachate that would continue to percolate through the tailings pile and enter groundwater at a slow rate. Surface runoff would not be contaminated and would discharge by way of the drainage ditches to Moab Wash and the Colorado River.

At some time after tailings reclamation has been completed, the remaining uncontaminated office building, if not retained for other use, could be dismantled and disposed. As much as possible of the building debris would be released for outside use, with the remainder to be disposed in a landfill on the Atlas site or in a permitted commercial landfill.

2.1.7 Mitigation

Mitigation proposed by the licensee consists of dust suppression measures and erosion control during the reclamation process. Water and/or chemical dust suppressants would be sprayed on the tailings pile and the primary travel routes on the site. At the end of each phase of reclamation, the areas surrounding the tailings pile that have been constructed to final grade would be seeded using a permanent seed mix and mulched. Certain areas where disturbance occurs occasionally would be seeded with fast-growing grasses. Silt fences and straw bales would be used as needed to control erosion and minimize runoff of sediments to Moab Wash and the Colorado River.

Riprap placement along the relocated Moab Wash would be completed as soon as practicable after relocation of the wash. Other mitigation would consist of the ongoing corrective actions as described above. Existing fuel and oil tanks on the Atlas site and any other tanks that may be brought onto the site would be placed within bermed areas capable of containing accidental spills. Possible additional mitigation of potential impacts is discussed in Section 4.

2.1.8 Possible Accidents

Possible accidents that could affect the public include failure of the tailings cover system and traffic accidents involving vehicles transporting borrow materials. The potential impacts of these accidents are discussed in Section 4.

As part of its evaluation detailed in the draft TER for the Atlas proposal (NRC 1996), staff will determine whether Atlas has acceptably designed the cover system to withstand the maximum credible earthquake and the probable maximum flood (PMF) on the Colorado River. The cover system also would protect the pile along Moab Wash (Figure 2.1-2). The relocation of Moab Wash farther to the northeast provides additional erosion protection.

For the purposes of this DEIS, it is assumed that a severe hypothetical flood (HF) occurs and that this flood has the capability of transporting significant quantities of tailings solids and liquids downstream. Further, this flood is assumed to have characteristics that enable it to produce worst-case conditions relative to tailings erosion and transport. Because the reclamation design is adequate to provide protection against flooding and erosion (see draft TER, NRC 1996), the impact assessments presented in this DEIS do not assume that the tailings pile failure is caused by the HF. Rather, these assessments assume that the pile fails by some arbitrary mechanism and that the HF occurs simultaneously to transport the tailings into the river.

It is important to note that the Probable Maximum Flood (PMF) was not used in these impact analyses, because such a flood may not represent the worst-case condition relative to flow velocities in the river channel or at the side slope of the tailings pile. Extensive analyses of water surface profiles that were performed by the licensee and reviewed by the staff (see draft TER for additional information) have indicated that the worst-case condition for flow velocities occurs at a river discharge of about 1980 m^3/s (70,000 cfs), which is approximately equivalent to the 1984 flood. However, maximum water levels occur during a PMF. Accordingly, the HF combines the worst-case conditions of all floods that could occur on the Colorado River. Maximum velocities are assumed coincident with maximum water levels to provide an upper-bound estimate of the ability of the river to erode and transport tailings.

In general, the tailings are assumed to fail in a manner (such as a massive slope failure onto the floodplain) that allows them to be eroded and transported by the river. Even though it would be extremely unlikely that a slope failure and flood would occur at the same time or that any tailings would reach the river before the tailings could be cleaned up, it is assumed that a significant quantity of tailings enter the river. It is assumed that as much as 15% $\pm$ 5% (1.9 million metric tons or 2.1 million tons) of the tailings would enter the river as a result of this hypothetical, maximum pile failure. Some fraction of the sands (coarse tailings) would likely settle to the bottom of the river proper or the inundated floodplain within the first few hundred meters downstream. Thereafter, the finer tailings that settled to the river bottom would, over the long term, be resuspended and transported downstream. The fines, clays, and slimes, which have higher levels of contaminants than the sands, would remain in suspension for much greater distances, mostly settling to the bottom of Lake Powell after an unknown period of several years of cycling and recycling between the water column, the riverbank, and the bottom sediments on the way to the reservoir. It is assumed that the pile would be repaired to prevent further contamination of the river after the HF event. Potential impacts of the hypothetical, maximum failure of the tailings pile are discussed in Section 4.

2.2 DISPOSAL AND RECLAMATION AT AN ALTERNATE SITE

This section includes conceptual descriptions of various alternatives to tailings reclamation at the Moab site. Because none of the alternatives is actually proposed for tailings disposal at this time, none has been subjected to the detailed planning that would be required for nearly final design of facilities and operations. Therefore, if any alternative were eventually selected for tailings disposal, its final design could differ from the conceptual descriptions. NRC requires conceptual-level (i.e., not highly detailed) information for alternate designs and reconnaissance-level information for alternate sites (10 CFR Part 51). This section is consistent with the Commission's directions in the statement of consideration for 10 CFR Part 51 that evaluations of alternative sites should be at reconnaissance levels.

As explained previously (Sections 1.1 and 1.5), the alternative of tailings transport by rail and disposal at the Plateau site has been selected for detailed comparison with the Atlas proposal. Should NRC not approve the Atlas proposed on-site reclamation plan, additional environmental evaluation would be required for any alternate plan.

2.2.1 Plateau Site

2.2.1.1 Overview

The Plateau site is located on an area known as Klondike Flat about 29 km (18 miles) northwest of the Moab site (Figure 2.2-1). The site is on a relatively level upland with a salt-desert vegetation used for grazing. No permanent stream is on the site, although an ephemeral wash is located near the site. Deposits of evaporites, including potash, underlie this area, and the Moab Fault may extend into the vicinity.

Tailings (9.5 million metric tons or 10.5 million tons) and contaminated soils [possibly about 726,000 metric tons (800,000 tons) including earth from beneath the tailings] would be moved by a covered conveyor to the railroad at the Atlas site and transported by rail to the Plateau site. A railroad spur would be constructed from the existing rail line south of the airport for approximately 5.3 km (3.3 miles) to the Plateau site (Figure 2.2-1). Alternative modes of tailings transport are discussed in Section 2.2.3. Contaminated mill debris that could not pass through the conveyor would be trucked to the Plateau site. Uncontaminated wastes or wastes having a level of contamination at acceptable release limits would be disposed on the Atlas site, at a commercial

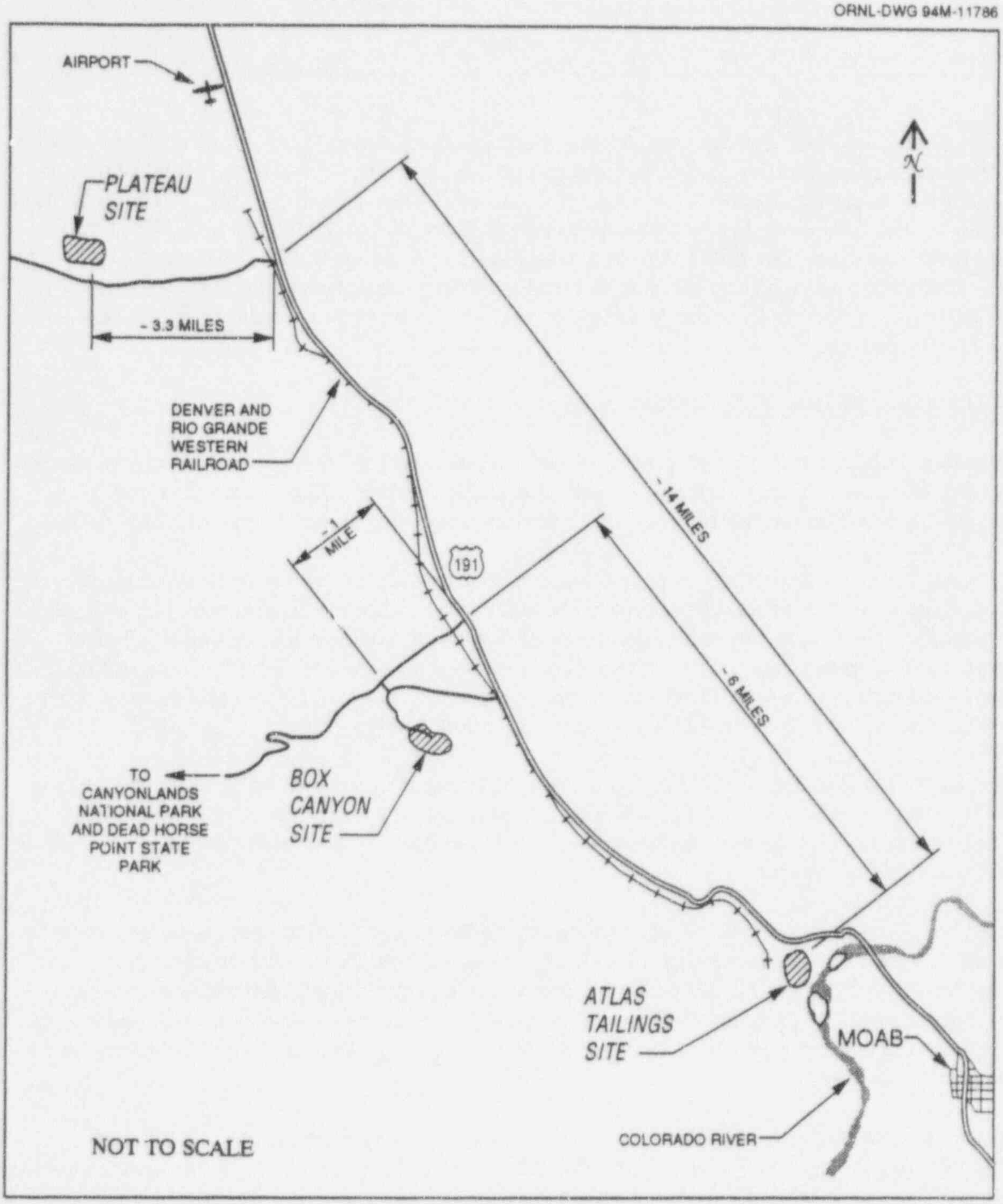

Figure 2.2-1. Location of the Plateau Alternate Site for Disposal of the Atlas Corporation Uranium Mill Tailings at Moab, Utah. Multiply miles by 1.609 to obtain kilometers. *Source*: CESC 1993, Figure 1.

landfill, or released for off-site use. Any borrow materials needed would be transported by truck to the Plateau site (Section 2.2.5). Water for dust control and compaction of the cover system at the Plateau site would be transported to the site by a new 34-km- (21-mile-) long, 15-cm (6-inch) diameter pipeline. The water line would require two or three pumping stations and a 757,000-L (200,000-gal) surge tank. The Moab tailings site would be cleaned up to EPA standards by removing contaminated soils from the site and transporting them by truck to the Plateau site. After completion of reclamation, the Moab site would be recontoured and revegetated where needed to limit erosion.

2.2.1.2 Alternative Modes of Tailings Transport

The following modes of tailings transport have been considered for final disposal of tailings at the Plateau site. However, tailings transport by conventional truck, private haul road, or slurry pipeline, as described below, are believed to be less desirable than transport by rail.

Conventional Truck. A conveyor system and truck loading facility would be constructed on the Moab site. Trucks would be used to transport the tailings on public roads, primarily U.S. 191, to the Plateau site. The trucks would be equipped with covers to minimize loss of tailings. Truck washdown facilities could be required at the Moab and Plateau sites. Vehicle speeds would be maintained at levels determined to be safe according to loads, road conditions, and existing traffic. Maintenance of gravel and dirt roads would include grading and dust control as needed.

A haul road for truck access to the Plateau site would be constructed, extending from the existing dirt road less than a mile south of the site. The area through which the new road would pass would not be expected to present any unusual or costly engineering problems, and little cut-and-fill would be required.

Transport would be halted in the event of extremely high winds or rainfall when wind or water erosion could result in widespread dispersal of any spilled tailings. Roadside trench-drain systems along the transport route would not be installed to contain possible spills. Rather, transport would be halted in the event of extremely high winds or rainfall when wind or water erosion could result in widespread dispersal of any spilled tailings. In the event of a spill, cleanup procedures would be implemented immediately.

The primary disadvantage of tailings transport by truck would be the use of U.S. 191 for many truck round trips per day over several years. The additional traffic would be a safety hazard and a nuisance for the public, and the potential would exist for public exposure to tailings.

Off-Road Truck and Private Haul Road. This alternative would involve construction of a private haul road and use of large-capacity trucks. However, this alternative does not appear feasible for the Moab tailings pile, because all feasible routes away from the Atlas site are already occupied by public roads that either go through the town of Moab or exit Moab Valley by way of the Moab Canyon or Colorado River canyon.

Rail Transport. A covered conveyor system, a silo facility for loading rail cars, and a side rail at the existing railroad would be constructed at the Moab site. The conveyor would cross State Highway 279 west of the tailings pile (the railroad and the highway are shown in Figure 2.1-1). An automatic scraper assisted by a dozer would be used to load the tailings onto the conveyor, which would lead to the new rail-car loading facility at the existing rail. A 5.6-km- (3.5-mile-) long rail spur with a 3.7-m- (12-ft-) wide access road would be constructed to the Plateau site from the existing track along U.S. 191. A fleet of about 25 gondola rail cars would be obtained and modified to prevent the loss of tailings during transport. An unloading facility having a mounted backhoe would be constructed at the Plateau site. The backhoe would unload the tailings from the open-top gondolas and transfer the tailings to a conveyor for distribution of the tailings over the disposal pit. Dust-trapping enclosures for rail car loading and unloading would be used at both the Moab and Plateau sites. The licensee estimated that transport of the tailings would last about 8.7 years if conducted 5 days per week or 6.2 years if conducted 7 days per week; the required time would be about 9.4 or 6.7 years, respectively, when transport of contaminated soils (including earth from below the tailings pile) is included in the estimate.

The alternative of tailings transport by rail would include transport of contaminated mill debris by dump truck, with the debris covered by tarp. The licensee estimated that debris transport would require a period of 70 days at 50 loads per day.

Railside trench-drain systems to contain possible spills along the transport route would not be installed. Rather, transport would be halted in the event of extremely high winds or rainfall when wind or water erosion could result in widespread dispersal of any spilled tailings. In the event of a spill, cleanup procedures would be implemented immediately.

Slurry Pipeline. To support tailings transport by slurry pipeline, a repulping plant to process tailings into a slurry form would be constructed near the tailings pile on the Moab site. A surge tank for the pipeline would also be constructed on the site. The coarse tailings and some of the contaminated soils would be transported by the slurry pipeline, which would likely be approximately 25 cm (10 inches) in diameter. The amount of tailings suitable for slurry transport has not been estimated. Wastes not suitable for slurry transport (such as contaminated mill debris) would be transported by conventional truck on U.S. 191. A likely route for the slurry pipeline would be near and parallel to U.S. 191. Water for slurry transport would be obtained from the Colorado River and/or wells on the Moab site. A water pipeline, which would likely be about 20 cm (8 inches) in diameter, would be constructed adjacent to the slurry pipeline to return used water from the Plateau site to the Moab site where it would be reused for slurry transport. To contain any spills resulting from leaks or breaks in the pipelines, a drain system consisting of a ditch containing the pipelines and several catchment basins along the ditch would be constructed. A road, probably of crushed rock, would also be constructed adjacent to the pipelines to provide access for surveillance, maintenance, and emergencies.

Continuous operation of the slurry transport system would require the stockpiling of tailings at the pulping plant. Trucks or a conveyor would move tailings from the Moab pile to the repulping plant. The tailings would be mixed with water to a 50% (by weight) slurry at a rate of 285 metric tons/hr (314 tons/hr) of tailings. The flow rate to the slurry pipeline would be about 6800 L/min. (1800 gpm), including about 297 metric tons/hr (327 tons/hr) of tailings—including 11.8 metric tons/hr (13 ton/hr) of tailings returned from the Plateau site to the pulping plant in the slurry liquid return pipeline. To make up for water loss during the process (e.g., evaporation from the Plateau site tailings pond and entrainment of water in the new tailings pile), water would be withdrawn from the Colorado River and/or wells on the Moab site at a rate of about 992 L/min. (262 gpm).

Trucks would be used to transport all materials that could not be transported by the slurry pipeline. These materials include contaminated building demolition wastes, stabilized slimes mixtures, soils currently covering the pile, and contaminated soils.

At the Plateau site, a decant barge would be used to recover about 3955 L/min (1045 gpm) of the slurry liquid for return through the return pipeline to the repulping plant at the Moab site. The return slurry liquid would consist of about 5% (by weight) tailings (11.8 metric tons/hr or 13 tons/hr of tailings). Earth from excavation of the pit would be used to construct an embankment to impound the above-grade portion of the tailings. After completion of slurry transport, water in the tailings would be pumped to the surface for evaporation to maximize the drying of the tailings. Water spraying could be used to increase evaporation.

The slurry pipeline alternative has several disadvantages and is not considered to be the best transport alternative. The economic costs would be high due to costs of construction and right-of-way acquisition. Costs of spill prevention and control could also be high. Truck transport of a large amount of tailings and debris would still be required. Tailings transported by pipeline would be wet and would have to be isolated from the tailings transported by truck and dewatered before being incorporated into the final tailings pile.

2.2.1.3 Tailings Disposal

The following description of tailings disposal at the Plateau site is based on information provided by the licensee. However, this preliminary design does not fully implement the requirement for below-grade disposal. The Plateau site would allow full-grade disposal, which would likely be required if such a site were selected for final disposition of the tailings.

Site Preparation. Initial preparation of the Plateau site would involve the construction of a security fence and a diversion system to prevent surface runoff from entering the disposal area and to drain any shallow groundwater that may be present. A sedimentation pond would be constructed below the tailings pile site to control surface runoff of sediments resulting from construction activities.

The pit for tailings disposal would be excavated with heavy earthmoving equipment. Excavated earth would be removed and used in part for construction of the tailings embankment and eventually for part of the tailings cover system. This excavation could require the removal of any groundwater that flows into the pit. Any excess excavated topsoil and subsoil would be segregated and stockpiled on the site for future use.

Tailings Disposal and the New Tailings Pile. Prior to tailings disposal, a clay liner would be installed on the surface of the excavated pit (Figure 2.2-2). Tailings surveys and field testing would be conducted as needed to ensure appropriate management of coarse and fine tailings and any tailings that could need additional drying. Fine tailings may be mixed with coarser tailings to minimize differential settlement of the new tailings pile. Tailings would then be deposited to fill the pit and piled 4.3 m (14 ft) above grade at the center of the pile. The top of the pile would be nearly level, and the pile sides would have slopes of 20% (1V:5H). The cover system would consist of a radon barrier directly on top of the tailings, a 0.6-m (2-ft) layer of cover soil, and a 15-cm (6-inch) layer of rock. Water would be obtained from a contractor or the city of Moab and used for dust control and compaction needs. The perimeter of the site would probably be fenced for institutional control. The licensee would need a waiver from NRC to implement partial below grade disposal at a new tailings site on Klondike Flat.

If NRC does not grant a waiver for partial below grade burial, the licensee would be required to bury the tailings entirely below grade at Klondike Flat. Only a more gently sloped cap would be permitted to extend above grade. Maximum depth of burial may be constrained by groundwater and would be constrained by the slope (30%) of the trench's wall (assuming land area requirements remain unchanged). It is likely that completely below grade disposal would require deepening of the trench, off-site disposal of excess excavated material that would not be needed in the cover's construction, and additional land acquisition. Less elaborate erosion protection would be required for the more gently sloped tailings cap.

2.2.1.4 Borrow Areas and Transport of Borrow Materials

Riprap requirements for the Plateau site remain to be determined. Riprap would likely be needed for the top and side slopes of the tailings pile. The design could be engineered to minimize the rock size and quantity needed, and if the final design is for below-grade disposal, the amount of riprap needed would be much reduced. The licensee assumed that riprap requirements would be relatively large (see Section 2.2.8), and it is possible that some rock would need to be obtained from the Castle Valley and Spanish Valley areas and transported by truck as described for the Atlas-proposed disposal at the Moab site. Clay for the bottom liner and clay and soil for the cover system would be obtained from the pit excavated for the tailings.

2.2.1.5 Final Disposition of the Moab Site

After removal of uranium tailings and contaminated earth and materials, the Atlas site would be cleaned up as required to allow unrestricted use. The need to clean up groundwater contamination at the site after the pile is moved would require additional effort and time. The licensee has estimated that it would take approximately 25 years for one cycle of natural flushing to occur (WTI 1989). The amount of effort and time for groundwater cleanup could be

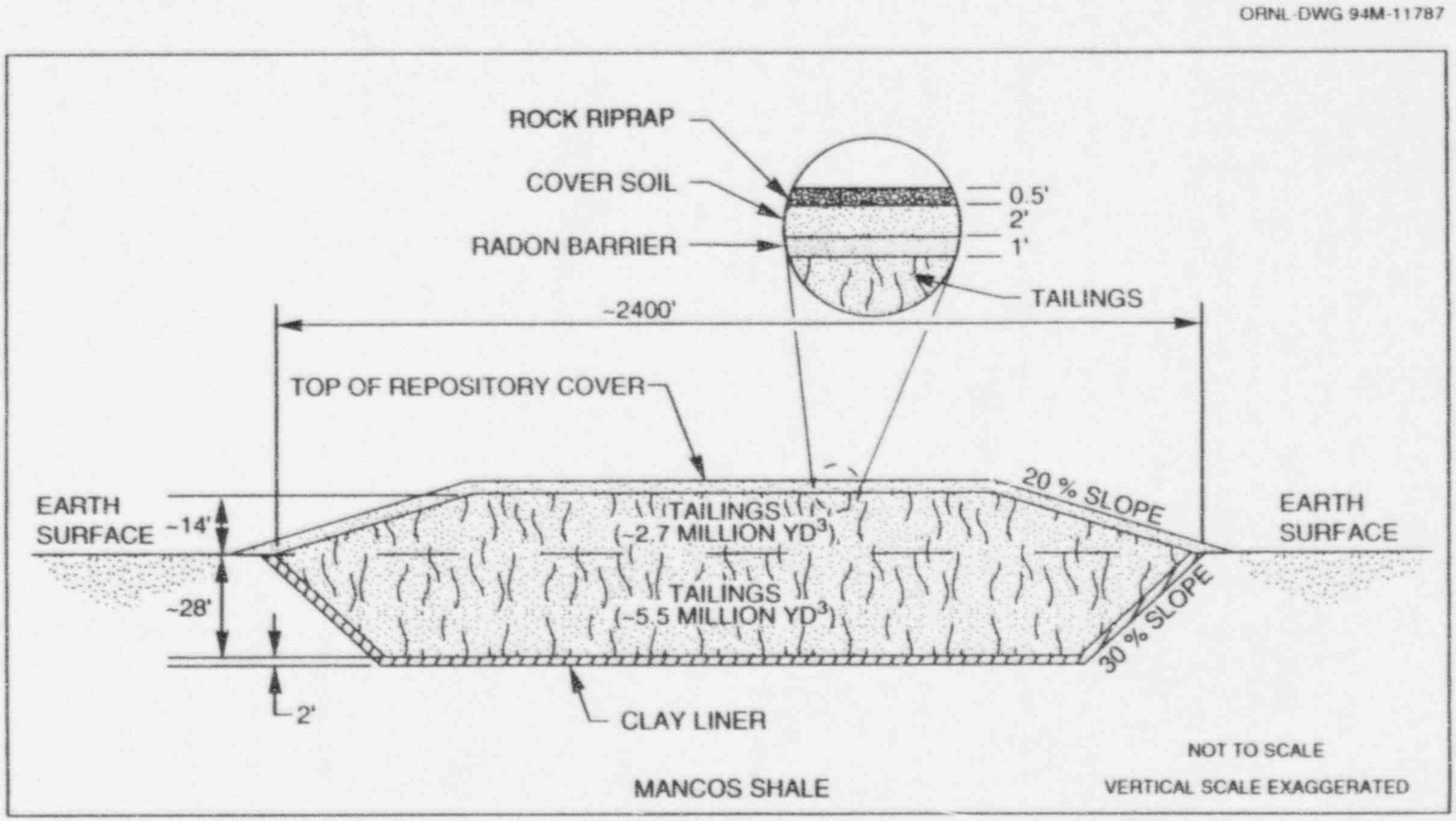

Figure 2.2-2. Conceptual Design of the Tailings Pile at an Alternate Site. Layer thicknesses and pile diameter are given in ft (divide by 3.281 to obtain meters). YD^3 = cubic yards.

substantial. If a decision to move the pile is made, additional environmental review and analysis would be required.

The requirement for unrestricted use is that radium-226 in any 100-m^2 (120-yd^2) area of the soil does not exceed background level by more than 0.19 Bq/g (5 pCi/g) averaged over the top 15 cm (6 inches) of earth and 0.56 Bq/g (15 pCi/g) averaged over 15-cm- (6-inch-) thick layers more than 15 cm (6 inches) below the surface (Criterion 6 of Appendix A, 10 CFR Part 40). If the pile were moved, groundwater at the site would have to be cleaned up to unrestricted use standards as opposed to ACLs that are based on health effects at the point of exposure. After completion of earth moving activities, the Atlas site would be recontoured where necessary and revegetated to control erosion.

2.2.1.6 Post-Reclamation Activities, Monitoring, and Surveillance

Programs for surveillance, maintenance, and monitoring would be developed for the new tailings disposal site and would incorporate the post-reclamation activities described in Section 2.1.2.3 for the Moab site. Roughly 10 piezometers, 20 groundwater-monitoring wells, and 15 settlement markers would be installed. Other monitoring and surveillance would be similar to that described for the Atlas proposal for the Moab site in Section 2.1.2.3.

2.2.1.7 Schedules for Reclamation and Employment

A schedule providing start and end dates for tailings disposal at the Plateau site is not feasible to develop at this time. The licensee estimated that tailings transport by rail would require 8.7 years if conducted 5 days per week or 6.2 years if conducted 7 days per week; the required time would be about 9.4 or 6.7 years, respectively, when transport of contaminated soils (including earth from below the tailings pile) is included in the estimate. The time period required for riprap transport would depend on the amount of riprap needed, if any. The number of workers would be about the same as for tailings disposal at the Moab site, although several more jobs might be created to transport the tailings. The time and effort required to clean up groundwater sufficiently to allow unrestricted use is not known at this time, but the licensee has estimated that such cleanup could possibly take 25 years (WTI 1989).

Extremely cold weather conditions could limit tailings transport for extended periods of time during the winter. High winds and rainstorms would not be expected to limit tailings transport for any significant length of time.

2.2.1.8 Natural Resource Requirements

Natural resources that would be required for tailings disposal at the Plateau site include clay, sand, and fuel for trains, trucks, and other vehicles. Riprap amounts are uncertain since below-grade disposal may be required.

The licensee provided the following estimates of natural resource requirements (CESC 1993):

- about 221,700 metric tons (244,400 tons) of rock riprap from Castle Valley or near Moab, including about 3990 metric tons (4400 tons) of crushed stone for the rail access road;
- about 485,500 m^3 (635,000 yd^3) of clay, obtained on the site and including 325,000 m^3 (425,000 yd^3) for the clay liner and 160,600 m^3 (210,000 yd^3) for the radon cap; and
- vehicle fuel (diesel fuel and gasoline) from a contractor (quantity not estimated).

2.2.1.9 Emissions, Discharges, and Solid Wastes

Emissions, discharges, and solid wastes would generally be the same as for disposal at the Moab site. If a vegetative cover is developed on the tailings pile, surface runoff during rain events may be minimal.

2.2.1.10 Mitigation

Disturbed areas at the Moab site and Plateau site would be recontoured and seeded where needed to limit erosion and promote re-establishment of native plant communities. Possible additional mitigation of potential impacts is discussed in Section 4.

2.2.1.11 Possible Accidents

Possible accidents that could affect the public include failure of the tailings cover system, spills or other accidental releases of tailings during tailings transport and handling, and traffic accidents involving trucks transporting mill debris. Potential accidents involving tailings transport are evaluated in Section 4.8.2. Severe hypothetical flooding at the Plateau site that would transport significant quantities of tailings solids and liquids downstream is an extremely low probability event that requires no detailed assessment. The Plateau site is located in the extreme headwaters of ephemeral streams that seldom experience severe flooding.

2.2.2 Other Alternate Sites

Prior to publication of the 1979 EIS for operation of the Moab mill (NRC 1979), the licensee, in cooperation with state, Federal, and local agencies, attempted to locate an alternate site for the disposal of mill tailings. For this DEIS, NRC and other agencies and individuals have also attempted to identify potential alternate sites. The following sites have been identified:

- the Box Canyon Site 11 km (7 miles) northwest of the Moab site, to which the tailings would be transported by truck or conveyor and rail,
- the Rio Algom Tailings Area about 48 km (30 miles) southeast of the Moab site, to which the tailings would be transported by truck,
- the Envirocare Site about 105 km (65 miles) west of Salt Lake City and 370 km (230 miles) northwest of Moab,

- the Emery County Development Corporation Site at East Carbon, about 130 km (80 miles) north-northwest of Moab, and
- three variants of the Plateau site, including sites 0.8 to 1.6 km (0.5 to 1 mile) west, 1.6 to 3.2 km (1 to 2 miles) west-northwest, and 0.8 km (0.5 mile) southwest of the Plateau site.

These sites are briefly examined here to determine whether they would, in comparison with the Plateau site, more greatly favor a decision to remove tailings from the Atlas site. However, because no significant environmental problem has been identified for the alternative of tailings disposal at the Plateau site (as discussed in Sections 2.4 and 4), it is doubtful that any alternate site would have a significant *environmental* advantage over the Plateau site. In fact, no such advantage has been identified for any of the sites. If no significant environmental advantage were identified, cost comparisons would be more important in selection of an alternate site.

The Box Canyon Site is off the west side of Moab Canyon (Figure 2.2-1). Transport of tailings would be by truck on U.S. 191 or by conveyor and rail. An access road would be constructed to the site from the existing paved road about 1.6 km (1 mile) to the northwest (Figure 2.2-1). If tailings transport were by rail, a rail spur about 3.2 km (2 miles) long would be constructed from the existing track along U.S. 191. Clay from the Plateau site would be transported by truck on U.S. 191. Staff visited the site in April 1994 and noted the presence of several small washes formed by surface runoff and the somewhat limited space for a tailings pile. These washes would likely require the use of significant diversion structures and large riprap to provide erosion protection for long-term stability of the tailings. Because of the potential erosion problem and the rather limited space at this site, the Box Canyon Site is not considered to be any better than the Plateau site for the comparison of alternatives in this DEIS.

The Rio Algom Site is an existing tailings disposal area. Under this alternative, trucks would be used to transport the tailings and would pass through the town of Moab, thus having potential impacts on the town. The transport distance would be about 48 km (30 miles), resulting in a higher financial cost than for the Plateau site. The site would have to be licensed by NRC for tailings disposal. Although the Rio Algom Site may be environmentally suitable, the potentially high costs and potential impacts on Moab associated with tailings transport suggest that it does not appear to be significantly better than the Plateau site alternative.

The Envirocare Site occupies 219 ha (540 acres) adjacent to a 40-ha (100-acre) pile of uranium mill tailings disposed on Utah-state land by DOE. The site has rail access. Additional land adjacent to the site may be available. Envirocare of Utah, Inc., has an NRC license to receive and dispose of up to 4.2 million m^3 (5.5 million yd^3) of uranium and thorium mill tailings and related wastes. The amount of tailings at the Atlas site is twice the licensed capacity of the Envirocare Site. Additional capacity for the Atlas tailings would require a change in the license from NRC and an environmental evaluation. The tailings-transport distance to the Envirocare Site would be over 322 km (200 miles). This transport distance could increase the cost and time required to complete tailings transport. Therefore, this alternative does not appear significantly better than disposal at the Plateau site, although it would not involve contamination of a new site.

The Emery County Development Corporation Site occupies 971 ha (2400 acres) with rail access. It is a private landfill that is licensed by the state of Utah for disposal of non-hazardous materials. Over 931 ha (2300 acres) of the site are currently available for additional waste disposal. The site would require a license from NRC similar to that held by Envirocare, which would require an EIS and several years to complete environmental review requirements. The Utah Department of Environmental Quality also would have to issue a permit to Emergy County Development Corporation to receive the Atlas tailings. The tailings-transport distance by rail would be approximately 160 km (100 miles). As in the case of the Envirocare Site, this alternative does not appear significantly better than the Plateau site for the comparison with the Atlas proposal in this DEIS. Nevertheless, it appears to be a reasonable alternative site deserving detailed evaluation if a decision is made to move the tailings.

Three variants of the Plateau site identified by the NPS (Poe 1994) are similar to the Plateau site itself but may reduce the visibility of the tailings pile from U.S. 191 and other vantage points, including those within Arches National Park. These sites would be considered for detailed examination if a decision were made to move the tailings pile.

2.3 THE NO-ACTION ALTERNATIVE

Under the no-action alternative, no NRC licensing action would occur and the current reclamation activities would cease at some time before full reclamation is complete. The staff considers that this alternative would place the NRC, the licensee, and other associated regulatory agencies in the position of not fulfilling their statutory responsibilities. An unreclaimed tailings pile would be less stable than a reclaimed pile and would be a greater hazard to the environment and human health. This alternative is considered to pose a greater risk to the environment than reclamation of the tailings at either the Atlas site or an alternate site.

2.4 COMPARISON OF THE IMPACTS OF ALTERNATIVES

This section provides a comparative summary of the potential impacts of the two alternatives examined in this EIS—i.e., the Atlas proposal and the Plateau site alternative. The impacts are assessed in detail in Section 4. The Atlas proposal includes (1) reclamation of the tailings on the Atlas site during five, 15-week phases; (2) obtaining, and transporting by truck, rock riprap from an area near the town of Castle Valley and an area southeast of Moab; and (3) obtaining clay from the Plateau site and transporting it by truck to the Moab site.

The Plateau site alternative includes (1) moving the tailings and contaminated soils from the Atlas site (Section 2.2.1) by conveyor and rail to the Plateau site over a period of 6.7 to 9.4 years, depending on the work week (i.e., 7 days or 5 days, respectively); (2) construction of a 4.8-km (3-mile) rail spur; (3) obtaining, and transporting by truck, a limited amount of rock riprap, possibly from near Moab or Castle Valley; (4) transporting mill debris by truck to the Plateau site; and (5) obtaining clay from the Plateau site, where the tailings would be disposed.

Assessment of the Atlas proposal also includes a hypothetical, maximum failure of the tailings pile design during an HF; this HF is described in Section 2.1.8 and would not be expected to actually occur. A similar pile design failure at the Plateau site was not analyzed because tailings would not enter a river and be transported downstream.

The primary differences in impact between the Atlas proposal and the Plateau site alternative are the long-term impacts that occur with the continued presence of the tailings pile. Short-term impacts may be relatively intense for a limited number of years. The more significant, long-term impacts include the following:

1. Tailings leachates would continue to enter a surficial groundwater aquifer that is not used for drinking or other uses near the Atlas site and which has naturally occurring, relatively high salinity levels caused by the dissolution of underlying salt strata (Sections 3.4.1 and 3.4.2). No groundwater would be affected at the Plateau site.
2. Tailings leachate seepage would continue to contribute small amounts of contaminants to the river, which, based on the analyses presented in Sections 4.4, 4.5, and 4.6, would not measurably or adversely affect water quality or aquatic biota beyond a small mixing zone. Under the Plateau site alternative, virtually no contaminants would enter area surface waters once reclamation and groundwater cleanup at the Atlas site are completed.
3. The hazard of a tailings pile failure with contamination of the Colorado River and downstream floodplains, including those in Canyonlands National Park and Glen Canyon National Recreation Area, would continue to exist at the Atlas site, whereas no such hazard would exist under the Plateau site alternative.
4. Use of roughly half of the Atlas site occupied by the reclaimed tailings pile would be precluded from alternative future uses under the Atlas proposal. Under the Plateau site alternative, future unrestricted use of the entire site would be possible after reclamation and groundwater cleanup has been accomplished. Development in the floodplain under either alternative would be subject to permitting by the U.S. Corps of Engineers.
5. Aesthetic impacts of the pile would be significantly greater at the Atlas site than at the Plateau site.
6. With reclamation in-place at the Atlas site, the tourist industry could be adversely affected by (a) the potential association of Moab and its immediate surroundings with radioactive wastes, (b) the potential negative economic effects on local and regional tourism and recreation of a pile failure due to perceived health and safety concerns, and (c) the unavailability of that part of the Atlas site occupied by the reclaimed tailings pile for alternative land uses, including tourism- and/or recreation-related uses.
7. The long-term dose to the public from the Atlas proposal would exceed that of the Plateau site alternative due to greater population density around the Atlas site.

The short-term impacts result from the reclamation operations, which include tailings transport under the Plateau site alternative. The primary differences in short-term impacts between the Atlas proposal and the Plateau site alternative include the following:

1. The Atlas proposal would involve tailings-handling activities and associated environmental disturbances and radiation releases over a shorter time period (i.e, about 5 years of general environmental disturbance and 2 years of relatively high radiation releases compared to about 6.7 to 9.4 years for the Plateau site alternative),
2. The Atlas proposal would involve more transport of riprap through Moab and Castle Valley, with potential adverse impact on recreational and other traffic, although transport would be done primarily in winter, and
3. Water use could be greater for the Plateau site alternative, because extensive dust control could be required at both sites rather than just at the Atlas site.
4. The short-term radiation dose to the public and workers would be greater for the Plateau site alternative than for the Atlas proposal because the former involves handling of all the tailings and associated activities at two sites.

The Atlas proposal and the Plateau site alternative also differ in the extent to which they would meet the 13 Appendix A technical criteria in 10 CFR Part 40 (listed in Appendix C). The Plateau site alternative would be better in regard to remoteness from populated areas (criterion 1.a), hydrologic features for isolation of tailings (criterion 1.b), below-grade disposal (criterion 3), minimal upstream catchment area (4.a), and groundwater protection (criterion 5). The Atlas proposal is not clearly better for any of the criteria.

Table 2.4-1 provides a summary of the impacts for the Atlas proposal and the Plateau site alternative for each of the resource areas evaluated. Section 4 provides a more complete discussion of these impacts.

In conclusion, the differences in potential long-term impacts listed above suggest that the Plateau site alternative is environmentally preferable to the Atlas proposal. No aspect of the Plateau site alternative would have a potentially significant, adverse, environmental or socioeconomic impact, although radiation doses associated with tailings handling operations would last longer. Thus, the high financial cost of moving the tailings may be the only significant disadvantage of the Plateau site alternative.

Table 2.4-1. Summary Comparison of the Impacts of the Atlas Proposal and the Plateau site alternative

Affected resource	Atlas proposal	Plateau site alternative
Air quality	During the 5-year reclamation process, vehicle emissions and fugitive dusts could affect several nearby residences. Air quality standards would not likely be violated, with the use of appropriate dust control measures. Trucks transporting riprap through the town of Moab would contribute to air pollution levels in the town. After reclamation, the tailings pile would emit essentially no dust. The hypothetical, maximum failure of the tailings pile design should have only a minor impact on air quality,	During the 6.7- to 9.4-year reclamation process, air quality impacts would be similar to those under the Atlas proposal except for the probably reduced truck traffic through Moab and the use of rail locomotives. After reclamation, negligible amounts of dust would be emitted by the pile at the Plateau site, and some dust would be emitted at the former Atlas site, depending on the type of activity at the site.
Land use	Reclamation activities would not impact land uses near the Atlas site. Construction of a rock quarry for borrow material would displace any other land use on the borrow site. Grazing at the Plateau site would be affected by obtaining borrow material from the site. Possible future use of roughly half of the Atlas site for commercial and/or residential purposes would be precluded. The hypothetical pile failure would be expected to produce only a slight level of contamination of lands along the river in Utah, and should not preclude agriculture, irrigation, or grazing over the long term. Land use could be restricted in certain areas until surveys of contamination were completed.	The extensive amount of land available for grazing in the region would be slightly reduced by construction of the tailings pile and rail spur. Any accident during tailings transport should have only negligible impact on land use. After reclamation and site cleanup, the former Atlas site would eventually have radioactivity levels low enough to allow unrestricted use of the site (although floodplain regulations would restrict development of part of the site). Future development may be restricted while groundwater cleanup proceeds to allow for unrestricted use.
Soils	Contaminated soils would be excavated and disposed in the tailings pile.	Tailings contamination of soils could occur at the Plateau site. Contaminated soils at the Atlas site would be cleaned up.

Table 2.4-1. Continued

Affected resource	Atlas proposal	Plateau site alternative
Groundwater	Water obtained from a contractor or the Moab municipal system would be used for dust control during reclamation. Some of this water may be groundwater. After reclamation, tailings leachates would continue to enter the alluvial groundwater, which flows to and enters the Colorado River. The leachates would continue to degrade alluvial groundwater quality. Alternative concentration limits may be proposed. The alluvial groundwater aquifer in the Moab area has naturally poor water quality and is not suitable for drinking without prior treatment. Because groundwater is not used in the site vicinity, groundwater use would not be affected. The hypothetical tailings pile failure would have minimal impact on groundwater.	During reclamation, groundwater use could be greater than for the Atlas proposal, because both sites could require water for dust control. No groundwater is near the surface at the Plateau site, and deeper groundwater is protected by overlying shale. Therefore, any groundwater impact at the site as a result of tailings disposal would be negligible. Any accident during tailings transport would be unlikely to have any appreciable impact on groundwater.
Surface water	Reclamation operations would have minimal impact on hydrology and water quality at the Atlas site and borrow sites. Dust control would require the use of some surface water supplied by the city of Moab. An erosion control plan is required, and Sect. 404 permit under the Clean Water Act may be required for operations on the Colorado River floodplain. Reducing the slopes of the tailings pile would result in a few additional acres of the floodplain being occupied by the pile. The continued presence of the pile would	Reclamation operations would have minimal impact on hydrology and water quality at the Atlas site, Plateau site, and borrow sites. Dust control could require the use of more surface water than the Atlas proposal. Although reclamation would require a longer time period of disturbance at the Atlas site, impacts on water quality should be minimal. Any accident during tailings transport would be unlikely to have any appreciable impact on surface waters. After reclamation, appreciable

Table 2.4-1. Continued

Affected resource	Atlas proposal	Plateau site alternative
Surface water (continued)	have negligible effect on flood levels. After reclamation, tailings leachates entering the river would continue to have minimal impact on water quality in the river, which already has relatively high contaminant concentrations regardless of the tailings. Under extreme low flow conditions in the river (i.e., flows near record lows), gross alpha radioactivity would be likely to exceed the state water quality standard. The hypothetical tailings pile failure would have a short-term impact on water quality, with only uranium from the tailings exceeding the state standard. In a few days, the tailings contaminants would be greatly diluted.	quantities of tailings leachates would no longer enter the Colorado River. No surface water would be affected by tailings disposal at the Plateau site.
Aquatic ecology, including threatened and endangered fish species	During reclamation, the minimal expected impact on water quality and control measures for erosion and spills would serve to minimize impacts on aquatic biota in the Colorado River. After reclamation, aquatic biota, including four endangered fish species, would continue to be exposed to very diluted quantities of leachates from the tailings pile. Contaminant and radiological doses would not be expected to cause a decrease in fish populations. The hypothetical tailings pile failure could have a short-term impact, but should not have any appreciable long-term impact on aquatic biota, because long-term impact on water quality should be negligible.	Reclamation would require a longer time period of disturbance at the Atlas tailings pile, but should have minimal impact on aquatic biota. Tailings transport would have minimal potential to impact aquatic biota. After reclamation, aquatic biota in the Colorado River would no longer be exposed to contaminants from the Atlas tailings. No aquatic biota would be impacted at the Plateau site, where no such biota are present.

Table 2.4-1. Continued

Affected resource	Atlas proposal	Plateau site alternative
Terrestrial ecology, including threatened and endangered species	Reclamation would involve minimal habitat loss and population reductions of terrestrial biota at the Atlas site and borrow sites. Threatened or endangered bird species that may visit the area of the site should not be affected. After reclamation, any additional habitat loss or population reduction would depend on future development activities on the site. Radiation and contaminant levels at the Atlas site and vicinity would be too low to affect populations of plants or animals. Contamination of lands along the Colorado River as a result of the hypothetical tailings pile failure should be too slight to affect plant or animal populations.	Impacts would be essentially the same as those for the Atlas site, except a larger habitat loss would occur at the Plateau site. The impact of this habitat loss on the terrestrial biota of the region including the Plateau site would be minor. Tailings transport would have minimal potential for impact on terrestrial biota. After disturbances are complete at the Atlas site, terrestrial biota would become established on any area not subjected to future development. Any contamination of land at the Plateau site should be too slight to have any appreciable effect on plant or animal populations.
Wetlands	A small area (e.g., 1.2 ha or 3 acres) of tamarisk wetland on the Atlas site would be lost. Borrow activities would not be expected to affect any wetland. The hypothetical tailings pile failure could result in a low level of contamination in Moab Marsh and smaller downstream wetlands.	No wetland would be affected by reclamation operations at the Plateau site. Borrow operations and tailings transport would also not be expected to affect any wetland. The potential for contamination of Moab Marsh would be eliminated.
Human population	Reclamation could result in a slight temporary increase in human population, as a result of reclamation workers moving into the area. Human use of roughly half of the Atlas site would be precluded under the Atlas proposal. The hypothetical tailings pile failure would not be expected to appreciably affect human population size in Moab or downstream areas, although several flooded residential areas could be slightly contaminated.	Impacts during reclamation would be essentially the same as for the Atlas proposal. After reclamation, commercial use of the former Atlas site could result in a slightly increased human population in the Moab area.

Table 2.4-1. Continued

Affected resource	Atlas proposal	Plateau site alternative
Economic resources	Reclamation employment would produce a slight economic benefit in Moab. Transport of riprap, which would be during the winter, could reduce sales in Moab if customers avoid areas of high truck traffic. Commercial or residential use of roughly half of the Atlas site would be precluded by the Atlas proposal. The hypothetical tailings pile failure would result in minor economic impact unless the public's perception of the recreational desirability of the area were substantially diminished, thus resulting in reduced visitation to the region. The low levels of land and water contamination after the failure should not appreciably affect economic factors related to the use of river water for irrigation, agriculture along the river, or grazing. Any impacts on tourism after a hypothetical pile failure would likely be short-lived, both locally and regionally. Tourism could decline slightly initially, but it is anticipated that tourism would recover moderately quickly as the nature, extent, and severity of any water contamination become understood and communicated. Secondary impacts of a pile failure could involve additional impacts on tourism in terms of traffic congestion and construction noise and activities during pile repair and reclamation.	Reclamation impacts would be essentially the same as for the Atlas proposal, but any loss of sales due to truck traffic should be less. The entire former Atlas site would be suitable for unrestricted use after reclamation and groundwater cleanup is completed, producing economic benefits to the community. Locally, tourism may be slightly enhanced with the removal of the pile from the Atlas site. Potential association of the city of Moab and immediate surroundings with radioactive wastes would be eliminated. Lack of negative perceptions could create a slight increase in the economic benefits to the tourism and recreation industries. If tourist or recreation facilities were constructed on the reclaimed Atlas site, additional benefits would be realized.

Table 2.4-1. Continued

Affected resource	Atlas proposal	Plateau site alternative
Aesthetics and recreation	Reclamation operations, borrow operations, and the presence of the reclaimed tailings pile would have an adverse aesthetic impact on recreationists and other persons in the area. Trucks transporting riprap on State Highway 128 would impact relatively heavy recreational use along the river in this area. Riprap transport, however, and clay transport from the Plateau site would be during the winter, thus minimizing the impact. After the hypothetical tailings pile failure, pile repair would produce some aesthetic impact. Recreation on the river might be restricted until the contamination was surveyed, and recreationists might avoid the area if their perception of the recreational desirability of the area were substantially diminished. Because Canyonlands National Park and Glen Canyon National Recreation Area are located downstream of the Atlas site, a pile failure could temporarily affect their visitation and the perception of the safety and quality of the recreation experiences available there. Duration of adverse perceptions would be uncertain, but would likely be short term.	Riprap transport would likely be much less, producing less impact, and no clay transport on public roads would be required. Reclamation operations would produce several more years of aesthetic impact than under the Atlas proposal. Conveyor and rail spur construction, tailings transport by conveyor and rail, and debris transport by truck on U.S. 191 would produce some aesthetic impact. After reclamation, the aesthetic impact of tailings would no longer exist at the Atlas site and should be negligible at the Plateau site. Removal of the Atlas pile eliminates any directly perceived threat to potential recreational and aesthetic experiences of downstream elements of the National Park system.
Public services and infra-structure	Reclamation operations have little potential for impact, although riprap transport on State Highway 128 could appreciably affect public traffic. Riprap transport during winter would minimize the impact. After the hypothetical tailings pile failure, contamination in flooded areas of Moab could affect services at some public facilities, including a sewage disposal plant and hospital.	Riprap transported on State Highway 128 is likely to be greatly reduced or not required. Tailings transport and other reclamation operations would have little potential for impact.

Table 2.4-1. Continued

Affected resource	Atlas proposal	Plateau site alternative
Historic and cultural resources	No historic or cultural resource would be affected.	No historic or cultural resource would be affected.
Radiological impacts	During reclamation, the dose to the nearest resident would be below the NRC limit, and the dose to the Moab area population would be very low compared to doses from background radiation. Doses after reclamation would be very low and, for the nearest resident, well below the limit.	Annual doses during tailings removal would be about the same as the reclamation-period doses for the Atlas proposal, but would last for 4 to 7 years longer. After tailings removal and site cleanup, doses would be less than for the post-reclamation period under the Atlas proposal. Transport of the tailings by rail would pose minimal risk.
Environmental Justice	No disparate positive or negative effects on specific ethnic or socioeconomic groups would be expected.	Same as for Atlas proposal.
Cost analysis	Non-discounted cost would be $13 to $16 million. The discounted cost would be $11 to $14 million. The cost could be 10 to 30% higher if highway restrictions require the use of smaller trucks for riprap transport.	Non-discounted cost would be $94 to $114 million. The discounted cost would be $62 to $75 million. Costs would be up to $2.5 million less when the value of the Atlas site is considered. The lost value of the Plateau site would be minimal (about $100/acre). Additional, undetermined cost may be associated with groundwater cleanup at the Atlas site.

3. THE AFFECTED ENVIRONMENT

3.1 METEOROLOGY, AIR QUALITY, AND VISIBILITY

3.1.1 Meteorology and Climate

The climate of the Moab region is semiarid. Average annual temperature is about 14°C (57°F). January is the coldest month, averaging -1°C (30°F), and July is the warmest month, averaging 28°C (82°F). Extreme temperatures have ranged from -28°C (-18°F) in January, 1963, to 44°C (111°F), which has occurred more than once (in July 1953 and on earlier occasions). Temperatures of 32°C (90°F) or higher occur about 100 days per year, with about 80% of those occurring during June, July, and August. Temperatures below freezing (0°C or 32°F) occur on 123 days of the year, on average, with about 80% of those occurring during November through February. The effects of high temperature on human comfort are moderated by the low relative humidity, which is often less than 50% during the daytime hours.

Average annual precipitation at Moab is 20 cm (8 inches), distributed about equally among the seasons with slight peaks during the spring and fall. Potential evapotranspiration [about 127 cm (50 inches) per year] greatly exceeds annual precipitation. Mean pan evaporation (about 140 cm or 55 inches) and lake evaporation (about 97 cm or 38 inches) also greatly exceed total annual precipitation.

The greatest amount of snow reported in one month was 51 cm (20 inches) in January 1978. Snowfall averages around 28 cm (11 inches) per year. The greatest precipitation amount reported at Moab in a single day was 5.3 cm (2.1 inches) on April 9, 1978, and the greatest amount in a single month was 17 cm (6.63 inches) in July 1918. The greatest expected 24-hour precipitation in 100 years is about 7.1 cm (2.8 inches) (Hershfield 1961), and the greatest expected 10-day precipitation in 100 years is about 9.9 cm (3.9 inches) (Miller 1964). For shorter-term precipitation episodes, the greatest expected 30-minute precipitation in 100 years is about 3.3 cm (1.3 inches) and the greatest expected 1-hour precipitation in 100 years is about 4.1 cm (1.6 inches) (Hershfield 1961). Additional data on maximum precipitation events is summarized in Table 3.1-1.

Low humidity in the region limits fog occurrences (visibility less than 0.5 km or 0.3 miles) to fewer than 10 days per year. Thunderstorms occur about 40 days per year. Hail occurs about 3 days per year.

Prevailing winds in the Moab region are westerly to southwesterly. Cold air drainage at the Atlas site can occur from the northwest under very stable conditions. The probability of a tornado is very small. One tornado with wind speeds of 160 km/hr (100 miles/hr)would be expected only once in about 100,000 years (ANS 1983).

Table 3.1-1. Expected Precipitation Extremes (inches) at Moab, Utah, for Selected Lengths of Time and Return Periods[a]

Return period	Duration									
	Hours					Days				
(Years)	0.5	1	2	6	12	1	2	4	7	10
2	0.4	0.6	0.7	0.8	0.9	1.0	1.1	1.4	1.6	1.8
5	0.6	0.8	1.0	1.2	1.4	1.5	1.6	1.9	2.1	2.3
10	0.8	1.0	1.2	1.5	1.7	1.9	2.0	2.2	2.3	2.8
25	1.0	1.2	1.4	1.7	2.0	2.2	2.5	2.7	2.9	3.3
50	1.1	1.4	1.6	2.0	2.2	2.5	2.7	3.0	3.2	3.6
100	1.3	1.6	1.9	2.2	2.5	2.8	3.1	3.4	3.6	3.9

[a]Multiply inches by 2.54 to obtain centimeters.

3.1.2 Air Quality

3.1.2.1 Ambient Air Quality and Visibility

National Ambient Air Quality Standards (NAAQS) exist for sulfur dioxide (SO_2), nitrogen dioxide (NO_2), carbon monoxide (CO), ozone (O_3), lead (Pb), and particulate matter small enough to move easily into the lower respiratory tract (particles less than 10 microns in aerodynamic diameter, designated PM-10). The NAAQS are expressed as concentrations of particular pollutants that are not to be exceeded in the ambient or outdoor air to which the general public has access [40 CFR Part 50.1(e)]. Primary NAAQS (Table 3.1-2) are designated to protect human health; secondary NAAQS are designated to protect human welfare by safeguarding environmental resources (such as soils, water, plants, and animals) and manufactured materials. Utah has adopted the NAAQS as the air quality standards for the state.

The air quality around Moab is good. Grand and San Juan counties are designated as being in attainment of the NAAQS for SO_2, NO_2, CO, and O_3 (40 CFR Part 81:345). Not enough data are available to support a classification for PM-10, so a designation of "unclassifiable" is given for that pollutant (40 CFR Part 81:345). The PM-10 (particulate matter less than 10 micrometers in diameter) data from Moab (Table 3.1-3) show one exceedance during the four-year period of 1991–1994; an average of one exceedance per year (on average, over a 3-year period) is allowed. No designation (attainment, nonattainment, or unclassifiable) is published for Utah for Pb, although data from Utah metropolitan areas indicate levels of Pb are less than 10% of the

Table 3.1-2. Air Quality Standards ($\mu g/m^3$)[a]

Pollutant	Averaging period	National Ambient Air Quality Standard		Allowable Increment for Prevention of Significant Deterioration	
		Primary	Secondary	Class I	Class II
Sulfur dioxide	annual	80		2	20
	24-hour[b]	365		5	91
	3-hour[b]		1300	25	512
Nitrogen dioxide	annual	100	100	2.5	2.5
Carbon monoxide	8-hour[b]	10,000			
	1-hour[b]	40,000			
Ozone	1-hour[b]	235	235		
PM-10[c]	annual	50	50	4	17
	24-hour[b]	150	150	8	30
Lead	3-month[d]	1.5	1.5		

[a]All concentrations are in units of micrograms per cubic meter ($\mu g/m^3$); Where no value is listed, there is no corresponding standard.

[b]Not to be exceeded more than once per year (for ozone and PM-10, on more than 1 day per year on the average over 3 years).

[c]Particulate mater less than 10 microns in diameter.

[d]Calendar quarter.

NAAQS (Tables 3.1-2 and 3.1-3). Lead concentrations in the atmosphere have decreased markedly in recent years, largely due to the substitution of unleaded gasoline for leaded gasoline.

The current median visual range for the Moab region is about 130 km (81 miles) (Trijonis 1990). At such distances, the curvature of the earth limits visual range where elevation differences between the viewer and the object viewed are less than around 1.4 km (0.9 mile).

3.1.2.2 Prevention of Significant Deterioration

In addition to ambient air quality standards, which represent an upper bound for allowable pollutant concentrations, there are standards for the prevention of significant deterioration (PSD) of air quality. The PSD standards differ from the NAAQS in that the NAAQS provide maximum allowable *concentrations* of pollutants, while PSD requirements provide maximum allowable *increases in concentrations* of pollutants for areas in compliance with the NAAQS. PSD standards

Table 3.1-3. Air Quality in the Moab Region

Pollutant	Monitor location	Year	Averaging period	Maximum ($\mu g/m^3$)[a]	Annual mean ($\mu g/m^3$)
Sulfur dioxide (SO_2)	Mesa County, Colorado	1991	3-hr	28	4
	Mesa County, Colorado	1992	3-hr	13	4
	Salt Lake City[b]	1993	3-hr	776	34
	Salt Lake City	1994	3-hr	509	29
	Mesa County, Colorado	1991	24-hr	9	4
	Mesa County, Colorado	1992	24-hr	12	4
	Salt Lake City[b]	1993	24-hr	176	34
Nitrogen dioxide (NO_2)	Salt Lake City	1991	annual		55
	Salt Lake City	1992	annual		49
	Provo[b]	1993	annual		49
	Provo[b]	1994	annual		45
Carbon monoxide (CO)	Grand Junction, Colorado	1991	1-hr	14,375	
	Grand Junction, Colorado	1992	1-hr	13,685	
	Grand Junction, Colorado	1993	1-hr	13,800	
	Grand Junction, Colorado	1994	1-hr	13,340	
	Grand Junction, Colorado	1991	8-hr	8,970	
	Grand Junction, Colorado	1992	8-hr	7,705	
	Grand Junction, Colorado	1993	8-hr	7,935	
	Grand Junction, Colorado	1994	8-hr	8,625	
Ozone (O_3)	Arches National Park	1991	1-hr	141	
	Arches National Park	1992	1-hr	135	
	Canyonlands National Park[b]	1993	1-hr	147	
	Canyonlands National Park[b]	1994	1-hr	143	
Inhalable Particulate Matter (PM-10)	Moab	1991	24-hr	181[c]	34
	Moab	1992	24-hr	65	33
	Grand Junction, Colorado[b]	1993	24-hr	67	25
	Grand Junction, Colorado[b]	1994	24-hr	63	24
Lead (Pb)	Salt Lake City	1991	3-mon[d]	0.09	
	Salt Lake City	1992	3-mon[d]	0.05	
	Salt Lake City	1993	3-mon[d]	0.05	
	Salt Lake City	1994	3-mon[d]	0.05	

[a]Units are micrograms per cubic meter. Values reported are from the nearest monitoring station.

[b]A different station had to be used for 1993 because of the discontinuation of reporting at the previous nearest station. For sulfur dioxide, the 1991 and 1992 values are believed to be more representative of current conditions at Moab than are the more recent values at the more distant station.

[c]One exceedance per year is allowed, the second highest value during 1991 was 111 $\mu g/m^3$ which is below the 24-hour standard.

[d]Calendar quarter.

are therefore expressed as allowable *increments* in the atmospheric concentrations of specific pollutants. Allowable PSD increments currently exist for only NO_2, SO_2, and PM-10. PSD increments are particularly relevant when a major proposed action (involving a new source or a major modification to an existing source) may degrade air quality without exceeding the NAAQS, as would be the case, for example, in an area where the ambient air is very clean. One set of allowable increments exists for Class II areas, which cover most of the United States, and a much more stringent set of allowable increments exists for Class I areas, which are specifically designated areas where the degradation of ambient air quality is severely restricted. Class I areas include certain national parks and monuments, wilderness areas, and other areas as described in 40 CFR Part 51.166 and 40 CFR Part 81:400–437. Maximum allowable PSD increments for Class I and Class II areas are given in Table 3.1-2. The PSD Class I area nearest the Atlas site is Arches National Park, immediately to the north of the Atlas site and about 300 m (1000 ft) from the north edge of the tailings pile. Arches National Park has been designated as a mandatory Class I Federal area where visibility is an important value (40 CFR Part 81.430).

3.2 GEOLOGY, SOILS, AND SEISMICITY

This section summarizes structural geology, soils, and seismicity in the Moab region, including the Atlas site and the Plateau site. Stratigraphy is discussed in Section 3.4.1. A detailed discussion of geology and seismicity is draft TER (NRC 1996) prepared for the Atlas Proposal.

3.2.1 Structural Geology

The Atlas and Plateau sites are located in the Paradox basin of southeastern Utah as shown in Figure 3.2-1. The Paradox basin was the site of widespread deposition of rock salt during Pennsylvanian time. The cross-hatched areas in Figure 3.2-1 are northwest-trending salt-anticlines. Northwest- and northeast-trending Precambrian and Paleozoic faults and lineaments also are shown in Figure 3.2-1 (Baars 1993). The lineaments may penetrate deep into the earth's crust and are relevant to seismicity.

Salt-anticlines in the Paradox basin formed by plastic flow of salt down dip (southwest) from near the Uncompahgre Uplift, then by upward flow of salt along northwest trending, basement penetrating, Paleozoic faults (Baars 1993). The upwelling salt pierced the overlying strata, faulted them, wedged them apart, and created local rift valleys (Cater 1970). Groundwater originating from the surface migrated down fault zones on either side of these rift valleys and eventually came in contact with the salt. As this groundwater leached the salt, fault zones reactivated by slumping into leached-out areas.

Renewed faulting generated new pathways for downward movement of groundwater into the salt and accelerated the process. The valleys grew deeper as vertical displacement along the bounding faults increased. The Atlas Moab site is located near the northwest end of a collapsed salt-anticline in Moab-Spanish Valley. No Quaternary sinkholes or other Quaternary subsidence

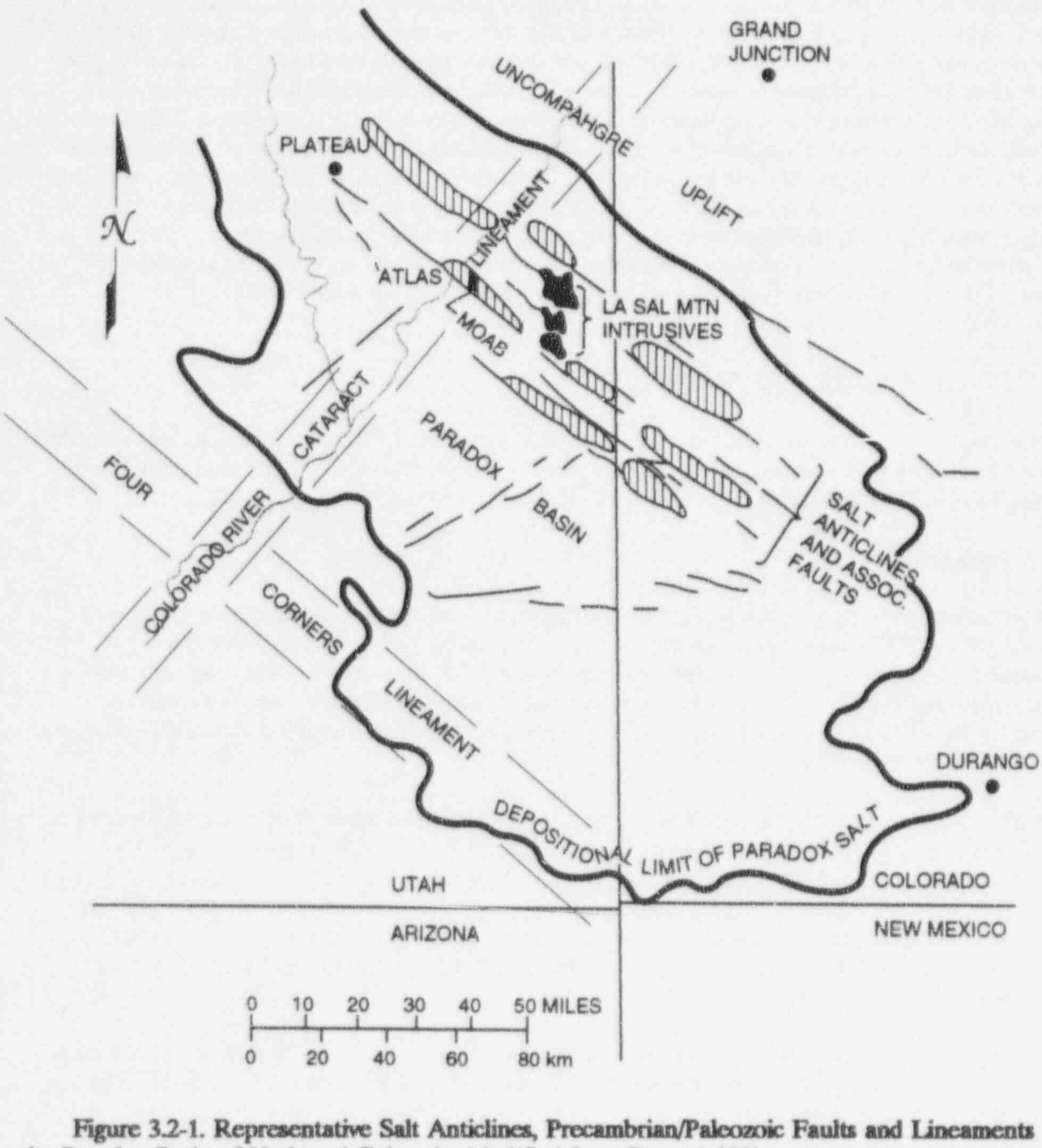

Figure 3.2-1. Representative Salt Anticlines, Precambrian/Paleozoic Faults and Lineaments in the Paradox Basin of Utah and Colorado. Modified from Baars (1993).

features are known to exist in Moab-Spanish Valley near the Moab site (except for Moab Marsh identified by Harden et al. (1985) as potentially resulting from subsidence beneath the Colorado River). Such features exist in collapsed salt anticlines elsewhere in the Paradox Basin (Oviatt 1988).

The Moab fault, which passes through or near the Atlas site (Figure 3.2-2), is believed to be the surface expression of the salt-anticline in Moab-Spanish Valley (Baars 1993; CESC 1994, Woodward-Clyde 1994). The Moab fault and its branches can be traced from Spanish Valley through Moab Canyon to Klondike Flat (Williams 1964), where the Plateau site is located. It is uncertain whether the Moab fault actually passes beneath the Atlas site—however, Atlas reported preliminarily that the Moab fault was detected beneath the northeast corner of the tailings pile (Cooksley Geophysics 1995). Nearest exposures of the Moab fault are 1.6 km (1 mile) northwest and 6 km (3.8 miles) southeast of the site (Doelling 1985).

Displacement along the Moab fault (Figure 3.2-3, Doelling 1985) has been a combination of salt collapse and crustal rifting resulting from upwelling of salt (salt diapirism). Total vertical displacement of strata along the Moab fault is about 790 m (2590 ft) in the vicinity of the Colorado River (Yeats 1961), but is not known at Klondike Flat—the Utah Geological Survey estimated vertical displacement at Bartlett Wash to be approximately 180 m (600 ft) (Ross, Doelling, and Christenson 1995). Major displacement along the Moab fault related to salt diapirism probably ended by the close of Cretaceous time (about 65 million years ago), when the upwelling of salt largely ceased (M. Ross, Utah Geological Survey, Salt Lake City, Utah, personal communication with W. P. Staub, ORNL, July 1, 1994; D. Baars, Kansas Geological Survey, personal communication with W. P. Staub, ORNL, July 7, 1994). Some localized upwelling of salt may still be active.

Recent detailed geologic mapping by the Utah Geological Survey found no direct evidence of Moab fault displacement of Pleistocene-Holocene (the last 1.6 million years) deposits, according to Woodward-Clyde (1994). However, some indirect evidence exists for late Quaternary (approximately the most recent one million years) displacement and earthquakes along the Moab fault (Hecker 1993). Woodward-Clyde (1994) suggests that Quaternary displacement along the Moab fault could have resulted from subsidence related to salt dissolution beneath Moab-Spanish Valley without the generation of strong-motion earthquakes. Landslides have occurred on the west wall of Moab Canyon as mapped by Doelling (1985).

Neither salt diapirism nor subsidence-related displacement is expected along the Moab fault near the Plateau site on Klondike Flat. There is no evidence of salt solution activity beneath Klondike Flat. Infiltration of surface water into the deeply buried salt is impeded by more than 100 m (several 100s of ft) of Mancos shale except where washes, which are usually dry, cross the Moab fault.

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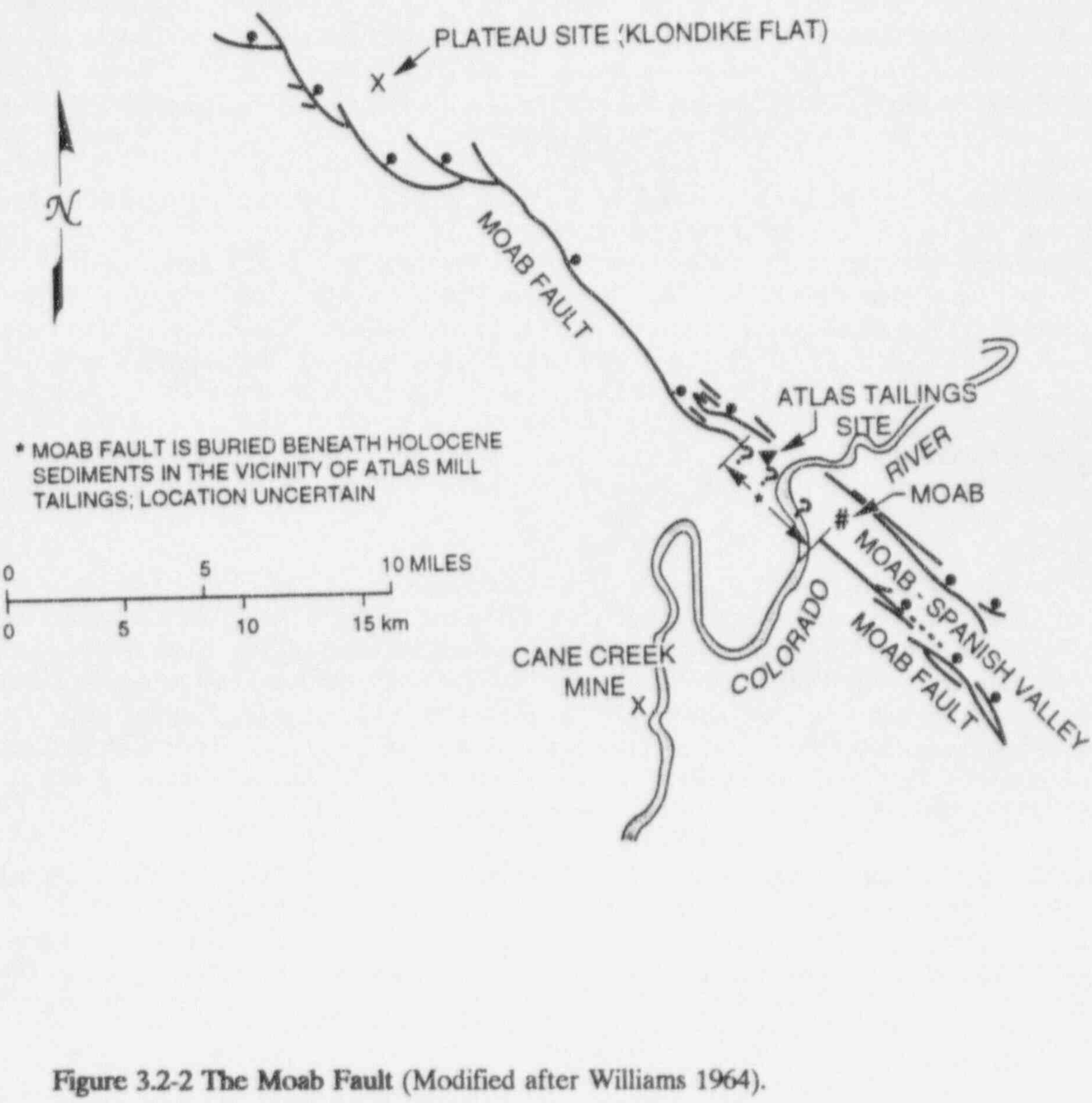

Figure 3.2-2 The Moab Fault (Modified after Williams 1964).

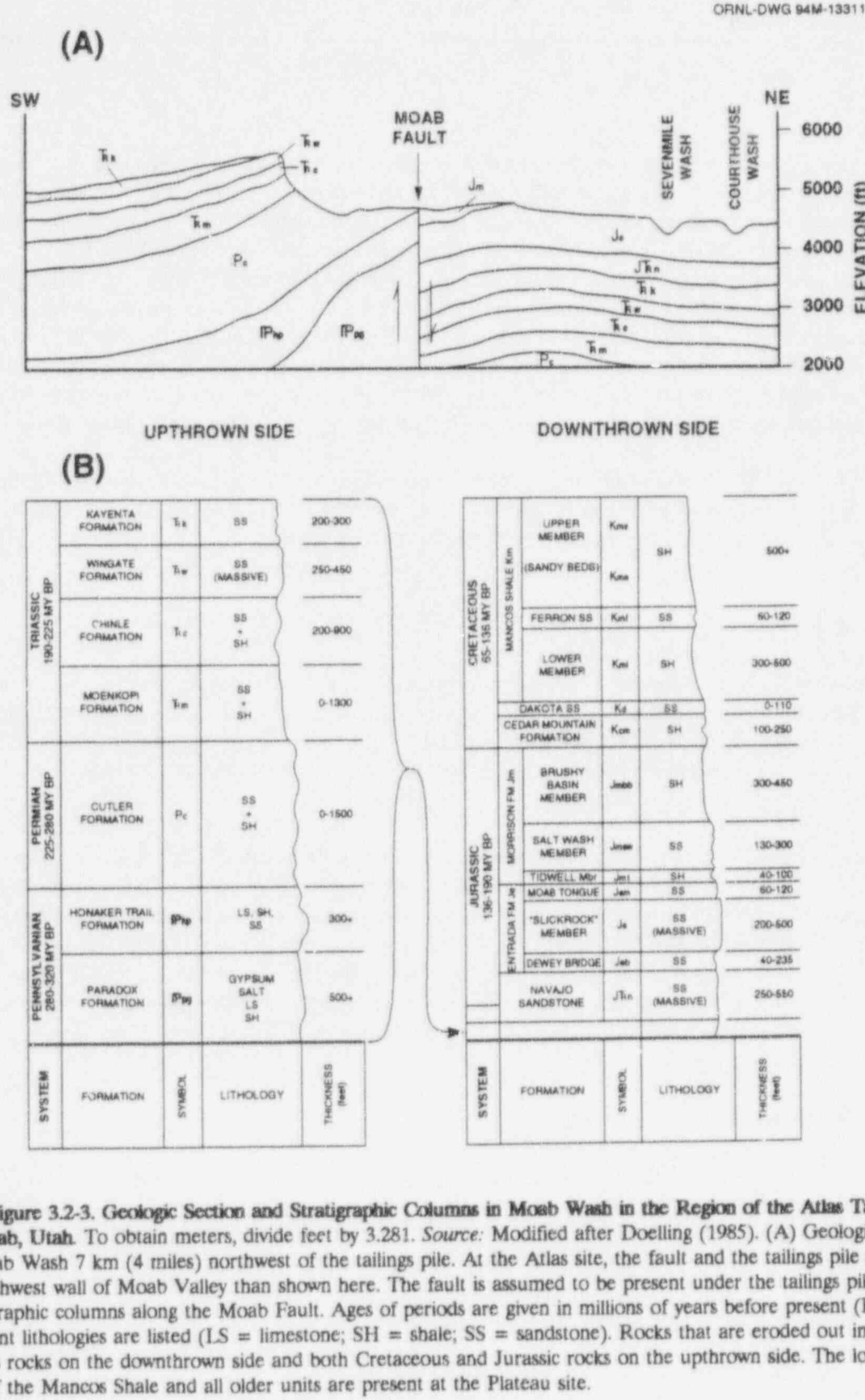

Figure 3.2-3. Geologic Section and Stratigraphic Columns in Moab Wash in the Region of the Atlas Tailings Pile at Moab, Utah. To obtain meters, divide feet by 3.281. *Source:* Modified after Doelling (1985). (A) Geologic section across Moab Wash 7 km (4 miles) northwest of the tailings pile. At the Atlas site, the fault and the tailings pile are closer to the southwest wall of Moab Valley than shown here. The fault is assumed to be present under the tailings pile. (B) Stratigraphic columns along the Moab Fault. Ages of periods are given in millions of years before present (BP). Predominant lithologies are listed (LS = limestone; SH = shale; SS = sandstone). Rocks that are eroded out include Cretaceous rocks on the downthrown side and both Cretaceous and Jurassic rocks on the upthrown side. The lower member of the Mancos Shale and all older units are present at the Plateau site.

3.2.2 Soils

The nature of soils can affect the potential for ground motion magnification and liquefaction during an earthquake. Foundation soils underlying the Atlas site may liquefy or cause ground motion magnification during a sufficiently large earthquake. The Atlas site is underlain by Quaternary colluvium and alluvium from the Colorado River and nearby tributaries. Quaternary sediments reach a maximum drilled thickness of 124 m (406 ft) near the eastern corner of the tailings pile (Well ATP-1) and a minimum thickness of 8.5 m (28 ft) on the north side of the pile. The soils are predominantly sand with mixtures of clay, silt, and gravel and are water-saturated to within 5 m (16 ft) of the surface most of the year. Saturated silt and fine sand bodies within this alluvium would be susceptible to liquefaction and ground motion magnification depending on the amplitude and duration of ground motion during an earthquake (Seed and Idriss 1971).

There is essentially no potential for ground motion magnification or liquefaction in the soils underlying the Plateau site. The soils are less than 3 m (10 ft) thick and underlain by the Cretaceous-age Mancos shale, which is not susceptible to ground motion magnification or liquefaction.

3.2.3 Seismicity

The probability of experiencing a strong earthquake at Moab can not be predicted with any degree of confidence. However, the presence of numerous balanced rocks (large remnants of weather-resistant rocks mounted on narrow pedestals of more easily weathered rock) in the Canyonlands region indicates that strong-motion earthquakes are rare events in the area (Barnes 1978).

Algermissen et al. (1991) provide the most recent seismic hazard analysis for the Colorado Plateau. They estimated that a peak ground acceleration (PGA) of 0.05 g has a 10% probability of exceedance (equivalent to a 90% probability of non-exceedance) at least once in 250 years (i.e., a return period of 2500 years) for rock foundations in southeastern Utah. This region is thus one of the lowest seismic hazard regions in the United States. Based on the seismic hazard curves of FEMA (1988), a PGA of 0.10 g might be expected to have a 10% probability of exceedance in 1000 years (i.e., a return period of 10,000 years). A more detailed analysis of the seismic hazards is presented in the draft TER (NRC 1996).

3.2.4 Mineral Resources

The Utah Department of Natural Resources (UDNR 1987) discusses the mineral resources of Grand County. Potentially commercial deposits of potash, rock salt, magnesium salts, and gypsum may be present at the Atlas site but may be too deep to be exploited at the Plateau site. Oil and gas production occurs in the Paradox Formation of Grand County, which also contains hydrocarbon source beds. No significant oil and gas reserves have been identified at either the Moab or Plateau sites. The nearest significant oil production is 16 km (10 miles) west of Moab. Most oil and gas production occurs in the northeast quarter of Grand County. Other mineral resources include tar sands and oil shale 8 km (5 miles) northwest of the Plateau site and coal in the Book Cliffs region, about 24 km (15 miles) north of the Plateau site. Abandoned uranium mines are located 8 to 16 km (5 to 10 miles) northwest of the Atlas mill site.

3.3 LAND USE

Approximately 0.71 million hectares (1.76 million acres) or 90% of the land in Grand County is administered by Federal (74%), state (15%), and city/county agencies (0.01%). Approximate percentages of Federal lands by agency are: Bureau of Land Management—82%; Indian Reservation—11%; National Park Service—4%; Forest Service—3%; and Bureau of Reclamation—0.1%. Arches National Park, the only national park in Grand County, is located adjacent to the north side of the Atlas site. Canyonlands National Park, in San Juan and Wayne counties, is about 24 km (15 miles) southwest of the site. Forest Service lands are in the La Sal Mountains about 19 km (12 miles) east-southeast of the site and in the northwestern corner of Grand County. The Indian Reservation (Uinta and Ouray) is about 45 km (28 miles) north-northwest of the site (Figure 1.1-1).

With so much land in public ownership, Grand County's economy has become tourism- and recreation-based (see Sects. 3.7.3 and 4.7.2). Sales tax receipts suggest that more than three-fourths of the county's revenues derive from these industries. Arches National Park is the northern terminus of a crescent of national parks and recreation areas that curve southwesterly to the Grand Canyon in Arizona. This series of parks anchors the tourism and recreation industries of the southwestern United States.

Grand County has little land suitable for farming and is the lowest producing county in the state for almost all major Utah agricultural commodities, including wheat, barley, corn, oats, hay, cattle and cows, and stock sheep and lambs. Grand County is one of Utah's three counties with the lowest cash receipts for agricultural commodities (UASS 1988).

Land use in the vicinity of the site is shown in Figure 3.3-1. The nearest residence is at the former Tex's Tour Center adjacent to the site, between the site and Courthouse Wash. A river tours and gift shop business is located adjacent to the east side of Courthouse Wash. The Grand Old Ranch House Restaurant and residence and two commercial parks for recreational vehicles, motor homes, and trailers are located along highway 191 from 1.2 to 2.4 km (0.75 to 1.5 miles) east of the Atlas site. The northwest edge of the main residential and commercial area of the city of Moab is located approximately 2.9 km (1.8 miles) from the tailings pile. The headquarters complex of Arches National Park is located in Moab Canyon about 1.9 km (1.2 miles) northwest of the tailings pile. No residences or residential areas other than those identified above are known to be located within 3.2 km (2 miles) of the tailings pile.

Other than designated park lands, grazing is the most extensive land use in the region, including the plateaus. However, the low rainfall and productivity limit cattle numbers. The land across the river from the Atlas site is grazed, primarily during the winter, by up to 50 head of cattle and 30

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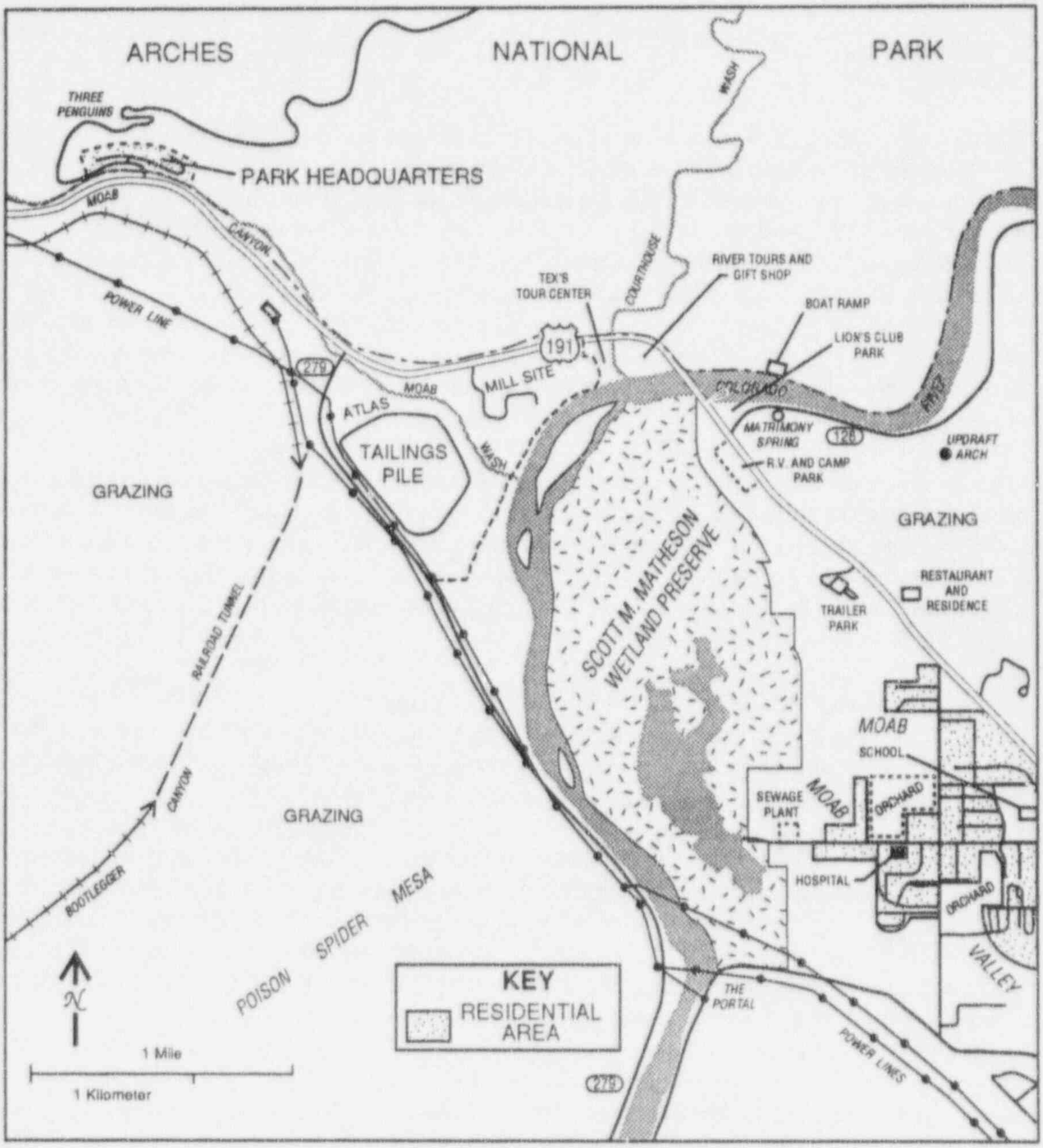

Figure 3.3-1. Land Use in the Vicinity of the Atlas Corporation Site, Moab, Utah. The Atlas site boundary is the dashed line and highways 191 and 279. R.V. = recreational vehicle.

horses. During 1990–92, 354 ha (875 acres) of this land, known as Moab Marsh, were purchased by the Nature Conservancy and designated the Scott M. Matheson Wetlands Preserve. The preserve is jointly owned and managed by the Nature Conservancy and the Utah Division of Wildlife Resources. Improvements will include a trail system, parking facilities, educational kiosks and signage, wildlife viewing platforms, and water delivery systems (The Nature Conservancy undated).

The amount of land suitable for cultivation is limited in Moab and Spanish Valleys. According to the licensee, as reported in the 1979 EIS (NRC 1979), 88 ha (217 acres) were farmed in Moab, 344 ha (850 acres) were under agricultural and rural residential use in Moab Valley between Moab and the Atlas site, and 121 ha (300 acres) were being irrigated in Spanish Valley. Orchard fruits (including apples, peaches, and pears) and livestock were the prime agricultural products. In Spanish Valley, agriculture was constrained by lack of irrigation water.

In Grand County, land uses along the Colorado River downstream from Moab include residences of about 15 families, 40–60 ha (100–150 acres) of alfalfa for hay (irrigated with Colorado River water), the potash facility (which produces potassium), and grazing (D. Nelson, Grand County Agricultural Extension Agent, Moab, Utah, personal communication with R. L. Kroodsma, ORNL, August 29, 1994; M. Page, Utah Division of Water Rights, Price, Utah, personal communication with R. L. Kroodsma, ORNL, August 30, 1994). Along the Colorado River in San Juan County, no croplands are present, and river water is not used for irrigation. A limited amount of grazing occurs. No grazing or agriculture is allowed along the river or along Lake Powell in Canyonlands National Park and Glen Canyon National Recreation Area (J. Keyes, San Juan County Agricultural Extension Agent, Monticello, Utah, personal communication with R. L. Kroodsma, ORNL, August 26, 1994). The park and recreation area, beginning about 27 km (17 miles) southwest of Moab, include all of the Colorado River and Lake Powell in Utah.

Land use on the 65-ha (160-acre) Atlas lease at the Plateau site, which is owned by the state of Utah, consists of grazing. The only other notable land use is for the Canyonlands Field airport, 3.2 to 4.8 km (2 to 3 miles) east-northeast of the site. Limited informal camping occurs along the dirt road that passes near the site, and bicyclists use the road. No prime or unique farmland (7 USC 4201; 7 CFR Part 658; 40 CFR Part 1508.27) is located on the Atlas site or Plateau site.

3.4 GROUNDWATER

3.4.1 Groundwater Resources and Hydrology

3.4.1.1 Stratigraphy

Unconsolidated surficial alluvium of Quaternary age (as much as 2 million years old) is exposed throughout Moab-Spanish Valley and lies beneath the base of the tailings pile (Sumsion 1971). The alluvium has an average depth of at least 21 m (70 ft). Alluvium is 124 m (406 ft) thick near the eastern corner of the tailings pile (Section 3.2.2). The porous alluvium is a gravelly sand as indicated by its textural composition (7% clay, 4% silt, 50% sand, 23% fine-to-medium gravel, and 16% coarse gravel). The Colorado River has carved a 6.1-m- (20- ft-) deep channel into the alluvium (Mussetter and Harvey 1994).

The Paradox Member of the Hermosa Formation of middle and upper Pennsylvanian age (290 to approximately 317 million years old) could underlie the alluvium. Paradox rocks consist of contorted evaporites and shales whose thickness exceeds 610 m (2000 ft) and may reach as much as 2100 m (7000 ft). Extrusion of these pliable salt strata within the evaporites upward through fault zones has caused unconformities in the Quaternary alluvium.

Sedimentary formations rim Moab-Spanish Valley and vary in age from middle Pennsylvanian to Cretaceous (67 to approximately 317 million years old). These consolidated deposits consist mostly of sandstone with some shale, siltstone, mudstone, gypsum, dolomite, limestone, and conglomerate. Intrusive igneous rocks of Tertiary age (about 25 million years old) were formed by injection through and into these strata during the laccolithic La Sal Mountain orogeny.

The Plateau site is situated on the relatively impermeable, upper Cretaceous (from 67 to 96 million years old) Mancos shale. The Mancos shale thickness ranges from 125 m (410 ft) to more than 244 m (800 ft). The weathered surface of the Mancos shale consists of a well developed, 1.5 to 3 m (5 to 10 ft) deep, friable soil having a large fraction of eolian sand (inferred from UNITAH 1994). The deeper Paradox salt strata are separated from the base of the shale by approximately 1000 m (3000 ft) of intervening sedimentary formations.

3.4.1.2 Groundwater Hydrology

Principal aquifers include the Quaternary alluvium in Moab-Spanish Valley, and the Wingate and Navajo sandstones (collectively referred to as the Glen Canyon aquifer) of the Glen Canyon Group that rim the valley. Some groundwater is provided by an unnamed Cutler Formation (arkosic) sandstone member composed primarily of quartz and feldspar (Sumsion 1971).

The alluvial surface slopes downward towards the Colorado River from both Moab-Spanish Valley and the Atlas tailings pile. The Quaternary aquifer discharges along both sides of the river during low river flows. The aquifer is recharged by the river at higher river stages. Wells yield 30 to 3800 L/min (8 to 1,000 gpm) (Sumsion 1971). Drawdown ranges from 10.7 to 33.5 m (35 to 110 ft). The average transmissivity of the aquifer is between 560 and 930 m^3/day/m [44,900 (measured) and 74,800 (calculated) gpd/ft].

Where intensely fractured, the Navajo sandstone yields 0.8 to 9254 L/min (0.2 to 2445 gpm) to springs and wells (NRC 1979). Wells tapping disturbed portions of the Wingate sandstone produce 30 to 136 L/min (8 to 36 gpm). Yields from the Cutler Formation range from 57 to 76 L/min (15 to 20 gpm).

The Navajo sandstone plunges beneath the Quaternary alluvium along the northeast side of Moab-Spanish Valley in a monoclinal fold. Associated faulting and jointing have shattered the area northeast of Moab City Park where several public and domestic wells pump groundwater, and where the transmissivity is 560 m^3/day/m (44,900 gpd/ft) (Sumsion 1979).The largest specific capacity was measured in a well where the Navajo sandstone is overlain by 11 m (36 ft) of alluvium. Transmissivities in less-disturbed upland portions of the Navajo sandstone are lower, ranging from 110 to 130 m^3/day/m (8,980 to 10,470 gpd/ft).

Groundwater moves through joints, fractures, and pores in the sandstone rim towards the center of Moab-Spanish Valley. Some groundwater enters the alluvial aquifer directly, while the remainder discharges from seeps and springs and enters surface water. Some springs in the Moab area are diverted into man-made impoundments and tanks. Ken's Lake and Recreation Area southeast of Moab is maintained by springs that discharge into perennial Mill Creek headwaters which flow into the lake, and diversions from other springs whose groundwater is piped and tunneled into the lake.

The Mancos shale beneath the Plateau site is relatively impermeable and yields no groundwater to wells or springs (Sumsion 1971, Blanchard 1990). Several springs in the surrounding locale appear to discharge from the Mancos shale, but actually discharge from the eolian sands overlying the shale. The viability of aquifers beneath the Mancos shale is unknown, but recharge in the site vicinity is minimal because of low precipitation and the impermeability of the overlying shale. Groundwater resides in the deeper sedimentary formations and Paradox salt strata beneath the Mancos shale, and at least 125 to 244 m (410 to 800 ft) below the land surface.

3.4.2 Groundwater Quality

Groundwater reports by Sumsion (1971) and Blanchard (1990) for Spanish Valley southeast of Moab provided information that is indicative of groundwater quality at Moab. Quaternary aquifer groundwater in the area contains twice the Federally permitted drinking water concentrations (40 CFR Part 141 and 143) for sulfate (250 mg/L) and total dissolved solids (500 mg/L). Principal dissolved species include calcium, magnesium, sodium, bicarbonate, sulfate, and chloride. The slightly basic groundwater is very hard. Silica, boron, nitrate, fluoride, potassium, and chloride levels are low. Iron occasionally exceeds the 0.3 mg/L Federal standard. For purposes of agricultural irrigation, the salinity hazard is high while the sodium hazard is low. Treatment is required prior to human consumption. The Atlas tailings pile has contaminated the Quaternary aquifer at the Atlas site, as discussed in Sect. 4.4.2.

The Navajo and Wingate sandstone aquifers have excellent groundwater qualities (Sumsion 1971 and Blanchard 1990). Sulfate, total dissolved solids, chloride, fluoride, and nitrate comply with Federal drinking water standards (40 CFR Parts 141 and 143). Calcium and bicarbonate are the dominant dissolved species. The pH is slightly basic. Iron occasionally exceeds the 0.3 mg/L Federal standard. Navajo sandstone groundwater is soft, while hardness in the Wingate sandstone aquifer ranges from moderately to very hard. Salinity and sodium hazards are moderate and low, respectively. Silica and boron levels are low. Both aquifers are suitable for public water supplies. Minimal treatment is required.

Groundwater in sedimentary strata beneath the Plateau site would be expected to be high in total dissolved solids because the downward flow of precipitation is cut off by the Mancos shale. Treatment would be required prior to human consumption. Water quality in the sedimentary strata also is degraded by upflows from the underlying Paradox salt strata where the groundwater is very saline (Blanchard 1990).

3.4.3 Groundwater Use

The Navajo and Wingate sandstones provide a water supply for the city of Moab. Groundwater is collected from upland springs, piped to man-made impoundments and storage tanks, treated, and finally distributed to consumers. Public wells in the Navajo sandstone northeast of Moab City Park have been used to supplement the springs during the growing season and tourist season. Private wells also obtain groundwater from the Navajo and Wingate sandstone aquifers.

The city of Moab does not use the Quaternary alluvial aquifer as a source of drinking water; its wells are 7.2 km (4.5 miles) from the Atlas site (L. Johnson, Moab Public Utilities, personal communication with R. O. Johnson, ORNL, September 12, 1994). The Quaternary alluvial aquifer is used primarily for irrigation of crops during the growing season. The aquifer may also serve as a domestic water supply at locations where recharge from the Navajo and Wingate sandstones dilutes the concentration of total dissolved solids to acceptable levels.

3.5 SURFACE WATER

3.5.1 Surface Water Bodies, Hydrology, and Floodplains

3.5.1.1 Water Bodies and Hydrology

The Atlas tailings pile is located on an alluvial terrace and is about 230 m (750 ft) from the Colorado River at the northwest end of Moab-Spanish Valley. The river drains one of the most arid sections of the North American continent. The rugged mountains, broad basins, and high plateaus in the Upper Colorado Basin (above Lees Ferry, Arizona) have been deeply entrenched and dissected (Price and Arnow 1974). Narrow intricate canyons have been carved in underlying rocks by the river and its tributaries.

The Dolores and Green rivers empty into the Colorado River upstream and downstream, respectively, from Moab and the tailings pile. Tributaries near Moab include Courthouse Wash, Moab Wash, and Mill Creek (Figure 1.1-1). Moab Marsh (Scott M. Matheson Wetlands Preserve), a shallow wetland, and Mill Creek are located on the opposite side of the river from the pile. Moab Marsh may be evidence of regional subsidence (Harden et al. 1985).

The Atlas site is located on the outside of a meander bend of the Colorado River (Figure 2.1-1). A chute cutoff flows along the inside of the meander where Moab Marsh is located. Several small islands separate the main channel from the chute. Courthouse Wash empties into the river near the upstream end of the chute on the same side of the river as the tailings pile, and across from Moab Marsh.

Upstream dams provide minimal control of the flow of the Colorado River near Moab. Several small diversionary dams are located on Colorado River tributaries, and a few are on the river's mainstem near the continental divide in north-central Colorado. These upstream dams have limited storage capacity. Glen Canyon Dam, which forms Lake Powell, is located 240 km (150 miles) downstream from Moab.

The course of the Colorado River is bounded by steep sandstone walls. Moab-Spanish Valley interrupts this geomorphology and provides an alternate water course. Resumption of the sandstone wall occurs 3 km (2 miles) downstream from the tailings pile at a location known as the Portal. Here, the Colorado River receives the flow from Mill Creek and makes an acute bend as it enters the Portal. The Portal constricts high Colorado River flows and influences the formation of backwater during floods (Mussetter and Harvey 1994).

The Cisco, Utah, gaging station is located 1.6 km (1 mile) below the confluence of the Colorado and Dolores rivers, and 50 km (31 miles) upstream from the Atlas site (NRC 1979). The drainage area above the gage is 62,400 km^2 (24,100 $miles^2$). The average discharge for 59 years of record (1911 to 1970) was 218.35 m^3/s (7,711 cfs), while maximum and minimum flows measured 2,150 m^3/s (76,000 cfs) and 15.8 m^3/s (558 cfs), respectively.

Courthouse Wash empties into the Colorado River 0.8 km (0.5 mile) upstream from the tailings pile, while Moab Wash cuts across the site's northeast corner (NRC 1979). Courthouse Wash drains 264 km^2 (102 $miles^2$), has an average discharge of 0.06 m^3/s (2.12 cfs), and produces peak flows reaching 348 m^3/s (12,300 cfs). Courthouse and Moab washes are ephemeral and are dry much of the year. Courthouse Wash sustains flows for longer durations than Moab Wash, which drains only 21 km^2 (8 $miles^2$).

The Colorado River in the vicinity of Moab receives large quantities of sediment, which have contributed to the formation of Moab Marsh. Courthouse Wash and portions of the river above Cisco are underlain by siltstone, sandstone, and shale, which are soft and erodible (Hagen et al. 1971). As a result, the Colorado River near Moab has a medium-to-high salinity hazard and a low-sodium hazard for agricultural irrigation (Sumsion 1971). Treated sewage is discharged to the Colorado River by the city of Moab (Sumsion 1971).

Because the Atlas tailings pile is located on the outer side of a bend in the Colorado River, the possibility that the river channel could migrate towards the tailings pile was considered. Although no evidence of channel migration has been documented since the mill was constructed on the site, some evidence of a small amount of bank erosion between Moab Wash and the river intake site was observed by staff during site visits. Mussetter and Harvey (1994) have identified several speculative reasons why the potential for lateral river migration may be low: (1) bedrock outcrops upstream and downstream from the Atlas site control and limit the potential for river meandering; (2) Moab Marsh absorbs hydraulic energy that would be directed towards the pile and cause erosion; and (3) the Portal limits flow velocities and concomitant erosion during floods. Clearly river channel migration would occur at a very slow rate such that mitigating measures could be taken if before the pile experienced erosion. The potential for bank erosion is discussed in the draft TER (NRC 1996).

The Plateau site on Klondike Flat is located near a surface water divide that diverts runoff towards the Colorado and Green rivers. Tenmile Wash flows southward from Klondike Flat to the Green River. Another wash (possibly altered by man to increase capacity) drains northward to Bartlett Wash, which enters Klondike Wash, which in turn discharges to Courthouse Wash, a direct Colorado River tributary (UNITAH 1994). Headwaters emanating from Klondike Flat drain small areas. These ephemeral arroyos are dry much of the year. The Plateau site lies in the Bartlett Wash watershed.

3.5.1.2 Floods and Floodplains

The tailings pile is located on the 100-year floodplain of the Colorado River (FEMA 1981). On several occasions, flood waters have risen from 0.9 to 1.2 m (3 to 4 ft) above the base of the pile, which has an elevation of 1,209.4 m (3,968 ft).

The U.S. Geological Survey estimated a 500-year flood discharge of 3,497 m^3/s (123,500 cfs) at the upstream Colorado River gaging station near Cisco (Jacoby and Gonzales 1993). Using this discharge, Mussetter and Harvey (1994) calculated for the Atlas site a 500-year flood level of 1,211.8 m (3,976 ft), which is 2.4 m (8 ft) above the base of the tailings pile. This estimate of flood level did not account for surface water entering the Colorado River between Cisco and Moab. Therefore, the flood level at Moab would be slightly higher than indicated above, and the water level would be slightly higher than 2.4 m (8 ft) above the base of the tailings pile.

The NRC calculated a 8,495 m^3/s (300,000 cfs) discharge applicable to the Moab site during the PMF (Jacoby and Gonzales 1993). The calculated PMF elevation was 1,218.2 m (3997 ft), which corresponds to a water depth above the toe of the pile of 8.8 m (29 ft) (Mussetter and Harvey 1994). The PMF discharge developed for Moab Wash ranged from 455 to 1019 m^3/s (16,069 to 36,000 cfs) (Jacoby and Gonzales 1993).

The headwaters originating on Klondike Flat where the Plateau site is located are ungaged. Calculations are not available to quantify extreme floodwater surface elevations, or evaluate the effects of extreme storms.

Apparently the largest flood of record along the upper Colorado River in Utah occurred in 1984 and probably flooded part of Moab (Christensen et al. 1991). This flood had an estimated recurrence interval exceeding 100 years and was caused by snowmelt combined with rainfall. The five major Utah floods (considering all rivers in the state) of record (1952, 1965, 1966, 1983, and 1984) having recurrence intervals ranging from 25 to more than 50 years did not inundate Moab. Anecdotal evidence indicates that the 1984 flood rose approximately 1.2 m (4 ft) above the toe of the tailings pile.

3.5.1.3 Low Flows

Localized drought has affected at least one stream in Utah every year since 1924 (Christensen et al. 1991). Extreme droughts occurred from 1930 to 1936, 1953 to 1965, and 1974 to 1978. Annual average Colorado River flows were reduced substantially during these droughts. The lowest recorded flow in the Moab area was 15.8 m^3/s (558 cfs).

3.5.2 Surface Water Quality

The principal surface water resource in the area, the Colorado River, lies 230 m (750 ft) from the eastern-most extent of the tailings pile (Figure 1.1-1). Moab Marsh (Scott M. Matheson Wetlands Preserve), a 354-ha (875-acre) wetland, lies in the floodplain on the east bank of the river southeast of the Atlas site. It is the only large floodplain wetland in the Colorado Plateau Province (S. Bellagamba, Moab Nature Conservancy, personal communication with G. K. Eddlemon, ORNL, July 18, 1994). The only other stream potentially under the influence of leachate and runoff from the pile is Moab Wash, which is an ephemeral tributary to the Colorado River and runs along the northeast toe of the pile. Bartlett Wash near the Plateau site is dry most of the year, and no water quality data for the wash are available.

Utah Administrative Code R-317-2-13 (Water Quality Standards) classifies the Colorado River and its tributaries as:

- 1C Protected as a raw water source for domestic purposes with prior treatment processes as required by the Utah Department of Health;
- 2B Protected for boating, water skiing, and similar uses, excluding swimming;
- 3B Protected for warm water species of game fish and other warm water aquatic life, including the necessary aquatic organisms in their food chain; and
- 4 Protected for agricultural uses including irrigation of crops and stock watering.

The water quality of the Colorado River has declined over the years as man's activities in the basin have expanded. Dams and water diversion projects have greatly accelerated water loss through evaporation and consumption, resulting in higher salinities (i.e., total dissolved solids or TDS), altered temperature and flow regimes, and altered nutrient and suspended solids transport (Carlson and Muth 1989; Upper Colorado Region State-Federal Interagency Group 1971). Industrial development (in particular, mining and milling) and rapid urbanization have introduced wastewaters containing a variety of contaminants into the river, including suspended sediments, acid mine drainage, heavy metals, radionuclides, and organic wastes. Water quality has been monitored upstream and downstream of the tailings pile by the Utah Division of Water Quality and others for approximately the last 10 years. The monitoring results, which are discussed in more detail in Sect. 4.5.2, reveal a very turbid river of considerable hardness, high suspended solids loading, fairly high salinity for a freshwater river (due to a large extent to high sulfate levels), and often wide fluctuations in the concentrations of all of these constituents. Upstream from the Atlas site, water quality standards for arsenic, copper, lead, mercury, and silver in the river have been exceeded.

3.5.3 Surface Water Use

The Colorado River Compact of 1922 established water allocations to the Upper and Lower Colorado Basins, which encompass seven states (Chrisman et al. 1976). The 1944 Treaty with Mexico established a Colorado River water reserve that must cross the international boundary. Glen Canyon Dam defines the point of compliance for water allocations between the Upper and Lower Colorado Basins. Numerous diversions occur for irrigation. Phoenix and Tucson, Arizona, as well as the Mexican border towns of Mexicali and Tijuana, obtain drinking water from the Colorado River. No discharge occurs into the Gulf of California because the Colorado River is completely diverted by the United States and Mexico (EBI 1990).

Surface water consumption from the Colorado River watershed is less than 1.1 m^3/s [25 Mgd (39 cfs)] in Grand County, Utah (Pyper and Saunders 1990). This water is used almost exclusively for agricultural irrigation. Industry, mining, and thermoelectric power plant cooling account for less than 10% of this consumption.

Water from the Colorado River was not diverted for use in Moab-Spanish Valley prior to 1971, other than for the Atlas Moab Uranium Mill (Sumsion 1971). Domestic and public drinking water supplies are obtained from groundwater (see Sect. 3.4.3) and from streams and springs. In Utah, use of Colorado River water for purposes other than recreation is very limited. In Grand County downstream from Moab, water is withdrawn from the river for irrigation of about 40–60 ha (100–150 acres) of hay and small grains, and may be withdrawn at the Potash plant. No additional water withdrawals are believed to occur in Utah, including Canyonlands National Park and Lake Powell (D. Nelson, Grand County Agricultural Extension Agent, Moab, Utah, personal communication with R. L. Kroodsma, ORNL, August 29, 1994; M. Page, Utah Division of Water Rights, Price, Utah, personal communication with R. L. Kroodsma, ORNL, August 30, 1994; J. Keyes, San Juan County Agricultural Extension Agent, Monticello, Utah, personal communication with R. L. Kroodsma, ORNL, August 26, 1994; J. Rittenouer, Glen Canyon National Recreation Area, Page, Arizona, personal communication with C. H. Petrich, ORNL, August 29, 1994). The river in the vicinity of Moab is used for swimming, rafting, boating, and fishing as well as other forms of recreation, and is a recognized scenic waterway.

3.6 ECOLOGY

3.6.1 Aquatic Ecology

Aquatic species of the Colorado River in the vicinity of the Moab site, as elsewhere in the river, have had to adapt to physical and chemical conditions that naturally fluctuate widely seasonally and even daily. These variable conditions include river flow, bottom scouring by sand and silt, temperature, sediment loading, chemical composition, and salinity. Heavy sediment loading, swift currents, and scouring of the sand and silt bottom impose severe limits on algal, invertebrate, and fish diversity in the main channel. Chironomids and oligochaetes probably dominate the benthic community of the main channel. Backwater areas, such as the wetland formed by a more or less permanent inundation of the floodplain just downstream and across the river from the tailings pile, probably support a much more diverse and more productive benthos. Similarly, rooted macrophytes, along with algae and zooplankton, flourish in the backwaters, but are almost non-existent in the main channel. The backwaters and inundated floodplains often serve as important nurseries and forage suppliers for fish, including the endangered Colorado squawfish (Valdez and Wick 1983). Fish species known or believed to reside in or pass through this reach of the river are listed in Table 3.6-1. A state sensitive mammal, the river otter, is also known to reside along the river here.

Because of the human activities noted in Sects. 3.5.1 and 3.5.2, many components of the upper Colorado River ecosystem (including the reach near the tailings site) have experienced dramatic changes over the last several decades. An additional important force for change has been the sometimes accidental, but often deliberate, introduction of non-native species into the river, including the carp, channel catfish, various minnow species, largemouth bass, and in the adjoining floodplains, tamarisk (*Tamarix* sp.), a shrub-like tree also known as salt cedar. These introductions, in concert with the physical and chemical alterations of the river, have significantly compromised growth and reproduction of several native species. Non-natives such as the channel catfish provide most of the take by fishermen. As reflected by the listing of species in Table 3.6-1, at least as many exotic species as native species of fish are now established in the Colorado River. Several fish species have been classified as endangered under the Endangered Species Act by the U.S. Fish and Wildlife Service. Threatened and endangered species are addressed in more detail in Sects. 3.6.4 and 4.6.4. No aquatic habitat is present at the Plateau site.

3.6.2 Terrestrial Ecology

3.6.2.1 Vegetation

Vegetation types at the Moab site include marsh on the Moab side of the river (Sect. 3.6.3), riparian woodland, grassland, and shadscale (saltbush). Riparian woodland at the site comprises a thick growth of tamarisk, an introduced species that has taken over land adjoining the river. Woodland dominated by native tree species such as black willow and cottonwood is present in the large (~875 acres) marsh and swamp known as Moab Marsh or the Scott M. Matheson Wetlands Preserve that is managed by the Nature Conservancy on the Moab side of the river. Other plants in the marsh include tamarisk, sedges, bulrush, and cattail (S. Bellagamba, Moab Nature Conservancy, personal communication with G. K. Eddlemon, ORNL, July 18, 1994). Although blackbrush has been recognized as the potential natural vegetation of valley bottoms in the region, it appears to be absent at the Moab site. Grassland and the shadscale community are the most extensive vegetation types at the site. (Eyre 1980, West 1988)

The Plateau site appears to be completely occupied by the shadscale community, which is extensive in this region of the Colorado Plateau. The vegetative cover on the site is somewhat sparse (e.g., 50% cover) with much bare soil, reflecting the low rainfall in this region and probably grazing by cattle. On Round Mountain in the Castle Valley area where rock riprap may be obtained for tailings reclamation the vegetation includes juniper, sagebrush, mormon tea, and

Table 3.6-1. Fish that Occur or May Occur in the Colorado River near the Tailings Pile[a]

Common name	Scientific name	Status[b]
Roundtail chub	*Gila robusta*	N
Humpback chub	*Gila cypha*	N, E
Bonytail chub	*Gila elegans*	N, E
Colorado squawfish	*Ptychocheilus lucius*	N, E
Longnose dace	*Rhinichthys cataractae*	I
Speckled dace	*Rhinichthys osculus*	N
Fathead minnow	*Pimephales promelas*	I
Carp	*Cyprinus carpio*	I
Red shiner	*Notropis lutrensis*	I
Sand shiner	*Notropis stramineus*	I
Flannelmouth sucker	*Catostomus latipinnis*	N
Bluehead sucker	*Catostomus discobolus*	N
Razorback sucker	*Xyrauchen texanus*	N, E
Channel catfish	*Ictalurus punctatus*	I
Black bullhead	*Ictalurus melas*	I
Rio Grande killifish	*Fundulus zebrinus*	I
Largemouth bass	*Micropterus salmoides*	I
Green sunfish	*Lepomis cyanellus*	I

[a]Sources: Bates (1994); Carlson and Muth (1989); Lee et al. (1980); NRC (1980).
[b]N = native to upper Colorado River; I = introduced species; E = Federally listed endangered species.

blackbrush, as well as cheat grass and other grasses. In Spanish Valley, where cobble to be used as riprap may be collected, vegetation cover includes juniper, mormon tea, and sagebrush as dominants overlying grasses and forbs. Additional information on regional vegetation is presented in the 1979 EIS for the Atlas Moab Mill (NRC 1979).

3.6.2.2 Wildlife

The Atlas Moab tailings pile supports little vegetation and therefore has little value as wildlife habitat. Dense growths of tamarisk occur along the base of the pile on the Colorado River floodplain and provide some habitat for birds and small mammals. No big game animals are likely to frequent the site, although desert bighorn sheep have been reintroduced in Arches National Park and may thus occur in the vicinity of the site. The tall cliffs mostly surrounding Moab Valley limit the movement of big game animals. The only big game animal frequently reported near the Atlas site is the mule deer. The site vicinity provides habitat for many species of smaller mammals, such as striped skunk, desert cottontail, jackrabbit, and rock squirrel. Muskrat and beaver occur in Moab Marsh. Also, many species of birds occur in Moab Valley, although relatively few species nest on the Atlas site. Over 150 species of birds have been observed at Moab Marsh which is also frequented by muskrat, beaver. A great blue heron rookery is present in the lower end of the marsh (The Nature Conservancy undated). The northern leopard frog, a species listed as sensitive by the state of Utah, also occurs in the marsh. Several raptor species occur in the area, including the turkey vulture, ferruginous hawk, red-tailed hawk, golden eagle, and the endangered peregrine falcon (see Section 3.6.4).

Because the Plateau site vicinity consists of essentially only one habitat type, the shadscale type, fewer wildlife species occur here than in Moab Valley. Also, population densities are relatively low because of the low productivity of the vegetation and a history of grazing. Pronghorn may occasionally occur at the site. Small animals include the prairie dog, short-horned lizard, raven, and horned lark. The raptors mentioned above also occur in the area.

3.6.3 Wetlands

Wetlands in the vicinity of the Atlas Moab site include Moab Marsh (Scott M. Matheson Wetlands Preserve) and portions of the river banks and floodplain adjacent to the Colorado River. Moab Marsh is the most extensive, covering about 354 ha (875 acres), and is the only major wetland along the river in the entire Colorado Plateau Province (Nature Conservancy undated). It is a palustrine wetland including persistent emergent wetland (e.g., wet meadow), scrub-shrub wetland, and forested wetland (Cowardin et al. 1979). Palustrine wetland also occupies part of the floodplain at the Atlas site, where dense stands of tamarisk form a scrub-shrub wetland. The Colorado River and its banks are riverine wetland, which includes nonpersistent emergent wetland, aquatic bed, unconsolidated shore, and unconsolidated bottom (Cowardin et al. 1979). Biota found in the wetlands are discussed in Sects. 3.6.1 and 3.6.2. No National Wetland Inventory maps are available for the Moab area (J. Zoschenko, U.S. Geological Survey, Denver, Colorado, personal communication with F. M. Glenn, ORNL, September 14, 1994), and no survey of wetlands has been conducted on the Atlas property. The Colorado River floodplain that is predominantly covered by dense growths of tamarisk is a wetland area.

3.6.4 Threatened and Endangered Species

The U.S. Fish and Wildlife Service (FWS) was contacted for information on threatened and endangered species. In a letter dated November 2, 1994 (Appendix E), the FWS identified the following species that may occur in the vicinity of the proposed project areas:

American peregrine falcon	*Falco peregrinus*
Humpback chub	*Gila cypha*
Bonytail chub	*Gila elegans*
Colorado squawfish	*Ptychocheilus lucius*
Razorback sucker	*Xyrauchen texanus*
Jones cycladenia	*Cycladenia humilis v. jonesii*

In May 1995, the FWS identified the southwestern willow flycatcher (*Empidonax traillii extimus*) as potentially occurring in the project area (S. Linner, U.S. Fish and Wildlife Service, Salt Lake City, Utah, personal communication with G. K. Eddlemon, ORNL, May 19, 1995). The Biological Assessment in Appendix F contains additional information on the Federally listed threatened and endangered species that the FWS has identified.

3.6.4.1 Aquatic Species

The U.S. Fish and Wildlife Service (FWS) has classified four species of fish native to the upper Colorado River as endangered: the razorback sucker, Colorado squawfish, humpback chub, and bonytail chub (Table 3.6-1) (Williams 1994). Moreover, the FWS has declared virtually the entire river mainstem and associated floodplains to be critical habitat, which provides those physical or biological features essential to the conservation of the species, and which may require special management considerations or protection (59 FR 13374–13400). This critical habitat includes the floodplains and river reach in the Moab area. The endangered status of these four species stems primarily from cumulative effects of dams, water diversions, pollutants, and introduced species.

The Colorado squawfish, the largest member of the minnow family native to North America, occurs in the river reach adjacent to the tailings pile and uses the backwater areas of Moab Marsh (Scott M. Matheson Wetlands Preserve) as important nursery habitat (W. Bates, Utah Department of Environmental Quality, Division of Wildlife Resources, personal communication with G. K. Eddlemon, ORNL, July 25, 1994). Young squawfish prey on small invertebrates in side channels and backwater area, whereas adults prey on other fish in virtually any part of the river (Behnke and Benson 1980). Both squawfish and razorback sucker are known to spawn in early or mid-summer about 3 km (1.9 miles) upstream of the tailings pile. Razorback suckers are known to spawn over gravel bars and probably also spawn in backwaters. When not spawning, these suckers may be found almost anywhere in the river, including slow runs in the main channel, inundated floodplains and tributaries (such as Moab Wash), eddies and backwaters, sandy bottom riffles, and gravel pits (59 FR 13374–13400). They feed primarily on benthic invertebrates and organic debris, but also on zooplankton (Behnke and Benson 1980). During the rare periods of inundation, lower Moab Wash and the riparian woodland near the toe of the pile could possibly provide important habitat for squawfish and razorback suckers (W. Bates, Utah Department of Environmental Quality, Division of Wildlife Resources, personal communication with G. K. Eddlemon, ORNL, July 25, 1994).

Much like the Colorado squawfish and razorback sucker, the bonytail chub uses main-stem river channels as well as inundated riparian areas. Potential habitat for the bonytail chub also exists in the reach of the river near the pile, but the actual presence of this rarest of all fishes native to the Colorado Basin has not been confirmed. The humpback chub prefers deep canyon swift water and rapids and is therefore thought not to venture much upstream of Cataract Canyon below the confluence of the Green and Colorado Rivers (many kilometers below the tailings pile) (W. Bates, Utah Department of Environmental Quality, Division of Wildlife Resources, personal communication with G. K. Eddlemon, ORNL, July 25, 1994; 59 FR 13374–13400).

3.6.4.2 Terrestrial Species

Peregrine falcons nest in the Moab region (Williams 1994) and occasionally hunt for prey in Moab Marsh (*The Scott M. Matheson Wetlands Preserve*, undated leaflet, The Nature Conservancy, Salt Lake City, Utah). The peregrine falcon is currently listed as an endangered species in this area, but it is currently being considered for delisting by the FWS (95 FR 16076, June 29, 1995). Although a peregrine aerie is known to have been present within 0.62 km (1 mile) of the Atlas site, recent information indicates that the birds may have moved further down river (J. Cresto, Bureau of Land Management, Moab, Utah, personal communication with R. M. Reed, ORNL, July 12, 1995). Peregrines also regularly nest within 1.2 Km (2 miles) of the site in Arches National Park and along the Colorado River. Peregrine falcons may prey on birds present in Moab Marsh. No area near the Plateau site is known to be particularly important to the peregrine.

The southwestern willow flycatcher, an endangered species, is known to occur in Canyonlands National Park. This species is dependent on riparian habitat consisting of willows and cottonwoods, though it is known to utilize tamarisk vegetation. No surveys have been done for this species at the Atlas site, but suitable habitat is present in Moab Marsh, and it is possible that the species could use tamarisk plant communities on the Colorado floodplain on the Atlas property.

The Jones cycladenia, a plant species listed by the FWS as threatened, is known to occur in Castle Valley (Williams 1994), on BLM land and from two other areas in Utah (51 FR 16526-29, May 5, 1986). In addition, there is an historic record of this species occurring in the Pipe Spring area of Mohave County, Arizona, and Kane County, Utah. The Castle Valley populations are found in mixed desert shrub and pinyon-juniper plant communities at elevations of 1500–1700 m (5000–5600 ft) on sparsely vegetated hills derived from arkosic sandstone of the Permian Cutler Formation. Two populations of about 1000 individuals each have been found on Bureau of Land Management (BLM) land in Castle Valley (51 FR 16526-29). No surveys for this plant have been conducted in areas where the riprap borrow areas have been proposed because the specific locations of these sites have not yet been determined.

Two plant species that occur in the Moab region are candidates for being considered for listing as threatened or endangered. However, they have not yet been proposed for listing and are therefore not yet protected under the Endangered Species Act. These species are *Astragalus sabulosus*, which occurs in a variety of habitats in the region, and *Oreoxis trotteri*, which is endemic to the vicinity of Courthouse Rock in Grand County (Peterson 1994).

Further information on threatened and endangered species is presented in the Biological Assessment in Appendix F.

3.7 SOCIOECONOMIC, CULTURAL, AND AESTHETIC RESOURCES

3.7.1 Population

Moab is the only town in Utah located on the Colorado River. The Atlas site and tailings pile are located on the west bank of the Colorado River, 5 km (3.1 miles) northwest of Moab. Few people reside near the Atlas site, and Moab's growth is constrained by the Colorado River and its floodplain and by topography from spreading much farther to the north toward the site. To the northeast of the Atlas site there is one private residence adjacent to the site. Three families of permanent residents live at the Arches National Park Headquarters across U.S. 191 from the tailings pile. During the summer season, about 20 people are employed and/or living in the vicinity of the Park Headquarters (N. Poe, Superintendent, Arches National Park, Moab, personal communication with C. H. Petrich, ORNL, July 11, 1994).

Moab, which had a 1992 population of approximately 4200, is the major population center in southeast Utah. The nearest large city is Grand Junction, Colorado, over 192 km (120 miles) to the northeast. The town of Castle Valley, with only several hundred people, is the only population center near Moab. Moab is the county seat for Grand County, which is 20th in population size of Utah's 29 counties. Table 3.7-1 shows the changes in population since 1970, according to census data (Utah Department of Employment Security and 1990 U.S. Census data). In summer months the population of Moab grows greatly with visitors to the nearby national parks and other recreation and tourist attractions. Population changes since 1990 suggest that the downwards trend between 1980 and 1990 has reversed and that population figures in both Moab and Grand County are higher than those of 1980 (V. Smouse, Deputy Grand County Tax Assessor, Moab, personal communication with C. H. Petrich, ORNL, August 10, 1994). Moab has a moderate to low population density, about 553 people/km^2 (1432 people per square mile) (1992 data from Utah Department of Employment Security and 1990 U.S. Census data). Grand County, which comprises 1425 km^2 (3692 square miles) with much public and uninhabitable land, also has an extremely low population density of 0.54 people/km^2 (1.4 people per square mile) (1992 data). Grand County is predominantly (96 percent) white with only 7 people recorded as African-American, 203 as Native American, and 24 as Asian [Hispanics (291 in Grand County) are not recorded as a separate race, but as an ethnic orientation; Hispanics may self-report in any racial category.] Grand County's Native Americans—predominantly from the Navajo Nation (W. Hedden, Grand County Council, Moab, personal communication with C. H. Petrich, ORNL, April 12 and August 16, 1994)—are represented at slightly higher densities than in the Utah as a whole, and its Hispanic population is slightly less dense than that of the state. Otherwise the racial make-up of the county is generally comparable to that of the whole state. San Juan County's Navajo Indian Reservation leads in part to its having a markedly higher percentage of American Indians than is reflected in the state percentages. Table 3.7-2 lists the racial composition for 1990

Table 3.7-1. Population Growth in Moab and Grand County, Utah, 1970–1992

Census year	Moab	Unincorporated areas	Grand County total
1970	4793	1895	6688
1980	5333	2908	8241
1988	4150	2400	6550
1990	3971	2649	6620
1992	4200	2800	7000

Sources: U.S. Census data and E. Inskip, Utah Department of Employment Security, personal communication with C. H. Petrich, ORNL, August 22, 1994.

Table 3.7-2. 1990 Population by Self-Reported Racial Category for the State of Utah, Grand County, and San Juan County (*Source*: U.S. Bureau of the Census 1991)

Racial Category	State of Utah	Grand County	San Juan County
Total population	1,722,850	6,620	12,621
White population (%)	1,615,845 (93.8)	6,341 (95.8)	5,501 (43.6)
Hispanic population (%)	84,597 (8.8)	291 (4.4)	440 (3.5)
Asian population	33,371 (1.9)	24 (0.4)	40 (0.3)
American Indian population (%)	24,283 (1.4)	203 (3.1)	6,859 (54.3)
Black population (%)	11,576 (0.7)	7 (0.1)	11 (0.1)
Other minority populations (%)	37,775 (2.2)	45 (0.7)	210 (1.7)
Total minority population (%)	151,596 (8.8)	512 (7.7)	7,274 (57.6)

for Grand County, San Juan County, and the whole state. These data form a portion of the baseline for assessing the potential for environmental justice issues discussed in Section 4.7.7.

3.7.2 Economic Resources and Employment

3.7.2.1 Economic Resources

The city of Moab and Grand County are undergoing substantial population and economic growth fueled chiefly by the tourist and recreation industries. For the last 2 years, property values have appreciated by approximately 5% in Moab and approximately 20% in Spanish Valley (J. Tangreen, Deputy Assessor, Grand County Tax Assessment Office, personal communication with C. H. Petrich, ORNL, December 5, 1995). In 1993–1994, 800 motel/hotel rooms were added, including those of the nine new motels constructed and opened. Tourist room sales increased in January–March 1994 by 22% over the same period in 1993 (V. Smouse, Deputy Grand County Tax Assessor, Moab, personal communication with C. H. Petrich, ORNL, August 10, 1994).

In 1993, a total of 32 new dwelling units were built in Moab, while in 1994, 53 units were projected. Much of the new residential development is in higher-grade housing in the southern section of the town. Condominium units are also being constructed for the first time in Moab. Because only 5% of Grand County and Moab is in private ownership (Table 3.7-3), land for purchase is a distinctly scarce resource, with property values having been bid up accordingly in response to increasing tourism, retirement home, and second-home pressures (V. Smouse, Deputy Grand County Tax Assessor, Moab, personal communication with C. H. Petrich, ORNL, August 10, 1994). In 1992, Moab and Spanish valleys had 4289 family dwelling units, including single-family detached homes, mobile homes, and apartments (E. Inskip, Utah Department of Employment Security, personal communication with C. H. Petrich, ORNL, August 22, 1994). Housing in Moab and Grand County is currently in high demand, with waits for rental units of up to one year not uncommon.

The town of Moab covers approximately 760 ha (1877 acres). Moab and Spanish Valley together cover 1555 ha (3842 acres), or approximately 2.3 km^2 (6 square miles), compared to Grand County, which covers 1425 km^2 (3692 square miles). In Moab and Spanish Valley, agriculture accounts for 61% of the land use, residential 31%, industrial 6%, and commercial 2% (E. Inskip, Utah Department of Employment Security, personal communication with C. H. Petrich, ORNL, August 22, 1994).

3.7.2.2 Employment

Most of the Grand County labor force is employed in Grand County or Moab (Table 3.7-4). The 1994 annual average unemployment rate for Grand County was 6.0% (6.5% in winter) as compared to a 1994 rate of 3.7% for the state. By October 1995, unemployment in Grand County was down to 4.2% (3.3% for the state) (E. Inskip, Moab Job Service, Utah State Employment Agency, personal communication with C. H. Petrich, December 4, 1995). Grand County had a total civilian labor force in 1994 of 4777, an 18% increase over its 1993 total (E. Inskip, Utah

Table 3.7-3. Land Ownership in Grand County

Land ownership	Percent
Federal lands	71
State lands	15
Indian Reservation	7
Private lands	5
City, county, and school districts	2

Source: E. Inskip, Utah Department of Employment Security, personal communication with C. H. Petrich, ORNL, August 22, 1994.

Table 3.7-4. Labor Market, Annual Average, 1992

Labor market	Percent
Trade	31.0
Government	24.3
Services	21.2
Mining	8.2
Utilities	5.6
Construction	3.1
Manufacturing	2.3

Source: E. Inskip, Utah Department of Employment Security, personal communication with C. H. Petrich, ORNL, August 22, 1994.

Department of Employment Security, personal communication with C. H. Petrich, ORNL, August 22, 1994). Utah is a right-to-work state, with legislation making it unlawful for any employer, person, firm, labor union, employee, or any agency to force or attempt to force any person to join or refrain from joining a labor organization.

Depressed markets for uranium and vanadium in the early 1980s resulted first in employment cutbacks and then in the closing of the Atlas mill in 1984. The effects on local employment are reflected in Figure 3.7-1. Over 200 people lost their jobs immediately, with an eventual decline in the Grand County total population of 5.5% (441 people) between 1980 and 1984.

In 1982, Grand County's per capita personal income (PCPI) was $9,231, ranked 6th in the state. In 1992, Grand County had a PCPI of $13,343, 14th in the state, 86% of the state average ($15,573), and 66% of the national average ($20,105). Grand County's annual average growth rate in PCPI over the 10 years from 1982 to 1992 was 3.8%. This compares to the state's average annual growth rate of 5.5% and the nation's of 5.7%. The downturn in the mining and mineral processing industries is reflected in these figures. Grand County's total personal income (TPI) of $95.2 million in 1992 ranked 20th in the state and accounted for just 0.3% of the state total. In 1982, Grand County's TPI of $77.7 million ranked 17th in the state. This change represents an annual growth rate in TPI of 2.1%, while the state average was 7.1% and the nation's was 6.7% (E. Inskip, Utah Department of Employment Security, personal communication with C. H. Petrich, ORNL, August 22, 1994). Earnings of Grand County residents increased at an annual growth rate of only 1.8% between 1982 and 1992. The largest industries in 1992 were services, which accounted for 22.9% of earnings; retail trade, 20.2%; and state and local government, 13.4%. In 1982, the largest industries were mining, 28.9% of earnings; services, 16.6%; and retail trade 11.0%. Since 1982, earnings from mining declined at an annual rate of 7.9% to only 10.5% of total earnings in 1992. Federal civilian government earnings grew at an annual rate of 9.6% to 9.1% of total earnings in 1992 (E. Inskip, Utah Department of Employment Security, personal communication with C. H. Petrich, ORNL, August 22, 1994).

3.7.3 Recreation

The Town of Moab received its name from Mormon pioneers who believed this remote location was, indeed, "the Far Country," named after the Biblical Moab, which was physically quite removed from the rest of the inhabited portions of the Middle East (Taylor 1990). This remoteness, coupled with the area's natural beauty, accounts for Moab's strong attraction to recreationists. Old prospecting roads lead throughout southeast Utah, gaining new life as trails for four-wheel drive vehicles, ATV's, dirt cycles, and mountain bikes. Moab's Easter Jeep Safari, begun in 1967, is now a nine-day event using more than two dozen trails and attracting more than 1500 vehicles (Knight 1990). Moab, which used to be known as the Uranium Capital of the World, is now, forty years later, known as the Mountain Bike Capital of the World. Some have tagged it the Four-Wheel Drive Capital of the World (Daughters of Utah Pioneers 1972). Whitewater rafting on the Colorado River has also become a major tourist draw in the past 20 years, with numerous outfitters providing expedition guides and equipment. Recreational services

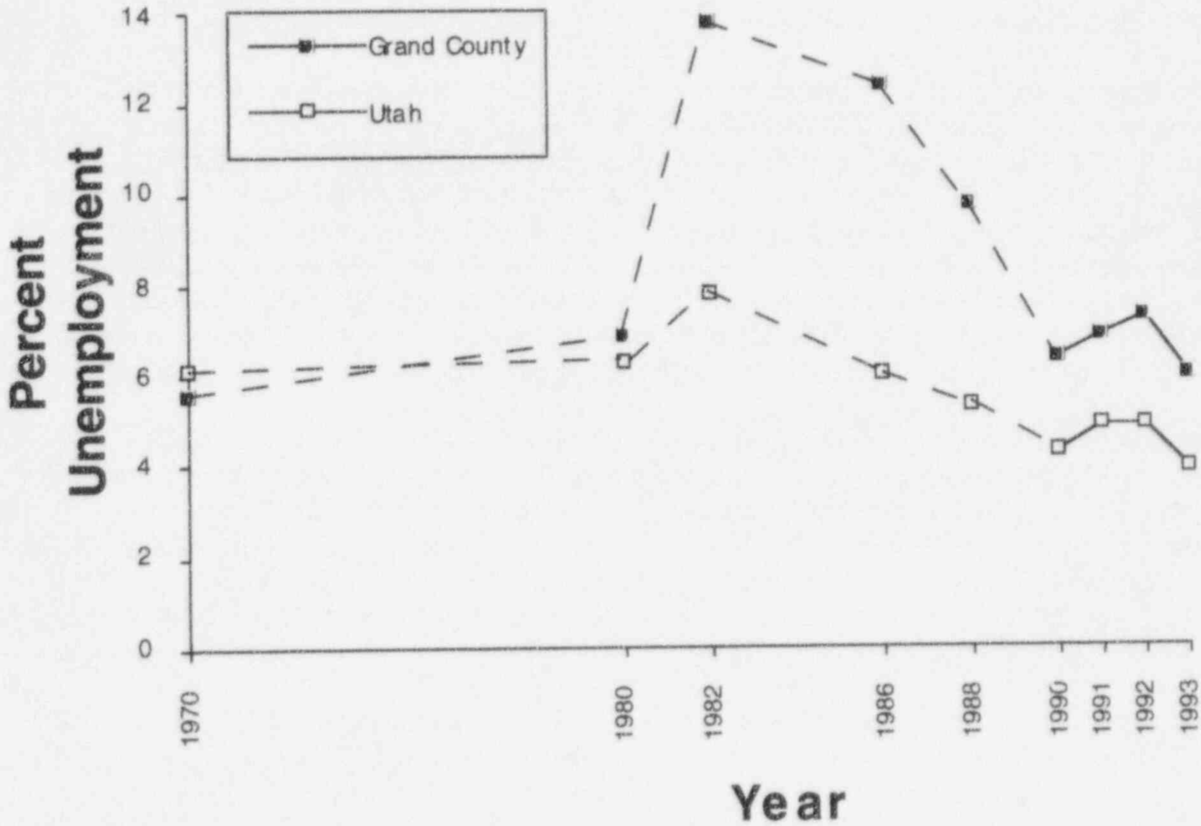

Figure 3.7-1. Annual Average Unemployment in Utah and Grand County, 1970–1992. Dashed lines represent unavailable data points. Preliminary data for Grand County in the first quarter (January to March) of 1994 indicate an unemployment rate of 6.5, compared to 7.0 for the same period in 1993. *Source:* E. Inskip, Utah Department of Employment Security, personal communication with C. H. Petrich, ORNL, August 22, 1994.

in the area are provided by 55 private operations, most based in Moab (M. Hoehine, Grand County Clerk Office, Moab, Utah, personal communication with C. H. Petrich, ORNL, August 22, 1994).

Moab sits in the middle of remote, wild, and beautiful canyonlands. In 1964, the U.S. Congress set aside 101,000 ha (250,000 acres) to create Canyonlands National Park immediately southwest of Moab [the most accessible parts are about 48 km (30 miles) away]. Seven years later, in 1971, Arches National Monument, immediately north of Moab and across U.S. 191 from the Atlas site, was upgraded to national park status.

Arches National Park, which covers 29,708 ha (73,379 acres), was first declared a National Monument in 1929, indicating that tourism might become important to the local economy (Stanton 1992). The Moab area generally, and Arches National Monument in particular, is celebrated in Edward Abbey's classic, *Desert Solitaire: A Season in the Wilderness* (1968), one of a handful of the most important writings contributing to the environmental movement of the late 1960s and the passage of the National Environmental Policy Act of 1969. Abbey specifically mentions the Atlas mill in the book. The entry to and visitor's center for Arches National Park are only a little over 2 km (1.2 miles) north of the Atlas tailings pile. The tailings pile is directly in the view of anyone driving south on U.S. 191 toward Moab from the Park entry.

Arches National Park has the greatest density of arches in the world. Over 2,000 catalogued arches range in size from a 1-m (3.3-ft) opening to one over 93 m (306 ft) from base to base. For the life of the Park and its predecessor status as a National Monument, visits have increased at well over 13% per year (Figure 3.7-2). Visitation substantially increased after the Uranium Boom days with the completion of an award-winning (from the American Society of Landscape Architects), paved main entry road into the Park in 1958 and the Visitors' Center, and continues to grow at an annual pace greater than 13%.

Based on exit surveys conducted monthly throughout 1993, Park researchers determined that one-third of all visitors come from foreign countries, and that as many as 42% of the summer visitors are foreigners (N. Poe, Superintendent, Arches National Park, Moab, personal communication with C. H. Petrich, ORNL, July 11, 1994). Most visitors come from Germany (15.8%), Colorado (10.3%), Utah (8.6%), California (8.5%), and France (3.1%).

Local residents account for less than 1% of summer visitors and 5% of winter visitors. Overall, 70% of visitors are making their first trip to Arches; in the winter months, first-time visitation drops to less than half of visits. While in Moab, 47% of visitors stay in lodging units and 37% camp. The average visitor spends 1.5 days in the Park. Better than 58% of visitors go to nearby Canyonlands National Park. The average Arches National Park visitor spends 2.9 days in Moab; 19% of park visitors spend 1 day, 36% spend 2 days, 22% spend 3 days, and 10% spend 4 days in Moab.

Among the area's other scenic and recreational attributes are the La Sal Mountains 30 km (18 miles) southeast of Moab. The La Sal Mountains, which rise to about 3962 m (13,000 ft), and the

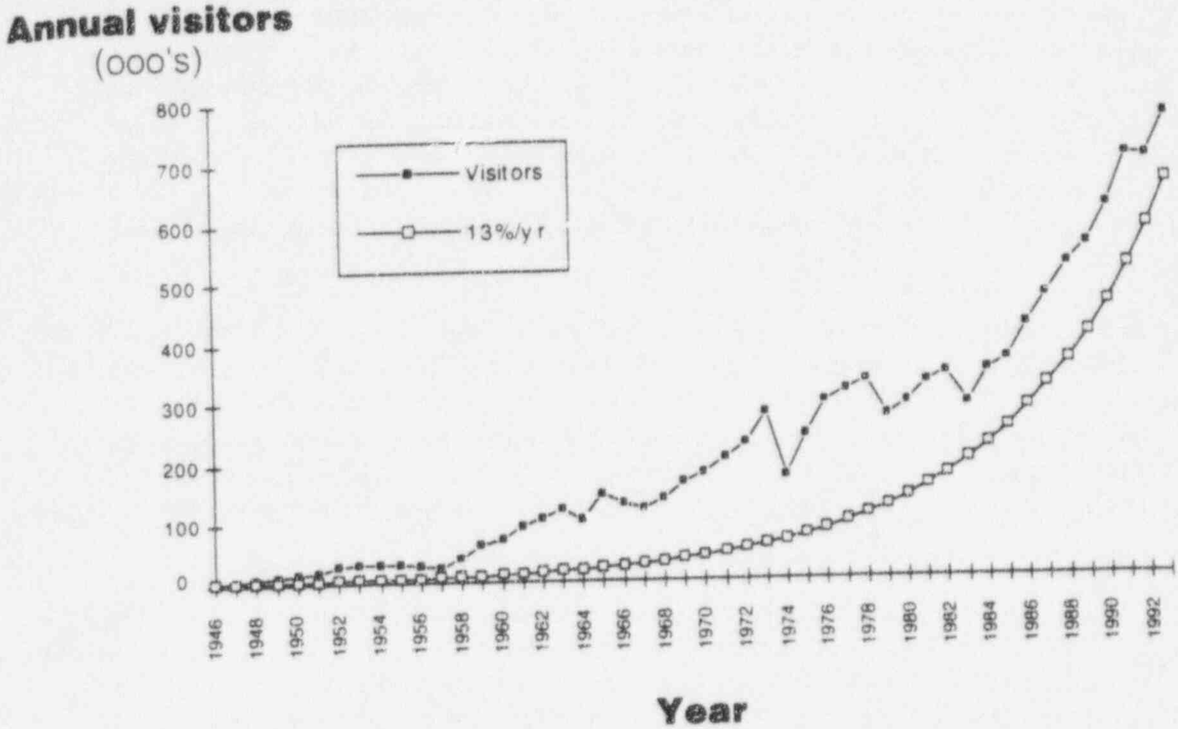

Figure 3.7-2. Growth in Annual Visits to Arches National Park, 1946–1993. *Source:* N. Poe, Superintendent, Arches National Park, Moab, Utah, personal communication with C. H. Petrich, ORNL, August 10, 1994.

Manti-La Sal National Forest, are well known for cross-country skiing, trout fishing, hiking, camping, and deer and elk hunting. Dead Horse Point State Park to the west of Moab provides photography, hiking, hang-gliding, and camping, as well as dramatic views of the Colorado River below.

3.7.4 Aesthetics

The Moab area has abundant aesthetically pleasing resources. The red sandstones, rushing rivers, closed canyons, expansive panoramas to the La Sal mountains, vertical buttes, receding layers of distant mesas, and subtle vegetative accents combine to reinforce the sense of remote wild western lands. A network of primitive trails and roads left from years of prospecting provides access—albeit often roundabout—to many spectacular views and other aesthetically pleasing experiences. Quiet niches abound due to the wide expanses and low visitation and population densities. Tourists tend to focus on the national parks and recreationists on the rivers and back country trails. Land largely in public ownership permits the relatively untrammeled exploration of the whole area.

The Atlas tailings pile is surrounded to the north and west by high sandstone cliffs at the northern terminus of Moab Canyon northwest of the outside bend of the Colorado River. Its existing rock color and texture blend well with the surrounding red sandstones, as does its flat-topped, mesa shape. Despite its 53-ha (130-acre) area and 27-m (90-ft) height, the pile is not particularly obtrusive within the scale and landforms of the existing landscape. The pile is, however, more conspicuous when viewed from the scenic turnouts along the entrance drive into Arches National Park.

One of the area's most scenic and popular routes for bikers, automobile sight-seers, and rafters is along the Colorado River near Castle Valley. The Grand River Toll Road that followed this route was constructed in 1901 to allow travelers to enter Moab from the east along the south side of the Colorado River. This became State Highway 128 in 1921, and in 1989 was proclaimed a Scenic Byway (Montgomery 1990). The local community has stressed development of the film, recreation, and tourism industries based on the area's natural beauty and as a means of diversifying its economy to protect from the boom and bust cycles associated with the resource extraction industries.

The proposed igneous bedrock riprap borrow site is Round Mountain in Castle Valley, northeast of Moab and 38.6 km (24 miles) from the tailings pile. Round Mountain is an intrusive igneous cone standing solitarily 330 meters above the undeveloped Castle Valley floor. Its outcrops are skirted by alluvial fans and talus slopes, the proposed source of the riprap. The land surrounding Round Mountain is grazing land where field reconnaissance provided both physical siting and strong evidence of mule deer. Vegetation around Round Mountain is sparse, with numerous and extensive patches of bare earth or rocks. Indian ricegrass, galleta, blackbrush, and fourwing saltbush are interspersed among sage brush, mormon tea, pinyon juniper, Utah juniper, antelope bitterbrush, and birchleaf mountain mahogany.

Round Mountain is itself visibly prominent in the near-to-mid-ground of those traveling along the Castle Valley portion of the Loop Road. It is a truncated conical-shaped outcrop with expansive alluvial fans. It is locally distinctive in that it is of igneous origin, but isolated from the La Sal Mountains. It does not have the red sandstone coloration of the surrounding rims, mesas, and buttes.

From Round Mountain, one has an impressive view to the northeast of the spectacular Castle Rock and Priest and Nuns buttes as well as of the famous Professor Valley along the Colorado River. To the northwest, viewers can see Castle Valley, bounded by the red sandstone cliffs of Porcupine Rim on the west. To the southeast, one has outstanding views of the nearby peaks of the La Sal Mountains. Round Mountain is generally visible from homes in Castle Valley.

Up the scenic Castle Valley Road (State Highway 128), in nearby Professor Valley, Director John Ford filmed one of his classic western movies, *Wagonmaster* (also known as *Wagon Train*), in 1949. It was the beginning of 45 years of films, television commercials, travelogues, television specials, documentaries, and, now, rock videos, to be made in and around Moab. The latest films produced in the Moab area were *Geronimo* (Judson 1994) and *City Slicker II*. During the 1950s, there was an average of one film per year filmed in the area. In every decade since the 1960s, at least one television commercial and/or print advertisement has featured a car atop Castle Rock or one of the area's other isolated, narrow, vertical buttes (Stanton 1989). Films have also been shot down the Potash Road, the scenic road that forms the western boundary of the Atlas site. Another igneous bedrock riprap borrow site is planned "in the same general vicinity" (Atlas Corporation 1994) as Round Mountain. More locational details have been withheld by the licensee for reasons of protecting a cost structure believed to be sensitive to premature disclosure. No further information is available from the licensee regarding this site.

The potential crushed bedrock and alluvial cobble borrow site in the Spanish Valley is characterized as open, flat arid land with the La Sal Mountains immediately to the east. Existing quarry operations along with the U.S. 191 corridor are the major signs of development in the immediate vicinity. The alluvial valley bottom is treeless, covered with blackbrush and fourwing saltbush and sparse growth of Indian ricegrass and galleta.

3.7.5 Public Services and Infrastructure

The Atlas site is accessed from National U.S. 191. It is bounded on the west by State Highway 279, known locally as the Potash Road because it leads to the potash mill and mines located west of Moab. The Denver and Rio Grande Western Railroad, which lies on the bluff west of the Atlas site, leads to the potash development area. It is a spur from the main railroad to the north. Utah Power and Light Company and Northwest Pipeline Company have rights-of-way through the Atlas property for passage of their utility lines. Mid-America also has a six-inch natural gas pipeline that crosses the Atlas property.

The Southeastern Utah Center for Continuing Education is operated by the Utah State University and offers college-level courses in Moab. It has an annual enrollment of about 400 students. The College of Eastern Utah also has satellite facilities in Moab. In 1989 the University of Utah established the Helen M. Knight Studio/Conservatory in Moab for advanced education and graduate studies in fine arts. The city of Moab currently has about 1550 students enrolled in one primary elementary school, an intermediate school, a middle school, and a high school. The school system is currently near capacity, with mobile classrooms in use at the intermediate school (D. Weeks, Grand County School System, Moab, Utah, personal communication with C. H. Petrich, ORNL, August 30, 1994).

Moab's Allen Memorial Hospital has 34-units, a 3-room emergency treatment center, a 10-bed acute care facility with labor and delivery support, and a 21-bed extended care facility. The hospital and medical support system currently are meeting demand for services in both the winter and the tourist season (B. Gay, Allen Memorial Hospital, Moab, Utah, personal communication with C. H. Petrich, ORNL, August 30, 1994).

3.7.6 Historic and Cultural Resources

Southeastern Utah has served as a homeland for Native Americans for thousands of years. There is some evidence of occupation as early as 10,000 B.C. Between A.D. 1 and 700, agriculture developed, with Anasazi and Fremont peoples becoming the area's first farmers. They flourished until A.D. 1200 to 1300, when they abandoned southeast Utah and the Four Corners area generally. The abundant pictographs and petroglyphs in Grand County and throughout southeastern Utah derive from these people in this period. Sometime after their occupation, the hunter-gatherer ancestors of the Ute and Southern Paiute moved into southern Utah. After Euro-American contact, these Native Americans began to acquire and use horses and other artifacts, changing their cultures dramatically and evolving into the Ute and Paiute cultures of the historic record (Reed 1990).

A prehistoric pithouse was excavated by archaeologists in the late 1980s, on the west side of Moab, as a result of sidewalk construction. Archaeologists estimate that the structure dates to 300 B.C., with evidence of occupation from A.D. 240 and A.D. 510. This evidence of Archaic peoples occupying the Moab Valley suggests that other sites might underlie the current city and that the most abundant sites might not be from the Anasazi, or Pueblo II, occupation as commonly reported; the evidence does represent continuity of this period with the earlier period (Louthan 1990).

Southeastern Utah was not settled by European-Americans until 1877, in part because of hostilities with the Ute Tribe and in part because of the isolation of the area due to the Colorado River (named the Grand River—thus, *Grand* County—until 1921). The first record of English-speaking people being in Grand County is a 1753 inscription chiseled in a sandstone rock along the Old Spanish Trail, near the current airport and the Plateau site (Daughters of Utah Pioneers 1972).

Spanish Valley, also known as Moab Valley, runs about 32.2 km (20 miles) south from the Colorado River at Moab. It is a nexus in a natural pathway between the southwest, intermountain, and northwest states. The valley takes its name from the annual trading trips that Spanish travelers made between Santa Fe and California, connecting the 1920-km (1200-mile) distance between the Spanish Rio Grande settlements and those along the Pacific Coast (Daughters of Utah Pioneers 1972). These Spanish traders crossed the Colorado River at Moab, headed north (near the Plateau site), and crossed the Green River at the present town of Green River. The trail was known to be in use by 1800, and was used until around 1830 (Peterson 1984) or 1850 (Daughters of Utah Pioneers 1972). The trail crossed the Colorado River at about the same location as the current bridge on U.S. 191.

Mormon missionaries settled briefly in the Moab area in the mid-1850s. The Elk Mountain Mission of 1855 was a short-lived attempt to settle the Spanish Valley and educate the Ute Tribe to Mormonism and to teach them farming. Parts of the mission's native stone fort still stand about 1 km (0.6 miles) north of Moab, about 3 km (1.9 miles) from the Atlas site. After the signing of a peace treaty with the Ute Tribe and the establishment of the Uintah Reservation in eastern Utah and southwestern Colorado, the Spanish Valley area was permanently settled by Mormon farmers and ranchers in 1877 (Daughters of Utah Pioneers 1972).

Most of Moab's first settlers arrived from the north, following Moab Wash until they reached the "jump," or drop-off into Spanish Valley near the entry to Arches National Park. Here, wagons were disassembled and lowered 7 m (23 ft) and then reassembled below. This route from the north eventually became an improved road, and is the route of the current U.S. 191 (Akens 1990). These first Mormon settlers forded the Colorado River at the Atlas site, not to the southeast where the Old Spanish Trail crossed the river (Taylor 1990).

Spanish Valley was originally known for its fruit and vegetable crops. Gold, silver, and copper prospecting and mining caused small population and economic booms and busts. An oil boom in Grand Valley in the 1920s also contributed to economic fluctuations. Also in the early 1920s, Madame Marie Curie came to the American Southwest and to Moab in search of uranium sources for her radium experiments at her laboratory in Paris (Newell 1992a). Sacks of uranium from Grand County's Blue Goose mine in the upper Spanish Valley were shipped to her in Paris.

Atomic weapons development during World War II and the continued demands for reliable sources for Cold War stocks created new interest in uranium, attracting prospectors into the area in the late 1940s and early 1950s. Moab, Grand County, and southeastern Utah were forever changed by the urananite strike on July 6, 1952 by Texas prospector Charles A. Steen. His was the richest single lode of uranium ore discovered anywhere to that date, and led to Moab becoming the "Uranium Capital of the World." His bonanza lured thousands of other prospectors, all trying to duplicate his $120-million (1952 dollars) find. The population of Moab grew from 1200 to over 7000 in less than a year (Newell 1992b). Steen's discovery and mining of the first urananite in the United States meant the country could be independent of foreign sources of uranium, not because of his rich mine alone, but because "it was the starter's gun for the greatest and most successful prospecting rush of the century" (Stanton 1992).

In 1952 when Steen made his strike 32 km (20 miles) south of Moab, just inside the San Juan County line, there were only two uranium mills in the United States. Neither was designed to process urananite, Steen's ore; the existing mills were made to process carnotite, a lower-grade uranium-bearing ore found in smaller deposits nearer the surface. To process his ore and capitalize as quickly as possible on his find, Steen built his own $8 million processing mill. Steen's Uranium Reduction Mill, constructed on the north side of the Colorado River 5 km (3 miles) north of Moab, was at the time the only major atomic facility ever built with private financing (Newell 1992a,b). It began processing ore in 1956. In 1962, the Atlas Corporation purchased Steen's mill for $25 million and operated it until it was closed in April 1984. It was this mill operation that generated the tailings pile that is the subject of this DEIS.

While San Juan County received taxes for Steen's mine (and other urananite and carnotite mines), most people involved in prospecting and mining lived and operated out of Moab. Grand County, too, developed extensive mining operations. By 1956, the uranium prospecting boom and speculative penny stock frenzy that accompanied it had largely ended. The construction of Steen's mill, however, provided a stabilizing influence for Grand County and Moab tax and employment bases for 30 years (Newell 1992a). With the closing of the mill, Grand County eventually lost a third of its tax base and nearly 20% of its population (Stanton 1992).

The last mining and mill boom to affect Moab and Grand County arrived with the discovery of one of the richest potash deposits in the nation in the late 1950s. The development of potash mining and milling operations began in the early 1960s. In 1962, a 48-km (30-mile) spur was built to connect the Denver and Rio Grande Western Railroad to the north with the Texas Gulf Sulfur Company (now called Texasgulf, Inc.) potash operations to the southwest of Moab (Norman 1991). It is this spur which would provide rail facilities for transporting the Atlas tailings to the Plateau site.

3.8 NATURAL RADIATION ENVIRONMENT

Natural sources of radiation exposure have been summarized by the National Council on Radiation Protection and Measurements (NCRP 1975). The primary external sources are cosmic and terrestrial radiation, while the internal dose originates primarily from radon inhalation. An additional dose originates from radionuclides incorporated in the body or ingested. The primary man-made radiation exposure results from medical applications of radiation.

In Utah, cosmic radiation contributes a yearly external dose of about 0.65 mSv (65 mrem) (O'Brien and McLaughlin 1970 and 1972; O'Brien 1975; Klement 1972) together with an associated cosmogenic component of about 0.01 mSv (1 mrem) from carbon-14. The terrestrial component of dose originates from potassium-40, rubidium-87 and radionuclides included in the decay chains for uranium-238, thorium-232, and uranium-235. The non-gaseous terrestrial component in Utah results in a yearly whole-body dose of about 0.35 mSv (35 mrem) (NCRP 1975).

The gaseous component must be considered separately. Based on the concentration of radium-226 in soils in the Moab area, radon concentrations of about 0.02 to 0.07 Bq/L (0.5 to 2.0 pCi/L) would be expected (NCRP 1975; Schaiger 1974). Medical radiation exposures result mostly from the use of X-ray equipment and for Utah, average 0.75 mSv/yr (75 mrem/yr) (HEW 1973).

NCRP (1987) contains a discussion of the total annual average effective dose equivalent to a member of the U.S. population by source. A composite of the information in NCRP (1987) is given in Table 3.8-1. The annual average effective dose equivalent for inhaled radon, 2 mSv (200 mrem), results from an average radon-222 concentration of about 0.056 Bq/L (1.5 pCi/L). Based on Utah specific information, the average Utah resident might experience slightly higher doses from natural sources.

Table 3.8-1. Annual U.S. Population Average Total Effective Dose Equivalent from Man-Made and Natural Radiation Sources [mrem/yr (mSv/yr)]

Man-made	
Diagnostic X-rays	39 (0.39)
Nuclear Medicine	14 (0.14)
Other	7 (0.07)
Subtotal	60 (0.60)
Natural	
Inhaled Radon	200 (2.00)
Cosmic Radiation	27 (0.27)
Cosmogenic	1 (0.01)
Terrestrial Radiation	28 (0.28)
In the Body	
lead-210, polonium-210	15 (0.15)
potassium-40	19 (0.19)
radium-226	1 (0.01)
all others	4 (0.04)
Subtotal	295 (2.95)
Rounded total	360 (3.60)

Source: NCRP (1987).

4. ENVIRONMENTAL CONSEQUENCES, MONITORING, AND MITIGATION

This section describes and evaluates potential environmental impacts of the Atlas proposal (Section 2.1) and the Plateau site alternative, which includes tailings transport by rail and tailings disposal on the Plateau site (Section 2.2). For each resource area (e.g., air quality and noise), reclamation impacts and post-reclamation impacts are considered. The discussion of reclamation impacts includes:

1. on-site reclamation operations (i.e., on both the Atlas site and the Plateau site),
2. borrow operations, including excavation of borrow materials (borrow) and borrow transport to either the Atlas site or Plateau site,
3. tailings transport by rail from the Atlas site to the Plateau site (only for the Plateau site alternative), and
4. possible accidents (e.g., spills and vehicle accidents during borrow transport).

The discussion of post-reclamation impacts includes consideration of:

1. normal impacts (e.g., leaching of tailings contaminants into groundwater), and
2. impacts of a hypothetical, maximum tailings pile failure. [The Atlas-proposed pile design is believed to be more than adequate to withstand the maximum credible earthquake and the probable maximum flood (PMF). Nevertheless, a hypothetical, maximum failure of the tailings pile design has been constructed for evaluation in this section, as described in Section 2.1.8. A more detailed consideration of this issue is presented in the draft TER (NRC 1996) that has been made available for public comment.]

Cumulative impacts are also discussed for each resource area (Section 4.9). Monitoring, information adequacy, and mitigation are discussed as needed.

With regard to the Plateau site alternative, the discussions of impacts and mitigation measures are preliminary, because at this time no decision has been made to remove the tailings from the Atlas site, and no detailed plan for construction, operation, mitigation, etc., has been developed for the Plateau site. If the tailings were to be removed from the Atlas site, the Plateau site and other alternate sites would be considered in detail in a separate NEPA document for selecting a site for tailings disposal.

4.1 AIR QUALITY AND NOISE

4.1.1 Reclamation Impacts at the Atlas and Plateau Sites

Air quality impacts during reclamation would result from vehicle emissions and fugitive dust under both the Atlas proposal and Plateau site alternative. Impacts would be less of a concern at the Plateau site, which is relatively remote from sensitive receptors such as homes, businesses, and parks. Therefore, this section focuses on air quality impacts at the Atlas site, where some control of fugitive dust would be necessary. Based on the following analysis, it is believed that dust control would allow the reclamation activity at the Atlas site to proceed without violating air quality standards, and that the standards could be easily met at the Plateau site.

Under the Atlas proposal, operations on the site would include trucks hauling borrow materials, contaminated soils, and mill debris to the tailings pile. Noise from trucks would probably be audible from areas within 0.5 km (0.3 miles). Heavy trucks can cause noise levels of up to 90 dB(A) at distances of 15 m (50 ft). However, noise levels decrease at about 6 dB(A) for each doubling of distance from the source, so that the maximum noise from the trucks would be about 40–50 dB(A) in the northern parts of Moab. This is equal to or less than daytime noise levels in a quiet suburban residential area. Therefore, noise from the trucks would usually not be audible in Moab. However, noise from these trucks is likely to be heard by visitors within 0.5 km (0.3 miles) of the tailings pile area and could be heard at even greater distances in some cases. Visitors hiking along the southern parts of Courthouse Wash or on some of the nearby ridges would be likely to hear occasional noise from heavy trucks, especially during acceleration. Noise from construction activities near the pile could be perceived from locations near the park boundary. The EPA has identified 55 dB(A) as a yearly average which, if not exceeded, would prevent activity interference and annoyance (EPA 1978). Therefore, noise impacts would not be expected to be annoying except possibly to visitors very near the park boundary during particularly noisy phases of construction.

Exhaust emissions of construction equipment would result in increases in atmospheric concentrations of carbon monoxide (CO), nitrogen dioxide (NO_2), sulfur dioxide (SO_2), volatile organic compounds, and particulate matter. During reclamation, approximately 13 pieces of construction equipment would be used on the site, including three 15- to 23-m^3 (20- to 30-yd^3) scrapers, two water trucks, a 140-hp track dozer, a 300-hp dozer, a 13,600-kg (30,000-lb) grader, a 2.3- to 3.1-m^3 (3- to 4-yd^3) front-end loader, a smooth drum compactor, a sheepsfoot compactor, and two pickup trucks. Operation of these types and numbers of vehicles would not be expected to add appreciably to air pollutant levels off the site and should have negligible impacts on ambient air quality.

Fugitive dust would result from excavation, grading, and hauling. To estimate potential impacts of fugitive dust on the nearest off-site receptor, a number of assumptions were made. First, it was assumed that (1) a maximum of 10 additional heavy construction vehicles would be used at any one time on the Atlas site during the reclamation phase, and (2) the maximum area being disturbed by earthwork at any one time would be 10 ha (25 acres). For heavy construction (earthwork) activity with no dust control during reclamation, a fugitive dust emission of 2.7 metric tons/ha (1.2 tons per acre) per month was obtained from EPA (1985), and 30% of the emission would be expected to be PM-10 (EPA 1988).

The maximum contribution of particulate matter (or dust) from reclamation earthwork to existing PM-10 concentrations at nearby sensitive receptors (the former Tex's Tour Center and Arches National Park headquarters) was estimated using the EPA-recommended Industrial Source Complex (ISC) (EPA 1993). The disturbed area was assumed to be a 10-ha (25-acre) rectangle having long sides 2.5 times the length of the short sides and an elevation 24 m (80 ft) higher than the nearest potentially sensitive receptor (the former Tex's Tour Center). To provide a conservative result, it was assumed that

1. the rectangle is oriented with its long axis pointed directly toward the nearest sensitive receptor,
2. the wind direction during reclamation activity (daylight only) is always exactly parallel to the orientation of the long axis, blowing towards the nearest sensitive receptor,
3. all 10 heavy construction vehicles are active simultaneously in the rectangle,
4. atmospheric stability is always neutral (stability class D), and
5. wind speed is a constant 4.8 km/hr (3 mph) during reclamation.

The modeling results indicated that, if no dust suppression measures were used, the maximum reclamation-related increase in 24-hour average PM-10 concentrations at the former Tex's Tour Center would be 144 $\mu g/m^3$. If this concentration is added to existing background levels of fugitive dust, the expected number of exceedances of the 24-hour standard would violate air quality regulations.

Sprinkling with water in semi-arid regions can reduce fugitive dust by 50% (EPA 1985), which could reduce the concentration increase by half to 72 $\mu g/m^3$. The three highest measured background 24-hour average concentrations in the vicinity of Moab during the last 3 years (1991–1993) were 181, 111, and 70 $\mu g/m^3$. The highest of these is 121% of the corresponding standard of 150 $\mu g/m^3$, and all others are below the standard. Adding the estimated concentration of fugitive dust (72 $\mu g/m^3$, assuming the disturbed area is sprinkled with water) to the background values given above would lead to one additional exceedance of the standard, for a total of 2 exceedances over the 3-year period. Up to 3 exceedances of the 24-hour NAAQS for PM-10 are allowed over a 3-year period (40 CFR Part 50). Because the two highest measured values (both during 1991) were associated with exceptionally high winds (R. Doebbeling, Utah Air Monitoring Center, Salt Lake City, Utah, personal communication with T. J. Blasing, ORNL, August 10, 1994), and the estimated concentrations due to construction are based on conservative assumptions, reclamation with adequate sprinkling would not be expected to cause nonattainment of the 24-hour NAAQS at the nearest sensitive receptor or any more distant receptor in that general direction from the tailings pile. Even if sprinkling did not attain a full 50% reduction of fugitive dust, the above analysis indicates that exceedance of standards would still not be expected, because the assumptions were sufficiently conservative.

Assuming the wind blows from southwesterly directions (from the tailings pile toward receptors in the area near the former Tex's Tour Center) 20% of the time during any year, the annual increment in PM-10 concentration due to reclamation with adequate sprinkling would be, at most, 20% of 72 $\mu g/m^3$, or less than 15 $\mu g/m^3$. Because the highest annual PM-10 concentration measured in the area around Moab during the last three years is 34 $\mu g/m^3$, or 16 $\mu g/m^3$ below the NAAQS, the increment of 15 $\mu g/m^3$ would not be expected to cause any exceedance of the annual standard at the nearest sensitive receptor. As above, compliance with standards would still be expected if sprinkling did not attain a full 50% reduction of fugitive dust.

The nearest headquarters building for Arches National Park is about 2.0 km (1.25 miles) northwest of the nearest edge of the tailings pile. Upslope winds, from the pile toward the headquarters area, are likely during daytime hours when reclamation earthwork is proceeding. Maximum PM-10 concentrations at the park headquarters were modeled as described above except that (1) the orientation of the disturbed area was changed so that its long axis pointed directly at park headquarters, (2) the wind was assumed to blow directly toward the nearest headquarters building, and (3) the tailings pile was not elevated with respect to park headquarters, so that no reduction in concentration due to downward dispersion of PM-10 would be included in this simulation. Based on these model calculations for park headquarters, the highest PM-10 concentrations due to reclamation are expected to be 52 $\mu g/m^3$ for the maximum 24-hour average and 13 $\mu g/m^3$ for the annual average. In neither case would these concentrations lead to exceedances of the NAAQS. For locations in the city of Moab, such as the nearest hospital, estimated dust concentrations due to construction would be lower than the above estimates.

The above calculations were based on very conservative assumptions, and the actual PM-10 concentrations, or model estimates of PM-10 concentrations based on actual meteorological data, would likely be substantially less.

The proposed activity would involve the hauling of tailings-contaminated soils to the pile from locations near the site boundary, and thus near areas used by the public. In such cases, fugitive dust could arise from unpaved roads or other areas of truck traffic. This fugitive dust could be reduced by the use of surfactants or by sprinkling with water. Fugitive dust from loaded trucks could be reduced if tarpaulins were used to cover the loads of tailings.

The visibility of the dust plume from reclamation operations would depend upon background conditions and the orientation of the viewer with respect to the plume. It is expected that visitors to Arches National Park would occasionally experience some slight reductions in visibility during the reclamation period. Such effects would be temporary and therefore would not contribute to a general deterioration of visibility over time.

4.1.2 Borrow Operations

Operations at the proposed riprap borrow sites in Castle Valley and Spanish Valley and the clay borrow site at Klondike Flat would not be expected to generate significant amounts of fugitive dust. If necessary, control of fugitive dust would be implemented. Impacts on air quality at these sites would be expected to be negligible. Air-quality impacts of 10 to 12 trucks per hour transporting borrow material should also be negligible overall, especially with tarpaulins covering the loads on the trucks. The five to six trucks per hour transporting riprap through the town of Moab would add slightly to pollutant and noise levels in town, where such levels are relatively high compared to remote areas. Although trucks transporting clay would travel on U.S. 191 along the boundary of Arches National Park, they would not be expected to cause any violation of air quality standards.

4.1.3 Tailings Transport

Excavation of tailings for transport to the Plateau site would be controlled to prevent significant air-quality impacts from fugitive dust at the Atlas site. Also, the conveyor would be designed to prevent escape of dust. Air quality impacts from trains used to transport the tailings would be negligible because of mitigative measures such as tarpaulins covering loaded train cars.

4.1.4 Accidents

Accidents involving the tailings conveyor, the trains transporting the tailings, and trucks transporting borrow materials would result in dust entering the air. The dust emissions should be temporary, because spill cleanup and other corrective actions would be conducted immediately. Therefore, adequate cleanup and controls would be expected to limit air quality impacts to negligible levels.

4.1.5 Monitoring and Information Adequacy

Meteorological monitoring at the Atlas site was conducted for a few years in the early 1980s. The data resulting from this monitoring were not sufficient to use in the modeling of air pollution effects in this section and the dose assessment provided in Section 4.8. Therefore, meteorological data collected in Moab were obtained from the Utah Climate Center. These data were suitable for use in this DEIS, although wind data indicated more turbulence than would be expected, apparently resulting from nearby structures such as buildings. The turbulence data were therefore adjusted to provide data more in line with what would be expected near the Atlas site and to provide a more conservative assessment in this DEIS.

4.1.6 Post-Reclamation Impacts

4.1.6.1 Normal Conditions

Reclamation would reduce the escape of fugitive dust from the pile and lead to a small reduction in the concentration of particulate matter in the area, and a small improvement in visibility. Thus, no deterioration of air quality or impact on a PSD Class I area (Arches National Park) would result from the proposed action after reclamation is completed. No noise level of concern would be produced on the Atlas site after reclamation is completed.

4.1.6.2 Tailings Pile Failure

If the tailings pile were to fail and loose materials at the surface were exposed to wind, tailings dust could be released to the air. As for other accidents discussed above, adequate cleanup and reconstruction of the surface cover system should limit the temporary air-quality impacts to negligible levels.

4.1.7 Conclusion

The licensee would implement a plan to minimize emissions of fugitive dust during reclamation. The plan would be required to consider all reasonable measures, including frequent sprinkling with water, use of surfactants, and covering contaminated soils during hauling. With appropriate control measures, neither the Atlas proposal nor the Plateau site alternative would be expected to result in nonattainment of air quality standards.

4.2 GEOLOGY, SOILS, AND SEISMICITY

Neither the Atlas proposal nor the Plateau site alternative would have any environmental impact on geology or seismicity. Contamination of soils could occur as a result of spills, but any spill of tailings or hazardous substance would be cleaned up. Existing contamination at the Atlas site would be cleaned up as part of the Atlas proposal. Soils contamination associated with the tailings pile design failure is discussed in Section 4.3.

This section summarizes potential effects on the tailings pile resulting from future possible earth movement associated with strong-motion earthquakes and with salt dissolution along the Moab Fault. These natural hazards phenomena, whose magnitudes and frequencies are described in Section 3.2, would have uncertain probabilities of destabilizing the reclaimed Atlas tailings pile, as discussed in more detail in the draft TER (NRC 1996).

The rate of long-term salt dissolution in the Moab region is largely unknown. Subsidence as a result of salt dissolution could range from gradual to rapid, depending on the depth to the salt and the flexibility or rigidity of the roof-rock overlying possible salt solution features. Both rates of subsidence have occurred during Pleistocene time within the Paradox basin. Gradual subsidence would cause cosmetic damage to the tailings pile. In contrast, a rapidly developing sinkhole could propagate upward into the tailings. This could damage the tailings pile and cause a portion of the tailings to be submerged below the water table.

The potential for earthquake damage at the Atlas site could be increased by ground motion magnification and liquefaction of the thick, unconsolidated sediments beneath the site. Atlas has thus far not determined the magnitude of such a maximum credible earthquake (MCE) (draft TER, NRC 1996). Two independent studies have estimated the MCE at 6.5 and 7.0 magnitudes (McGuire et al. 1982 and Bernreuter et al. 1995). Bernreuter's estimated maximum peak ground acceleration ranges between 0.2 g and 0.4 g. Atlas has not committed to these seismic design parameters. Unconsolidated sediments are thin or absent at the Plateau site. Landslides are possible on the bluffs at the Atlas site and could damage the tailings pile and affect drainage ditches and Moab Wash.

In summary, the draft TER (NRC 1996) lists the following unresolved geologic issues related to the Atlas site: (1) capability of the Moab fault and its branches, (2) the nature of a buried scarp at the Atlas site, (3) the rate and nature of subsidence, (4) the effects of migrating sand dunes, (5) the effect of landslides emanating from Poison Spider Mesa, and (6) the seismic design basis.

4.3 LAND USE

4.3.1 Reclamation Impacts at the Atlas and Plateau Sites

The proposed reclamation activities at the Moab site would not be expected to affect nearby land uses because no construction would occur off the site and no significant amount of contaminated or radioactive dusts would be expected to escape from the site and significantly contaminate nearby areas. Thus, nearby recreational activities, park visitation, grazing, operation of existing commercial establishments, agricultural activities, and gardening and other residential lands uses would not be affected. In the unlikely event of a significant radioactive release, cleanup would be initiated immediately to restore contaminated land to a condition sufficient to support previous land uses.

Tailings disposal at the Plateau site would reduce the amount of land available for grazing, essentially the only land use at the Plateau site other than a limited amount of recreation. Because forage production at the site is low and a vast acreage of such land would remain available in the surrounding area, loss of this land for grazing would be a minor impact. Aviation at the Canyonlands Field, which is 3 to 5 km (2 to 3 miles) east-northeast of the Plateau site, would not be affected.

4.3.2 Borrow Operations

Under the proposed action, obtaining clay from the Plateau site would reduce, at least temporarily, the amount of land available for grazing. Recontouring and revegetation of the borrow site after completion of borrow activities would restore the area to some extent for grazing. Obtaining riprap from quarries near the town of Castle Valley and from the surface in an area southeast of Moab could have a minor impact on recreation, forestry, and/or grazing. Quarry construction or expansion of existing quarries would remove a small amount of land from its previous use.

Under the Plateau site alternative, impacts of borrow activities would be minimal. Clay would be obtained at the site, and riprap requirements are likely to be substantially less than for the Atlas proposal.

4.3.3 Tailings Transport

Transport of tailings by rail would require the construction and operation of a conveyor at the Moab site, a loading facility at the existing rail, and a rail spur to the Plateau site. The conveyor would cross State Highway 279 after it leaves the Moab site and would cross over steeply sloping land currently not used for any purpose, although two small power lines (e.g., 138 kV) pass through this area. It is not known whether these two power lines would have to be modified to allow construction of the conveyor. The railroad spur and its adjacent access road would occupy a relatively small amount of land [e.g., 8 ha (20 acres)] and have minimal impact on grazing.

4.3.4 Accidents

No borrow transport accident or on-site reclamation accident has been identified that would have any appreciable impact on land use. Tailings could be accidentally spilled when being conveyed to the rail loading facility or when being transported on the existing rail. Impacts of such a spill on land use should be minimal, because the affected area would be cleaned up to allow continued use. Grazing and limited recreation are essentially the only land uses along the rail transport route.

4.3.5 Monitoring and Information Adequacy

Atlas conducted annual land-use surveys in the site vicinity. Information on land use was obtained from these surveys, other available sources (e.g., published soil surveys), and a staff site visit. The information obtained is adequate to describe local land uses and to evaluate potential land-use impacts of the Atlas proposal and the Plateau site alternative. No other information or surveys other than the continued annual survey are needed from the licensee.

4.3.6 Post-Reclamation Impacts

4.3.6.1 Normal Conditions

Under the Atlas proposal, the area occupied by the tailings pile would be precluded from other possible future uses. About half of the Atlas site would be available for unrestricted development after reclamation and groundwater cleanup is completed. The amount of time and effort to cleanup the groundwater is uncertain, but the licensee has estimated that it may take 25 years (WTI 1989). Under the Plateau site alternative, the Moab site would be cleaned up sufficiently to allow unrestricted use of the site, although any development in the floodplain would be subject to permitting by the U.S. Corps of Engineers). Again groundwater cleanup at the site after the tailings were moved would take considerable time, and development of the land could not occur until monitoring had demonstrated that contamination had been reduced to acceptable levels.

4.3.6.2 Tailings Pile Failure

Release of 1.9 million metric tons (2.1 million tons) of tailings into the Colorado River during the HF would result in contamination of flooded lands downstream and impacts on the use of river water for irrigating croplands. Potential impacts on uses of these lands are evaluated in this section. The evaluation primarily compares the 1.9-million-metric-ton (2.1-million-ton) tailings contribution to the river with the amounts of contaminants already present in the river.

The dissolved and solid substances in the released tailings would increase the concentrations of similar substances already present in the river. The majority of the tailings entering the Colorado River initially would temporarily remain in suspension because of the short duration of the hypothetical release. Partial dissolution would occur during downstream migration. Estimates of the amount of suspended solids that pass the Atlas site annually are:

1. 12.7 million metric tons (14 million tons), which is the amount estimated for a monitoring station near Cisco (USGS 1965); and
2. 3.3 million metric tons (3.6 million tons), based on the suspended-solids concentrations and annual mean river flow (220 m^3/s or 7770 cfs) at the Atlas site that are presented in Section 4.5.2.

Estimates of the amount of dissolved solids that pass the Atlas site annually are (for a mean river flow of 220 m^3/s or 7770 cfs):

1. 8.3 million metric tons (9.1 million tons), based on a dissolved solids concentration of 1200 mg/L reported by USGS (1965); and
2. 4.4 million metric tons (4.9 million tons), based on a dissolved solids concentration of 645 mg/L presented in Section 4.5.2.

Thus, the total amount of solids (suspended plus dissolved) that passes the Atlas site annually is estimated to be 7.7 million metric tons (8.5 million tons) or more. The chemical elements present in these total solids, as discussed in Section 4.5.2, include those present in the tailings pile.

During a period of 1000 years, 7.7 billion metric tons (8.5 billion tons) of suspended and dissolved solids would be expected to pass the Atlas site, if present conditions persist. The 1.9 million metric tons (2.1 million tons) contributed to the river by the tailings pile failure would represent 0.025% of the 1000-year total, or approximately 1 part in 4000. Thus, during time intervals of 1000 years or more, this tailings contribution is a negligible fraction of the total.

The tailings contribution considered during the short term after a tailings pile failure would be more significant. However, analyses presented in Section 4.5.2 indicate that most water quality standards in the river (uranium being the exception) would not be violated during a pile failure, because of the great dilution provided by the HF. The analyses also indicate that, a few days after pile failure, all substances would be much further diluted, and all regulated elements (i.e., elements for which a standard exists) would have concentrations well below their standards throughout the river.

For several days after the tailings pile failure, water use downstream might be prohibited. Prohibition of water use for several days would result in a temporary downstream effect on about 40 to 60 ha (100 to 150 acres) of irrigated alfalfa and small grains, all in Grand County. Considered over an entire growing season, however, the impact on use of irrigated land would be expected to be minor. No crops are believed to be grown along the Colorado River in San Juan

County (Section 3.3). No impact would occur in Arizona, where the concentrations of any tailings contaminants would be extremely low as a result of dilution.

Flooded lands would be contaminated by dissolved substances in the water and by deposition of tailings solids. However, because of dilution of tailings by both dissolved and suspended solids already present in large quantities in the flooded river, contaminant levels in soils would be expected to be only slightly higher than normal. The contaminant levels should not be high enough to limit the growing of crops or grazing of livestock after flood waters recede. A limited amount of livestock grazing occurs along the Colorado River downstream from Moab (Section 3.3). If the hypothetical pile failure occurred, water and soil surveys would be needed to determine when existing land uses could continue.

The high flood levels and great dilution at the time of the pile failure should result in a rather even distribution of contamination of lands along the length of the river, with no area becoming significantly more contaminated than any other. Thus, no particular area would be expected to experience a relatively great impact.

Although some tailings may deposit in flooded areas of Moab Valley, the amount should be small, because almost all of the tailings that enter the river would pass through the Portal (Figure 2.1-1) and deposit downstream from there. Thus, urban lands up to 1218 m (3997 ft) amsl (the estimated maximum level of the PMF) in or near Moab could become slightly contaminated. Urban land uses in this area include several residential areas, a hospital, a few orchards, and a sewage plant. After flood waters in Moab Valley recede, the use of previously flooded lands could be restricted until surveys of contamination and any necessary cleanup activities were completed and the results evaluated.

4.3.7 Conclusion

Under the Atlas proposal, about half of the Atlas site would be available for future commercial or residential development once reclamation and groundwater cleanup are completed. Under the Plateau site alternative, additional land presently under the pile would be available for future development once reclamation and groundwater cleanup are completed. In this case, however, the land at the Plateau site used for disposal of the tailings would not be available for other future uses. In the event of the hypothetical pile design failure, downstream land uses should not be appreciably affected over the long term. Some temporary restrictions of land use could apply until surveys and any necessary cleanup were completed. No requirement for monitoring or mitigation appears necessary with regard to land-use impacts.

4.4 GROUNDWATER

4.4.1 Reclamation Impacts at the Atlas and Plateau Sites

For both the Atlas proposal and the Plateau site alternative, the use of groundwater for dust control, compaction of the cap, mixing of concrete, and human consumption would be essentially the only impacts on groundwater during the proposed reclamation activity. More water could be needed for the Plateau site alternative because extensive dust control could be required at both sites rather than at just the Atlas site. No major impact on groundwater use is anticipated because of the low volumetric requirements. No continuous process-type water supply is required by the proposed action or the alternatives. The Moab municipal water supply would provide groundwater for all reclamation activities. A potable water line is available at the Atlas site. Water would be trucked to the Plateau site, or a water pipeline would be constructed to the site from Moab.

Sanitary waste associated with the Atlas proposal or the Plateau site alternative would be handled using existing lavatories at the Atlas site and portable toilets at both sites as needed. Groundwater impacts are not anticipated because sanitary waste disposal would be performed in accordance with applicable regulations of the state of Utah.

Groundwater is not present in significant quantities near the surface at the Plateau site. If any is present, it could be impacted as the excavated pit is filled with tailings. The underlying, relatively impermeable Mancos shale would isolate the tailings from groundwater present in deeper sedimentary strata. Therefore, groundwater impacts would be minimal.

4.4.2 Borrow Operations

Sand from the Quaternary alluvium on the Atlas site would be excavated and used in the tailings cover system. The thick Quaternary alluvium is very permeable. Thus, the removal of a fraction of the alluvial thickness would not alter seepage and would not contribute to groundwater impacts. Excavations to obtain sand would not be deep enough to intersect the water table.

Mancos shale deposits would be removed from the Plateau site on Klondike Flat to fabricate the tailings pile cover at the Atlas site. Groundwater would not be impacted because the relatively impermeable Mancos shale is not an aquifer and because the excavated depth would penetrate only 5% to 10% of the total thickness of shale.

Obtaining rock riprap would not be expected to impact groundwater. The rock in the area southeast of Moab is generally dispersed along the surface of the ground, where its removal would not affect recharge and seepage of groundwater. In the case of quarries, groundwater entering the quarry might have to be pumped to the surface and released. This impact should be minor and would be temporary, as the pumping would cease when the quarry is abandoned. Transport of borrow materials would not affect groundwater.

4.4.3 Tailings Transport

Construction of conveyors at the Atlas and Plateau sites and construction of a rail spur at the Plateau site would not impact groundwater. Surface grading for these facilities would not be deep enough and the facilities would not be large enough to influence groundwater seepage.

Transport of tailings by rail from the Atlas site to the Plateau site would not impact groundwater as long as no unanticipated release of tailings or leachate occurs. Rail cars would be covered to prevent the escape of fugitive tailings dust. Conveyers and loading and unloading facilities would be covered to minimize escape of fugitive dust that could be dissolved by rainwater and seep into the ground.

Rail cars used to transport fine tailings could have collection systems to capture leachates. The leachates would be evaporated at the Plateau site, and the remaining precipitate would be disposed in the tailings pile. If tailings leachate were to leak from rail cars, it could contaminate surface water and groundwater along the transport route. Any leachate collection system of rail cars would be inspected regularly for leakage and repaired as needed.

4.4.4 Accidents

Accidental spills of potentially hazardous construction materials such as solvent, paint, sealer, caulk, oil, fuel, and grease would be cleaned up in a timely manner to minimize runoff, seepage, and impacts to groundwater. Spills of borrow material would pose little hazard, because these materials are relatively insoluble and non-hazardous, and can be cleaned up before any impact on groundwater would occur.

Spills of tailings during rail transport could contaminate the area around the spill and could impact groundwater, with the degree of impact depending on the size of the spill and whether the tailings were the coarse tailings or the more radioactive fine tailings. Fine tailings would cause larger impacts than coarse tailings, because they are more radioactive, expose more surface area to rainwater, and possess a higher cation exchange capacity. To minimize the chance of a spill and the impact of any spill that might occur, rail transport would occur at slow speeds so that derailment would be less likely and would not take place during highly inclement weather. High winds and rains could increase the chance of an accident and rapidly disperse spilled tailings prior to cleanup, resulting in surface runoff to nearby streams and seepage into groundwater.

4.4.5 Post-Reclamation Impacts

4.4.5.1 Normal Conditions

Although leaching of contaminants from the tailings at either the Atlas site or the Plateau site would continue to occur after successful reclamation, the cover system would be designed to minimize the leaching rate and minimize impacts on groundwater. The leaching currently occurring in the existing tailings pile at the Atlas site represents a level of impact that would not be exceeded after reclamation. The cover system would be designed to prevent rain water from entering the tailings, and the slopes on the tops and sides of the pile would be designed to convey water off the pile. Thus, actual leaching after reclamation should be less than the existing leaching rate (draft TER, NRC 1996). Therefore, the existing impact of the tailings on groundwater is described in the following discussion to represent the maximum potential impact that would occur at the Atlas site after reclamation.

Under existing conditions, leachate seeping from the tailings pile is diluted by groundwater of the Quaternary aquifer, which flows under the pile and toward the east, entering the Colorado River. East of the river, groundwater in Moab and Spanish valleys is not likely affected by tailings leachates. In the aquifer beneath the tailings pile, the percentage of clay, which consists of negatively charged colloidal minerals capable of adsorbing cations, is about 7%. This amount is insufficient to substantially retard seepage of cations and would result in only minimal adsorption of tailings contaminants in the Quaternary aquifer.

Between the tailings pile and the river, the groundwater quality is degraded (Table 4.4-1). Federal drinking water standards (40 CFR Parts 141 and 143) are greatly exceeded by total dissolved solids, total alpha radioactivity, sulfate, and chloride (Atlas Corporation 1993). Measurements indicate that dissolved uranium is responsible for the radioactivity with smaller contributions from radium and thorium. The uranium is natural, consisting of uranium-238, with 0.7% by weight of the fissionable uranium-235 isotope, and trace quantities of uranium-234. Dominant species also include, nitrate, lead, molybdenum, selenium and vanadium. Nitrate, lead, and selenium exceed Federal drinking water standards. Relatively large quantities of uranium, vanadium, and copper are present in the pile (NRC 1979). Species concentrations expected in natural waters (Hem 1989) are exceeded by molybdenum but apparently not by vanadium.

The average seepage rate through the tailings pile at either the Atlas or Plateau sites is estimated to be 95 L/min (25 gpm), assuming a tailings pile surface area of 81 ha (200 acres), an average annual precipitation rate of 20.8 cm/year (8.2 inches/year), no impedance of infiltration (uncovered tailings pile), and an approximate 70% moisture loss to evaporation. With the cover system over the tailings, the expected seepage rate would be a fraction of the maximum rate given above for no impedance of infiltration of precipitation. The leachate exiting the bottom of the pile at the Atlas site would continue to be diluted by the Quaternary aquifer, resulting in a maximum level of groundwater contamination about equal to the existing contamination described above. Seepage through the pile could slowly increase over time. Lack of planned cover maintenance, burrowing animals, and growth of plant roots in the cover materials could over time increase infiltration to some degree, especially if one assumes for environmental impact analysis that long-term custodial activities ceased.

Periodic Colorado River flooding would temporarily raise the groundwater level above the bottom of the tailings pile. Receding groundwater after the flood would contain dissolved species from the tailings pile. The groundwater at the tailings pile would continue to be impacted until the entire leachable content of the pile had leached out. However, it is expected that the tailings will continue to leach well beyond the design life of the pile. Because groundwater on the Atlas side

Table 4.4-1. Comparison of Groundwater at the Atlas site with Federal Drinking Water Standards

Contaminant	Concentration	Standard
Total dissolved solids (mg/L)[a]	8,000 to 30,000	500 (Federal)
Total alpha radioactivity [pCi/L (Bq/L)]	> 3,000 (> 111)	15 (0.56) (Federal)
Sulfate (mg/L)[b]	10,000 to 17,000	250
Chloride (mg/L)	1,000 to 2,400	250
Nitrate (mg/L)	50 to 300	45
Lead (mg/L)	0.1	0.05
Molybdenum (mg/L)	1.0	0.1[c]
Selenium (mg/L)	0.02	0.01
Vanadium (mg/L)	0.01 to 0.05	0.07[d]

[a]Roughly 1000 mg/L in uncontaminated groundwater in the same aquifer as at the Atlas site.
[b]Roughly 500 mg/L in uncontaminated groundwater in the same aquifer as at the Atlas site.
[c]The concentration expected in natural waters—not a standard.

of the river is not used for any purpose, the continued contamination associated with the tailings would not impact groundwater use.

NRC regulations governing the disposal of uranium and thorium mill tailings provide for the establishment of compliance limits for contaminant concentrations in groundwater (Criterion 5 of Appendix A in 10 CFR Part 40). Compliance limits in general can be background levels, maximum concentration limits (MCLs), or alternate concentration limits (ACLs). At points of compliance, concentrations or radioactivities of specified constituents must not exceed the compliance limits. Corrective action is required if contaminant excesses occur at compliance points. Constituent ACLs may be proposed by licensees, must be as low as reasonably achievable after considering practicable corrective action, must not pose substantial present or potential hazards to human health or the environment as long as ACLs are not exceeded, and must include consideration of underground sources of drinking water as well as the presence of EPA exempted aquifers.

Groundwater compliance limits at point-of-compliance (POC) wells were established by NRC in 1988 and revised in 1993 by Amendment No. 19 to Source Material License SUA-917, under License Condition No. 17. A Corrective Action Plan has been prepared by WTI (1989). Some of the compliance limits proposed by WTI (e.g., chromium) would be ACLs which would exceed

(1) MCLs listed in 10 CFR Part 40, Appendix A and (2) constituent levels measured at background well AMM-1. The Corrective Action Plan is currently being reexamined by NRC.

Greatly increased future pumping and use of groundwater on the Moab side of the river is unlikely, but possible, and could induce migration of contaminants beneath the river. The potential for such contaminant migration occurring at some future time after reclamation, and the need for monitoring of any such migration, would be matters for consideration by the DOE in its long-term surveillance plan and the State of Utah. If contaminant migration under the river occurred or was suspected, groundwater monitoring on the Moab side of the river would be advisable. Minimal groundwater monitoring would be required at the Plateau site.

At the Plateau site, tailings leachate would accumulate at the base of the pile above the clay liner, because the clay liner and Mancos shale (an aquitard) beneath the pile would prevent further seepage downward. The accumulated leachate would have high concentrations of chemical species dissolved from the tailings and would not be diluted by groundwater. Potential aquifers beneath the Plateau site would not be impacted because the clay liner and relatively thick, impermeable Mancos shale would isolate the tailings from deeper sedimentary strata. The clay liner would partition metal cations and retard the rate at which contaminants migrate downward into the Mancos shale.

During extreme storms at the Plateau site, the tailings could be exposed to somewhat increased infiltration of rainwater. However, the cover system, including the clay cap, would be expected to minimize infiltration to the same extent as the cover system that would be used for the Atlas proposal (draft TER, NRC 1996). Thus, no significant amount of liquid would be expected to accumulate in the base of the tailings, and no overflow of the below-grade sides of the pile (i.e., the bathtub effect) would be expected. Under a hypothetical assumption that the bathtub effect occurs, the immediate area surrounding the facility would be impacted by seepage into the relatively thick sandy soil. Mancos shale would prevent seepage from reaching potential aquifers in deeper sedimentary strata. The large quantities of precipitation associated with extreme storms probably would greatly dilute the effluent from the pile. No groundwater use occurs in the vicinity of the pile where contamination would occur under the bathtubbing assumption. Although detailed design of a disposal facility at the Plateau site is not available, such a facility would be built in accordance with all applicable regulations and in such a manner that effects attributable to the bathtub effect and seepage into the ground would be minimized.

4.4.5.2 Tailings Pile Failure

Groundwater could become slightly contaminated wherever it is recharged by river water contaminated with tailings. Also, rainfall onto land contaminated by tailings could dissolve contaminants in the soil and transport them into groundwater. In both cases, however, the contaminant levels in groundwater should be too low to affect any groundwater use. Because a hypothetical tailings pile failure could result in increased chronic, low-level contaminant concentrations in both groundwater and surface water (affected by groundwater discharge), it would be advisable to measure the water quality prior to use. In extreme cases, water treatment would be required. Monitoring would be required for several years after any tailings pile failure.

4.4.6 Monitoring and Information Adequacy

A groundwater compliance monitoring program was established by NRC in 1988 and revised in 1993 by Amendment No. 19 to Source Material License SUA-917, under License Condition No. 17. The monitoring program included the establishment of groundwater quality limits, POC wells, a background well, sampling frequency, groundwater sampling locations, selected constituents for monitoring, and a Corrective Action Plan (WTI 1989).

From 1979–88, the groundwater monitoring system consisted of 12 on-site wells and one off-site well (CESC 1994b). The current monitoring program initiated in 1988 consists of a background well (AMM-1), 2 POC wells (AMM-2, and AMM-3), and one piezometer (ATP-2-S) (Figure 4.4-1). The off-site well at Arches National Park is no longer sampled. Background well AMM-1 is located northeast and upgradient from the tailings pile in the vicinity of the Colorado River. POC wells AMM-2 and AMM-3 are located downgradient between the pile and the river. Well AMM-2 resides near the midpoint of the edge of the pile facing the river, while well AMM-3 is stationed near the southeastern corner.

The background well, POC wells, and piezometer are sampled quarterly for chloride, nitrate, sodium, sulfate, pH, TDS, and water table elevation. The POC and background wells are sampled semiannually for chromium, gross alpha radioactivity, lead, molybdenum, nickel, radium-226, radium-228, selenium, silver, uranium, and vanadium. Additional sampling that occurred between 1979 and 1988 measured many other species concentrations (CESC 1994b).

After reclamation is completed, the DOE or the state of Utah would submit for NRC approval a long-term surveillance plan (LTSP) that would include plans for groundwater monitoring. NRC would require monitoring for a period of time (e.g., probably a few decades) sufficient to verify the adequacy of the engineered tailings pile to achieve its design objectives for controlled seepage of listed constituents. Appropriate mitigative measures would be taken if the design objectives could not be satisfied.

Limits on groundwater quality have been established that would require corrective action if they were exceeded at the POC wells (NRC 1993; CESC 1994b, Table 5). The limits are:

chromium—0.08 mg/L	total alpha radioactivity—1.22 Bq/L (33 pCi/L)
molybdenum—0.05 mg/L	nickel—0.06 mg/L
combined radium—226/228 radioactivity—0.19 Bq/L (5 pCi/L)	selenium—0.01 mg/L
vanadium—0.04 mg/L	uranium activity—0.15 Bq/L (4 pCi/L)

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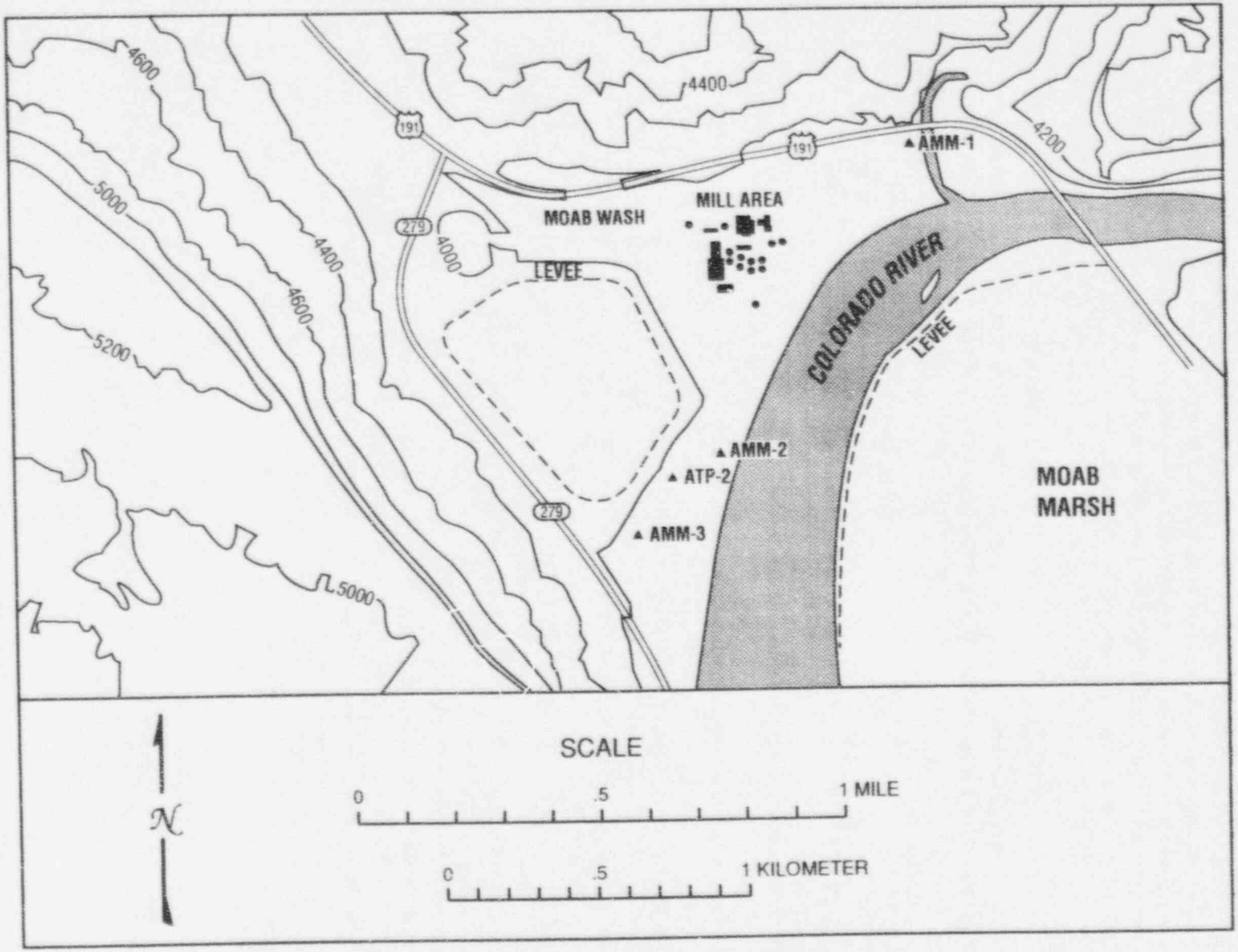

Figure 4.4-1. Location of Current Groundwater Monitoring Wells. (*Source*: Modified from Figure 2, CESE 1994).

The Atlas groundwater monitoring program (NRC 1993) appears to be adequate to assess potential off-site seepage from the existing tailings pile into groundwater and the Colorado River. The data provided by Atlas allow sufficient evaluation of groundwater quality. Additional groundwater may be required in the future and would be performed in a manner acceptable to DOE, NRC, EPA, and the state of Utah.

4.4.7 Conclusion

Although tailings leachates have significantly degraded the groundwater quality at the Atlas site, no use of groundwater occurs on the Atlas side of the Colorado River or in areas adjacent to the opposite side of the river. Therefore, the tailings contaminants in groundwater currently represent no hazard to public health.

4.5 SURFACE WATER

4.5.1 Surface Water Hydrology and Floodplains

4.5.1.1 Reclamation Impacts at the Atlas and Plateau Sites

Excavation and earthwork during reclamation at the Atlas or Plateau site would increase the potential for runoff, erosion, and sedimentation on the site. Rainfall is minimal in the region, however, and no significant amount of surface runoff would be anticipated. The soils of the area are porous, allowing rainfall to quickly infiltrate. Approximately 91% of precipitation in the state of Utah is returned to the atmosphere by evapotranspiration (Pyper and Saunders 1990). No hydrological impact on the Colorado River would be expected, because the river has a relatively large minimum perennial flow. No water from the river would be used for reclamation activities.

In accordance with Section 402(p) of the Clean Water Act, EPA requires that stormwater discharges associated with industrial activity comply with limits specified in a stormwater permit [40 CFR Part 122.26(a)(1)(ii)]. Stormwater permit requirements for the Atlas proposal may be evaluated by the state of Utah and EPA. For compliance with pending state of Utah and EPA requirements, design of the surface water drainage system at the Atlas or Plateau site may have to consider stormwater detention compatible with a 1-year, 24-hour storm. The state of Utah may also require that Atlas obtain approval of an erosion control plan for the Atlas site (see Section 4.5.2).

A small area [e.g., 2 ha (5 acres)] of 100-year floodplain would be lost as a result of leveling of the tailings pile slopes, and a small floodplain area would be modified for the relocation of Moab Wash. These effects on the floodplain may require a Section 404 permit under the Clean Water Act from the U.S. Corps of Engineers.

At the Atlas site, Moab Wash would be relocated farther away from the tailings pile. Drainage ditches lined with riprap would be constructed on and adjacent to the pile to direct surface runoff to Moab Wash and the Colorado River (Section 2.1.2.1).

4.5.1.2 Borrow Operations

Surface water hydrology would not be appreciably affected at borrow areas. Excavation of clay at the Plateau site and possible construction of rock quarries near Castle Valley would form pits in which rainwater could collect. Removal of sand from various areas on the Atlas site would not impact hydrology. After completion of borrow activities, the clay and sand borrow areas would be recontoured and revegetated. Transport of borrow materials would have no hydrological impact.

4.5.1.3 Tailings Transport

Construction of conveyors at the Atlas and Plateau sites and construction of a rail spur at the Plateau site would not appreciably impact surface water hydrology. Culverts would be located as needed beneath the railroad spur and would be sized in accordance with U.S. Department of Transportation regulations. Transport of tailings would have no hydrological impact.

4.5.1.4 Accidents

No accident that would have any appreciable impact on surface water hydrology has been identified.

4.5.1.5 Monitoring

Monitoring of surface water flow has not been conducted at the Atlas site. Data on Colorado River flows were obtained from a USGS gaging station at Cisco (Section 3.5.1).

4.5.1.6 Post-Reclamation Impacts

Normal Conditions. After reclamation is completed, no further alteration of or impact on surface water hydrology would be expected to result from the Atlas proposal or the Plateau site alternative. The presence of the tailings pile on the Atlas site has negligible impact on flood levels in the vicinity because the pile occupies only a small fraction of the floodplain.

Tailings Pile Failure. No extremely severe flood on the Colorado River would be expected to cause tailings-pile failure under current geomorphic conditions (draft TER, NRC 1996). These geomorphic conditions include (1) the Portal (Figure 2.1-1), which is narrow and would restrict flood flows, thus minimizing the river flow velocities in Moab Valley, and (2) the broad floodplain separating the tailings pile from the river channel, which would also minimize the current at the tailings pile (NRC 1996).

In the event of a hypothetical pile failure and HF (Section 2.1.8), tailings are assumed to slide out over the Colorado River floodplain and enter the river. Flow in the river channel could be modified slightly before the tailings are washed downstream. The temporary impact on flow would be too minor to have any notable impact on river hydrology or flooding of adjacent areas such as Moab Marsh.

4.5.1.7 Conclusion

Both the Atlas proposal and the Plateau site alternative have negligible potential for impact on surface water hydrology under both normal conditions and conditions involving failure of the tailings pile design. Therefore, no requirement for hydrology would be necessary.

4.5.2 Surface Water Quality

4.5.2.1 Reclamation Impacts at the Atlas, Plateau, and Borrow Sites

At the Atlas site, Plateau site, and borrow sites, construction-related activities during tailings reclamation could have temporary, adverse effects on surface water quality through accidental spills and the release of sediment- and contaminant-laden runoff. These activities include earth moving, obtaining borrow material at borrow sites, generation of wastewaters (e.g., from equipment washing), and small leaks and spills of liquids such as oils, cleaning wastes, and fuels for vehicles (probably no more than a few liters per incident). At the Atlas site, some sediments mobilized by earthmoving operations and rain during reclamation may be contaminated with low levels of trace elements and radionuclides.

Rain-mobilized soils and small spills may occasionally result in temporary increases in surface water concentrations of suspended solids and contaminants. Concentrations in the Colorado River beyond a small mixing zone would probably not be measurable and of no consequence. It should be noted that the Colorado River naturally experiences large swings in suspended solids—concentrations average nearly 700 mg/L just upstream of the tailings pile. In smaller streams at rock quarries in Castle Valley, impacts of suspended solids and spilled liquids on water quality could be more substantial. However, only minor impacts would be expected because of the low probability of spills, the expected small size of any spill, and the low rainfall in the region. No appreciable impact is expected on the washes in the borrow area southeast of Moab and on the wash east of the Plateau site.

Removal of the entire pile to the Plateau site would involve impacts similar to those described above, but the potential for contamination of the Colorado River during removal operations could be greater because of the more extensive disturbance of tailings. The Plateau site itself has no permanently flowing streams in the area, but, during rare periods of heavy precipitation, a wash or swale south of the site probably carries some surface flow to Courthouse Wash, an intermittent stream channel that eventually joins with the Colorado River near Moab (Figure 1.1-1).

Adverse effects on water quality of both the Colorado River and smaller streams near borrow areas could be largely mitigated by use of (1) adequate drainage controls and retention basins for spills and runoff, (2) prompt implementation of well-planned spill response measures when necessary, (3) limiting major earthmoving operations, where feasible, to seasons of low thunderstorm potential, and (4) topographic and vegetative restoration of borrow areas. Because of the much greater drainage area of Moab Wash compared to the Atlas site itself, effective erosion and drainage control during relocation of the wash could be difficult when thunderstorms occur over the drainage basin. Earthmoving for relocation of Moab Wash could be limited to periods of low thunderstorm frequency. A National Pollutant Discharge Elimination System (NPDES) permit would probably be required for the release of storm water to the river. Compliance with permit conditions would probably require implementation of some or all of the above potential mitigative measures. Specific requirements for the licensee are presented in Section 4.5.4.

4.5.2.2 Tailings Transport

Surface waters that could be impacted by tailings spills during transport include the Colorado River, Moab Wash, and several tributaries of Courthouse Wash (the primary ones being Sevenmile Canyon Wash, Bartlett Wash, and Klondike Wash), which leads to the Colorado River. The potential for impact on surface water quality, however, is negligible because any spill would likely occur some distance from the washes and would be cleaned up immediately.

4.5.2.3 Accidents

Possible spills would be expected to involve only small amounts of hazardous substances that could be cleaned up sufficiently to avoid appreciable impact. Requirements for spill prevention and control are discussed in Section 4.5.4.

4.5.2.4 Post-Reclamation Impacts

Normal Conditions. Once completed, the proposed stabilization of the pile in place would diminish the pathways by which contaminants and sediments enter the Colorado River and Moab Wash. These pathways include (1) surface runoff, (2) leachate transport to groundwater, and (3) wind-blown dusts. Stabilization would effectively isolate tailings from surface runoff and wind. Only small amounts of uncontaminated soils and dusts would be available for transport to the river by these pathways.

After reclamation is completed, the estimated average seepage rate through the tailings pile at either the Atlas or Plateau sites would be approximately 95 L/min 25 gpm), assuming a tailings pile surface area of 81 ha (200 acres), an average annual precipitation rate of 20.8 cm/year (8.2 inches/year), no impedance of infiltration, and an approximate 70% moisture loss to evaporation. The assumption of no impedance to infiltration is conservative, since no credit is taken for the designed cover restricting infiltration and enhancing runoff. With the cover system over the tailings, the expected seepage rate would be significantly less than the average rate given above for unimpeded infiltration (NRC 1996). The leachate exiting the bottom of the pile at the Atlas site would continue to be diluted by the Quaternary aquifer, resulting in a decreasing level of groundwater contamination from the existing contaminant concentration. Seepage through the pile would likely increase at a slow rate if long-term maintenance is suspended at some point. Lack of cover maintenance, burrowing animals, and the presence of vegetation (i.e., roots) would increase infiltration. However, because of the low permeability of the cover material, absence of ponded water, and other design features, infiltration through the cover, even if unmaintained, is not expected to approach the current flux. Periodic Colorado River flooding would raise the groundwater level within the tailings pile above its base. Receding groundwater after the flood would contain dissolved constituents from the tailings pile. The groundwater at the tailings pile will continue to be impacted until the entire leachable content of the pile has leached out. Because the ambient groundwater quality on the Atlas side of the river will not support any consumptive use, the continued contamination associated with the tailings would not impact existing or anticipated future groundwater use.

Under the Plateau site alternative, contaminant transport from the former Atlas site to the Colorado River should almost disappear. For some undetermined time, small amounts of residual contaminants in the groundwater at the existing site would continue to migrate to the river. Continued groundwater corrective action may be required at the former tailings site before the property could be released for unrestricted use. Effects on surface water quality in Bartlett Wash near the Plateau site would be expected to be negligible, because the clay liner would restrict the escape of leachates.

The Atlas proposal to reclaim the tailings pile on the Moab site would be expected to significantly reduce the infiltration of rain water into the tailings and the flow of tailings contaminants to the Colorado River (draft TER, NRC 1996). Therefore, the existing level of impact on water quality is assumed to represent the maximum impact that could occur after reclamation without tailings pile failure and is assessed in the discussion below.

The water quality data (Table 4.5-1) indicate that water quality downstream of the tailings pile does not differ measurably from that upstream of the pile. Possible exceptions include suspended solids, pH, manganese, and gross alpha. However, because the upstream and downstream sampling stations are as much as 102 river km (63 miles) apart, many natural and human-related sources other than the tailings pile could account for these differences. With regard to suspended solids, over half the difference between upstream and downstream averages can be explained by one exceedingly high measurement at the lower station without a corresponding sample from the upper station until 7 days later. Moreover, a related variable, turbidity, suggests an opposing

Table 4.5-1. Comparison of Water Quality of the Colorado River Upstream and Downstream of the Tailings Pile[a]

Parameter	Upstream[b] mean	Range	Downstream[c] mean	Range	State standard[d]
Flow (cfs)	7,711	558–76,800	7,770		
Temperature (°C)	11.7	-0.4–26.1	13.8	0–26.8	27
pH	8.2	7.2–9.0	7.8	6.6–9.0	6.5–9.0
Dissolved oxygen (mg/L)	9.0	5.0–12.9	9.0	5.9–13.5	5.5
Specific conductivity (μS/cm)	1010	270–1600	890	320–1500	
Total hardness (mg/L)	330	116–535	302	140–501	
Total dissolved solids (mg/L)	690	230–1110	600	230–1070	1200
Total suspended solids (mg/L)	470	<3–3480	930	39–10,000	
Turbidity (NTU)	173	3.5–>1000	165	13–490	+10
Total Kjeldahl nitrogen (mg/L)	0.66	0.1–1.7	0.88	<0.1–3.4	
Ammonia nitrogen (mg/L)	<0.1	<0.1–0.4	<0.08	<0.05–0.24	–[h]
Nitrate nitrogen (mg/L)	0.54	0.13–1.1	0.52	0.11–0.97	4
Sulfate	264	51–520	226	59–460	
Orthophosphate (mg/L)	<0.13	<0.01–0.66	0.12	<0.01–0.49	
Arsenic (μg/L)[j]	<2.8	<0.5–6.5	<3.1	<0.5–5.5	190 / 0.017[i]
Cadmium (μg/L)	<1	<1–3	<1	<1–3	1.1
Copper (μg/L)	<21	<10–49	<20	10–25	12
Iron (μg/L)	<34	<20–80	<40	<20–77	1000
Lead (μg/L)	<7.9	<5.0–30	<8.4	<3–29	3.2
Manganese (μg/L)	156	15–1000	233	<10–855	

Table 4.5-1 (Continued)

Parameter	Upstream[b] mean	Range	Downstream[c] mean	Range	State standard[d]
Mercury (μg/L)	<0.2	<0.1–<0.33	<0.3	<0.1–1.0	0.012
Molybdenum (μg/L)	<10[e]	<10			
Nickel (μg/L)	<2.5[e]	<1–4			
Selenium (μg/L)	<4.9	<2–10	<4.0		
Silver (μg/L)	<2.0	<2.0	<2.0		
Uranium (natural) [Bq/L (pCi/L)]	0.17 (4.5)[f]	0.06–0.30 (1.6–8.1)[f]	5.1[f]	1.8–12[f]	
Vanadium (μg/L)	<6[e]	<6			
Zinc (μg/L)	<30	<10–120	<43	10–100	110
Gross alpha [Bq/L (pCi/L)]	0.48 (13)	<0.07–1.85 (<2–50)	16	3–74	15
Gross beta [Bq/L (pCi/L)]	<1.1 (<30)	<0.4–3.0 (<10–81)	<27	<5–99	50
Radium-226 [Bq/L (pCi/L)]	<0.04 (<1)	<0.004–0.07 (<0.1–2)	<1	0.1–2	5[g]
Radium-228 [Bq/L (pCi/L)]	0.04 (1)	0.04 (1)	1	1	5[g]

[a]Except where noted, all data were provided by Utah Department of Environmental Quality, Division of Water Quality, Salt Lake City. Each average and range of values represents a sample size as low as 5(Se) to as high as 85 (total dissolved solids). Blank spaces mean no data or standards were available.

[b]Colorado River above U.S. 191 bridge.

[c]Above Colorado/Green Rivers confluence.

[d]Water quality standards in Utah Administrative Code R317-2; values shown are the most conservative expression of the standard (e.g., 4-day average criterion for aquatic life).

[e]Based on 4 samples during 1985–86 near Cisco, Utah, upstream of Atlas site (USGS 1987).

[f]From Atlas Corporation Environmental Monitoring Reports for 1989–93.

[g]Total activity for radium-226 and radium-228 combined.

[h]Dependent on temperature and pH.

[i]The first (higher) value is for protection of aquatic life; the second (lower) value is for protection of human health.

[j]For trace elements, the acid soluble fraction is given.

trend, as average turbidity was slightly lower downstream than upstream. Several constituents at least occasionally exceeded state water quality standards for protection of aquatic life—cadmium, copper, lead, mercury, zinc, ammonia, gross alpha, and gross beta. Of these, only gross alpha *averaged* higher than the standard: 0.59 Bq/L (16 pCi/L) at the downstream station versus the state standard of 0.56 Bq/L (15 pCi/L). Some of the alpha contamination, but not necessarily all, is from natural sources. A small amount of the total alpha count at downstream sampling stations almost certainly comes from the Atlas tailings pile. Other mining and milling operations and tailings piles far upstream near places like Grand Junction also probably contribute to the relatively high gross alpha counts.

One constituent for which no state water quality standard currently exists, manganese (Mn), registered substantially higher concentrations downstream from the pile than upstream. EnecoTech (1988) reported a Mn concentration of 21 mg/L in the tailings pile liquor (mean of two measurements). Even at the lowest recorded Colorado River flow of 558 cfs, the post dilution (completely mixed) increase in Mn concentration is only 2.1 μg/L. At average flow, the increase would be only 0.15 μg/L. These increases are trivial compared to the mean ambient river concentrations of 156 μg/L upstream of the pile and 233 μg/L downstream. It is unlikely, therefore, that the tailings pile is totally responsible for the nearly 50 % increase in mean Mn concentration between the U.S. 191 bridge sampling station and the downstream station just above the confluence of the Colorado and Green rivers. Instead, the increase might be attributable to other sources, both natural and anthropogenic, in the drainage basin between the pile and the downstream sampling station. It should also be noted that the reported Mn values are quite variable; concentrations at the upstream station ranged from 15 μg/L to 1000 μg/L, while downstream concentrations ranged from less than 10 μg/L to 855 μg/L. While the Mn concentrations upstream and downstream of the pile are considerably higher than reported for many other U.S. surface waters, and do exceed the calculated population EC20 (112 μg/L, the concentration that is estimated from limited data and extrapolation models to cause a 20 % reduction in recruit abundance of largemouth bass) reported in Suter and Mabrey (1994), the mean values are well below the lowest reported *test* EC20 of 1270 μg/L for fish. In conclusion, there may be cause to investigate further the source and biological significance of high Mn concentrations in the Colorado River, but the Atlas tailings pile is very unlikely to be a significant contributor to these relatively high Mn concentrations. For further discussion of Mn in the Colorado River, see the Biological Assessment (BA) in Appendix F.

The results of another approach to assessing how much the tailings pile may affect water quality of the Colorado River are summarized in Table 4.5-2. In this case, mean tailings leachate concentrations for several contaminants that exhibited one or more unusually high measurements were multiplied by the estimated flow of leachate to the river [these "tailings leachate" values actually represent concentrations in the residual tailing liquor between the pile and the river; the estimated flow is based on a comparison of expected TDS concentration in the pile (about 150,000 mg/L) and the residual tailing liquor (about 13,000 mg/L), yielding a flow rate of about 0.63 cfs (17.8 L/s or 280 gpm). Dividing the resulting estimated mass flux of each contaminant in μg/s or pCi/s by the river flow in L/s produces an estimate of the *contribution* of the tailings pile to the ambient contaminant concentration in the river. These contributions are presented in Table 4.5-2 for the mean river flow of 220 m^3/s (220,000 L/s or 7,770 cfs) and the record low flow of 15.8 m^3/s (15,800 L/s or 558 cfs). It is conservatively assumed that there is no significant contaminant attenuation at work through such mechanisms as sorption and precipitation.

Table 4.5-2. Mean Concentrations of Selected Tailings Contaminants in Groundwater and Contaminant Contribution to the Colorado River Following Complete Dilution at Average (7770 cfs) and Minimum (558 cfs) River Flows

Contaminant	Tailings leachate concentration[a]	Contributed to river at mean flow[b]	Contributed to river at low flow[b,c]	Ambient river concentration[d]
Uranium (natural) [pCi/L (μg/L)][e]	3100 (4500)	0.25 (0.36)	3.5 (5.1)	4.8 (7.0)
Gross alpha (pCi/L)[e]	2700	0.22	3.1	14
Radium-226 (pCi/L)[e]	0.28	0.000023	0.00032	<1
Radium-228 (pCi/L)[e]	2.1	0.00017	0.0024	1
Molybdenum (μg/L)	1100	0.089	1.2	<10[f]
Nickel (μg/L)	<39	<0.0032	<0.044	<2.5[f]
Selenium (μg/L)	<24	<0.0019	<0.027	<4.9
Vanadium (μg/L)	<32	<0.0026	<0.036	<6[f]
Total dissolved solids (mg/L)	12600[g]	1.0	14	630

[a]As measured in groundwater monitoring wells between the pile and river; residual tailing liquor flow assumed to be 0.631 cfs (283 gpm).
[b]The leachate contribution is the amount by which the leachate increases the ambient concentrations.
[c]Minimum recorded flow from 1895–1986 (USGS 1987).
[d]Without contribution from tailings leachate. Sources: Utah Department of Environmental Quality, Division of Water Quality, Salt Lake City; Atlas Corporation Environmental Monitoring Reports for 1989–93.
[e]Conversion: 1 pCi/L = 0.037 Bq/L.
[f]Based on four samples from the Colorado River near Cisco, upstream from the Atlas site (USGS 1987).
[g]Corrected for background (6770 mg/L).

With respect to river sediments, contaminant concentration data is quite sparse. The gross alpha and beta counts for unreplicated grab samples taken by Atlas Corporation adjacent to and downstream of the tailings pile in November of 1994 (Edwards 1994) indicate that sediments in the immediate vicinity of the pile may be slightly contaminated with alpha- and beta-emitting radionuclides [This same, limited sampling effort, on the other hand, showed considerable contamination in the water column by uranium (0.77 mg/L adjacent to the pile compared to only 0.016 mg/L about 1 km downstream)]. The single day sampling campaign conducted by Atlas Corporation contractors in May 1995 (WestWater Engineering 1995) also shows no clear evidence of sediment contamination adjacent to or downstream of the pile by either radionuclides or other nonradioactive contaminants—U-234, Fe, Pb, Mn, As, and Cr data suggested very slight enrichment in sediments adjacent to and/or downstream of the pile. These results, however, may have been influenced by rising water levels immediately preceding and during the sample collections. Further details on this sampling program and its results may be found in the BA in Appendix F, and in the WestWater Engineering Report (1995).

It is evident that, at average river flows, the tailings leachates contribute only trivial amounts of most contaminants compared to the relatively high reported ambient concentrations of contaminants in the river. Given minimal dilution at record low flow conditions, however, uranium, gross alpha (nearly all from uranium and its daughters), ammonia, and molybdenum from tailings could constitute a significant fraction of the river's contaminant concentrations. Nevertheless, under record low flow conditions, only gross alpha and ammonia would be likely to exceed the state water quality standard. Of these two contaminants, ammonia at post-dilution concentrations as high as 2.1 mg/L, a level toxic to most aquatic animals (see Table 4.6-1), would pose the greatest hazard to aquatic biota at low river flows. To date, no evidence has been found that such concentrations have occurred in the Colorado River in the vicinity or downstream of the Atlas tailings pile.

Tailings Pile Failure. The maximum hypothetical pile failure, as described in Section 2.1.8, results in 20% [1.9 million metric ton (2.1 million tons)] of the tailings plus entrained liquids entering the Colorado River during the HF. Some fraction of the sands (coarse tailings) would likely settle to the bottom of the river proper or the inundated floodplain within the first few hundred meters downstream. Thereafter, the finer tailings that settled to the river bottom would, over the long term, be resuspended and transported downstream. The fines, clays, and slimes, which have higher levels of contaminants than the sands, would remain in suspension for much greater distances, mostly settling to the bottom of Lake Powell after an unknown period of several years of cycling and recycling between the water column, the riverbank, and the bottom sediments on the way to the reservoir.

Contaminants in the tailings liquids would eventually enter Lake Powell, but an unknown amount would remain in solution or colloidal suspension and continue downstream past the dam and into Grand Canyon National Park.

Primary assumptions of the assessment that follows are: (1) all 1.9 million metric tons (2.1 million tons) of tailings enter the river during a 10-hour period, (2) one quarter of the released tailings mass is liquid, and (3) the tailings are diluted by flood waters at an average of 4250 m^3/s (150,000 cfs)—considered to be half (over a 10-hr period) of the estimated instantaneous flow of 8500 m^3/s (300,000 cfs) for a PMF. Based on tailings radionuclide concentrations published in the Moab Uranium Mill EIS (NRC 1979) and typical values published in the Final Generic EIS on Uranium Milling (NRC 1980), erosion of 20% of the tailings could result in an estimated 4300 Ci of radionuclides entering the Colorado River.

During the short period (e.g., 10 hours) when the bulk of the tailings solids are suspended in the water column, radionuclide concentrations in the affected water mass could exceed 1070 Bq/L (29,000 pCi/L) (mostly uranium-238 and uranium-234). Radionuclides and other contaminants dissolved in the tailings liquid would likely remain in solution after most solids have settled to the bottom of the river. Table 4.5-3 compares contaminant concentrations with Utah water quality standards, benchmarks for lowest concentrations known to adversely affect aquatic organisms, and normal or ambient concentrations in the river. None of the contaminants except uranium would exceed any of these criteria. Uranium would have a concentration more than four times the state standard for gross alpha but would be diluted as it moves downstream. As this slug of contaminated water flows to Lake Powell (a matter of a few days), dilution would lower the contaminant concentrations, including the gross alpha contribution, by at least a factor of 20. The sum of the ambient alpha concentration and diluted contribution from the tailings liquid would probably be moderately below the state standard in the river as it enters Lake Powell. During the passage of the contaminated water mass down the river, it would be advisable to prohibit any diversion of the water for human consumption or agriculture.

4.5.2.5 Monitoring and Information Adequacy

Information on the extent of earth disturbance and other features of the proposed reclamation and Plateau site alternative was generally adequate to assess impacts. However, additional information on control of erosion and spills would be required from the licensee (Section 4.5.4). The description of water quality of the Colorado River and the assessment of possible effects of the tailings pile on existing and future river water quality were based primarily on monitoring data reported by Atlas Corporation, the Utah Division of Water Quality, and to a lesser extent, water quality data reported by the USGS (1987) and general scientific literature related to the Colorado River. The Atlas Environmental Monitoring Program reports are submitted semiannually to the NRC and present river and groundwater quality data resulting from quarterly sampling. The data from the Utah Division of Water Quality were collected from each of three sampling stations at frequencies of two to five times per year. Concentrations of both radioactive and nonradioactive constituents are included in these reports.

For the most part, the data from the Atlas reports and the Division of Water Quality's database have been adequate for describing general river water quality and assessing the effects of the tailings pile on water quality and aquatic biota of the Colorado River. There are, however, deficiencies with respect to a few parameters of possible concern. Molybdenum and nickel, for example, were not monitored in the river, although monitoring of groundwater contaminated with tailings leachate indicated these contaminants occurred at concentrations in excess of limits

Table 4.5-3. Comparison of Dissolved Contaminant Concentrations with Water Quality Standards, Benchmarks, and Ambient Conditions in the Colorado River after the Hypothetical, Maximum Failure of the Tailings Pile

Contaminant	Tailings solution[k]	Flooded river[a,b]	Utah standards[c]	Benchmarks (aquatic life)[d]	Ambient river[e]
Uranium (natural) [pCi/L[m] (μg/L)]	18,800 (27,000)	63 (91)		98 (142)[f]	4.8 (7.0)[g]
Thorium (natural) (pCi/L)[m]	50	0.16			0.57
Radium-226 (pCi/L)[m]	150	0.50	5[h]		< 1
Radium-228 (pCi/L)[m]	2.7	0.0090	5[h]		1
Lead-210 (pCi/L)[m]	150	0.50			2.7
Polonium-210 (pCi/L)[m]	150[l]	0.50			3.7
Gross alpha (pCi/L)[m]	19,300	64	15		14
Molybdenum (μg/L)	2,600	8.7		880	< 10[i]
Nickel (μg/L)	600	2.0	160	160	< 2.5[i]
Lead (μg/L)	300	1			<7.9
Selenium (μg/L)	440	1.5	5	35	< 4.9
Vanadium (μg/L)	2,000	6.7		80	< 6[i]
Sulfate (mg/L)	28,300	94			264
Total dissolved solids (mg/L)	38,800	129	1200[j]		630

[a]Assuming tailings are 25% liquids, enter the river at a constant rate over a 10-hr period, and are diluted by flood waters at 150,000 cfs. Does not include contaminants not in solution.

[b]Each value is the increase (i.e., the increment only) in river concentration caused by the tailings.

[c]Utah Administrative Code, R317-2--Standards of Quality for Waters of the State, as amended August 12, 1992. Blank spaces indicate data or standards are unavailable.

[d]Source: Suter, Futrell, and Kerchner (1992).

[e]Utah Department of Environmental Quality, Division of Water Quality (1994).

[f]142 μg/L (lowest reported chronic value); 98 pCi/L = 0.692 pCi/μg U-nat x 142 μg/L.

[g]Mean of river concentrations reported in Atlas Corporation river monitoring reports for period November 1989 through June 1993.

[h]Radium-226 and -228 combined; for protection of agricultural uses.

[i]Based on four samples from Colorado River near Cisco, upstream of tailings pile (USGS 1987).

[j]For protection of agricultural uses.

[k]Source: Atlas Corporation Corrective Action Program Review (Letter of December 29, 1993).

[l]Based on relative concentrations of radium-226, polonium-210, and lead-210 in typical tailings liquids (NRC 1980).

[m]Conversion: 1 pCi/L = 0.037 Bq/L.

prescribed by NRC in the Source Material License. It was nevertheless possible to eliminate these two trace metals as potential concerns by comparing their predicted post-dilution concentrations in the river with various standards and benchmarks.

Most surface water data reported by Atlas were generated from two sampling stations: one just upstream of the U.S. 191 bridge, and one adjacent to the tailings pile. The latter station is so near the tailings pile that it may not be downstream of all areas where tailings leachates enter the river. Thus, the contamination reported at this station could be lower than that actually resulting from the entire tailings pile. Downstream data supplied by the Utah Division of Water Quality were collected at stations several kilometers or miles to 101 km (63 miles) downstream of the Atlas site and could thus reflect contaminants from sources other than the tailings.

From the radiological perspective, polonium-210 and lead-210 upstream and downstream of the tailings pile were shown in this assessment to contribute substantial fractions of the total dose to some aquatic organisms, based on few samples of river water. Initially in this assessment, few or no data on polonium-210 and lead-210 concentrations in tailings, groundwater, river sediments, or biota were available. Recent, but limited sampling, however, has provided some additional information (WestWater 1995). These recent data are considered in Sections 4.5.2.2, 4.6.1.2, and the BA in Appendix F.

Some 1989 data on concentrations of gross alpha in river water and sediments were supplied by Atlas in two different, apparently independently obtained, data sets. The two data sets show conflicting results, with one reporting gross alpha values between 0 and 0.07 Bq/L (0–2 pCi/L) for water and between 0 and 0.07 Bq/g (0–2 pCi/g) for sediments, whereas the other reported much higher values of between 0.22 and 3.1 Bq/L (6–84 pCi/L) for water and between 0.6 and 1.4 Bq/g (16–37 pCi/g) for sediments. Also, the variability within the data precludes making a definitive conclusion on whether or not the tailings pile is a substantial contributor to the gross alpha levels in the river, although the data possibly suggest that the pile may measurably raise alpha and beta concentrations in the water and sediments in the immediate area (i.e, the mixing zone).

4.5.2.6 Conclusion

The available data do not indicate that the existing tailings pile has more than a minimal impact on the water quality of the Colorado River beyond a small mixing zone near the bank. Leaving the pile in place would therefore have little adverse impact. Both the Atlas-proposed stabilization in place and the alternative removal of the tailings to the Plateau site would reduce mobilization and transport of contaminants to the river. Tailings disposal at the Plateau site would provide the greater benefit to water quality, because the leaching of tailings contaminants to the river would be virtually ended.

At the Moab site, the hypothetical failure of the tailings pile design during an HF would have some temporary impact on water quality in the river near the pile. However, the river's water quality, which is already degraded regardless of the tailings pile, would be further degraded by only a slight amount. Contaminants from the tailings would be quickly diluted to currently existing levels, which are generally below water quality standards and criteria for the protection of aquatic biota. Thus, the long-term impact to water quality should be negligible.

During reclamation activities, sediment- and contaminant-laden runoff could enter the Colorado River and any small stream present at the riprap borrow site. Therefore, the licensee would be required to prepare, for staff approval, a spill prevention and control plan and an erosion control plan appropriate to the Moab site and riprap and clay borrow areas. When preparing the plan, the licensee would be required to consider the following generic control measures as they might apply to the sites:

- Training of personnel in spill prevention and response;
- Interception and storage of sediment- and contaminant-laden runoff through use of drainage control, retention and treatment ponds, silt fences, and other means;
- Avoidance of major earthmoving operations during periods of high thunderstorm potential;
- Siting the riprap borrow areas distant from streams or lakes; and
- Implementing topographic and vegetative restoration measures to return disturbed areas to pre-disturbance conditions.

With regard to leaching of tailings contaminants to the river, additional limited sampling was conducted in May 1995 for ammonia, gross alpha concentrations, polonium-210, lead-210, and other unmonitored daughters of uranium in river sediments, water, and fish along the river bottom where tailings contaminants enter the river (WestWater 1995). These survey data are considered in this DEIS.

4.5.3 Surface Water Use

Reclamation operations would have no impact on surface water use, with the exception that some of the water used for dust control would originate from surface waters in the Moab area. After reclamation, continued leaching of tailings contaminants would also have no impact on surface water use, as the leachates do not significantly affect water quality. After the hypothetical tailings pile failure, the use of Colorado River water for irrigation, which occurs downstream in Grand County, would likely be temporarily restricted. However, after several days, water quality in the river should return to normal. No other uses of Colorado River water were identified (Section 3.5.3). The hypothetical tailings pile failure would not be expected to have a long-term impact on surface water use because long-term impacts on water quality would be minimal.

4.6 ECOLOGY

4.6.1 Aquatic Ecology

4.6.1.1 Reclamation Impacts at the Atlas, Plateau, and Borrow Sites

Aquatic biota at the Atlas site and in streams near the quarries in Castle Valley could be affected by potential water quality impacts that could result from sediment runoff and spills as discussed in Section 4.5.2. The effects of increased suspended solids and siltation on aquatic biota are well documented and include reduction of light penetration and photosynthesis, impairment of respiration (gill function) and feeding, obliteration of spawning sites and microhabitats such as the interstitial spaces of bottom substrates, smothering of benthos and demersal fish eggs, alterations in species composition, and lowered fish production. With respect to possible mobilization through erosion (or other mechanisms) of tailings solids from the pile itself, local effects on aquatic biota from radionuclides and metals in the tailings could possibly occur if appropriate measures for minimizing disturbance of tailings solids are not employed.

Because the Colorado River has large dilutive capability, and naturally experiences large swings in suspended solids concentrations and turbidity, any adverse effect of reclamation activities on aquatic biota would likely be of short duration and limited to a small mixing zone adjacent to the site. Moreover, aquatic organisms native to the mainstem of the Colorado River are generally quite tolerant of these conditions. The river averages nearly 700 mg/L of suspended solids just upstream of the tailings pile. Also, only minor impacts would be expected because of the low probability of spills, the expected small size of any spill, and the low rainfall in the region. Erosion control practices that would minimize impacts on water quality as discussed in Section 4.5.2 would also minimize impacts on aquatic biota.

A stream at a quarry site could be more affected by sediments and spills because it would have a small dilution capacity and possibly much lower ambient concentrations of suspended solids. Consequently, aquatic biota would be more likely to be impacted. Depending on the nature of the aquatic resources at the quarries (many such streams flow only intermittently at best), effective control measures for sediments and spills may be necessary.

Because surface waters and their aquatic communities do not exist at the Plateau site, impacts on aquatic biota from reclamation activities at this site are not an issue.

4.6.1.2 Tailings Transport

Significant communities of aquatic biota are not believed to be present in the washes that could be affected by tailings transport, because these washes have standing or flowing water only infrequently (Section 4.5.2.1). Therefore, no impacts would be expected.

4.6.1.3 Accidents

Control measures and cleanup of any spills to protect water quality, as described in Section 4.5.2, would also protect aquatic biota. Therefore, no appreciable impacts are anticipated.

4.6.1.4 Monitoring and Information Adequacy

Although monitoring of aquatic biota in the vicinity of the tailings pile has been limited (a single day's effort yielding unreplicated samples of fathead minnows for analysis of contaminant concentrations), the results, in concert with analysis of available information on contaminant concentrations and flux to the river, and characteristics of the river itself, allowed for a reasonable assessment of potential effects on biota.

4.6.1.5 Post-Reclamation Impacts

Normal Conditions. Aquatic biota would continue to be subjected to tailings leachates under the Atlas proposal. Impacts would not occur at the Plateau site, because no aquatic biota occur on or near the site.

Post-reclamation impacts of the Atlas proposal would be limited to those resulting from continued leaching of tailings contaminants into the underlying groundwater and subsequent migration into the Colorado River. Reclamation would reduce infiltration of precipitation into the tailings and thus reduce mobilization and transport of tailings contaminants to the river (draft TER, NRC 1996). Thus, impacts of the reclaimed tailings pile on aquatic biota would be less than the currently existing effect, which is assessed below.

Under existing conditions at the Atlas tailings pile, an average of about 95 L/m (25 gpm) of contaminant-bearing leachate from the pile enters the flowing groundwater and migrates via this groundwater to the Colorado River. For those contaminants having river or leachate concentrations high enough to be a concern, concentrations in the downstream river water containing diluted tailings leachate were calculated and compared with ambient (i.e., upstream) river concentrations, state water quality standards, and published toxicity benchmarks for aquatic life (see Table 4.6-1 and the discussion in Section 3.5.2) (Suter, Futrell, and Kerchner 1992). This analysis assumes conservatively that sorption and other processes that may attenuate contaminant levels are not significant and that no effective cover is in place. An effective cover which would be installed under the proposed action would substantially reduce movement of contaminants into the Colorado River.

Based on Table 4.6-1, even at record low flow (15.8 m^3/s or 558 cfs), contaminant concentrations (leachate contribution plus ambient concentration) are well below both state water quality standards and toxicity benchmarks, with the exception of ammonia and gross alpha. Ammonia concentrations in the tailings liquid (up to 2275 mg/L) could result in adverse effects on aquatic biota, including endangered species, depending on river flow, pH, temperature, and ammonia

Table 4.6-1. Contributions of Tailings Leachates to the Colorado River during Mean and Low River Flows, as Compared with Ambient Concentrations, Water Quality Standards, and Toxicity Benchmarks[a]

Contaminant	River at mean flow[b]	River at low flow[b,c]	Utah water quality stds	Benchmarks (aquatic life)	Ambient river[g]
Uranium (natural) (pCi/L)[k]	0.25	3.5		98[f]	4.8[i]
Gross alpha (pCi/L)[k]	0.22	3.1	15		14[g]
Radium-226 (pCi/L)[k]	0.000023	0.00032	5[d]		<1[g]
Radium-228 (pCi/L)[k]	0.00017	0.0024	5[d]		1[g]
Molybdenum (μg/L)	0.089	1.2		880	<10[h]
Nickel (μg/L)	<0.0032	<0.044	160	160	<2.5[h]
Selenium (μg/L)	<0.0019	<0.027	5	35	<4.9[g]
Vanadium (μg/L)	<0.0026	<0.036		80	<6[h]
Total dissolved solids (mg/L)	1.0	14	1200[e]		630[g]
Ammonia-nitrogen (mg/L)	0.15	2.1	var[j]	var[j]	<0.1–0.4

[a] Complete dilution is assumed. Mean flow is 220 m^3/s (7770 cfs). Minimum flow is 15.8 m^3/s (558 cfs). Blank spaces indicate data are unavailable. Leachate concentrations were measured in groundwater monitoring wells between the tailings pile and the river. Residual tailing liquor flow was assumed to be 17.9 L/s (0.631 cfs or 283 gpm).

[b]Each value is the increase (i.e., the increment only) in river concentration caused by the tailings leachate.

[c]Minimum recorded flow from 1895–1986 (USGS 1987).

[d]Radium-226 and -228 combined standard for protection of agricultural uses.

[e]For protection of agricultural uses.

[f]142 μg/L (lowest reported chronic value).

[g]Utah Department of Environmental Quality, Division of Water Quality (1994).

[h]Based on four samples from Colorado River near Cisco, upstream of tailings pile (USGS 1987).

[i]Mean of river concentrations reported in Atlas Corporation river monitoring reports for the period November 1989 through June 1993.

[j]var = variable, depending on temperature, pH, and concentration of un-ionized ammonia.

[k]Conversion: pCi/L = 0.037 Bq/L.

removal processes, even after complete dilution. Should natural ammonia removal processes prove inadequate, post-dilution concentrations of ammonia in the river could exceed 2.1 mg/L as nitrogen under extreme low flow conditions and 0.15 mg/L under average flow conditions. The higher concentration exceeds the state standards for protection of aquatic life in the Colorado River, and the lower concentration might exceed the state standards, which vary depending on pH and temperature. State monitoring of ammonia downstream of the tailings pile (Table 4.5-1) shows no evidence of increased ammonia levels; the monitoring stations, however, are many kilometers downstream of the pile. Under record low flows, and assuming gross alpha levels are not otherwise affected by the conditions leading to such low flows, the tailings contribution could cause the gross alpha concentration in the river to exceed the state standard of 0.56 Bq/L (15 pCi/L) (when ambient alpha concentrations are not already above the standard).

The doubling of suspended solids concentrations in the Colorado River far downstream of the pile also cannot be attributed to the tailings pile. Nearly all precipitation over the pile is prevented from directly entering the river; that which percolates through the pile (an average of approximately 95 L/min) picks up only about 7.5 mg/L before mixing with groundwater. Both upriver (470 mg/L) and downriver (930 mg/L) suspended solids concentrations reported in Table 4.5-1 are within the ranges typically reported for rivers of the arid western United States; native fish and invertebrates would be expected to be well adapted to the high and highly fluctuating suspended solids concentrations characteristic of this river. Note also that Section 4.5.2.2 above discusses the elevated suspended solids level, explaining that more than half the difference between upstream and downstream averages can be accounted for by one exceedingly high measurement at the lower station without a corresponding sample from the upper station until 7 days later.

Although a few samples have been taken by the USGS far upstream at its Cisco monitoring station, vanadium has not been monitored downstream of the site. However, the sum of the post-dilution vanadium concentration increment due to the tailings pile (<0.036 μg/L at record low river flow) and the USGS river concentrations of <6 μg/L still results in a total concentration far below the aquatic life benchmark of 80 μg/L, a vanadium benchmark for aquatic life shown in Tables 4.5-3 and 4.6-1. Similarly, molybdenum and nickel concentrations are estimated to be well below published toxicity benchmarks for aquatic life (see Table 4.6-1). Uranium can induce chemical toxicity as well as radiotoxicity, and Table 4.5-3 (see footnote f) presents information related to this issue. However, the levels of uranium in the river expressed in pCi/L are well below both the concentrations known to produce toxic effects in aquatic organisms, and the state of Colorado chronic toxicity standard (1500 μg/L) as well. For example, even the maximum concentration of natural uranium in pCi/L reported downstream of the pile (12 pCi/L) is equivalent to only 17 μg/L U [(12 pCi/L)/(0.69 pCi/μg U)]. This compares to the lowest estimated chronic value of 142 μg/L and the estimated lowest test EC20 value of 455 μg/L (Suter and Mabrey 1994). Note also that the mean uranium concentration is lower downstream than upstream.

Radiological and not chemical effects of natural Th, Ra-226, Ra-228, Pb-210, and Po-210 were addressed in Table 4.5-3 and elsewhere because chemical effects on biota are extremely unlikely at the listed concentrations. With respect to chemical toxicity, Th is relatively inert (Sittig, 1985). This fact, coupled with the very low chemical concentrations observed in the river (5 μg/L), strongly argues against the possibility of toxic effects on aquatic biota. Chemical toxicity from the other radionuclides is even less likely. At the radio-concentrations shown in Tables 4.5-3 and 4.6-2, for example, the chemical concentrations of Pb-210 and Po-210 would be measured in ag/L (attograms/L or 1 E -18 g/L), if methods able to measure these substances at such low concentrations existed.

A dose assessment for a generic fish, invertebrate, and aquatic plant was performed because (1) ambient gross alpha levels are typically near the state standard and (2) tailings leachate contributes a potentially significant fraction of the alpha activity in the form of uranium-238 and its daughters (at least at extremely low river flow). In this assessment, internal dose conversion factors for specific radionuclide/organism combinations generated by the BIORAD computer code were used [Killough and McKay (1976)]. The dose factors account for bioaccumulation of radionuclides by the different organisms. Radionuclide concentrations used in the dose calculations were those occurring in the river as indicated by sampling. Doses to organisms from external exposure to these radionuclides were also calculated, using dose conversion factors compiled from Oak Ridge National Laboratory's EXREM III computer code.

Results of the dose assessments are presented in Table 4.6-2. Because the radionuclides of concern are almost exclusively alpha emitters, the calculated external doses were so small that they did not materially affect overall dose. Therefore, external doses were not included in the table. It should be noted that the ambient concentrations of thorium-230, lead-210, polonium-210, and radium-226 (all daughters of uranium-238) used in this analysis are averages of only six samples from two stations (one immediately upstream, the other downstream of the tailings pile) over a three year period. This analysis indicates that polonium-210 contributes more to total dose incurred by fish and invertebrates than do all of the other radionuclides combined, and contributes nearly half of the total dose to aquatic plants. Total dose to fish is estimated at 5.3×10^{-3} gray per year (Gy/yr) (0.53 rad/yr), while invertebrates incur a much higher dose of almost 0.8 Gy/yr (80 rads/yr).

To place these values in perspective, the total doses were compared to an interim dose limit for the protection of native aquatic animals set forth in DOE Order 5400.5. This interim dose limit is based on the belief of many researchers that aquatic populations are not significantly affected at doses below 0.01 Gy/yr (1 rad/day) (IAEA 1992, National Research Council of Canada 1983). The calculated doses for all three organism types are well below DOE's interim dose limit of 0.01 Gy/day (1 rad/day) or 3.65 Gy/yr (365 rads/yr).

Although it is conceivable that one or more radionuclides could accumulate to some extent in certain depositional areas (eddies and backwaters) downstream of the pile, the limited data currently available do not indicate measurable enrichment of water downstream of the pile (all the radionuclides considered in this assessment are found in comparable concentrations upstream as well). Moreover, a limited sampling effort by WestWater Engineering (1995) directed at this issue in May of 1995 found little or no evidence of enrichment of any radionuclides in sediment depositional areas downstream of the pile—additional information is provided in the BA (Appendix F). It therefore seems unlikely that concentrations of radionuclides in sediments downstream of the pile would measurably exceed concentrations upstream for more than a short time in a few depositional areas.

Although current impacts are minor overall, a greater level of impact may exist at the earth surface (substrate) where groundwater enters the river, before sufficient dilution occurs at this interface. Estimated dose to invertebrates in the river after tailings leachate dilution (Table 4.6-2)

Table 4.6-2. Estimated Internal Radiological Dose to Aquatic Biota in the Colorado River Assuming Record Minimum Flow (558 cfs)[a]

Contaminant	Concentration pCi/L[e] (range)	Dose to fish rad/yr[f]	Dose to invertebrates rad/yr[f]	Dose to plants rad/yr[f]
Uranium (natural) (pCi/L)	8.3 (1.6–12)	0.071	0.71	7.1
Thorium-230[b]	0.80 (0.1–1.4)	0.022	0.36	1.0
Lead-210[b]	2.7 (1.1–4.6)	0.15	0.051	0.10
Polonium-210[b]	3.7 (0.9–5.7)	0.190	78	7.8
Radium-226[b]	1 (< 0.5–3)	0.10	0.51	5.1
Total	13	0.53	79	21
Percent of interim limit[c]	87%	0.14%	21%	NA[d]
Gross alpha	14 (< 1–83)			

[a]Based on application of dose conversion factors compiled by Killough and McKay (1976).
[b]Ambient concentration based on six samples by Atlas Corporation over a three-year period.
[c]Interim limit set forth by DOE Order 5400.5.
[d]Not applicable.
[e]Conversion: pCi/L = 0.037 Bq/L.
[f]Conversion: rad = 100 Gy.

is sufficiently high (21% of the DOE limit) to suggest that local adverse effects are possible at the groundwater–surface water interface before much dilution has occurred. Although probably unlikely, it is possible that any individual fish residing or feeding for long periods of time in this relatively small area may receive potentially harmful doses. Neither the river sediment data collected during a survey in 1989 (CESC 1994a), nor the limited sediment data collected for Atlas Corporation in May 1995 (WestWater Engineering 1995), indicate that levels of radioactivity or trace metals are substantially elevated in sediments adjacent to or downstream of the tailings pile.

Should radionuclides accumulate in the sediments at and downstream of the tailings pile, doses to aquatic organisms would be higher. Based on the gross alpha data presented in Table 4.6-1, less than 2% of the radioactivity in sediments beyond the mixing zone would be expected to originate from the tailings pile. Few data are currently available on polonium-210 and lead-210 in river water, sediments, and biota. What data are available for river water indicate that they contribute substantially to total estimated dose.

In an attempt to clarify some of the above uncertainties and better characterize the contribution of the tailings pile to the contaminant burdens of the Colorado River, and its sediments and biota, a one day sampling program was proposed by the National Park Service and the Fish and Wildlife Service. Backwater and eddy areas were specifically targeted for sampling because (1) as depositional areas they would be most likely to exhibit high concentrations of any contaminants leaching from the tailings pile, and (2) these areas tend to be favored habitat for endangered Colorado squawfish and possibly razorback suckers, as well as other fish species. This sampling program was partially implemented on May 3, 1995 by WestWater Engineering for the Atlas Corporation. The resulting report (WestWater Engineering 1995) describes the sampling program, including objectives, methods and results. Figure F-1 (Appendix F) shows the location of the sampling stations.

Fish were collected with a seine. Fathead minnows were preserved for analysis; all other fish were immediately returned to the river. The effort was hampered by time constraints (one day for all sampling), few or no replicates for individual sampling stations coupled with considerable variability among upstream and downstream stations, a rapidly rising river level which flooded backwater areas selected earlier for representative deposition area sampling sites, and the absence of adequate quantities of invertebrates and periphyton so early in the season.

As indicated in Figures F-2 through F-14 of Appendix F, the resulting data nevertheless suggest that, at least for certain contaminants, concentrations in fish and/or sediments were elevated at one or more sampling stations adjacent to or downstream of the pile. These contaminants include arsenic, iron, lead, manganese, mercury, selenium, vanadium, gross alpha, gross beta, lead-210, polonium-210, radium-226, thorium-230, and total uranium. The BA in Appendix F addresses each of these contaminants in detail.

Of the non-radioactive contaminants, only selenium and mercury concentrations in fish at adjacent or downstream stations appear to exceed upstream concentrations by more than a factor of 2 or 3. As discussed in the BA (Appendix F), the tailings pile otherwise appears to be an unlikely source for the selenium in the one sample of fathead minnows that exhibited high concentrations. Although mercury has not been monitored in tailings leachates (except for two samples from water ponded on top of the pile), there appears to be a greater probability that the tailings pile is at least partially responsible for the elevated mercury concentrations in whole fathead minnows.

The very limited sampling data indicated that mercury and selenium concentrations in fathead minnows were anomalously high—high enough to raise concerns about the safety to predators (e.g., endangered fish) of these and other chemically contaminated organisms. Considering (1) the endangered status of at least three fish species that occur or possibly occur in the area, (2) the relatively high doses absorbed by invertebrates (Table 3-5), and (3) the uncertainties concerning trace elements and ammonia outlined above, the data available for this assessment are not sufficient to support a conclusion that the existing tailings pile does not have an effect on individual invertebrates and endangered Colorado squawfish and razorback suckers that could be present in the mixing zone or downstream deposition areas.

As shown in the BA in Appendix F, calculated absorbed doses from radionuclides found in fathead minnows collected during the May 1995 sampling program are well below levels believed to be harmful to fish populations.

Tailings Pile Failure. Aquatic biota would be affected by the impacts on water quality that are described in Section 4.5.2.2. For several kilometers downstream, the tailings contribution to the high levels of suspended solids (from both the tailings pile and numerous other natural and man-made sources) would adversely affect aquatic biota for a relatively short period of time through clogging, abrasion, or irritation of gills, smothering of benthic organisms and fish eggs, and interference with feeding and other life-supporting functions. Catastrophic failure as opposed to a more gradual mass wasting process could directly kill fish and other aquatic biota in the immediate vicinity. During this time, exposures to radionuclides could exceed, by a factor of about four, long-term levels recommended for the protection of aquatic populations.

As the tailings-contaminated water mass moves downstream, the exposures would likely decline rapidly as uncontaminated waters enter the river and dilute the contaminants, and as the bulk of the contaminated solids settle to the river bottom. Any harmful levels of radiation, although not expected, would be temporary, as most of the contaminated tailings solids would probably migrate to Lake Powell after many cycles of settling and resuspension in the river water column, while being diluted by uncontaminated sediments. The tailings contaminants would probably become semi-permanently sequestered in the bottom sediments of Lake Powell, where their concentrations would be low and would be expected to have little adverse impact aquatic biota.

In the stretch of river near the tailings pile, relatively large quantities of radioactive solids could settle to the bottom in certain areas and cause harmful radiation effects on biota residing or feeding in the bottom sediments. The current in the river channel at the Atlas site would probably tend to prevent most sediments from entering important aquatic habitats in Moab Marsh and the floodplain on the Moab side of the river.

In Section 4.5 (Table 4.5-3), concentrations of tailings contaminants *dissolved* in the river after pile failure are compared with state standards, benchmarks, and ambient concentrations. No non-radioactive contaminant is likely to occur at levels potentially harmful to aquatic life. As shown in Table 4.6-3, even radioactive contaminants are unlikely to harm populations of aquatic biota, based on the assumptions and data used in the analysis. Invertebrates would incur about 26% of the recommended dose limit from dissolved contaminants. Note that more than 90% of the dose to invertebrates is due to polonium-210. As shown in Table 4.5-3, most, perhaps all, of the polonium-210 in the water would be from sources other than the tailings pile.

Table 4.6-3. Estimated Internal Radiological Dose to Aquatic Biota from Dissolved Contaminants after a Tailings Pile Failure[a,b]

Contaminant	Diluted in river (pCi/L)[c]	Dose to fish (rad/day)[d]	Dose to invertebrates (rad/day)[d]	Dose to plants (rad/day)[d]
Uranium (natural)	68	0.0015	0.015	0.15
Thorium-230	0.73	5.4e-5	0.00090	0.0026
Lead-210	3.2	0.00049	0.00017	0.00032
Polonium-210	4.2	0.00059	0.24	0.024
Radium-226	<1.5	0.00041	0.0021	0.021
Total	78	0.0030	0.26	0.20
Percent of interim limit[d]		0.30%	26%	NA[f]

[a]Based on application of dose conversion factors compiled by Killough and McKay (1976).

[b]Assumes that tailings are 25% liquids, enter the river at a constant rate over a 10-hr period, and are diluted by flood waters at 150,000 cfs. Also assumes that organisms are exposed for 24 hours due to drift with the current.

[c]Ambient concentration plus concentration increase from eroded tailings; 1 pCi/L = 0.037 Bq/L.

[d]Conversion: rad × .01 = grey (Gy)

[e]Interim limit for protection of aquatic populations of 0.01 Gy/day (1 rad/day) set forth by the U.S. Department of Energy at DOE Order 5400.5.

[f]Not applicable—no limit has been established.

In river bottom sediments where relatively high concentrations of undissolved contaminants may occur in addition to dissolved contaminants, the invertebrate populations residing in the sediments may receive greater than the recommended dose and possibly experience local declines in numbers and/or health. Again, however, polonium-210 from sources other than the tailings would probably account for most of the dose.

4.6.1.6 Monitoring

Assessment of potential impacts on aquatic biota was based primarily on water quality monitoring discussed in Section 4.5.2.

4.6.2 Terrestrial Ecology

4.6.2.1 Reclamation Impacts at the Atlas and Plateau Sites

Plant and animal populations would be reduced in proportion to the amount of habitat lost at the Atlas site and Plateau site. The Atlas proposed reduction in the tailings pile slopes would result in a small increase in the amount of floodplain occupied by the tailings pile. Other activities on the Atlas site (e.g., relocation of Moab Wash) would temporarily disturb terrestrial habitats. The primary concern is to avoid significant loss of habitats required by particularly important species, such as game animals and endangered species (Section 4.6.4). Staff visits to the sites in April 1994 and information provided by the FWS and the state of Utah did not identify any particularly important habitats or species that would be affected by reclamation on the Atlas or Plateau site (Appendix E). Because habitat disturbances at the Atlas site would be limited to portions of the site, and because particularly important biological resources are not present on the site (Section 3.6.2), the impacts of reclamation at the Atlas site would be negligible.

At the Plateau site, a few hundred acres of existing terrestrial habitat could be disturbed during reclamation, including 40 to 70 ha (100 to 175 acres) that would be occupied by the relocated tailings pile. The site has a sparse cover of vegetation that supports a wildlife community of relatively few species having relatively low population densities, which is typical of the upland habitats in this semi-arid region (Section 3.6.2). Because of this limited terrestrial resource on the site and the extensive acreages of the same resource in surrounding areas, the loss of roughly 60 ha (150 acres) would not be a significant impact.

4.6.2.2 Borrow Operations

Under the Atlas proposal, obtaining clay from the Plateau site would destroy terrestrial habitats on an acreage of probably less than 40 ha (100 acres). After borrow activities are completed, and if the area is adequately restored, terrestrial biota would slowly become reestablished. Operations at riprap borrow sites would also disturb terrestrial habitats, and could result in a small permanent loss of habitat if a rock quarry is constructed. Borrow transport would have negligible impact on terrestrial resources.

4.6.2.3 Tailings transport

Construction of a conveyor at the Atlas site would affect little habitat and thus would have negligible impact on terrestrial biota. Construction of a rail spur to the Plateau site would result in the loss of probably less than 14 ha (35 acres) of terrestrial habitat. Transport of the tailings would temporarily produce noise and exhaust emissions that would have minimal impact on plants and animals.

4.6.2.4 Accidents

Any spill of hazardous substance or tailings could have some temporary impact on biota. However, a spill would be limited to a small area of habitat and would thus be unlikely to affect any significant plant or animal populations.

4.6.2.5 Monitoring and Information Adequacy

Systematic surveys of plant and animal populations have not been conducted at the Atlas or Plateau site. However, project information supplied by Atlas and the general information on biota in the region, including information obtained from the state of Utah and the FWS, were sufficient to assess the potential impacts of reclamation.

4.6.2.6 Post-Reclamation Impacts

Normal Conditions. After reclamation is completed, the only additional habitat loss that would occur would be that associated with future development of those portions of the site that are released for unrestricted use. The level of tailings contamination on the Atlas site after reclamation would be low enough to protect humans and should thus have no significant effect on plant or animal populations (IAEA 1992). Tailings contamination of the Colorado River would have little impact on water quality (Section 4.5.2) and would thus not be expected to have toxic effects on wildlife that drink the water or prey on fish or waterfowl.

Tailings Pile Failure. The minimal impact on water quality after the hypothetical pile failure (Section 4.5.2) should preclude any significant toxic effects related to wildlife use of the water. The level of tailings contamination of lands flooded during the HF should also be too low to produce significant toxic effects, bioaccumulation of contaminants, or reductions in populations.

4.6.3 Wetlands

4.6.3.1 Reclamation Impacts

Several acres of tamarisk wetland on the Atlas site could be lost, depending on the extent to which the slopes of the tailings pile would be reduced and the need to construct roads around the periphery of the pile to haul and place riprap. The wetland vegetation is dominated primarily by tamarisk and has a relatively low diversity of other species. Because this wetland has low plant diversity and has standing water only when infrequently flooded, it does not represent high quality wildlife habitat. The loss of some of this wetland during reclamation of the tailings pile is unlikely to have a significant impact on wetland wildlife. Prior to initiation of reclamation activities, Atlas would consult with the U.S. Corps of Engineers to determine the need for obtaining a permit for construction in wetlands in accordance with Section 404 of the Clean Water Act.

The Plateau site alternative would not impact wetlands. Removal of the tailings from the Atlas site could involve temporary expansion or improvement of haul roads around the base of the tailings pile during the reclamation period. Impacts could include removal of or disturbance to some of the tamarisk-dominated wetlands, but these impacts would be limited in extent and temporary. No wetlands are known to occur on the Plateau site, and none is likely to be affected along the route for transporting the tailings to the Plateau site.

No impacts to wetlands are anticipated from activities associated with obtaining riprap materials in Castle Valley or Spanish Valley, although the specific locations for these borrow areas have not yet been determined. Wetlands are not present in the immediate vicinity of the Round Mountain borrow area. There is a stream and associated riparian wetlands in the general area that has been identified for collection of cobble materials in Spanish Valley. When a more specific location has been determined for the borrow operations, Atlas will need to ensure that no impacts to wetlands in the area occur. Since there are no wetlands at the Plateau site where cover materials would be obtained, no impacts to wetlands are anticipated from those operations.

4.6.3.2 Post-Reclamation Impacts

Tailings leachates, which enter the Colorado River, have little impact on water quality (Section 4.5.2) and should not impact Moab Marsh or smaller wetlands located downstream from Moab. The hypothetical tailings pile failure could result in a low level of tailings contamination in Moab Marsh. However, because virtually all of the tailings contaminants would be expected to be carried through the Portal, the contamination in the marsh should be too low to affect plant or animal populations using the marsh. Small wetlands downstream of the Portal should also experience levels of tailings contamination too low to affect plant or animal populations.

4.6.4 Threatened and Endangered Species

As noted in Section 3.6.4, a BA (Appendix F) has been prepared by the staff in compliance with the Endangered Species Act of 1973, as amended. This BA includes the most recent water quality and biota sampling data collected in May 1995 (WestWater Engineering 1995) and was forwarded to the FWS for review and response in November 1995.

4.6.4.1 Reclamation Impacts

No threatened or endangered species are known to occur on the Atlas mill tailings site itself or on the surrounding Atlas property. Peregrine falcons are known to be present in the vicinity of the Portal and may feed on birds in the Moab Marsh. Noise and disturbance associated with reclamation of the tailings pile could temporarily disrupt peregrine falcons feeding in the area, but the levels of noise and the activity levels should be similar to those occurring when the mill was active and should have no long-term effect on the use of Moab Marsh as a feeding area for peregrines. In addition, the availability of riparian habitat in Moab Marsh and along the Colorado River corridor, both upstream and downstream of the mill tailings site suggests that peregrines can avoid any significant disruption to their use of the area by feeding in areas somewhat more distant from the pile. Activities at the site during reclamation activities are sufficiently distant from any known nesting site that impacts to breeding and nesting activities are unlikely to occur.

The endangered southwestern willow flycatcher could utilize Moab Marsh and possibly some of the tamarisk habitat adjacent to the pile during the nesting season, although there is considerable uncertainty as to whether this species is present in the area (Appendix F). Noise and other activities associated with reclamation could disturb nesting birds and affect their breeding success if they are present in these areas. In addition, some portion of the tamarisk-covered floodplain area on and immediately adjacent to the tailings pile would be disturbed by reconfiguration of the pile and use and creation of roads to haul and place riprap along the base of the slopes. Similar disturbance would occur to the tamarisk plant communities if the tailings pile were moved to the Plateau site because haul roads to move the tailings are likely to be developed or expanded in the floodplain.

No threatened or endangered species are known to be present at the Plateau site or borrow sites, although the Jones cycladenia, a threatened plant species, is known to occur on BLM land in Castle Valley (Section 3.6.4). After Atlas has identified the location of the second borrow site in Castle Valley (Section 2.1.3), potential impacts on the Jones cycladenia will be assessed and additional consultation with the FWS will be undertaken as necessary to comply with the Endangered Species Act.

Two additional plant species that are candidate species for being proposed for listing as threatened or endangered species) occur in the Moab region (Peterson 1994) (Section 3.6.4), but they are not known to occur on the Atlas site, Plateau site, or borrow areas and are not yet legally protected under the Endangered Species Act.

Reclamation operations at the Atlas site would not be expected to jeopardize threatened and endangered fish species in the Colorado River, although a small additional amount (e.g., 1.2 ha or 3 acres) of critical habitat (floodplain, Section 3.6.4) would be covered by the tailings pile. Spill and erosion control measures for protecting water quality, aquatic life, and endangered species during reclamation are discussed in Section 4.5.4.

4.6.4.2 Post-Reclamation Impacts

Normal Conditions. As discussed earlier, post-reclamation water quality of the Colorado River would probably improve relative to existing conditions. Nevertheless, tailings leachates would continue to enter the river, albeit at a reduced rate. Based on the analyses presented in Sections 4.5.2, 4.6.1 and the BA in Appendix F, the tailings pile is unlikely to have adverse radiological effects on any of these endangered species under existing conditions, with the possible following exceptions. Near the leachate-contaminated groundwater-surface water interface, pre-dilution concentrations of U-238 and its daughter isotopes, and possibly ammonia, may occur at levels sufficiently high to harm local invertebrates and individual members of an endangered fish species should they reside there for long periods of time. Even in these conditions, few fish or invertebrates would be likely to spend long periods at the more contaminated interface. The site-specific data needed to assess effects on endangered fish in these conditions do not exist.

Tailings Pile Failure. The hypothetical tailings pile failure would have little effect on water quality in the river and should not jeopardize the fish species, either in the short or long term. Contaminant levels should also not jeopardize endangered bird species (e.g., bald eagle and peregrine falcon) that may occasionally visit the area.

4.6.5 Conclusion

Aquatic Ecology, Including Threatened and Endangered Fish Species. In most respects, the existing conditions related to the tailings pile do not appear to adversely affect aquatic biota of the Colorado River beyond a small mixing zone adjacent to and downstream of the pile. Very limited but recently obtained data on fish contaminant levels, however, suggest that possibly hazardous levels of selenium and mercury occur in fathead minnows collected near the pile. Further the tailings liquor is known to have high levels of ammonia, although no evidence of excessive ammonia levels in the river have been reported. Should individual endangered Colorado squawfish or razorback suckers reside in or frequent the mixing zone or downstream depositional areas, these individuals could possibly incur some degree of harm ranging from slightly reduced reproduction to death. Tailings disposal at the Plateau site would provide the greater benefit to aquatic biota over the long term because the source of contamination would be removed.

At the Moab site, a massive failure of the tailings pile design during the HF would have a substantial temporary impact on aquatic biota in the river near the pile. The river's water quality, which is already degraded regardless of the tailings pile, would be further degraded by only a slight amount over the long term. Contaminants from the tailings would be quickly diluted to levels below water quality criteria for the protection of aquatic biota and should have no significant long-term impact.

During reclamation activities, sediment- and contaminant-laden runoff could enter the Colorado River and any small stream present at the riprap borrow sites. Plans for control of water pollution would be required as discussed in Section 4.5.4.

Terrestrial Ecology, Including Threatened and Endangered Species. Habitat losses as a result of reclamation at the Atlas site or Plateau site would primarily involve some limited loss of tamarisk-dominated plant communities on the Colorado River floodplain immediately adjacent to the pile. The existing pile has a very sparse vegetation cover and provides little if any habitat for terrestrial species. On the long term, reclamation of the pile at the present site would result in the reestablishment of riparian tamarisk communities on floodplain areas adjacent to the pile and the establishment of vegetation elsewhere on the site. Contamination resulting from tailings leachates should be reduced, and no significant impacts on terrestrial biota would be anticipated. The hypothetical pile failure would result in some localized disturbance to terrestrial plant communities on the pile slopes and adjacent floodplain. Over time these communities would become reestablished. Contamination from the hypothetical tailings pile failure would be localized and should be too low to affect any terrestrial biota.

Should the pile be moved to the Plateau site, the existing Moab site would be recontoured and revegetated and would thus provide new habitat for terrestrial species. Once reclamation and groundwater cleanup are completed, however, the site may be used for commercial or residential development. At the Plateau site, existing terrestrial habitat would be replaced with the new disposal area, and there would be a net loss of existing terrestrial habitat as a result. The existing habitat is of low quality and similar to extensive areas adjacent to it.

Wetlands. The loss of several acres of tamarisk wetland on the Atlas site would have little impact on wetland biota. No wetland is present on the Plateau site, and none is likely to be present on the riprap borrow areas. Contamination levels from long-term release of tailings leachates under the Atlas proposal would be too small to affect population numbers of wetland biota in Moab Marsh or other downstream wetlands. Contamination levels resulting from the hypothetical tailings pile failure should be too low to appreciably affect wetland ecology or population numbers of wetland biota. In consideration of the above, neither the Atlas proposal nor the Plateau site alternative should have significant impacts on wetlands.

4.7 SOCIOECONOMIC, CULTURAL, AND AESTHETIC RESOURCES

4.7.1 Population

4.7.1.1 Reclamation Impacts

Low-intensity construction activities, which would involve only 20 to 30 workers at peak at either site, would result in only minimal, temporary population growth in Grand County and Moab. The growth would occur at the same time as the seasonal influx of recreation enthusiasts and tourists. During reclamation, project-related activities at the northern gateway to Moab could have a slight negative effect on tourism and recreation, but would only minimally and temporarily affect population size. Construction activity at the Plateau site would not be visible from any improved roads and would result in only minimal and temporary population effects.

4.7.1.2 Borrow Operations

Because trucking materials from borrow sites to either reclamation site would involve few workers, the only projected effect on population would be a slight increase in trucking and related support workers—all would be temporary employees hired in the winter, the off-season. It is expected that this slight increase would result in only minimal and temporary population growth in Grand County. Under the Plateau site alternative there would be less trucking than for the Atlas proposal because the clay would be obtained on or adjacent to the site and the amount of riprap is likely to be much less than for the Atlas proposal. Therefore, any population impacts from trucking activities would be smaller than with the Atlas proposal. It is expected that transport of borrow materials would cause little traffic congestion because the hauling would be done primarily during the winter months when traffic congestion is at its lowest.

4.7.1.3 Tailings Transport

Construction of rail facilities and conveyors at the Moab and Plateau sites would involve few workers for only short time periods. Such small employment increases would be unlikely to cause significant population growth. Transport of tailings to the Plateau site would also likely have few if any effects on populations. No residences are near the Plateau site and few are located along the rail route, which follows the heavily traveled U.S. 191.

4.7.1.4 Accidents

Trucks hauling riprap on the road through Castle Valley and on State Highway 128 would increase traffic-related accident risks. Atlas proposes to transport riprap during the winter to avoid the tourist season, which now extends from March to Thanksgiving due to mountain bike riders' desire for cooler temperatures. The chances for an accident during borrow transport would depend on the transport route used, the size of the trucks used for hauling, the time-of-year and time-of-day used for transport, the number of haul trips daily and in total. Atlas proposes to use 18-metric-ton (20-ton) trucks for hauling riprap, although the state of Utah may not allow trucks this large on State Highway 128 (D. Stapley, Utah Department of Transportation, Price, Utah, personal communication with C. H. Petrich, ORNL, July 15, 1994).

Plans for riprap transport must satisfactorily address issues of snow and ice, safety factors, and road surface durability on State Highway 128. This highway and the loop road are winding and dangerous in any season, especially in poor weather, with poor visibility, or when bikes and recreation vehicles are present. Trucks hauling riprap on U.S. 191 through Spanish Valley and Moab could also present substantial socioeconomic conflicts (W. Hedden, Grand County Council, Moab, personal communication with C. H. Petrich, ORNL, April 12 and August 16, 1994). An accident in the town would be unlikely to have permanent population impacts, but could cause significant temporary disruption and exacerbate negative perceptions of the area being industrialized.

Trucks carrying clay from the Plateau site to the Atlas site would use U.S. 191. While heavy traffic would be encountered here during the tourist season, grades, horizontal and vertical curves, surfacing, shoulder widths, and sight distances are all adequate to accommodate frequent heavy trucking, as they currently do. Accidents here would be less likely than for the Atlas proposal and would be unlikely to have serious impacts on surrounding populations.

Annual Average Daily Traffic (AADT) information was available for a five-year period (1989 to 1993) from the Planning Statistics Section of the Utah Department of Transportation (UDOT). The most recent AADT data available were for 1993. The percentage of heavy duty trucks (2% single-unit heavy trucks and 16% combination trucks) on U.S. 191 is based on the UDOT traffic classification counts from station 421 (U.S. 191 MP 130.2) for the year 1993. The percentage of heavy duty trucks (3% single-unit heavy truck and 3% combination trucks) on State Highway 128 is based on the latest UDOT traffic classification count.

Monthly, weekly, and daily traffic variation was also obtained from the UDOT traffic classification counts from station 421 (U.S. 191 MP 130.2) for the year of 1993. Based on these data, approximately 17% of the annual traffic occurs within the winter period from November through February, with about 70% of this being weekday traffic. Approximately 55% of the winter weekday traffic occurs between 8:00 a.m. and 5:00 p.m. This time period is referred to as the study period for this analysis.

Accident data were obtained for the six-year period 1989–1994. A total of 384 accidents occurred within this six-year period, resulting in an area-wide accident rate of 1.21 accidents per million vehicle miles traveled (VMT). Forty-six of these 384 accidents involved heavy trucks. Thus, the area-wide accident rate for heavy trucks was 0.84 accidents per million VMT. However, only five accidents involved single-unit heavy trucks, resulting in an area-wide accident rate of only 0.76 accidents per million VMT. Single-unit heavy trucks had the lowest accident rate within the study area.

It should be noted that 3 out of the 5 accidents that were reported as involving single-unit heavy trucks actually involved regular single-unit trucks. Of the other two, one accident involved a dump truck, and the other involved a special kind of mobile equipment (e.g., construction or utility truck) that collided with a motorhome.

The accident rates within the study period are higher than the year-round accident rates. During this period, the single-unit heavy truck accident rate increased from 0.76 to 2.22 accidents per million VMT. Two factors may have contributed to the higher winter accident rates—first, the exposure measure in terms of VMT is much lower during the winter months, and second, the snowy and icy pavement conditions during the winter in Utah are likely to increase vehicle-related accidents.

The six-year accident history fails to generate a valid dump truck accident frequency. Only one accident involving a dump truck occurred within the study area during the past six years, and that accident did not occur during the study period. Also, there is no dump truck VMT data available. Therefore, an accident rate for single-unit heavy trucks is used to estimate the expected number of accidents. Only one single-unit heavy truck accident occurred within the study period during the past six years. This accident involved a special kind of mobile equipment and a motorhome. There were no accidents involving a dump truck or a regular single-unit heavy truck within the study period during the six years.

For purposes of analysis, four alternatives are considered for estimating expected numbers of accidents for two different sizes of trucks as follows:

Alternative 1 Leave tailings at Atlas site and cover with rip-rap from Spanish Valley.

Alternative 2 Leave tailings at Atlas site and cover with rip-rap from Round Mountain.

Alternative 3 Move tailings to Plateau site and cover with rip-rap from Spanish Valley.

Alternative 4 Move tailings to Plateau site and cover with rip-rap from Round Mountain.

These alternatives are used for comparative purposes only and represent more trucking along specific routes than would actually take place. Alternatives 3 and 4 overstate potential impacts because the amount of riprap, and therefore the number of trucks needed, would be much less than is assumed in the above analysis. The expected dump truck traffic and the expected number of induced accidents is presented in Table 4.7-1 along with the probability of a given number of accidents occurring for two dump truck types and four alternative rock quarry-tailing site combinations.

Based on information in Table 4.7-1, the probability of not having an accident during the project period is close to 65% under alternative 1 using 10-cubic-yard dump trucks. On the other hand, there is a 22% chance that one can expect three accidents during the project period, and the probability of having no accident is only 4.61% under alternative 4 using 6-cubic-yard trucks. In general, the more dump truck VMT, the more accidents expected. Therefore, using 10 cubic yard trucks would reduce the number of trips required to haul the rocks resulting in fewer expected accidents. On the other hand, alternative 1 involves the shortest travel distance and, therefore, is expected to result in the least number of expected accidents during the project period.

4.7.1.5 Post-Reclamation Impacts

Normal Conditions. Moab and Grand County have little land available for development, especially north of Moab. Reclaiming the tailings pile on-site would constrain the use of the riverfront land on the Atlas site. Population impacts associated with the Atlas site pertain to the opportunity costs for alternative uses of the site. This could negatively affect the availability of Grand County riverfront land for other suitable uses that could have helped support population growth. Public perception of the tailings pile as a threat to health or safety would be unlikely to be extensive enough to significantly affect population growth.

Disposal at the Plateau site would preclude other land uses on the area occupied by the tailings pile (Section 4.3). Competing land uses there, however, are minimal (very low-intensity grazing), and no local populations would be affected.

Tailings Pile Failure. As a result of the hypothetical tailings pile failure, a small fraction of the tailings contaminants could enter areas of Moab below 1218 m (3997 ft) amsl, which is the estimated maximum flood level for a PMF. Thus, a low level of tailings contamination could occur in several residential areas. Surveys would be conducted to determine the level of contamination and cleanup required to allow continued residential use. Effects on the tourist and recreationist population is discussed in Section 4.7.2.

Table 4.7-1. Expected Dump Truck Traffic and Expected Number of Accidents

		Alternative 1	Alternative 2	Alternative 3	Alternative 4
Vehicle Miles of Travel		16.94	28.01	36.16	47.26
Number of One-way Trips	6-cubic yard Truck	85,500	85,500	85,500	85,500
	10-cubic yard Truck	33,750	33,750	33,750	33,750
Miles of Travel	6-cubic yard Truck	1,448,370	2,394,855	3,091,680	4,038,165
	10-cubic yard Truck	571,725	945,338	1,220,400	1,594,013
Single-Unit Truck Accident Rate		0.76	0.76	0.76	0.76
6-cubic yard Truck	Expected Number of Accidents	1.10	1.82	2.36	3.08
	Probability of having no accident	33.17%	16.12%	9.48%	4.61%
	Probability of having 1 Accident	36.60%	29.42%	22.34%	14.18%
	Probability of having 2 accidents	20.20%	26.85%	26.31%	21.82%
	Probability of having 3 accidents	7.43%	16.33%	20.66%	22.38%
	Probability of having 4 accidents	2.05%	7.45%	12.17%	17.22%
10-cubic yard Truck	Expected Number of Accidents	0.44	0.72	0.93	1.21
	Probability of having no accident	64.69%	48.66%	39.46%	29.68%
	Probability of having 1 accident	28.18%	35.05%	36.69%	36.05%
	Probability of having 2 accidents	6.14%	12.62%	17.06%	21.89%
	Probability of having 3 accidents	0.89%	3.03%	5.29%	8.86%
	Probability of having 4 accidents	0.10%	0.55%	1.23%	2.69%

4.7.1.6 Conclusion

No appreciable impact is expected on population growth in the Moab area for the Atlas proposal, the Plateau site alternative, or the hypothetical tailings pile failure. Atlas would be required to submit a borrow transport plan addressing (1) possible Utah weight restrictions, (2) minimization of potential impacts on population and socioeconomic resources, and (3) minimization of accident potential.4.7.2 Economic Resources and Employment

4.7.2 Economic Resources and Employment

Grand County is heavily dependent on the tourist and recreation industries for its economic base. Using sales tax revenues as an indicator, 76% of the county's revenues derive from these sources (W. Hedden, Grand County Council, Moab, personal communication with C. H. Petrich, ORNL, April 12 and August 16, 1994). Within Utah, only Garfield County in the southern portion of the state, and without Grand County's more diversified and larger economic base, has a higher dependency on tourism and recreation. During the winter months, unemployment rates in Grand County rise above the state average, reflecting the downturn in tourism, recreation, and construction. Less than 10% of the labor force is involved in the construction industry.

4.7.2.1 Reclamation Impacts

The Atlas proposal would involve an average of 25 project workers over the proposed 5 summer reclamation seasons of 15 weeks each. An estimated 30% of these workers would come from the local Grand County work force, while the remainder (primarily supervisory and field staff workers) would come from outside the county. During peak construction, 30 project workers would be employed. Subcontractors would account for up to 30 additional workers during occasional brief periods throughout the construction period. Trucking of borrow materials would primarily be done during winter months, the off-peak construction period.

Indirect employment would be generated as direct employee earnings and other project moneys are respent and circulated through the local economy. Including these secondary employment impacts, total project-related employment is expected to only marginally reduce the county-wide unemployment rate by 3 to 4%. During the peak period, nearly all of the 30 to 40 workers employed in project-generated jobs would reside in the Moab area (Moab and Grand County). Once reclamation was completed, direct project employment would fall to zero, and only indirect and induced employment impacts would remain.

Much of the equipment to be used under the Atlas proposal or Plateau site alternative would come from outside the local or regional economies, e.g., locomotives, railroad cars, heavy equipment for earth moving, etc. Most of the labor, exclusive of some operators and managers, could be hired locally. Haul truck drivers might be hired from outside the area, but hauling in the winter would help balance demand and supply of workers. Multipliers of the project expenses in the local community are difficult to derive with the current level of project estimates and project details.

The primary labor need during construction would be for heavy equipment operators, with up to 14 or 15, respectively, being needed for the Atlas proposal or Plateau site alternative during some operational phases. This does not include truck drivers for hauling borrow material. In general, fewer operators would be needed at the Plateau site, but for longer periods of time. Some employees would be needed for as long as 12 years at the Plateau site.

During the five 15-week summer reclamation work seasons, about 18 additional workers (70% of an estimated total of 30) would be expected to reside in the Moab area. Even fewer would be needed for the Plateau site alternative. This small number of workers from outside the area, in the non-school season, would be scarcely noticed in the seasonal, tourism-based economy. Even if 75% of these 18 workers came with families (the 1990 average household size for Utah was 3.2), then a total of 48 additional people would reside in the area for five summers. The local tourist council indicated that this small influx of people would not stress existing services, including campgrounds, trailer parks, or motels (H. Sipress, Grand County Travel Council, Moab, Utah, personal communication with C. H. Petrich, ORNL, September 2, 1994). The influx above normal tourism loads in recent years readily accommodated the film crews and other production support personnel for *Geronimo* and *City Slicker II*, both major movies, for extended stays.

4.7.2.2 Borrow Operations

Transport of riprap through the town of Moab could impact commercial and retail businesses. Some loss of sales would be expected as potential customers avoid high truck traffic, expected to be 5 or 6 18-metric-ton (20-ton) trucks per our through Moab during the winter season. Simultaneously, economic benefits would occur to those involved in the trucking. The Atlas proposal would produce more truck traffic than the Plateau site alternative because it would require more borrow materials.

4.7.2.3 Accidents

Costs associated with borrow-transport accidents would increase with the frequency of accidents. Accident frequency, however, would be expected to be too low to have any appreciable impact on the area's economic resources and employment.

4.7.2.4 Post-Reclamation Impacts

Normal Conditions. Under the Atlas proposal, roughly half of the 162-ha (400-acre) site would be cleaned up suitably for unrestricted use and could be sold to private individuals or firms. The time and effort to clean up this area are unknown but could be substantial (Sections 2.2.1.5 and 5.1.5.2).

The Atlas site is currently valued on the Grand County tax rolls at $612,880. This consists of 25 ha (61 acres) valued at $4950/acre, 99.6 ha (246 acres) valued at $1,000/acre, and 52.6 ha (130 acres) considered in the floodplain and valued at $500/acre. At the 1995 tax rate of 0.013462 for the Moab Mosquito Abatement District, the tailings pile site, the taxes currently paid to the county from the Atlas site amount to $8,251. [Grand County taxes real property at 100% of its fair market value (J. Tangreen, Deputy Assessor, Grand County Tax Assessment Office, personal communication with C. H. Petrich, ORNL, December 5, 1995).

The Plateau site is on state land valued by Grand County at $100/acre. Recent purchases from the BLM of land similar to the Plateau site (but nearer to Moab) netted the Federal government $1,000/acre.

Under the Atlas proposal, roughly 53–71 ha (130–175 acres) (depending on extent of the floodplain) of the site could be made available for alternative uses after reclamation and groundwater cleanup were successfully completed.

Using the valuations provided above for the existing site, coupled with the information that—using the highest value of property—residential land in the City of Moab (i.e., full city services provided, platted, and sold in 1/4-acre lots) is selling in 1995 for about $92,000/acre and commercial land on Main Street in downtown Moab for $85,000/acre (J. Tangreen, Deputy Assessor, Grand County Tax Assessment Office, personal communication with C. H. Petrich, ORNL, December 5, 1995; see Section 3.7.2.2), the changes in land valuation and the implications to the tax receipts for Grand County were estimated. Estimates are expressed as annual amounts in constant 1995 dollars. Comparisons to present tax valuations and revenues collected should be made remembering that no inflation has been accommodated and that valuations are for bare land without any structures or other improvements. The length of time needed to clean up groundwater at the Atlas site under the Plateau site alternative is not known, but could be 25 years or more. Therefore, the land on the Atlas site might not be available for unrestricted use a substantial period of time after the pile was moved. It was assumed that property values for residential use could be decreased 20–40% by the presence of the nearby tailings pile.

The portion of the site that would accommodate the tailings pile and surrounding buffer would go into Federal or state ownership and would not be on the tax rolls. This would mean a loss from the tax rolls of land valued at $153,375 and of taxes of $2,065. For residential development, the land that would become available at the Atlas site after reclamation (and *not* net of the above losses) would be valued (in constant 1995 dollars) at a low of $7.27 million for a 40% property value degradation (due to the nuisance presence of the pile) on 52.6 ha (130 acres) and generating taxes of $97,932 to a high of $12.83 million and taxes of $172,696 for the 20% degradation on 70.8 ha (175 acres) of buildable land. For commercial development, the land would be valued from $4.48 million to $7.99 million (depending on the amount of land deemed "buildable") and would generate taxes of $90,525 to $159,578. Table 4.7-2 shows these comparisons. Using the Atlas proposal and the Plateau site alternative as guides, the land uses, buildable areas, and extent of aesthetic degradation have been varied. Under the Atlas proposal the availability of portions of the site for partial alternative land use could not begin until at least the end of reclamation (estimated to take 5 years), while under the Plateau site alternative availability of land for alternative uses would not occur sooner than 6.4–9.7 years after reclamation was begun. Land on the site would more likely be available for alternative uses much

Table 4.7-2. Projected Grand County Property Valuations and Annual Tax Revenues (in constant 1995 dollars) for the Atlas Mill Tailings Site.

		Atlas Proposal				Plateau Alternative (108 ha buildable)	
		Low Development (53 ha buildable)		High Development (71 ha buildable)			
Land Use	Aesthetic Degradation (%)	Projected Valuation[a]	Projected Taxes (annual)[b]	Projected Valuation	Projected Taxes (annual)	Projected Valuation	Projected Taxes (annual)
Residential	20	$9.69 M	$130,381	$12.83 M	$172,696	$24.67 M	$322,081
	40	$7.27 M	$ 97,932	$ 9.62 M	$129,596		
Commercial	20	$8.94 M	$120,388	$11.85 M	$159,578	$22.80 M	$306,920
	40	$6.72 M	$ 90,525	$11.20 M	$150,781		

[a] All projected property valuations and taxes are in constant 1995 dollars.
[b] Assumes the 1995 tax rate of 0.13462 for the Moab Mosquito Abatement District.

later because of the need to clean up groundwater. The 1995 valuation of the Atlas site was $612,880, with $8,251 in taxes collected.

Under the Plateau site alternative, more of the Atlas site could be converted to other uses that would replace the current Atlas valuation and collection. It was assumed that alternative uses could not begin until the earliest estimated completion date for tailings removal from the Atlas site. The unbuildable portions of the Atlas site would remain under their current valuations. For residential development, the estimated buildable portions of the Atlas site [108 ha, or 267 acres, in contrast to the roughly 53-71 (130-175 aces) used in the calculations above] could add about $25 million to the tax roll valuations and $330,000 in taxes collected. For commercial development, the converted land would add $23 million to the tax rolls and $306,000 to the taxes collected annually (in constant 1995 dollars). (These figures are *not* net of the current valuation of the Atlas site.)

The above analysis suggests that the Atlas site would provide a greater value under the Plateau site alternative than under the Atlas proposal. This may not be the case, however, if groundwater cleanup under the Plateau site alternative sufficiently delays development of the Atlas site for other uses. If development on the site is delayed, which is likely since the licensee has estimated that groundwater cleanup could take at least 25 years (WTI 1989), lost annual tax revenues should be factored into any comparative analysis for each year of any projected delay, as well as the discounted value of projected annual revenues.

All the dollar estimates above are solely for the land itself and do not consider any real property as construction or other improvements to the land. For example, if the Atlas site were developed into a large motel-restaurant-retail complex, there would be additional tax revenues based on the extent and quality of the new structures as well as taxes collected based on tourism and other sales taxes. The addition of utility services (via the City of Moab extending them across the Colorado River) to the Atlas site under either reclamation scenario could spawn secondary development in the Moab Wash area and elsewhere if private land were to became available for development. All calculations assume no unimproved property value increases over time. With property appreciating 15-20% over the past two years in the Moab area, projecting property values 12 or 13 years from now would be highly speculative, especially in an area with a long history of booms and busts.

Tailings Pile Failure. With Grand County dependent on tourism and recreation for the majority of its economic base (76% of sales tax revenues), a major tailings pile failure could result in substantial economic loss, particularly to downstream recreational attractions. Although the immediate effects of a maximum pile failure are forecast to last only several days, the perception of the region's safety and desirability for Colorado River-based recreational experience could be noticeably diminished, no matter what the actual safety factor might be. Because visitation to one major national park is typically accompanied by visits to the others nearby, the whole region's economic base could be adversely affected to some degree. Arches and Canyonlands National Parks have heavy foreign visitation in the summer. News of a major flood and subsequent uranium tailings pile failure could affect individual and group decisions to come to the region at all. The perception of the extent of the affected region could extend as far downstream as Lake Powell, even though dilution of any contaminants by that point would be extensive.

The Glen Canyon National Recreation Area receives 3.6 million visitors annually, with 1.6 million visitor-nights on the shore or water. Visitors generally are drawn from throughout the American Southwest, and would presumably know of any accident related to a flood of the magnitude discussed. Lake Powell supports sport fishing that would probably not be at all affected by an accident, but the public perception may be that it is not safe to eat the fish. To what extent this might be the public perception or how long the public might retain (and make decisions based on) such a perception is difficult to predict. With multiplier effects, visitors to Lake Powell currently generate $340 million for the local economy (J. Rittenouer, Glen Canyon National Recreation Area, Page, Arizona, personal communication with C. H. Petrich, ORNL, August 29, 1994).

There are few direct users of Colorado River water as a potable or irrigation water source between the tailings pile and Glen Canyon Dam. A small amount of irrigated cropland [40–61 ha (100–150 acres) of alfalfa hay and small grains] is present along the Colorado River in Grand County. Impacts of restrictions on water use would be expected to last only several days.

Lands and facilities that could be contaminated by small amounts of tailings sediments deposited by the HF include the croplands along the river, a few orchards in Moab, a fishery in Moab that stocks trout, the local sewage treatment center, a school, a hospital, and several campgrounds.

After the hypothetical tailings pile failure, the responsible agency would survey affected properties and conduct any remediation necessary before the properties could be returned to their normal use. The tailings pile would also be repaired. Repair work would involve considerable heavy equipment operations similar to those in the original reclamation, i.e., grading of tailings and hauling and placement of borrow material. Impacts associated with hauling riprap and clay would likely be similar to those envisioned for the original reclamation. There would be gains to the local economy from the additional construction activity, but these could possibly be more than offset by the potential loss of recreation and tourism revenues.

4.7.2.5 Conclusion

Although the Atlas proposal and Plateau site alternative would cause some economic costs and benefits in the Moab area, the net impact to the overall local economy would not be expected to be significantly adverse. The hypothetical tailings pile failure should also not significantly affect the local economy over the long term. Therefore, no requirement for the licensee appears necessary (other than the borrow transport requirement in Section 4.7.1.3).

4.7.3 Recreation

4.7.3.1 Reclamation Impacts

Both alternatives would involve dust, noise, and the clutter of construction equipment and activities, all potentially interfering with recreational pursuits. Under the Atlas proposal, reclamation activities would be of shorter duration, but would be more visible to greater numbers of recreationists. Rafters on the Colorado River would be exposed to the noise, activity, and machinery. Bicyclists and other travelers on U.S. 191 and State Highways 128 and 279 would see the activity at close range, particularly on State Highway 279. State Highways 279 and 128 are designated scenic highways by the state of Utah. The reclamation activity would be highly visible from the Arches National Park entrance road and its numerous scenic overlooks, thus attracting attention to the tailings pile.

Reclamation at the Plateau site would involve a longer construction duration, but at a site more remote from most recreational activities. Noise from the reclamation activities would probably be inaudible to any major recreational group. Occasional mountain bikers pass by the site.

4.7.3.2 Borrow Operations

Impacts on recreationists would occur at the borrow areas, including the Plateau site, two quarries in the Castle Valley area, and an area in Spanish Valley southeast of Moab. The Atlas proposal would require considerably more riprap than would the Plateau site, but the quantity of material mined and loaded on trucks would not be directly proportional to noise, odor, or other recreational impacts potentially created by such mining and loading at the borrow site. Less recreational impact would occur at the Plateau site, which would provide clay for both alternatives.

Riprap transport would occur down State Highway 128 at Castle Valley and on U.S. 191 through Moab. Transport of riprap from the area near Castle Valley would entail substantial aesthetic impacts and impacts on recreational activities, particularly hiking, camping, and biking, near Castle Valley and along State Highway 128. Mountain bikers use State Highway 128 extensively, and the sounds, smells, and appearance of heavy trucking would seriously disrupt the recreational experience of riding along this route. Truck transport of riprap through Moab could conflict with the image of recreation, tourism, and scenic beauty that the region wishes to convey. The Atlas proposal to truck in winter to avoid recreational users and other tourists would be feasible as long as lack of snow kept the roads passable.

Trucks transporting clay to the Atlas site would use U.S. 191, with some adverse impacts in terms of sound, smell, and aesthetic effects on tourism and recreational use. Because heavy trucking already occurs here, conflicts of the Atlas proposal with other users would be relatively low.

Under the Plateau site alternative, transport of rock on U.S. 191 between Moab and the Plateau site would be much less than under the Atlas proposal and should cause few recreational impacts beyond what normally occur from frequent heavy truck traffic on this road. Although tourists use this road, adverse recreational impacts would be slight. There would be no off-site recreational impacts from clay transport because the clay would be acquired on or near the site.

4.7.3.3 Tailings Transport

Construction at the Plateau site. About 5 km (3 miles) of rail spur would be constructed from the north-south spur west to the Plateau site. Some of the construction activity would be visible to bikers who occasionally use the nearby access roads. There would be noise, dust, and equipment clutter associated with construction activities including rail access, improved roads, excavation of overburden for receipt of the tailings, and the conveyor.

Conveyor Construction. The main aesthetic impacts of the loading operations would be from the conveyor system. This system would be elevated over State Highway 279, a scenic highway. At this point along the highway, though, the pile itself is immediately east of the road, limiting foreground aesthetic quality. During the projected 6.7–9.4 years of the loading operation for moving the pile, the activity of the operations in the foreground would be distracting to drivers and bikers trying to appreciate the quiet and foreground views of the Colorado River, Moab Canyon, and the La Sal Mountains. Dust and noise from the operations would also be a negative recreational intrusion.

Transport Activities. Transport of the mill tailings by rail should cause few negative recreational impacts because rail transport of ore and other bulk materials is common along this railroad (the original spur was built to service a large potash mine and mill), few trips would be made daily, it is a short run of approximately 30 km (18 miles), and only a few side roads would be crossed, causing only slight inconvenience to those waiting to cross the tracks. The train, at the estimated 12 cars per train, would cause only a short wait. If the gondola cars are covered with tarpaulins, there should be no blowing tailings dust from the transport operations. Truck transport of old mill structures and equipment on U.S. 191 would require relatively few trips and temporarily distract from the visual quality of the general area.

4.7.3.4 Accidents

Accidents involving borrow-transport trucks and other vehicles could occur on State Highway 128, having aesthetic impact on the high scenic quality of this area along the Colorado River. An accident involving riprap- or clay-carrying trucks or trains along U.S. 191 should cause little aesthetic impact. An accident near the entry to Arches National Park on U.S. 191 could be disruptive and create negative impressions with park visitors.

4.7.3.5 Post-Reclamation Impacts

A reclaimed tailings pile would have some aesthetic impact on recreationists at both the Atlas and Plateau sites, although the impact would be greater at the Atlas site because of the greater number of tourists and recreationists in this area. The tailings pile failure at the Atlas site could result in a temporary restriction of recreation on the Colorado River downstream from the site and aesthetic impacts resulting from the required repair of the pile. Other impacts of pile failure on recreation are discussed in Section 4.7.2.2.

4.7.3.6 Conclusion

The Atlas proposal would be expected to reduce overall recreation in the area by a minor amount that would not have a noticeable effect on park visitation or business in Moab or Grand County. Temporary local effects on the number of recreationists could be more noticeable, such as along State Highway 128 during riprap transport. The hypothetical tailings pile failure should also not significantly reduce recreation in the area over the long term. To minimize impacts on recreation, Atlas would be required to submit to NRC, for approval, a plan to minimize fugitive dust during reclamation activities at the Atlas site (Section 4.1.3).

4.7.4 Aesthetics

4.7.4.1 Reclamation Impacts

Both the Atlas proposal and the Plateau site alternative would involve dust, noise, and the clutter of construction equipment and activities at both the Atlas site and Plateau site. Under the Atlas proposal, reclamation activities at the Atlas site would be of shorter duration, because tailings removal under the Plateau site alternative would require several more years. Rafters on the Colorado River would be exposed briefly to the noise, activity, and machinery as they pass by the site. Travelers on U.S. 191 and State Highways 128 and 279 would see the activity at close range, particularly on State Highway 279. State Highways 279 and 128 are designated scenic highways by the State of Utah. The reclamation activity would be highly visible from the Arches National Park entrance road and some of its numerous scenic overlooks, thus attracting attention to the tailings pile itself.

Reclamation operations at the Plateau site would be remote from most viewing populations. Noise from the activities would also be inaudible to any major population group. Visitors include occasional mountain bikers that pass by the site and an occasional ranch hand overseeing cattle grazing in the area.

Operation of heavy machinery and possibly explosives at the Round Mountain borrow area would conflict directly with the sense of quiet, solitude, desert grandeur, and remoteness enjoyed by residents of Castle Valley. "Quarrying" activities would create vivid contrasts in color and line with the undisturbed Round Mountain landscape. Because many of the homes in the Castle Valley community are oriented in such a manner as to have views of the La Sal Mountains, any activities at Round Mountain would be most visible. Residents of the Castle Valley area have expressed their objection to the aesthetic intrusion of the proposed operations (Donnavan 1995). The views toward the La Sal Mountains from the Castle Valley-La Sal Mountain Loop Road would also include quarrying operations on Round Mountain.

"Quarrying" operations in Spanish Valley would be easily seen from U.S. 191, but they would be isolated from most residences. With the generally level topography, views would not be particularly intrusive. Because current sand and gravel operations are taking place in the area, the proposed collection of cobble material would constitute an additional increment of disturbance to that which is already occurring.

Other issues related to aesthetic impacts during reclamation are essentially the same as those discussed under recreation (Section 4.7.3.1) and are not repeated here.

4.7.4.2 Post-Reclamation Impacts

Normal Conditions. The riprap used to cover and stabilize the pile at the Atlas or Plateau site may contrast in color, size, and texture with the surroundings. The reclaimed pile at the Atlas site would have approximately the same general physical configuration as the current pile. The chief aesthetic impact would be in terms of color and texture. The fine-grain sandstones that currently contribute dominantly to the pile's outward appearance would be replaced by riprap. Depending on the source of the riprap, the color could be starkly different. Rock available from the La Sal Mountain or Castle Valley area may be dark gray in color (N. Poe, Superintendent, Arches National Park, Moab, personal communication with C. H. Petrich, ORNL, July 11, 1994). Aesthetic impacts of a different kind could occur as a result of any development of portions of the site not occupied by the tailings pile.

A reclaimed pile at the Plateau site, as described by the licensee, would probably be less than 6.1 m (20 ft) high above ground level and should not be easily visible from U.S. 191. To some extent, the pile would blend in with the hills to the north and west of the site. These hills rise to elevations greater than 27 m (90 ft) above the elevation of the site. If the pile were designed to be completely below grade, visual impacts would be minimal once reclamation was completed. If the pile were to be designed to be below grade, these impacts would be even less. Under this alternative, the Atlas site would eventually be released for unrestricted use. Aesthetic impacts associated with development of these areas cannot be evaluated at this time because the types of development are not known.

The exact location of the proposed borrow area on Round Mountain has not been determined. For purposes of this DEIS, it is assumed that the site would be the talus slopes on the northwest face. Because this slope faces toward the homes of Castle Valley (and their viewing direction) toward the La Sal Mountains and the Castle Valley-La Sal Mountain Loop Road, scars from the quarrying operations and any necessary haul roads would be readily visible. With the limited rainfall, vegetative reclamation would likely take tens of years to be solidly reestablished. Rock and earth exposed from operations would also take years to weather to colors not in stark contrast with the existing Round Mountain and surroundings. Because of the extensive visibility in the dry air, views of the reclaimed area would be easily visible from long distances.

Reclamation of the Spanish Valley borrow areas would likely also be limited by low rainfall. Revegetation would take tens of years. Contrasts in color with the surroundings would not be particularly visible to people viewing from U.S. 191 due to the flat topography. The long-term contrast in colors and weathering would, however, be readily visible from higher-elevation locations such as the Castle Valley-La Sal Mountain Loop Road and from the slight ridge forming part of the eastern side of Spanish Valley. Again, existing sand and gravel operations in this area would likely provide decreased viewer sensitivity to the proposed activity.

Tailings Pile Failure. Impacts of the hypothetical tailings pile failure on aesthetic resources would result primarily from the operations required to repair the pile, as discussed in Section 4.7.3.2. Other aesthetic impacts would involve the likely contrasting appearance of the repaired portions of the pile and the weathered portion from the original reclamation. The contrast could attract the attention of those unfamiliar with the accident and the repair necessity. Weathering would tend to unify the appearance of the pile.

4.7.4.3 Conclusion

The Atlas proposal would result in continuation of aesthetic impact associated with the existing tailings pile; some aesthetic impact could also result from development of parts of the site not occupied by the reclaimed pile. The Plateau site alternative would allow more commercial and/or recreational development of the Atlas site, which could result in aesthetic impacts of a different nature than those resulting from a tailings pile. The significance of the aesthetic impacts under the Atlas proposal would primarily be a function of any impacts on recreation and tourism, which would not be expected to be limited appreciably due to continued aesthetic impact of the pile. No mitigative action has been identified that could appreciably reduce the aesthetic impact of the Atlas proposal.

The riprap borrow operations proposed for Round Mountain would likely have substantial negative aesthetic impact on residents of Castle Valley and on visitors to the area. Post reclamation, the borrow activities would create scars that would likely take tens of years to weather and revegetate sufficiently to not bear strong indications of the operations.

Mitigation options for the Round Mountain aesthetic impacts are limited by the local low rainfall. Reasonable relief for local residents of Castle Valley should involve compensation of some sort. The licensee should cooperate with the landowner (State of Utah) to meet regulatory requirements for reclamation. The licensee should also consult and cooperate with local residents of Castle Valley and with the State and the NRC to determine measures that might provide reasonable compensation in a timely way for the impacts of both the quarrying operations and their inherent reclamation limitations. Because the impacts will be both immediate and long-lived, compensation alternatives for property owners should also provide comparable dimensions of immediacy and longevity.

Mitigation in Spanish Valley should involve adequate reclamation if implemented according to State regulations. In both Round Mountain and Spanish Valley, revegetative species choice and actions should follow the advice of local range management specialists. Land should be released as having achieved successful revegetation only after approval of such experts, i.e., likely entailing a multiyear reestablishment period.

4.7.5 Public Services and Infrastructure

4.7.5.1 Reclamation Impacts

Neither the Atlas proposal nor the Plateau site alternative should create any serious impacts to the area's public services or infrastructure. Utility lines may have to be moved at the Atlas site, but these would cause few public impacts, service interruptions, or other inconveniences. Appreciable additional enrollment in the Grand County School System should not result from the external workers' families because of the summer reclamation work scheduling. Impacts of additional workers and their families to fire, emergency medical, health delivery, police, water, and sewer systems should be readily accommodated (and masked) as part of the seasonal fluctuation that the area normally experiences.

4.7.5.2 Borrow Operations

The largest infrastructure impacts of the Atlas proposal would likely result from riprap transport through Castle Valley and through Moab. The Utah Department of Transportation is concerned about the load-bearing capacity of existing road surfaces and about the safety of other road users, particularly along the river road, State Highway 128 (D. Stapley, Utah Department of Transportation, Price, Utah, personal communication with C. H. Petrich, ORNL, July 15, 1994; K. Adair, Utah Department of Transportation, Richfield, Utah, personal communication with C. H. Petrich, ORNL, July 15, 1994). The larger quantities of riprap required at the Atlas site would mean greater safety and infrastructure impacts in this respect if this were the preferred alternative. The requisite number of haul trips would greatly expand if smaller trucks were required, increasing costs and the probability of accidents. Resurfacing the public roads before and after the hauling, an option suggested by the UDOT (D. Stapley, Utah Department of Transportation, Price, Utah, personal communication with C. H. Petrich, ORNL, July 15, 1994), would most likely be prohibitively expensive (upwards of $50 million).

4.7.5.3 Tailings Transport

Transport of tailings by rail and of mill debris by truck on U.S. 191 has virtually no potential to impact public services and infrastructure. Rail transport could involve delays at road crossings, but these should be brief.

4.7.5.4 Accidents

Borrow transport accidents would have little potential to affect overall public services and infrastructure. Accidents, any one of which could cause a brief local impact, should not occur frequently enough to have a large cumulative impact. The chances for an accident during borrow transport will depend on the transport route used, the size of the trucks used for hauling, the time-of-year and time-of-day used for transport, and the number of haul trips daily and in total.

4.7.5.5 Post-Reclamation Impacts

No appreciable impact on public services or infrastructure would occur after project completion, no matter which site is used. With a lack of impact on water quality (Section 4.5.2), the hypothetical tailings pile failure should not have an appreciable long-term impact on public services involving water use. While the HF could cause extensive disruption to Moab's services (e.g., damage to roads, bridges, sewerage systems), the addition of tailings pile sediment could complicate the repair and clean-up activities. Depending on results of surveys of contamination, cleanup of contamination may be necessary before facilities could be repaired. Presumably, the Federal government would be liable for any tailings-related cleanup costs and associated delays.

4.7.5.6 Monitoring and Information Adequacy

The size of the riprap-transport trucks that would eventually be allowed by the state of Utah Department of Transportation is unknown. Any requirement to use smaller trucks could increase the number of truck trips and the length of time required to complete borrow transport.

4.7.5.7 Conclusion

Borrow transport through Castle Valley and the town of Moab would cause a minor impact on public services and infrastructure. Section 4.7.1.3 provides a requirement for minimizing the impacts of borrow transport. The hypothetical tailings pile failure could cause a short-term impact related to contamination of public service facilities.

4.7.6 Historic and Cultural Resources

Neither alternative would impact any historic or cultural resource. As mentioned in the scoping comments, the Plateau site alternative would remove one of the last highly-visible vestiges of Moab's uranium boom days. The uranium mill, while not 50 years old, might have been eligible for consideration as a historic site, but is being dismantled (J. Dykmann, Utah State Historical

Society, Salt Lake City, personal communication with C. H. Petrich, ORNL, August 30, 1994). As described in Section 3.7.6, the Moab mill and the mine that supplied it were globally important in the 1950s because the Steen discovery—and the successful prospecting that it catalyzed—meant that the country would not have to rely on foreign sources of material for producing weapons-grade enriched uranium.

Under either alternative, Grand County officials may wish to consider erecting an historic marker near the site of the old mill explaining its importance relative to the Cold War, nuclear power development, and other subjects.

The Utah State Historic Preservation Office was contacted for information regarding the potential for historical or cultural resources to be affected by disposition of the uranium tailings at the Plateau site. The Office indicated that no known historic or cultural site is known to be located at the Plateau site and recommended that a survey be conducted (Dykmann 1994; J. Dykmann, Utah State Historical Society, Salt Lake City, personal communication with C. H. Petrich, ORNL, August 30, 1994). During reclamation, normal precautions would be taken to protect cultural resources or human remains that might be unearthed at the Plateau site.

4.7.7 Environmental Justice

4.7.7.1 Background and Method

Executive Order 12898, *Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations*, was issued February 11, 1994 (59 FR 7629]. The Order requires Federal agencies to conduct their activities so as to ensure that they "do not have the effect of excluding persons from participation in, denying persons the benefits of, or subjecting persons to discrimination ... because of their race, color, or national origin." The Order directs each Federal agency to identify and address "disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations and low income populations."

In accordance with the Executive Order, and because the Council on Environmental Quality has not yet developed guidance for considering environmental justice in NEPA documents, the NRC Office of Nuclear Materials Safety and Safeguards (NMSS) developed interim guidance for addressing environmental justice in NRC environmental assessments and impact statements. The guidelines suggest using a 6.4-km (4-mile) radius in rural areas as the potentially affected zone, with other radii or configurations to be used where the potential impacts justify such. The guidance defines minority as those who report themselves to the U.S. Census Bureau as either Black; Asian or Pacific Islander; American Indian, Eskimo, or Aleut; Hispanic; or other non-white. Low-income is defined as being below Federal Poverty Guidelines, as adjusted according to family size. These guidelines were then applied by U.S. Bureau of the Census to determine the number of persons in poverty in the 1990 census.

The NMSS guidance establishes a threshold below which a potential for environmental justice concern is ruled out and above which a potential for environmental justice concern exists. This threshold is based on a comparison of the percentage of minorities and low-income households in the study area to those in the state or county where the project is located. Because the study area used for this project comprises almost all of the Grand County population (6,151 people out of a total of 6,620), the state of Utah is used for comparison. (The adjacent San Juan County, which contains a portion of the cobble borrow site, is not used for comparison because it is not at all racially comparable to the state or to Grand County because the Navajo Indian Reservation is present along its southern boundary.) The threshold established in the guidance is a 20-percentage point difference between the study area and the state. That is, if the study area's percentage of population in poverty or percentage minority is 20 percentage points higher than the state's percentage in poverty or percentage minority, respectively, then there exists a potential for environmental justice concern.

The assessment included both adverse impacts forecast from potential on-site activities and those from associated transportation of materials. The notion of adverse effect used in this section entails only noise, congestion, dust, and aesthetic considerations. Potential health risks are discussed in Section 4.8, and the potential for traffic accidents is discussed in Section 4.7.1.1.

The 1990 Federal census data were used as the basis of this analysis to identify minority and low-income populations in the zone of potential impact surrounding the existing Atlas tailings site, the plateau site, and the Round Mountain and Spanish Valley riprap and cobble borrow sites. The approach screens for the potential for environmental justice concern by determining the presence of minority and low-income populations. If the threshold is met, additional analysis must be conducted.

The study area includes 6.4-km (4-mile) radii around the plateau, Atlas, and Round Mountain sites (all considered rural) and a 4-km- (2.5-mile-) wide ellipse that encompasses the transportation corridor from the Spanish Valley cobble source site through downtown Moab and nearly to the Atlas site (Figure 4.7-1). The latter study area was configured as a 4-km-wide ellipse to reflect the sparse population in the southern end of Spanish Valley and to capture most of the households along the potential cobble haul route along the U.S. 191 corridor not captured in the radius around the Atlas site itself. The U.S. 191 corridor from the Atlas site to the Plateau site and the State Highway 128 corridor from the Castle Valley-La Sal Mountain Loop Road to the junction with U.S. 191 were not assessed because of the absence of residences along these routes. The only residences are those of National Park Service employees (who are mostly seasonal workers) at the headquarters of the Arches National Park; these people are considered in the study area around the Atlas site.

The race and ethnicity data analyzed here are drawn from the U.S. Bureau of the Census *1990 Census of Population and Housing, Summary*, Tape File 1A. The data are aggregated at the census "block" level, the smallest unit reported by the Census Bureau. Using this level of detail helps to identify small minority neighborhoods that would not be identifiable at the census block group or tract levels. The percentage minority is determined by totaling the percentages black,

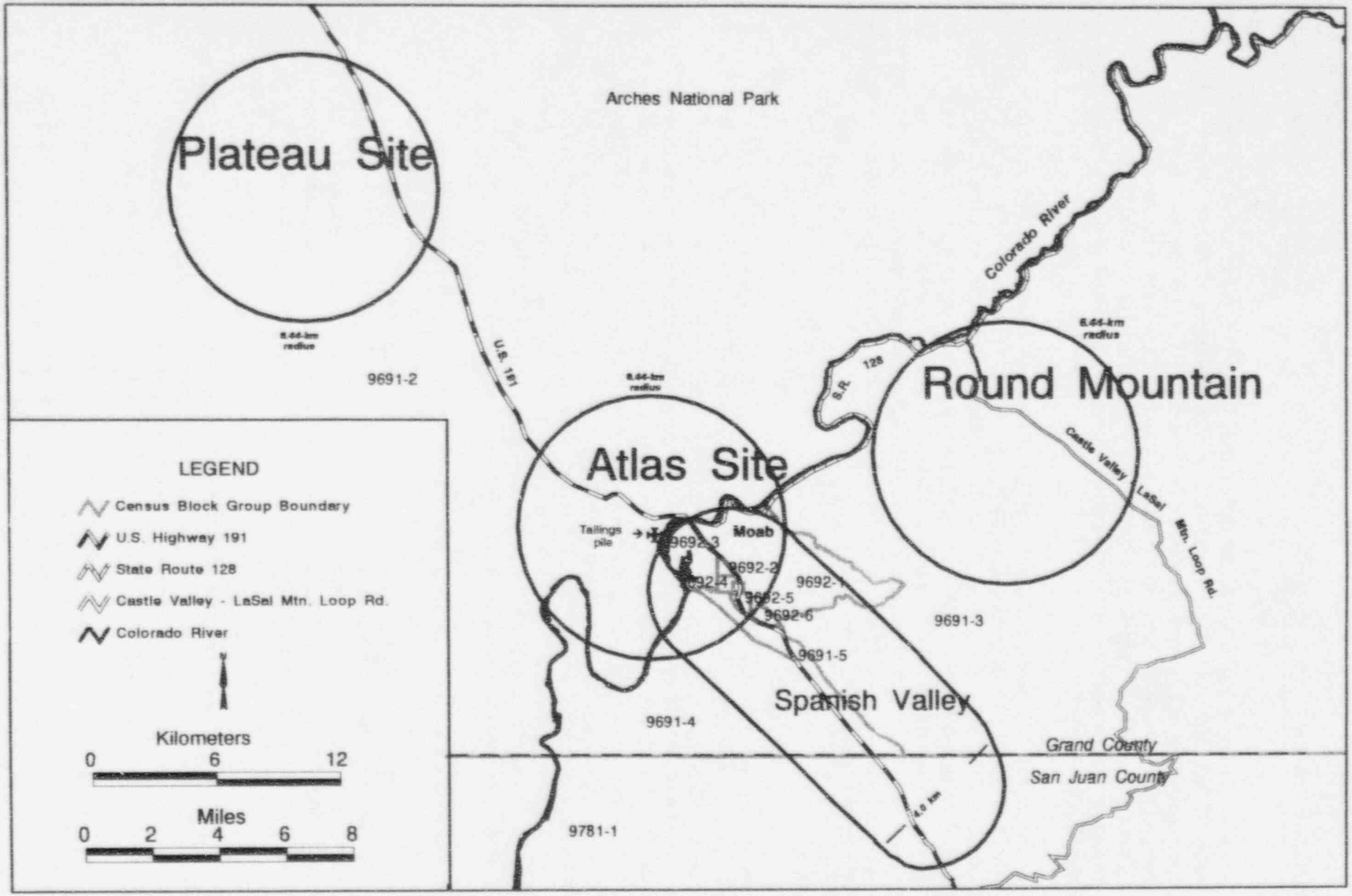

Figure 4.7-1. Study Areas Used in Assessing Environmental Justice Concerns. Census block groups are identified by number and location.

American Indian, Asian, other, *and* Hispanic. When reporting to the U.S. Bureau of the Census, persons self-identify their race and report themselves as being or not being of Hispanic origin. This distinction allows persons to identify themselves as being members of two groups identified here as minorities. To avoid double counting the minority populations, persons who identified themselves as both black or American Indian or Asian *and* Hispanic are not included in the Hispanic category in this analysis. Persons who identified themselves as "other" *and* Hispanic are counted in the Hispanic category.

The poverty data are drawn from the U.S. Bureau of the Census *1990 Census of Population and Housing*, Summary Tape File 3A. This analysis employs poverty data of the finest resolution provided by the U.S. Census: the block group. Persons in poverty, rather than households in poverty, are reported here because households may not give an accurate representation of the number of persons in poverty because household size may be disproportionately larger (or smaller) at different ends of the income spectrum. Self-reported housing information (value ofhouse or of monthly contract rent) from the 1990 census were also used to provide rough indicators of relative income at the block level.

4.7.7.2 Analysis

Detailed tabular data on race and ethnicity of the populations within the various study areas delineated in the text and in Figure 4.7-1 are provided in Appendix G. These data serve as the screen for environmental justice concerns regarding minority populations. The census blocks having minority populations at levels greater than 20 percentage points above the state level are listed in Table 4.7-3 and identified in Figure 4.7-2. As can be seen from the figure, the only blocks that have potential environmental justice concern are distributed throughout the city of Moab and south of Moab. There are no concentrations of environmental justice-concern minority neighborhoods along the proposed cobble haul route, but block numbers 9691-411, 9691-519B, 9692-518, 9692-509, and 9692-503 are directly on the U.S. 191 proposed haul route. Other, non-environmental justice-concern neighborhoods and predominantly white neighborhoods—including concentrations of these—are also on the same proposed haul route.

The identified blocks do not aggregate to concentrated communities subject to environmental justice concern. They are distinct minority neighborhoods interspersed with blocks characterized by majority populations equally subject to any forecast project impacts. While non-white ethnic populations do not appear to be differentially adversely affected by the proposed action, at this level of analysis, one cannot determine if particular groups or individuals might experience greater or lesser impacts from proposed project activities than might majority groups in the same areas nor if these minority populations might be less capable of coping with adverse aspects of such activities.

The analysis also examined the potential project effects on low-income populations. Grand County had slightly higher rates of poverty in 1989-90 (14.6%) than did the state as a whole (11.4%). Table 4.7-4 reflects that this slightly higher poverty rate holds across the three study areas examined (no citizens live within the 6.44 km (4-mile) radius of the plateau site). None of

Table 4.7-3. Census Blocks and Block Groups of Potential Environmental Justice Concern. Shaded areas represent census blocks located directly on the proposed haul route. (*Source*: U.S. Bureau of Census 1991, *1990 Census of Population and Housing*, Summary Tape Files 1A and 3A, CD-ROM, Washington, D.C.)

Block Group Number	Block Number	Block Group Population	Block Population	Block Group Poverty Rate (%)	> 20 Percentage Points Above State Poverty[a] Rate?	Minority Population (%)	> 20 Percentage Points Above State Minority[b] Level?	> 20 Percentage Points Below State Mean Housing Value[c] Level?	> 20 Percentage Points Below State Mean Contract Rent[d] Level?
9691-3		1,173		15.94	no				
	-333		5			40	yes	no	N/A
9691-4		575		5.57	no				
	-411		**25**			**32**	**yes**	**yes**	**yes[e]**
9691-5		966			no				
	-519B		**4**			**75**	**yes**	**N/A**	**N/A**
	-524B		18			33.3	yes	yes[e]	no
9692-3		597		10.22	no				
	-305		2			50	yes	N/A	N/A
	-318		4			75	yes	N/A	no
9692-4		543		30.94	no				
	-407		4			75	yes	no	N/A
9692-5		966		18.12	no				
	-503		**56**			**37.5**	**yes**	**yes**	**yes[e]**
	-506		13			30.8	yes	yes[e]	N/A
	-509		**15**			**33.3**	**yes**	**N/A**	**no**
	-513		60			63.3	yes	yes	yes
	-518		**6**			**50**	**yes**	**yes**	**no**

[a] 11.4% for the state; 14.6% for Grand County

[b] 8.8% for the state; 7.7% for Grand County

[c] $80,000 (self-reported in the U.S. Census, not from local tax assessment rolls) for the state; $56,700 for Grand County

[d] $322/month (self-reported in the U.S. Census, not from local tax assessment rolls) for the state; $222 for Grand County

[e] response becomes a "no" when using > 20 percentage points below Grand County level as a comparison

N/A = not available

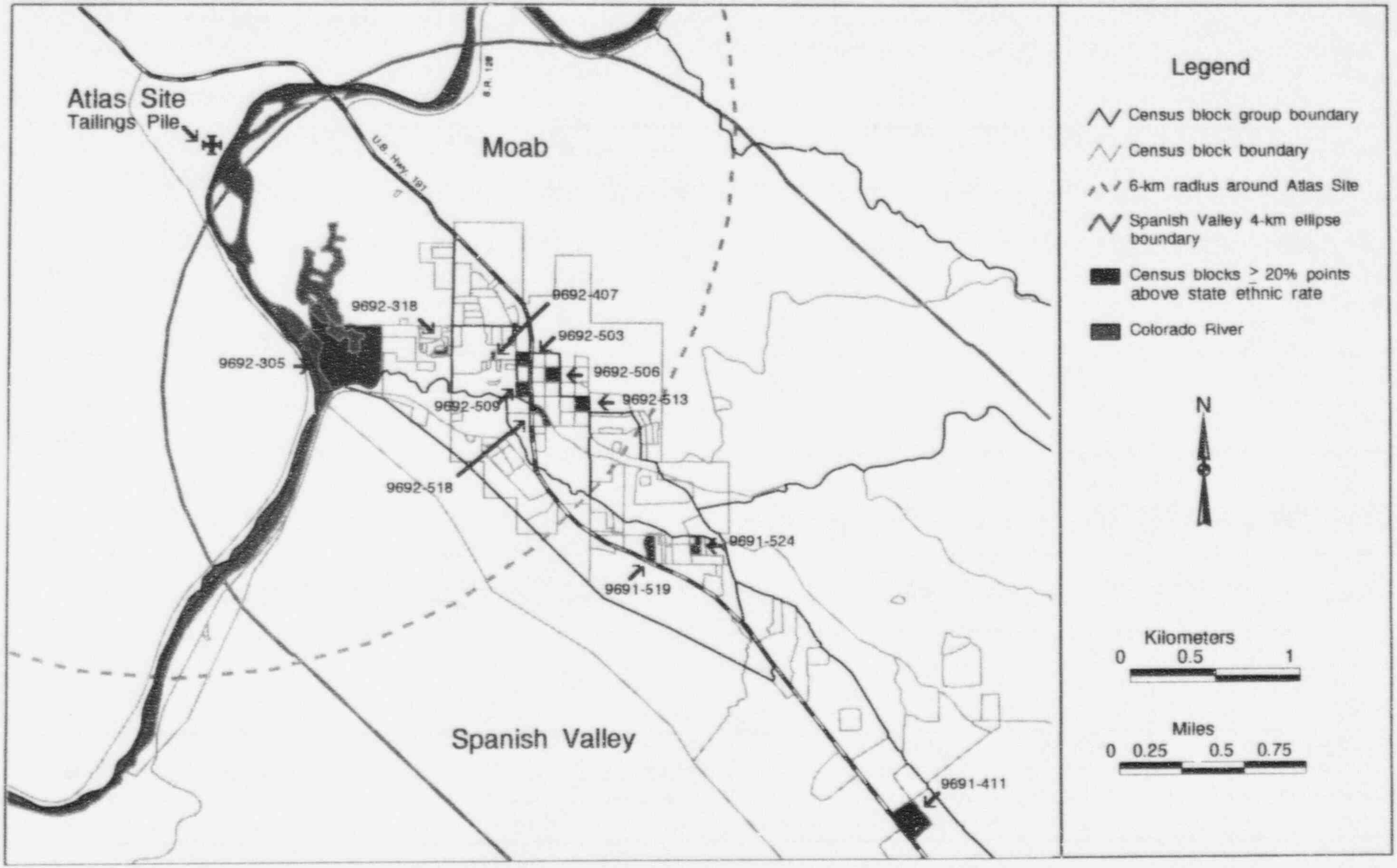

Figure 4.7-2. Census Block Groups and Blocks Identified by Number and Location in Moab and the immediate vicinity. Shaded areas represent those blocks whose minority populations exceed the state concentrations of minority populations by at least 20 percentage points, the threshold for environmental justice concern in this analysis.

Table 4.7-4. Persons in the Various Study Areas with Incomes Below the Poverty Level[a, b]

Block Group	Total	Persons Below Poverty Level	Percent of Population	Poverty Percentage > State Poverty Rate (11.4%)	20 Percentage Points > State Poverty Rate (31.4%)
		Atlas Tailings Site Poverty Level			
9691-4	575	32	5.57	no	no
9691-5	966	175	18.12	yes	no
9691-1	896	73	8.15	no	no
9691-2	560	38	6.79	no	no
9691-3	597	61	10.22	no	no
9692-4	543	168	30.94	yes	no
9692-5	482	112	23.24	yes	no
Whole area	4,619	659	14.27	yes	no
		Spanish Valley Poverty Level			
9691-4	575	32	5.57	no	no
9691-5	966	175	18.12	yes	no
9692-1	896	73	8.15	no	no
9692-2	560	38	6.79	no	no
9692-3	597	61	10.22	no	no
9692-4	543	168	30.94	yes	no
9692-5	482	112	23.24	yes	no
9692-6	455	71	15.60	yes	no
Whole area	5,074	730	14.39	yes	no
		Round Mountain Poverty Level			
9691-3	1,173	187	15.94	yes	no

[a] For comparison, Grand County's percentage of population at or below the poverty level is 14.6%.
[b] *Source*: U.S. Bureau of Census 1991, Summary Tape File 3A, CD-ROM, Washington, D.C.

the study areas as a whole or the block groups within the areas had poverty rates exceeding the environmental justice threshold of concern (>31.4%, i.e., >20 percentage points above the state poverty level of 11.4%).

This analysis–coupled with those of the impacts for each of the resources analyzed in this DEIS, and with the impacts of other past, present, and reasonably foreseeable future activities at the Atlas and Plateau sites, as well as at the cobble and riprap sites and along the proposed transportation routes–suggests that no adverse project-related impacts nor any reasonably foreseeable cumulative adverse impacts are expected to low-income populations. While low-income groups or individuals do not appear to be differentially adversely affected by the proposed action, at this level of analysis, one cannot determine if particular low-income groups or individuals might experience disproportionately greater or lesser adverse impacts from proposed project activities than might higher-income groups or individuals in the same areas nor if these people might be less capable of coping with adverse aspects of such activities.

The block group designations for poverty levels are too coarsely aggregated to assess whether any of the blocks identified in Table 4.7-3 are also low income neighborhoods. While no individual block group in any of the study areas exceeded the environmental justice threshold for poverty-level concern (31.4%), specific census blocks within them may have. To estimate whether any minority blocks of environmental justice concern might also be of low income concern, housing valuations and/or monthly rental contracts (all self reported) were used as proxies for income level. Table 4.7-3 displays those blocks for which the mean housing values or monthly rent are at least 20% less than the comparable mean values for the state (and, in the footnote, for the county). Using this decision criterion, only blocks 9691-411 (at the south end of Moab in the Spanish Valley) and 9692-503 (in downtown Moab) qualify as being neighborhoods which meet environmental justice concerns for minority populations and, possibly, for low-income populations. Both are directly on the haul route. Block 9692-518 (downtown Moab), also directly on the haul route, might also qualify, but the housing value and rental contract data are, together, possibly ambiguous in terms of meeting the 20% threshold.

These identified blocks, however, do not appear to constitute concentrated communities subject to environmental justice concern. They are dispersed neighborhoods, and have blocks and block groups characterized by higher incomes and majority populations interspersed among them and equally subject to the forecast project impacts.

Given an appreciation of the above caveats regarding the inability to pinpoint potential adverse impacts to individual households or individuals or to geographic-specific populations, this analysis otherwise identifies no disproportionate effects on specific racial or socioeconomic groups from any of the proposed project activities under consideration nor from the associated transportation activities.

4.8 RADIOLOGICAL IMPACTS

Radiological impacts of the Atlas proposal and the Plateau site alternative are discussed in Sections 4.8.1 and 4.8.2, respectively.

4.8.1 Impacts of the Atlas Proposal

The Atlas proposal (Section 2) would eliminate release of wind-blown dusts containing natural radionuclides above background concentrations and reduce emissions of radon gas. During reclamation operations, dust releases would be temporarily increased due to heavy vehicle traffic on and around the tailings pile. The Atlas proposal would also reduce seepage of tailings pile leachates to groundwater and leachate discharges to surface water. Impacts resulting from the Atlas proposal would be qualitatively similar to currently experienced impacts. Since the impacts associated with current conditions are dominated by radon and particulate releases rather than by releases to surface water or groundwater, this analysis focuses on releases to the air.

Potential impacts due to releases to air are dominated by particulate-associated radon daughters growing in from released radon gas. The particulates with which radon daughters are associated are predominately normal air particulates rather than particulates released from the pile. The particulates released from the pile contain other radioactive and nonradioactive materials. The potential impacts of tailings pile-associated nonradioactive materials are generally very low compared to normal air particulate-associated radon daughters growing in from released radon or the other tailings pile-associated radioactive materials (NAS 1986). Thus, the following analysis focuses on the radioactive material releases to air.

4.8.1.1 Methodology and Approach

This analysis evaluates the radiation dose to members of the public as well as occupational personnel. Dose to maximally exposed individuals (MEI) and to populations are considered. NRC regulations at 10 CFR Part 20.1301 specify that the radiation dose to individual members of the public, in unrestricted areas, may not exceed 1.0 mSv (100 mrem) per year. Radionuclide emission limits are provided in 10 CFR Part 40, which specifies that the radon release rate must be maintained below a site average value of 0.74 $Bq/m^2/s$ (20 $pCi/m^2/s$). Soil concentration limits in 10 CFR Part 40 require that radium-226 activities in any 100-m^2 area not exceed background level by more than 0.19 Bq/g (5 pCi/g) averaged over the top 15 cm (5.9 inches) of earth and 0.56 Bq/g (15 pCi/g) averaged over 15 cm-thick layers more than 15 cm below the surface.

The town of Moab is located 5 km (3 miles) southeast of the Atlas site. Three families of permanent residents live at the Arches National Park headquarters located 1.9 km (1.2 miles) northwest of the tailings pile. An additional 20 persons reside in this location during the summer. Another residence location is a trailer park located 2.6 km (1.6 miles) east-southeast of the tailings pile. The nearest residence to the tailings pile is at the former Tex's Tour Center, located 0.9 mile (1.4 km) east-northeast of the center of the tailings pile. Radiological impacts were calculated for (1) this residence, considered the nearest habitable site; (2) Arches National Park headquarters; and (3) the trailer park. The population dose was calculated for the town of Moab.

CAP88-PC (personal computer version; Parks 1991) was used to calculate doses from radionuclides associated with the tailings pile. CAP88-PC is composed of dose assessment methods developed under auspices of DOE, NRC and EPA; it has been certified for evaluating compliances with the National Emission Standards for Hazardous Air Pollutants (NESHAPS). CAP88-PC can be used to calculate doses and risks to the MEI and to populations due to inhalation, food chain, air immersion, and ground radiation.

Concentrations of radionuclides in air are calculated using the Gaussian plume model assuming an elevated release of 27 m (90 ft) (the height of the tailings pile). Depositions on soil and plant surfaces are determined by the methods described in Slade (1968). Estimates of radionuclide concentrations in produce, leafy vegetables, milk and meat consumed by humans are made by coupling the output of the Gaussian plume model with NRC Regulatory Guide 1.109 for terrestrial food chain models.

Atlas has recently sponsored a screening risk assessment for reclamation of uranium mill tailings at Moab (SENES 1995). The assessment was conducted by SENES Consultants Limited and used the CAP88-PC model. In applying this model, SENES used lower radioactive material release rates for current conditions and during reclamation for the proposed alternative than was done in the analysis for this DEIS. In the SENES study, credit was taken initially for the interim cover and for portions of the pile covered during reclamation. Release rates for the Plateau site alternative were similar to those used in this DEIS for dry, uncovered tailings piles. Therefore, the differences between the alternatives were larger in the SENES analysis than those given in this DEIS. Although the SENES analysis and the analysis presented here differ in details (i.e., the DEIS analysis is more conservative from a modeling perspective), the general conclusions are similar.

One of the most important limitations of CAP88-PC is that the effects of complex terrain on radionuclide concentrations cannot be modeled. Thus, uncertainties can be very high. However, no regulatory model is generally accepted for modeling concentrations in complex terrains. Modeling complex terrains as flat surfaces is thought to be conservative in most cases because complex terrains tend to increase dispersion. The area around the Atlas tailings pile represents complex terrain.

The complex terrain issue can be partially resolved for the Atlas site because actual measurements are available for the Atlas site and for similar tailings piles in the western United States. Although this assessment utilizes components of the CAP88-PC system for evaluating future compliance (the site would eventually become the responsibility of DOE or the state of Utah), the primary basis for this assessment is the monitoring data collected by the licensee along with modeling results.

4.8.1.2 Estimated Releases

A summary of the information and assumptions used to calculate releases is presented in Table 4.8-1. The information in the table is taken from Appendix C of the 1979 EIS for the Atlas Mill (NRC 1979). The mill operated using both alkaline-leach and acid-leach processing circuits. The acid-leach circuit resulted in the highest concentrations of radionuclides in the tailings and is used for this radiological assessment. Annual releases of radioactive materials from the tailings area are estimated for the current condition of the tailings pile, for reclamation operations, and for the tailings pile after completion of reclamation (Table 4.8-2). Estimates for radon releases in the 1979 EIS were doubled to include the total surface of the tailings pile after evaporation of the pond that was formerly on the pile. (Evaluations in recent ALARA reviews suggest that radon levels may be increasing slightly with time.) Particulate-release fractions under current conditions are assumed to be the same as those used in the 1979 EIS.

Releases of particulate tailings under current conditions should be precluded by the interim cover that Atlas has installed over the tailings. When the tailings pile would be graded in preparation for installation of the final cover system, a significant area of the tailings could be exposed. Dust releases caused by vehicular activity during reclamation operations are discussed in Section 4.1.1. The release of PM-10 dusts with no control is estimated, from information in Section 4.1.1, to be about 36.3 metric tons/yr (40 tons/yr) for exposed dry tailings. Dust control measures would be expected to reduce releases to about 18.1 metric tons/yr (20 tons/yr) or less during vehicular activities including scraping and dumping. The 20-ton/yr estimate is used in the analyses below for reclamation operations and represents a conservative, upper-bound value because of the large acreage (10 ha or 25 acres) of tailings assumed to be exposed and other assumptions provided in Section 4.1.1. The estimated releases of particulate-associated radioisotopes during reclamation operations (Table 4.8-2) assume that the disturbed materials contain about 26 Bq/g (700 pCi/g) of Ra-226 and 1.0 Bq/g (27 pCi/g) of U-238 as estimated from Table 4.8-1.

Reductions in emissions expected after completion of reclamation are described in Section 10 of the 1979 NRC EIS (NRC 1979). If the radon release rate were reduced only to the NRC limit [0.74 $Bq/m^2/s$ (20 $pCi/m^2/s$)] as required in 10 CFR Part 40, then the radon release rate after completion of reclamation is estimated to be about 1.1×10^{13} Bq/yr (300 Ci/yr). Releases of particulate tailings after reclamation would be precluded by the cover system. Radon releases greatly dominate particulate releases under current conditions and would also do so during the reclamation period.

4.8.1.3 Exposure Pathways, Doses and Risks

CAP88-PC may be used to estimate radionuclide doses and risks for the pathways of ingestion and inhalation intake, ground-level air immersion and ground surface irradiation. Releases from uniform area sources and point sources can be accommodated. The tailings pile is considered to be an area source for locations within several km. CAP88-PC contains options to evaluate dose and risk to the MEI and the collective population. CAP88-PC calculates the dose to the gonads, breast, red marrow, lungs, thyroid and endosteum in addition to the 50-year effective dose

Table 4.8-1. Principle Parameters and Conditions Used in the Radiological Assessment of the Atlas Mill Tailings Site[a]

Parameter	Processing circuit	
	Alkaline-leach	Acid leach
Ore quality, U_3O_8 (uranium oxide)	0.2%	0.25%
Ore activity, Ra-226 [Bq/g (pCi/g)]	21 (560)	26 (700)
Ore activity, Th-230 [Bq/g (pCi/g)]	21 (560)	26 (700)
Ore process rate [metric tons/yr (tons/yr)]	1.9 E+05 (2.1 E+05)	2.0 E+05 (2.2 E+05)
Fraction of U to tailings		0.06
Fraction of Th to tailings		0.95
Fraction of Ra to tailings		0.998
Total tailings area (m^2) (ft^2)		4.7 E+05 (50.6 E+05 ft^2)
Tailings density (g/cm^3)		1.6
Radon release rate from tailings [$Bq/m^2/s$ ($pCi/m^2/s$)]		24 (650)
Fraction of slimes in tailings		0.3
Concentration of Ra-226 in slimes [Bq/g (pCi/g)]		47 (1275)

[a]Abbreviations of elements: Pb = lead; Po = polonium; Ra= radium; Rn = radon; Th = thorium; U = uranium.
Source: Based on the 1979 Final Environmental Statement for the Atlas Uranium Mill (NRC 1979).

Table 4.8-2. Annual Emission Estimates for the Atlas Mill Tailings Pile

	Annual emissions (Curies; 1 Curie = 3.7 E + 10 Bq)		
Nuclide	Current	During reclamation	After reclamation
Rn-222	1 E+04	1 E+04	300[a]
U-238	4 E-04	1.1 E-03[b]	9.5 E-06[c]
U-234[d]	4 E-04	1.1 E-03[b]	9.5 E-06[c]
Th-230[e]	8 E-03	2.3 E-02[b]	1.2 E-05[c]
Ra-226[e]	8 E-03	2.3 E-02[b]	1.2 E-05[c]
Po-210[e]	8 E-03	2.3 E-02[b]	1.2 E-05[c]
Pb-210[e]	8 E-03	2.3 E-02[b]	1.2 E-05[c]

[a]Atlas would be required to limit radon emissions on the site to 0.74 $Bq/m^2/s$ (20 $pCi/m^2/s$).

[b]Upper-bound estimates of wind-blown particulate emissions and particulate emissions initiated by machines.

[c]Background soil with concentrations of about 0.04 Bq/g (1 pCi/g) of each of the particulate-associated radionuclides is assumed to constitute the top layer of the pile cover.

[d]U-234 is assumed to be in equilibrium with U-238.

[e]Th-230, Ra-226, Pb-210 and Po-210 are assumed to be in equilibrium.

equivalent. Total cancer risk is related to effective dose equivalent, which is the sum of the risk-weighted organ doses. Therefore, effective dose equivalents are the focus of this analysis.

For the short-lived Rn-222 decay products, CAP88-PC develops concentrations in units of working levels (WL) rather than in other units of concentration or dose. One WL is any combination of short-lived radon daughters in one liter of air that produces 1.3×10^5 MeV of alpha particle energy in the complete decay through Po-214. Equilibrium fractions for the short-lived radon decay products as a function of downwind distance are incorporated into the CAP88-PC code. Estimated radon concentrations are converted to WL concentrations using the equilibrium fractions, and the WL concentrations are converted directly to risk estimates. Dose estimates are not given. However, in order to directly compare doses from the various radioisotopes through the various pathways to regulatory dose limits, this analysis uses radon-daughter dose estimates developed by NCRP (1987).

4.8.1.4 Impacts to the Maximally Exposed Individual

Particulates. The MEI for the Atlas site is located at a residence adjacent to the former Tex's Tour Center about 1.4 km (0.9 mile) northeast of the tailings pile. Estimates of external, inhalation, and ingestion doses from the CAP88-PC modeling are provided in Table 4.8-3, based on the upper-bound particulate release estimates in Table 4.8-2. Dose estimates based on actual measurements at the Atlas tailings pile and other tailings piles are discussed below following the modeling results.

Table 4.8-3. Estimated Impacts of Particulate Releases on the Maximally Exposed Individual Based on Computer Modeling with CAP88-PC

	Effective dose equivalents (mrems per year)[a]								
	Current conditions (Total = 3.49)			During reclamation (Total = 11.42)			After reclamation (Total = 4.49)		
Nuclide	Inhalation	Ingestion	External	Inhalation	Ingestion	External	Inhalation	Ingestion	External
U-238	0.053	5.1 E−04	5.10 E−03	0.14	1.4 E−03	0.014	1.26 E−03	1.4 E−03	0.014
U-234	0.053	6.94 E−04	6.94 E−03	0.14	1.9 E−03	0.019	1.26 E−03	1.9 E−03	0.019
Th-230	2.28	0.011	0.11	6.55	0.031	0.31	3.42 E−03	0.031	0.31
Ra-226	0.04	0.095	0.95	0.11	0.27	2.72	6.0 E−05	0.27	2.72
Pb-210	9.69 E−05	0.036	0.36	2.79 E−04	0.1	0.99	2.53 E−08	0.1	0.99

[a]Ingestion and external doses are based on 20 years of particulate deposition for current conditions. For the reclamation and post-reclamation periods, results for ingestion and external doses are based on the 20-year deposition plus deposition during reclamation (see text); 1 mrem/yr = .01 mSv/yr.

The modeled effective dose equivalents for ingestion and external ground radiation (Table 4.8-3) are upper-bound estimates because ground surface concentrations are assumed to result from (1) in the case of current conditions, 20 years of deposition at the maximum release rate; (2) in the case of the reclamation period, the addition of deposition during reclamation to the total 20-yr maximum deposition for current conditions (and also the conservative assumptions discussed in Section 4.8.1.2); and (3) in the case of the post-reclamation period, all previous, maximum cumulative deposition on ground surfaces. The licensee's measurements (Section 4.8.1.7) indicate that surface soil or vegetation levels have not significantly increased around the tailings pile, possibly because the dry parts of the pile are covered with uncontaminated soil. Because most of the pile has this interim cover, model dose estimates in this analysis, which assumes uncovered tailings, may be considered to represent worst case conditions for the current situation and for the reclamation period. Post-reclamation inhalation doses assume that the tailings pile cover reduces particulate emissions to background levels.

The time periods over which the CAP88-PC dose estimates apply are: (1) for current conditions—until reclamation begins; (2) for the reclamation period—until construction of the clay cover is completed; and (3) for the post-reclamation period—until the deposited radionuclides disperse by natural processes. Clearly, total effective dose equivalents due to particulates associated with the tailings pile are well below the NRC limit of 100 mrem/yr (1 mSv/yr).

CAP88-PC results can be compared with measurements obtained from environmental monitoring programs at the Atlas site and other sites. Measured and calculated mass concentrations of particulates near dry, uncovered tailing piles [about 100 m (330 ft) from the edge, over 300 meters (980 ft) from the center] have been reviewed by Sears et al. (1975). Representative concentrations vary around 15 $\mu g/m^3$ at wind speeds of about 1.6 km/hr (10 mph). Because concentrations vary as the third power of wind speed, infrequent wind speeds of 48 km/hr (30 mph) could temporarily increase downwind particulate concentrations by a factor of about 30.

Assuming a particulate concentration of 15 $\mu g/m^3$ from the Atlas tailings [based on Sears et al. (1975)], the Atlas tailings composition indicates that concentrations of radionuclides would be: U-238 and U-234—2.3×10^{-5} Bq/m^3 (6.3×10^{-4} pCi/m^3) each; and Th-230, Ra-226, Pb-210, and Po-210—3.7×10^{-4} Bq/m^3 (1×10^{-2} pCi/m^3) each. The Ra-226 estimate is in agreement with measurements of Ra-226 at other tailings piles, which are on the order of 3.7×10^{-4} Bq/m^3(10^{-2} pCi/m^3).

The licensee's environmental monitoring program (see below and Section 4.8.1.7) shows that concentrations are lower than the Sears-based estimates. The lower concentrations may result from the temporary cover that has been placed on the dry areas of the tailings pile, thus reducing particulate releases to values well below the Sears-based estimates for dry uncovered tailings. Thus, the Sears-based estimates represent upper-bound values for the Atlas tailings pile (Radon daughters, which dominate estimated doses as discussed below, are less affected by the current temporary cover.). The Atlas measurements also reflect particulates from other sources than the tailings pile, such as the mill site.

Based on the Sears-based estimates of radionuclide concentrations, doses are calculated using dose conversion coefficients for radionuclides given in Eckerman et al. (1988). Assuming continuous exposure to the Sears-based concentrations about 100 m (330 ft) from the pile, the resulting inhalation effective dose equivalents are: U-238 and U-234— 0.0069 mSv/yr (0.69 mrem/yr) each; Th-230—0.33 mSv/yr (33 mrem/yr); Ra-226—0.0073 mSv/yr (0.73 mrem/yr); Pb-210— 0.0222 mSv/yr (2.22 mrem/yr), and Po-210—0.0073 mSv/yr (0.73 mrem/yr). At the MEI location (1.4 km or 0.9 mile), estimated doses are about 10 times lower and in good agreement with the CAP88-PC estimates for current conditions given in Table 4.8-3.

Estimated external dose rates on and near uncovered tailing piles can be significant. Representative measurements vary around .01 mSv/hr (1 mrem/hr) at on-pile locations but fall off rapidly to 0.1–0.2 μSv/hr (10–20 μrem/hr) about 100 m (330 ft) from piles (Sears et al., 1975). At a few hundred meters from tailings piles, direct radiation from tailings becomes very small compared to background levels. This conclusion is confirmed by the Atlas monitoring program at the Atlas tailings pile, where the background external dose rate is about 0.045 μSv/hr (4.5 μrem/hr) or 0.40 mSv/yr (40 mrem/yr).

Radon. CAP88-PC estimates of radon WL concentrations by direction and distance from the Atlas tailings pile are given in Table 4.8-4 (based on CAP88-PC values for radon daughter equilibrium fractions). At the MEI location, 1.4 km (0.9 mile) northeast of the pile, the radon daughter concentration is estimated to be less than 0.004 WL. The corresponding radon concentration in pCi/L is about 1.2. This estimated outdoor concentration is based on the total radon release from the entire area of the tailings pile, including possibly wet areas. It is comparable to the national average background concentration of 0.06 Bq/L (1.5 pCi/L) in indoor air (Nazaroff and Nero 1988).

CAP88-PC concentration estimates can be evaluated by comparison with actual measurements. Radon measurements on the surface of tailings piles similar in size to the Atlas pile ranged from 1 to 1.1 Bq/L (30 pCi/L) and averaged less than 0.56 Bq/L (15 pCi/L) (Sears et al. 1975; NRC 1979). At distances of 400–800 m (0.25–0.5 mile) from the piles, radon concentrations averaged about 10 times lower or about 0.06 Bq/L (1.5 pCi/L). As described in Section 4.8.1.7, Atlas conducts an environmental monitoring program that began with mill operations. Radioisotopes associated with particulates and radon concentrations are measured by continuous air sampling around the perimeter of the mill, at Arches National Park headquarters, and at a station 3.2 km (2 miles) south of the mill. Semiannual reports are provided to NRC and an annual audit is conducted. The most recent audit was sent to the NRC in May 1994 (Edwards 1994).

The semiannual monitoring reports for 1989 through the first half of 1994 were reviewed to determine excess radon concentrations at the off-site locations. Using the station 3.2 km (2 miles) south of the mill as representing background, the excess radon concentration northeast of the mill was 0.05 Bq/L (1.4 pCi/L). This value reflects some radon contributions from areas closer to the monitoring station than the pile, such as the storage area and the mill salvage yard. The mill itself is currently being dismantled. Concentrations at the monitoring station near the park headquarters were near background. The MEI location (i.e., the former Tex's Tour Center residence) is about

400 m (1300 ft) farther from the mill than the measurement location. Therefore, concentrations at the MEI location are expected to be about 2 times lower or about 0.03 Bq/L (0.7 pCi/L). The dose to an individual at Arches National Park headquarters located 1.9 km (1.2 miles) northwest of the tailings pile would be about one half the dose at the MEI location according to CAP88-PC results, but actual measurements at park headquarters yield concentrations near background.

The total doses associated with the Atlas tailings pile under current conditions and during reclamation are dominated by the radon daughter doses, whether estimates are based on CAP88-PC or on actual measurements. The NCRP (1987) estimates that the effective dose equivalent from background radon daughters (i.e., from radon concentrations of 0.06 Bq/L (1.5 pCi/L) or about 0.007 WL indoors) is about 2 mSv/yr (200 mrem/yr). At the MEI location 1.4 km (0.9 mile) from the Atlas pile, the calculated concentration of about 0.004 WL is associated with a dose of about 1.14 mSv/yr (114 mrem/yr). For the 0.03-Bq/L (0.7-pCi/L) concentration based on measurements, the WL concentration is about 0.0024 and the estimated dose is about 0.67 mSv/yr (67 mrem/yr). Note that this estimate incorporates radon sources additional to the tailings pile.

The emission rate of radon from the tailings pile (assuming the tailings are dry and uncovered) is estimated to be about 24 Bq/m^2/s (650 pCi/m^2/s) (Table 4.8-2). In order to reduce the total effective dose equivalent for all radioisotopes at the MEI location by all routes to less than 1 mSv/yr (100 mrem/yr), the dose component due to radon daughters would have to be less than .95 mSv/yr (95 mrem/yr) after reclamation, because particulates contribute a maximum of 0.05 mSv/yr (5 mrem/yr). Thus, the radon emission rate would have to be less than 34 Bq/m^2/s (922 pCi/m^2/s)— 650 × (95/67)—based on measured dose, and less than 20 Bq/m^2/s (542 pCi/m^2/s) based on CAP88-PC doses. The NRC requirement of 0.74 Bq/m^2/s (20 pCi/m^2/s) from the covered pile would result in maximum doses at the MEI location that are well below the dose limit. The emission of radon daughters from the tailings pile after reclamation would result in an estimated maximum effective dose equivalent at the MEI location of about 0.034 mSv/yr (3.4 mrem/yr) based on CAP88-PC and about 0.02 mSV/yr (2 mrem/yr) extrapolated from actual measurements.

4.8.1.5 Impacts to the Surrounding Population

Estimated total population doses around uranium mill tailings piles are generally low. This is also the case for the Atlas pile. Low population doses are primarily due to low population densities around tailing sites. Radon and radon daughters, which dominate doses currently and would dominate doses during reclamation operations, have estimated concentrations of less than 3.3×10^{-5} WL at Moab (Table 4.8-4). Based on the discussion in Section 4.8.1.4, the average individual in Moab would receive a maximum dose attributable to the Atlas tailings pile of less than 0.013 mSv/yr (1.3 mrem/yr). Thus, the annual dose to the entire Moab population of about 4000 would be less than 0.052 person Sv (5.2 person rem) compared to a total natural background dose of about 18 person Sv (1800 person rem) annually.

During the post-reclamation period, the maximum dose attributable to the pile at the MEI location would be reduced from approximately 0.67 mSv/yr (67 mrem/yr) to less than 0.02 mSv/yr (2 mrem/yr). The maximum dose to an individual in Moab would be reduced to less than

Table 4.8-4. Radon Concentrations in Working Levels at Various Distances and Directions from the Atlas Mill Tailings Pile[a]

Distance (km)	N	NE	E	SE	S	SW	W	NW
0.25	0.1	0.05	0.05	0.015	0.016	0.003	0.04	0.06
0.5	0.01	0.01	0.01	0.005	0.005	0.0009	0.013	0.02
1.0	0.01	0.005	0.004	0.001	0.001	0.0003	0.003	0.006
2.0	0.001	0.002	0.001	0.0005	0.0007	0.0001	0.001	0.002
3.0	0.002	0.001	0.0008	0.0003	0.0003	6.0 E−05	0.0006	0.001
5.0	0.001	0.0004	0.0004	0.0002	0.0002	3.3 E−05	0.0004	0.0006
10.0	0.0006	0.0003	0.0002	7.8 E−05	0.0001	1.6 E−05	0.0002	0.0003

[a]Estimated by computer modeling.

0.2 μSv/yr (0.02 mrem/yr), and the total annual dose to the Moab population attributable to the pile would be less than 8×10^{-4} person Sv (0.08 person rem).

4.8.1.6 Occupational Dose Associated with the Atlas Proposal

Occupational doses would be controlled by the licensee's radiation protection program based upon real time monitoring. The analysis in this section is intended to identify possible order-of-magnitude doses in the absence of worker protection measures. The licensee has a long-standing ALARA program which is focused on reducing exposures to radioactive materials to "As Low As Reasonably Achievable." This program is audited annually (Edwards 1993).

As discussed in Section 4.8.1.4, external gamma doses on and near uncovered uranium mill tailings piles have been measured to be as high as 0.01 mSv/hr (1 mrem/hr) or 0.02 Sv/yr (2 rem/yr) for a 2000-hour occupational exposure and radon concentrations averaging about 0.56 Bq/L (15 pCi/L). Based on the discussion in Section 4.1.1, and as summarized in Sears et al. (1975), particulate concentrations during machine activity on uncovered tailings piles could be several hundred μg/m^3.

The degree of equilibrium between radon and short-lived daughters on the pile is low (< 0.3; the CAP88-PC value is 0.267 at 150 m or 490 ft) because radon diffuses away from the pile before significant ingrowth of daughters occurs. The effective dose equivalent per Bq/L of radon would be correspondingly lower than the NCRP estimate of about 36 mSv/yr per Bq/L (133 mrem/yr per pCi/L) for indoor exposures, where the degree of equilibrium is more than twice as high. If the degree of equilibrium for outdoor exposures on limited area sources is about 0.3, the annual effective dose equivalent due to radon daughters would be less than 0.01 Sv/yr (1 rem/yr) for a 0.56 Bq/L (15 pCi/L) radon concentration. This approximation applies under continuous exposure conditions. For 2000 hrs/yr of occupational exposure, the annual effective dose equivalent to a worker due to radon daughters would be less than 2.5 mSv (250 mrem).

In Section 4.8.1.4, the effective dose equivalent associated with particulate emissions for tailings piles under continuous exposure conditions was estimated to be about 0.38 mSv/yr (38 mrem/yr) for a particulate concentration of 15 μg/m^3. Under occupational exposure conditions, this concentration of particulates would result in a dose of about 0.01 mSv/yr (10 mrem/yr). Because the 15 μg/m^3 concentration applies to a distance of about 100 m (328 ft) from the edge of tailings piles, concentrations on the piles could be 10–100 times higher (150–1500 μg/m^3). Thus, occupational doses due to particulates on the pile would be in the range of 1–10 mSv/yr (0.1–1 rem/yr) without the interim cover. The total theoretical effective dose equivalents to workers during 2,000 hours/yr of exposure to particulates and radon daughters could range up to 0.035 SV/yr (3 rem/yr).

Several operational conditions would reduce workers' doses to well below these theoretical values. A major factor is that the reclamation operations under the Atlas proposal would be conducted only about 15 weeks/yr, resulting in a dose reduction by a factor of about 3. Another major factor for the Atlas proposal is that particulate releases containing excess radionuclides would stop after the first two 15-week periods, because installation of the clay cap would be completed during this time. Before installation of the clay cap, tailings slimes would be covered by about 2.6 m (8.5 ft) of coarse (sand) tailings and affected soil, thus reducing external gamma and radon doses. Under these conditions prior to completion of the clay cap, maximum doses to the workers for the Atlas proposal are expected to be less that 0.01 Sv/yr (1 rem/yr).

In addition to the operational conditions that reduce occupational dose, respiratory protection would be required for workers during dusty operations. Under conditions of respiratory protection, external gamma doses would dominate potential doses in general and would be less than 1 rem/yr. Based on results of the Atlas monitoring program, recent occupational exposures to particulates, radon daughters and external gammas have resulted in doses less than 1% of standards for particulate-associated radioisotopes, less than 6% of standards for radon daughters, and less than 10% of standards for external radiation.

4.8.1.7 Radiological Monitoring Program

The Atlas Moab mill was operated from 1956 until 1962 by the Uranium Reduction Company and from 1962 until 1984 by the Atlas Corporation. A radiological monitoring program was initiated in 1956 and has subsequently been revised and expanded. The monitoring program would continue after reclamation until NRC has determined that full compliance is obtained. This section focuses on the current radiological monitoring program and monitoring during and after reclamation to ensure minimal environmental impact. The current radiological monitoring program, which is summarized in Table 4.8-5, includes the collection of air, surface water, soil and vegetation samples, along with direct radiation monitoring. Monitoring locations are indicated in Figure 4.8-1.

Air. Particulate-associated radionuclides and radon are currently measured at three locations near the perimeter of the Atlas site, at Arches National Park Headquarters, and at a location about 3.2 km (2 miles) south of the site near Moab (Table 4.8-5 and Figure 4.8-1). The sites were selected based on prevailing wind patterns and population distribution. Measurements are reported to NRC semiannually as required by Source Material License SUA-917. Particulate samples are collected continuously. Filters are changed weekly and composited for analyses of natural uranium, Th-230, Rn-222, and Ra-226. The filters are analyzed weekly for gross alpha and gross beta activity. Results are reported on a quarterly basis.

After completion of the radon barrier, and prior to placement of erosion protection, radon flux would be measured over the tailings pile to confirm that radon flux from the reclaimed tailings pile meets or is lower than the NRC requirement of 0.74 $Bq/m^2/s$ (20 $pCi/m^2/s$).

Groundwater. Seepage from the mill tailings results in elevated levels of radionuclides in groundwater between the tailings pile and the Colorado River. A corrective action program has been conducted to dewater the tailings by pumping water from wells in the tailings to the surface for evaporation.

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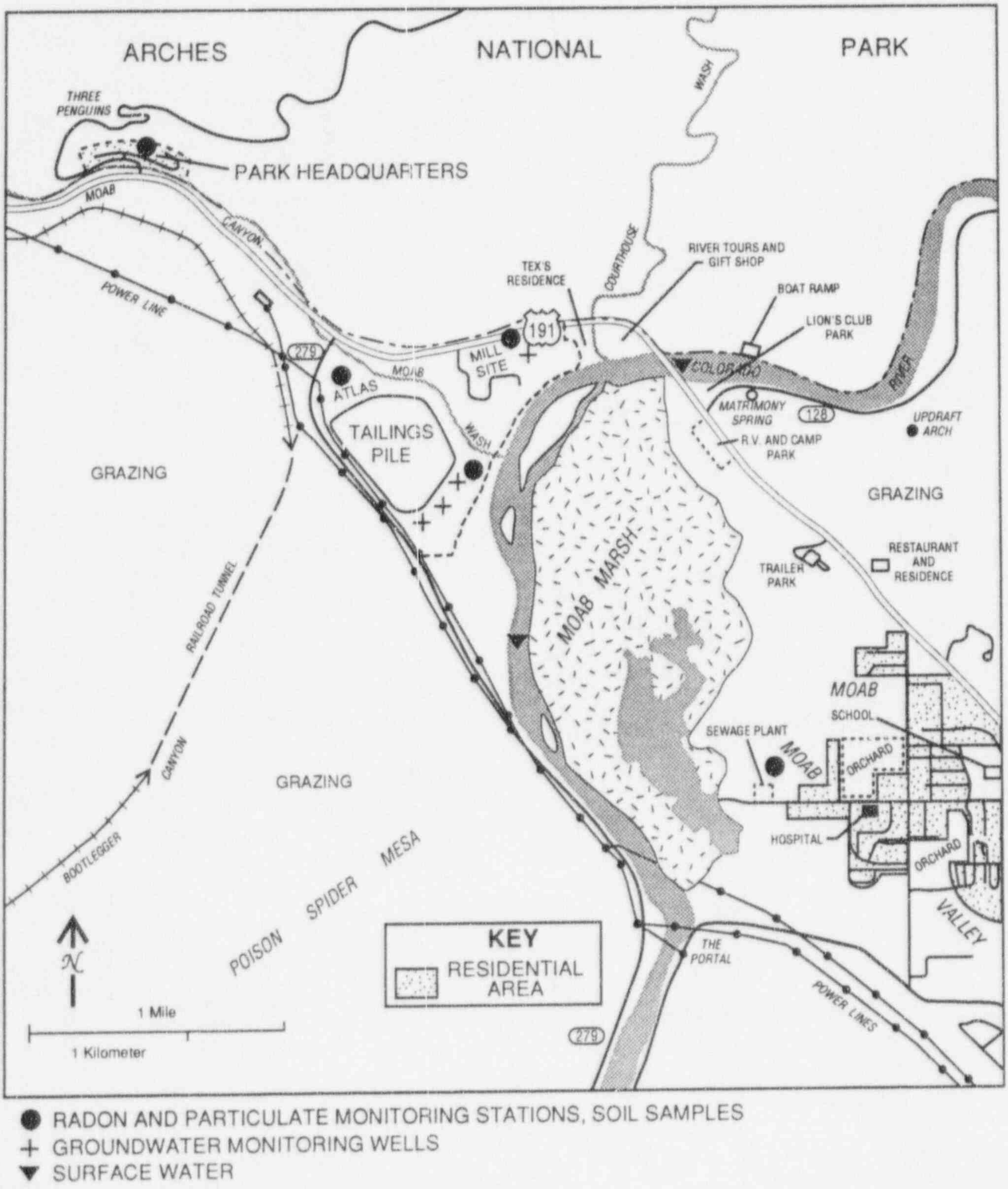

Figure 4.8-1. Locations of Monitoring Stations for the Atlas Radiological Monitoring Program.

Table 4.8-5. Radiological Monitoring Program

Environmental medium	Material sampled	Sampling location (see Figure 4.8-1)	Sampling method	Sampling frequency	Test frequency	Isotope or radiation
Surface water	Colorado River	One site upstream of mill, five sites downstream of mill	Grab (1 gallon)	Monthly	Monthly	U-natural
External radiation	Ambient	Six locations around tailings pond area and near site boundary and particulate collection sites	Scintillation counter	Quarterly	Quarterly	Direct reading of gamma dose rate
Soils	Five samples minimum	Same locations as airborne particulates	Grab	Annually	Annually	U-natural, Ra-226, Pb-210
Vegetation (shrubs, forbs, grasses)	Foliage	Off-site cattle grazing areas	Grab	During grazing	During grazing	Ra-226, Pb-210
Groundwater	Monitor-well water	Three monitor wells located between mill and Colorado River, and several natural sites for comparison	Grab	Quarterly	Quarterly	Gross alpha, U-natural, Ra-226, Ra-228
Ambient air	Airborne suspended particles	Site boundary (NW, NE and SE); Arches park headquarters; near Moab about 4.3 km (2.7) miles from site	Continuous	Filter change weekly, or as required by dust loading	Monthly (composite) Quarterly (composite)	U-natural, Pb-210 Ra-226, Th-230
Ambient air	Gaseous air	Same locations as airborne particulates	One week continuous per month	Monthly	Monthly	Rn-222

Three monitoring wells between the pile and the Colorado River and one well in the northeast corner of the site are used to monitor gross alpha, natural uranium, Ra-226 and Ra-228. Section 4.4 discusses the monitoring results and potential impacts on groundwater quality.

Atlas is required by Condition No. 17 of its license to monitor for a suite of indicator parameters to determine compliance with groundwater standards and maintenance of water quality. Groundwater monitoring by Atlas would continue during and after reclamation until the NRC determines that full compliance is achieved. If, under the Atlas proposal, the Atlas license were terminated after successful reclamation, and responsibility for the tailings were transferred to DOE or the state of Utah, groundwater monitoring would be conducted in accordance with the long term surveillance plan required of the custodial agency (10 CFR Part 40.28).

River Water and Sediments. River water is currently monitored at points upstream and downstream of the mill site, but sediments are not routinely monitored. Grab samples of surface water are analyzed for natural uranium. Potential impacts on surface water quality and aquatic biota are discussed in Sections 4.5 and 4.6. Tailings leachate contaminants in sediments are currently being surveyed, and the results will be included in the FEIS.

Soil and Vegetation. Soil samples are collected annually at the five air monitoring sites (Table 4.8-5; Figure 4.8-1) and analyzed for Ra-226 and Pb-210. Soil samples have not generally shown elevated levels of radionuclides. Soils would be analyzed after reclamation to confirm that the soil Ra-226 levels meet the criteria of 10 CFR Part 40. Vegetation samples are collected annually from a pasture near the site and at a background location and analyzed for Ra-226 and Pb-210. Vegetation samples have not shown elevated concentrations of these isotopes.

External Radiation. External gamma radiation measurements are made at six locations around the tailings pile and near air monitoring sites using real-time scintillation detectors. In addition, worker doses from external radiation are continuously monitored using TLD badges. Special surveys are conducted as necessary using real-time scintillation detectors. These measurements would continue during reclamation.

4.8.1.8 Evaluation of Radiological Impacts for the Atlas Proposal

A comparison of radiological impacts to the maximally exposed individual with the NRC limit of 1 mSv/yr (100 mrem/yr) above background is presented in Table 4.8-6. Impacts under current conditions and during reclamation are dominated by radon daughter doses. Radon daughter doses during a several-month period when tailings would be exposed during reclamation could be greater than under current conditions.

The post-reclamation dose would be dominated by the estimated maximum external gamma dose from soil assuming that all the activity deposited (as discussed in Section 4.8.1.4) since the beginning of mill operation remains in place. This post-reclamation dose would persist until natural processes dilute the surface soil concentrations. Dilution has probably already occurred to some extent. Based on measurements, no detectable increase in soil concentration has occurred.

Table 4.8-6. Comparison of Doses to the Maximally Exposed Individual to 10 CFR Part 20 Limits

	Total effective dose equivalent (mrem/yr)[a]		
Time period	Particulates[b]	Radon[c]	Ratio of total effective dose to NRC limit (100 mrem/yr; 1 mrem/yr = 0.01mSv/yr)
Current	4	67	0.7
During reclamation	11	67	0.8
Post reclamation	4.5	2.0	0.07

[a]1 mrem/yr = 0.01 mSv/yr.
[b]Upper-bound estimates based on total maximum soil deposition (Section 4.8.1.4).
[c]Radon daughter dose estimates are based on extrapolation of actual measurements. Model results were about 1.7 times higher (Section 4.8.1.4).

Even under the maximum worst case assumptions, the post-reclamation dose is only about 0.07 of the 10 CFR Part 20 limit.

The dose to an individual at Arches National Park headquarters located 1.9 km (1.2 miles) northwest of the pile would be about one half the dose at the MEI location according to CAP88-PC results, but actual measurements at park headquarters yield concentrations near background. Thus, the CAP88-PC results, but not actual measurements, for current conditions and the reclamation period suggest that the dose at park headquarters is about half of the NRC limit. The dose to an individual at the trailer park located 2.6 km (1.6 miles) east-southeast of the pile would be about one tenth of the dose at the MEI location and would thus be well below the NRC limit.

4.8.2 Radiological Impacts of the Plateau Site Alternative

4.8.2.1 Impacts at the Atlas Moab Site

As discussed in Section 1.5, the scope of this EIS includes general rather than detailed treatment of alternatives. This analysis is intended to indicate whether the Plateau site alternative offers significant radiological advantages or disadvantages. For the Plateau site alternative, machine activity on the pile would involve an automatic scraper assisted by a dozer to collect and load the tailings into a covered conveyer.

The methodology and pathways, doses and risk considerations for the Moab site under the Plateau site alternative are the same as for the Atlas proposal. Estimated releases, impacts at the MEI location and to the surrounding population are summarized in this section. Releases under current conditions would be the same as for the Atlas proposal (Table 4.8-2). Release rates during removal of the tailings would be less than or similar to the upper-bound releases for the Atlas proposal. However, total releases would be substantially higher because all of the tailings would be handled over a much longer time period (e.g., 9 years) than for the proposed action (e.g., several months). Therefore, the total period for radionuclide deposition on soils and plant surfaces, which would lead to food chain uptake and external ground radiation, is closer to 30 years than to the 20 years discussed in Section 4.8.1.4.

Releases from the Atlas site under post-reclamation conditions would be about 5 times higher for wind-blown particulates and radon if no final soil cover is placed on the site, because Ra-226 concentrations of 0.19 Bq/g (5 pCi/g) above background are allowed for cleaned up sites (Criterion 6 of Appendix A to 10 CFR Part 40).

Impacts to the Maximally Exposed Individual. Annual inhalation dose rates from particulates attributable to the alternative during tailings removal would be less than or about the same as for the upper-bound estimates for the reclamation period of the Atlas proposal. However, the total inhalation dose over the duration of the tailings removal would be higher—about 0.03–0.06 mSv (30–60 mrem) for the 9-yr reclamation period required for the Plateau site alternative compared to 0.07–0.14 mSv (7–14 mrem) for the 1–2 years during which the clay cap would be installed under the Atlas proposal.

Ingestion and external radiation doses during tailings removal may increase by about 50% (30 year deposition period compared to 20 years assumed for the Atlas proposal). Therefore, based on the upper-bound estimates given in Table 4.8-3, the annual dose rate at the MEI location at the Atlas site may be about 0.067 mSv/yr (6.7 mrem/yr) during tailings removal compared to about 0.045 mSv/yr (4.5 mrem/yr) during the reclamation period under the Atlas proposal.

If the Ra-226 soil concentration in the post-reclamation period for the alternative is 0.19 Bq/g (5 pCi/g), then radon emanation rates would be about 5 times background or about 0.30 $Bq/m^2/s$ (8 $pCi/m^2/s$) compared to 0.74 $Bq/m^2/s$ (20 $pCi/m^2/s$) for the Atlas proposal. Thus, the post-reclamation radon daughter dose to the MEI at the Atlas site would be about 0.014 mSv/yr (1.4 mrem/yr) based on CAP88-PC modeling and about 0.008 mSv/yr (0.8 mrem/yr) based on extrapolation of actual measurements.

Impacts to the Surrounding Population. During tailings removal under the Plateau site alternative, radiological impacts on the population surrounding the Atlas site would be dominated by radon and radon daughter doses and are about the same as the upper-bound values for the reclamation period of the Atlas proposal (Section 4.8.1.5). The post-reclamation total dose to the population of Moab would be less than for the proposed action by the same factor as for the MEI location.

Occupational Dose. Respiratory protection would be required for dusty operations. Therefore, external gamma would dominate potential doses. Similar to the case for the Atlas proposal, external doses could be a maximum of about 0.02 Sv/yr (2 rem/yr) assuming 2000-hr/yr exposure. Operational conditions (less than 2,000 hr/yr) and a protection factor for operators by the shielding afforded by the machines would ensure that external doses would be less than 0.01 Sv/yr (1 rem/yr). Although the annual doses for the Atlas proposal and the Plateau site alternative would be quite similar, the total dose to the workers on either the pile being removed or the one being constructed could be 5–10 times higher than for the Atlas proposal, because of the longer time frame involved.

The worker protection program includes monitoring of doses to workers and real-time monitoring of the site using ionization chambers to detect any hot spots that might be present due to uranium and decay products.

4.8.3 Risk Assessment for Tailings Transport

This section assesses the radiological impacts that would be associated with transport of mill tailings by conveyor and rail from the Atlas site to the Plateau site. The methodology of the risk assessment will be presented along with a description of the transportation route, characterization of the mill tailings, a description of the RADTRAN-4 computer code used to perform the radiological risk assessment, and a summary of the transportation risks. The radiological health impacts considered were those associated with both normal transport (incident-free) and with potential accidents severe enough to release radioactive material.

4.8.3.1 Mill Tailings Transportation

The mill tailings would be transported by rail from the Atlas site to the Plateau site approximately 24 km (15 miles) to the northwest. A covered conveyor would be constructed to move the tailings from the Atlas site to the railroad located just west of the site. It is assumed that each rail shipment would consist of 25 gondola cars each carrying 82 metric tons (90 tons) of tailings. Two shipments would be made each day for a total transport of 4,080 metric tons/day (4,500 tons/day). A total mill tailings inventory of 9.5 million metric tons (10.5 million tons) and perhaps roughly 726,000 metric tons (800,000 tons) of contaminated soils need to be shipped. Assuming two trips per day, the duration of the project would be an estimated 6.7 years at 7 days per week or 9.4 years at 5 days per week. A new rail spur would be constructed at the Plateau site. The main rail branch parallels U.S. 191 between Moab and the Plateau site. The total travel distance and the fraction of travel in each population density zone are needed inputs to the RADTRAN-4 code. To obtain the population densities, a routing computer code was used along the expected rail route (Joy 1983, Peterson 1985). The data from the routing model, which makes use of 12 population density zones, has been collapsed into 3 zones (i.e., rural, suburban, and urban) for use in RADTRAN. The results of this routing code established that the entire tailings shipment route is in a sparsely populated zone with a population density of 1.4 people/km^2 (3.6 people/square mile).

4.8.3.2 Characteristics of the Tailings

The form of the mill tailings is estimated to be 68% dry coarse tailings (sands) and 32% fine tailings (slimes) having a 25% to 40% moisture content by weight. An isotopic content and chemical composition analysis determined that the following radioisotopes were present: uranium-238, thorium-230, radium-226, and lead-210. The total curies per gondola car for each radioisotope was calculated from this analysis. The dose rate at 1 meter (3.3 ft) from each gondola is conservatively assumed to be 0.1 μSv/hr (0.01 mrem/hr).

4.8.3.3 Radiological Health Effects

The radiological health effects of tailings transport are presented in this section. The health effects are presented for a single rail shipment and for the shipment of the entire inventory of mill tailings from the Atlas site.

Rail Transport. The RADTRAN-4 computer code (Neuhauser 1984, 1992) was used to model both the incident-free radiological exposure and the consequences of radiological releases due to severe accidents. The incident-free risks are dependent on the radiation dose rate from the shipment, package dimensions, route distance, vehicle velocity, and population densities along the route. The accident risk is dependent on the radiological inventory, accident severity, probability of occurrence of each accident category, and the amount of inventory released, aerosolized, and inhaled, as well as the dispersibility of the waste form. Accident severity categories and the probability of accidents for each category were defined according to methods described in RADTRAN guides (Madsen 1986; Neuhauser 1992). The RADTRAN code does not consider a fixed exposure or accident site along the route but, instead, models moving line- and point-sources along the entire route with accident rates expressed per unit distance traveled. The primary RADTRAN assumptions used for the radiological transportation risk assessment are shown in Table 4.8-7. Incident-free radiological exposure was determined by calculating a total body dose for the transport crew and the general population from the radiation dose rate at 1 meter (3.3 ft) from the package surface. Both point-source and line-source approximations were used based upon the distance between the exposed individuals and the radiation source. Each gondola car was modeled as a single "effective" package with a homogeneous distribution of the radiological inventory throughout the gondola car. The characteristic dimension, known in RADTRAN as the variable PKGSIZ, is the largest linear dimension of the configuration and is used in the line-source approximation to calculate total dose. The source term was conservatively assumed to consist entirely of gamma radiation for calculation of the incident-free dose. The dispersibility category is used to characterize the relative dispersibility of the radiological inventory based upon the physical and chemical properties of the material. RADTRAN uses the dispersibility category to determine the fractions of the total inventory that are aerosolized and respirable. A dispersibility category of 5 (fine powder) was chosen as a representative dispersibility for the mill tailings. RADTRAN contains default values for aerosolized and respirable fractions based on the assignment of dispersibility category. The user assigns a dispersibility category to each material and chooses release fractions based on the type of package as a function of accident severity.

Table 4.8-7. RADTRAN-4 Assumptions for the Radiological Risk Assessment of Tailings Transport by Rail from the Atlas Site to the Plateau site

	Single shipment of tailings	Shipment of entire tailings inventory
Primary radionuclides (Ci/gondola car)[a]		
Uranium-238	3.43E-3	3.43E-3
Thorium-230	5.69E-2	5.69E-2
Radium-226	5.71E-2	5.71E-2
Lead-210	5.71E-2	5.71E-2
Dispersion category for radionuclides[b]	5	5
PKGSIZ (meters)[c] [ft]	20 [66]	20 [66]
Radiation dose rate (mrem/hr)[d]	0.01	0.01
Total number of shipments	1	4667
Gondolas per shipment	25	25

[a] 1 Ci = 0.037 Bq

[b]The dispersion category is used to classify the relative dispersibility of the radiological inventory and to determine the amount of material that would be aerosolized and respirable. Dispersion category 5 is for fine powder similar to mill tailings.

[c]The PKGSIZ, or characteristic dimension, is the largest linear dimension of the configuration. This value is used in determining the incident-free risk from exposure to radiation emitted from the package.

[d]Conservative estimate of radiation dose rate at 1 meter from the package surface; 1 mrem/hr = 0.01 mSv/hr.

The analysis of accident risks considered both acute fatalities and latent cancer fatalities (LCFs) (chronic) in both the present and future generations. The accident risk (expected value of dose from accidents) is the summation of the products of estimated dose for each accident-severity category and the associated probability of occurrence for the category.

For both a single tailings shipment and shipment of the entire tailings inventory, Table 4.8-8 lists the risk of LCFs expected to result from radiation exposure during incident-free transportation and as a result of possible accidents. Radiation doses to the population and truck crews were converted to estimates of LCFs using the upper-limit risk coefficient suggested by the National Academy of Sciences (ICRP 1991; NAS 1990). The NAS report, commonly called the BEIR-V report, gives statistics on the number of cancer deaths expected to occur from a continuous exposure of 1 rem/year above background from age 18 until age 65. This value results in a risk factor of 4.0×10^{-4} LCFs per person-rem, which is most applicable to occupational exposures. The BEIR-V report also considers the number of cancer deaths expected to occur from a continuous lifetime exposure of 0.1 rem/year above background which results in a risk factor of 5.0×10^{-4} LCFs per person-rem, which is most applicable to exposures of the general public.

Table 4.8-8. Summary of the Radiological Transportation Risk Assessment for the Atlas Mill Tailings[a]

	Single shipment of tailings	Shipment of entire tailings inventory
Incident-free LCFs[b]		
Crew[c]	1.38E-8	6.44E-5
Total population[d]	2.50E-10	1.50E-6
Accident LCFs for total population	5.60E-15	2.63E-11
Maximum individual radiation dose (rem)[e]	4.37E-8	2.04E-4

[a]Transportation risks were calculated using RADTRAN version 4.0.16 dated April 12, 1994. Access to RADTRAN 4 was furnished on the TRANSNET MicroVAX computer by the Department of Energy's Transportation Technology Center at Sandia National Laboratories.

[b]The number of radiological latent cancer fatalities (LCFs) statistically expected to occur from the calculated exposures was estimated using a conversion factor of 4.0E 04 LCFs per person-rem for the crew (NAS 1990; UNSCEAR 1988) and 5.0E-04 for the total population (ICRP 1991; NAS 1990). The number of LCFs presented here should be compared to the national average lifetime risk of cancer from all causes, which is approximately 2.5E-01 (about 1 in 4).

[c]The crew size was assumed to be three persons for rail transport. The LCF value shown is conservative since it is unlikely that the same three crew members would ship the entire inventory.

[d]The incident-free risk to the total population does not include the risk to the crew.

[e]The maximum individual radiation dose assumes a hypothetical individual located 30 meters (100 ft) from the railway during the shipment of the entire radiological inventory. This dose represents an incident-free risk.

Note that even though assumed general public exposure is less than the assumed occupational exposure, the general public LCF risk factor is slightly higher. This is because the general public dose is assumed to occur over an entire lifetime as opposed to the occupational work period from age 18 until age 65. The younger population is more sensitive to radiation-induced health effects. Both of these risk factors were used in this assessment.

This assessment indicates that the radiological risks of tailings transport are quite low. The number of LCFs statistically expected to occur from the calculated exposures during incident-free transportation of the entire tailings inventory would not exceed 6.44×10^{-5} for the railroad crew (3 crew members), or 1.50×10^{-6} for members of the public. The maximally exposed individual would receive 2.04×10^{-4} rem, which is less than 0.057% of the 3.6 mSv (360 mrem) average annual effective dose received from natural background radiation sources. The value of 6.44×10^{-5} LCFs for the railroad crew is conservative since it is unlikely that the same 3 crew members would participate in all of the transport of the entire tailings inventory. The radiation dose for the maximally exposed individual assumes a hypothetical individual located 30 meters

(100 ft) from the railway during the shipment of the entire tailings inventory. This dose represents an incident-free risk from normal transport (not an accident dose).

The results of the analysis indicate that there would be no fatalities from acute radiation exposure as a result of the release of radioactive material from any of the hypothetical accidents. The largest number of LCFs associated with a hypothetical accident for the tailings shipment would be 2.63×10^{-11} LCFs.

Transport by Conveyor System. Transport of mill tailings by rail would require the construction of a tailings conveyor system at the Atlas Moab site along with loading and unloading facilities at the Moab and Plateau sites. The conveyor system would be approximately 760 m (2,500 ft) in length and cross over State Highway 279 up to the rail loading facility. During routine use, the conveyor system would be designed to limit the escape of dusts. Health impacts from normal operation of the conveyor should be negligible.

Mill tailings could be accidentally spilled when being conveyed to the rail loading facility. The impacts from an accidental conveyor spill should be minimal since the affected area would be cleaned up immediately. A limited amount of dust emissions may occur. Workers involved in an accident clean-up effort would wear proper respiratory protection to prevent inhalation of dust. Direct gamma exposure from an 8-hr clean-up period for 5 workers due to a large conveyor tailings spill would result in an overall increased risk of approximately 3.2×10^{-5} LCFs. This is a conservative risk value assuming the maximum exposure from the higher activity tailings and a long clean-up period of 8 hours.

4.9 CUMULATIVE IMPACTS

Cumulative impact is "the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions" (40 CFR Part 1508.7). Potential cumulative impacts are identified and summarized below. Detailed assessments of the impacts of the Atlas proposal, the Plateau site alternative, and the hypothetical tailings pile failure are found in Sections 4.1 through 4.8 above.

4.9.1 Air Quality

Fugitive dust and vehicle emissions would add to existing levels of air pollutants in the region, which are in compliance with NAAQS. However, no other source of air pollutants has been identified that would cause a significant cumulative impact in combination with the Atlas proposal or the Plateau site alternative. The analysis of compliance with NAAQS for fugitive dust associated with the Atlas proposal included cumulative impacts of all existing pollutant sources, because the reclamation emissions were added to existing air pollutant levels to determine compliance with standards. Long-term releases of air pollutants after reclamation at either the

Atlas site or Plateau site would be negligible and would have virtually no pot...ial to cause a cumulative impact involving exceedance of air quality standards.

4.9.2 Geology

About 3.2 km (2 miles) south of the Atlas site, the Suburban Gas Company stores liquid petroleum gas (LPG) 610 m (2000 ft) underground in a salt cavern constructed by the insitu leaching method (Baars 1993). Decommissioning or additional construction of such underground petroleum storage facilities in the vicinity of the Atlas site could lead to a small increase in instability within the Paradox salt and a potential for subsidence. Such subsidence also could lead to increased communication between the Paradox salt and the Colorado River. The Suburban Gas Company facility is too distant to be considered a risk to stability of the tailings pile.

4.9.3 Land Use

No existing, future, or proposed project has been identified that could, in combination with the proposed or alternative action, produce a significant cumulative impact on land use at the Moab site, Plateau site, or borrow area. The transfer of land on the Atlas site for unrestricted use at some point in the future would positively impact future development in the Moab area. Such impact would be greater under the Plateau site alternative since more land would be released and the pile would no longer be present. Negligible cumulative losses of grazing land may be expected from possible future developments in the region (e.g., the expansion of Canyonlands Field).

The deposition of tailings onto downstream lands after the hypothetical tailings pile failure would add to the existing level of contamination that has resulted from deposition of existing contaminants in the river during previous floods. Judging from the expected dilution of tailings in the river and the lack of impact on water quality, the increase in contamination should be too slight to have any appreciable long-term cumulative impact on land uses along the river.

4.9.4 Groundwater

The increased use of water during reclamation under the Atlas proposal or the Plateau site alternative could cause a slight cumulative increase in the total groundwater use in the Moab area. Although groundwater consumption in the Moab area has been gradually increasing over the years, shortages have not occurred and are not expected. No appreciable cumulative impact is anticipated.

No extensive use of groundwater from the Quaternary alluvial aquifer in the vicinity of Moab is anticipated in the foreseeable future. Over the long term, a huge increase in withdrawal rates could eventually lower the water table sufficiently to cause residual tailing liquor at the tailings pile to migrate under the Colorado River and towards wells in Moab and Spanish Valley. Groundwater treatment prior to consumption would be required if contamination of well water occurred. However, no such cumulative impact would be expected because extensive use of the alluvial aquifer is not anticipated. No cumulative impact to groundwater would be anticipated at the Plateau site because no viable supply of groundwater has been identified there.

4.9.5 Surface Water

The negligible hydrological impacts associated with the tailings reclamation at the Atlas site or the Plateau site would not contribute appreciably to any cumulative impact. Some water, potentially including surface water as well as groundwater, for dust control would be obtained from a contractor or the city of Moab. No water use would occur for the Atlas proposal or the Plateau site alternative after reclamation is completed. No other projects have been identified that would significantly increase surface water withdrawals during the tailings reclamation period and produce cumulative impacts in combination with tailings reclamation. Other losses of 100-year floodplain in the Moab area have not been identified. The ecologically most valuable floodplain in the area has been protected by the establishment of the Moab Marsh Preserve. The hypothetical tailings pile failure would not be expected to appreciably alter surface water flow at the Atlas site.

Impacts of reclamation operations would temporarily add to existing levels of impacts on surface water quality in the Colorado River. Existing impacts result from numerous sources. With adequate controls, this cumulative, temporary impact would be expected to be negligible. No other projects have been identified that, in combination with tailings reclamation, would result in a significant cumulative impact on water quality.

Under the Atlas proposal, tailings leachates would continue to enter the Colorado River and have a small, generally undetectable, cumulative impact on surface water quality. The greatest potential for cumulative impact would occur during periods of low flow in the river when the tailings contribution to flow would be fractionally larger than during high flows. If upstream water withdrawals result in decreased flows past the Atlas site in the future, the tailings leachates would make proportionally greater contributions to existing contaminants in the river. No future project that would increase discharges into the river is known.

At the Plateau site, any impact of the tailings on surface water quality in Bartlett Wash would add to the impact associated with grazing. Because the clay liner would restrict the escape of tailings leachates, there would be little cumulative impact to Bartlett Wash and no cumulative impact on the Colorado River, which is far downstream.

The tailings pile failure would have a relatively large, short-term cumulative impact (e.g., several weeks) and a small, long-term cumulative impact, which would likely be undetectable after a short time period (e.g., months to several years) after the failure. Over the long term during which no tailings pile failure would be expected, the tailings contaminants would have negligible cumulative impact, because they would be virtually completely dominated by the large amount of existing contaminants continually transported by the river.

4.9.6 Ecological Resources

If sediments or small amounts of spilled substances were to enter the river during reclamation operations, they would add to existing levels of contaminants in the river and cause a minor, short-term cumulative impact on aquatic biota, which include four endangered fish species. Under the Atlas proposal, tailings leachates would continue to add slightly to existing contaminants in the river and have a minor, long-term cumulative impact.

The loss of terrestrial habitat at the Atlas site would add slightly to habitat losses that are expected to result from urban growth in the Moab Valley. No threatened or endangered plant or animal would be affected. No other past, present, or future impact has been identified that would, in combination with the Atlas proposal or Plateau site alternative, cause a significant cumulative impact on habitat or plant and animal populations.

After reclamation is completed, no appreciable cumulative impact should occur, because no additional habitat loss would occur. No reduction in habitat or wildlife populations numbers should occur in the event of the hypothetical tailings pile failure.

A small amount (e.g., 1.2 ha or 3 acres) of tamarisk wetland would be lost on the Atlas site. No other anticipated loss of wetland in the Moab area has been identified. Most wetland in Moab Valley has been preserved by the establishment of the Moab Marsh Preserve by the Nature Conservancy.

4.9.7 Socioeconomic, Population, and Cultural Resources

Reclamation of the tailings pile at either the Atlas or Plateau site would result in a slight, short-term increase in employment and population in the Moab area. This increase could add slightly to the effects of the increased population in the area during the primary tourist season. However, the Moab area should be able to absorb the increased population with no significant adverse cumulative impact. No other projects have been identified that, in combination with tailings reclamation, would have an appreciable cumulative impact on economic resources and employment. No impact on historic or cultural resources is anticipated.

The transport of borrow material by truck would add to existing traffic, have some adverse and beneficial impacts on business in Moab, and increase the potential for traffic accidents. Economic impacts would depend on the extent of traffic congestion, the severity of any accidents, and the publicity attending such accidents. If other nuclear waste reclamation projects (e.g., Monticello and Blanding) and other possible new industries contribute to truck traffic in the area, a perception could develop that the area is becoming increasingly industrialized, which could interfere with recreational pursuits and aesthetic enjoyment.

Under the Plateau site alternative, the 6.7 to 9.4 years of moving the tailings pile and contaminated soils by rail could create an adverse recreational impact associated with nearly constant, low-level activity for such a long period. If additional trucking of uranium mill tailings from Monticello to Blanding (J. Berwick, Grand Junction Project Office, DOE, personal communication with C. H. Petrich, ORNL, July 15, 1994), there could be cumulative impacts associated with the perception that the area is inundated with radiation problems (even though the Atlas proposal would, in fact, involve transport of only borrow material on U.S. 191). This could affect tourism, especially if an accident were to occur (W. Dabney, Superintendent, Canyonlands National Park, Moab, personal communication with C. H. Petrich, ORNL, July 11, 1994). Because truck transport of borrow material and mill debris in the Moab area would be relatively short term and would be conducted primarily during the winter season, truck traffic associated with the Atlas proposal or Plateau site alternative would not be expected to produce a significant cumulative impact.

The hypothetical tailings pile failure could cause short-term impacts cumulative with other unidentified future projects. Because of a lack of impact on water quality, tailings pile failure would not be expected to produce a significant cumulative economic impact related to surface water use.

4.9.8 Radiation

Increased releases of radiation during grading of the tailings would add to existing levels of radiation but would not exceed NRC limits. After site clean-up and placement of the cover system over the tailings, radiation releases would be less than they are currently with the interim cover and would not exceed NRC limits. Radiation release rates during tailings removal under the Plateau site alternative would be about the same as the rates during reclamation under the Atlas proposal, but would involve activities at two sites and would last for a longer time period, potentially causing slightly greater cumulative effects over time.

4.10 UNAVOIDABLE ADVERSE ENVIRONMENTAL IMPACTS

4.10.1 Air Quality

The unavoidable impacts of tailings reclamation on air quality stem primarily from earth-moving activities and trucks transporting borrow materials for the Atlas proposal and from earth-moving activities and tailings transport for the Plateau site alternative. With adequate control measures, such as treating exposed areas with water or chemical surfactants and limiting the extent of earthwork during high winds, earthwork under either alternative could avoid exceedance of air quality standards.

4.10.2 Soils

Under either the Atlas proposal or Plateau site alternative, soils would be disturbed by vehicles and earthwork. Soil structure and processes would be disrupted by moving and compaction. Contaminated soils would be cleaned up, and disturbed soils would be revegetated, thus minimizing the long-term impacts.

4.10.3 Land Use

Reclamation operations under the Atlas proposal would have no impact on off-site land use near the Atlas site, but would result in small changes in land use at the riprap borrow areas and on the Plateau site where clay would be obtained. Also, the Atlas proposal would preclude future commercial use of roughly half of the Atlas site. Under the Plateau site alternative, land use on a few hundred acres of relatively low-quality grazing land would be converted from grazing to a tailings disposal area, and the Atlas site would eventually become available for unrestricted use.

4.10.4 Mineral Resources

No known or commercially valuable mineral resource would be appreciably affected by the Atlas proposal or Plateau site alternative.

4.10.5 Groundwater

Dust control during reclamation under either the Atlas proposal or the Plateau site alternative would require the use of water, probably including some groundwater obtained from a contractor or the city of Moab. No adverse impact on groundwater resources or other groundwater users would be expected. After reclamation under the Atlas proposal, tailings leachates would continue to enter groundwater that has low quality and is not used in the site vicinity. Under the Plateau site alternative, impacts on groundwater quality at the Atlas site would be greatly reduced, and no impact would occur at the Plateau site, where groundwater is not present near the surface.

4.10.6 Surface Water

Surface runoff and erosion associated with earthwork at the Atlas site, under either the Atlas proposal or Plateau site alternative, would have minimal impact on surface water quality in the Colorado River. No surface water is present at the Plateau site. Minimal impact on surface water would be expected at the rock quarries. After reclamation under the Atlas proposal, tailings leachates would continue to enter the Colorado River and have minimal impact on water quality. Under the Plateau site alternative, the relatively minor effects on surface water quality at the Atlas site would be reduced, and no impact would occur at the Plateau site, where surface water is not present. Reclamation under the Atlas proposal would result in the loss of a small additional amount (e.g., 1.2 ha or 3 acres) of floodplain, which would be occupied by the tailings pile.

4.10.7 Ecological Resources

Because impacts on water quality in the Colorado River during reclamation operations would be minimal, aquatic biota would not be appreciably affected under either the Atlas proposal or Plateau site alternative. After reclamation under the Atlas proposal, tailings leachates would continue to enter the Colorado River and have minimal impact on aquatic biota. Under the Plateau site alternative, potential impacts on aquatic biota at the Atlas site would be further reduced, and no impact would occur at the Plateau site, where aquatic biota are not present.

During reclamation operations, relatively small amounts of terrestrial habitats would be lost under either the Atlas proposal or Plateau site alternative, resulting in small decreases in regional plant and animal populations. The Atlas proposal would include the loss of several acres of tamarisk wetland on the floodplain on the Atlas site and disturbance of terrestrial habitats at the rock borrow areas and at the clay borrow area on the Plateau site. The Plateau site alternative would result in the loss of a few hundred acres of sparse vegetation that supports relatively low numbers of wildlife.

4.10.8 Socioeconomic, Cultural, and Aesthetic Resources

Reclamation operations, including transport of borrow materials under the Atlas proposal and transport of tailings under the Plateau site alternative, would have both adverse and beneficial effects on the local economy. No large net effect, either adverse or beneficial, would be expected. The relatively small number of employees required under either alternative would have little effect on public services and infrastructure. Under the Atlas proposal, truck traffic associated with borrow transport during the winter would add to existing traffic and increase the potential for accidents. Aesthetics would be adversely affected for the duration of operations, which would be 5 years for the Atlas proposal or 6.7 to 9.4 years for the Plateau site alternative. A reclaimed tailings pile would have permanent aesthetic impact on a relatively large number of people near the Atlas site and a much smaller number of people at the Plateau site. Future commercial use of all of the Atlas site would be possible under the Plateau site alternative but not under the Atlas proposal. Thus, the Atlas proposal would limit growth in population and economy potentially associated with commercial use of the entire Atlas site.

4.10.9 Radiation

To accomplish the Atlas proposal, tailings would have to be exposed to reduce the tailings pile side-slopes and to install the final cover system, thereby increasing the levels of radiation during reclamation. However, NRC radiation limits for the protection of public health would not be exceeded. The Plateau site alternative would require the exposure of tailings for a period of time roughly 6 to 9 years longer than Atlas proposal.

4.11 RELATIONSHIP BETWEEN SHORT-TERM USES OF THE ENVIRONMENT AND LONG-TERM PRODUCTIVITY

Short-term uses of the environment for the Atlas proposal include obtaining bedrock from quarries in Castle Valley, obtaining rounded alluvial cobble from the surface of an area in Spanish Valley southeast of Moab, obtaining clay from the Plateau site, and use of the Atlas site for reclamation activities. These short-term uses of the environment would permit reclamation of the Atlas tailings to promote long-term environmental protection. Use of the Plateau site for tailings disposal would promote long-term protection of the Colorado River and groundwater at the Atlas site.

The Atlas proposal or the Plateau site alternative would produce short-term effects on the local economy while providing for long-term protection of the environment and public health. Under the Atlas proposal, long-term economic productivity would be limited by the unavailability of roughly half of the Atlas site for commercial use.

4.12 IRREVERSIBLE AND IRRETRIEVABLE COMMITMENTS OF RESOURCES

Reclamation of the tailings on either the Atlas site or Plateau site would commit the land to a permanent use for tailings disposal. Any construction or expansion of rock quarries would commit a small amount of land to quarry-type uses. Under the Atlas proposal, rock and clay from off-site borrow areas would be committed to tailings disposal. Reclamation on the Atlas site would commit a small additional amount of floodplain wetland to being occupied by the tailings pile.

Water would be consumed for dust control during reclamation operations under the Atlas proposal and the Plateau site alternative, but no water would be consumed after reclamation is completed. After reclamation under the Atlas proposal, the Colorado River would serve to dilute any tailings contaminants entering the river in groundwater.

The commitment of lands, as noted above, involves a loss or commitment of plant and animal resources that currently exist or could exist on those lands. A small additional area of tamarisk wetland on the floodplain would be occupied by the tailings pile under the Atlas proposal.

Reclamation operations would require a commitment of human and financial resources. Commitments of machinery, vehicles, and fossil fuels would be required.

5. COST AND BENEFITS ASSOCIATED WITH RECLAMATION ALTERNATIVES

5.1 COST COMPARISON FOR THE ATLAS PROPOSAL AND PLATEAU SITE ALTERNATIVE

The licensee estimated that the proposed action would cost $13 to $16 million and that the Plateau site alternative would cost $94 to $114 million (CESC 1993). This section evaluates these estimates and considers whether additional costs and benefits should be included. The design of the Atlas proposal and the licensee's conceptual design for the Plateau site alternative appear to be reasonable designs on which to base cost estimates. Also, the details of the Atlas cost estimates were examined by the staff and appear to be reasonable in general. However, in certain areas, additional factors that could have significant effects on costs should be considered. This section identifies these factors and potential adjustments in cost estimates.

The costs associated with the hypothetical, maximum failure of the tailings pile (Section 2.1.8), such as repair, cleanup, and lost productivity resulting from short-term pollution of the Colorado River, are not considered. These costs could be appreciable in the short term after the pile failure during the HF. However, cost estimates would be highly speculative because the HF is not expected to occur and the extent of such an event and its effects are unknown.

5.1.1 Project Costs Compared to Other Cost Estimates for Tailings Disposal

Uranium mill tailings sites include 21 Title I and 19 Title II sites under the Uranium Mill Tailings Radiation Control Act (UMTRCA) of 1978, as amended [Public Law 95-604]) (Section 1.4). Title I sites are abandoned sites selected for remedial action by the DOE's Uranium Mill Tailings Remedial Action Program. Each Title II site is the responsibility of a private company, such as Atlas, that must fulfill obligations associated with an operating license granted by the NRC. The total amounts of tailings at the Title I and II sites were 22.9 and 153 million metric tons (25.2 and 169 million tons), respectively.

Experience with tailings reclamation cost that can be compared to the projected cost of the Atlas proposal is limited. As of 1994 no Title II site has been fully reclaimed, and so no actual final cost data are available for Title II sites. However, Ferdinand (1995) estimated the costs of 17 Title II sites. Ferdinand's estimated costs ranged from $1 to $18 per ton, with a median cost of $3.18/ton and, for the Atlas tailings, an estimated cost of $2.38/ton (total project costs of $25 million[1]). Atlas's estimate of its tailings reclamation cost is $1.24 to $1.52/ton (CESC 1993), which is within the range of Ferdinand's estimates. By contrast, Ferdinand's estimate of the average cost for 21 Title I sites was $81.91/ton.

Per-ton costs of reclamation projects for Title I sites are generally not suitable for comparison with the Atlas proposal, as many of these projects involve relatively small amounts of tailings,

[1] The Ferdinand estimate includes costs already incurred, while the Atlas cost estimate includes only future costs.

transport of tailings to alternate sites, or remedial actions for vicinity properties where tailings were used in construction materials (S. Hamp, U.S. Department of Energy, UMTRAP Office, DOE Operations, Albuquerque, New Mexico, personal communication with J. W. Van Dyke, ORNL, August 17, 1994). However, a comment during the scoping process suggested that based on the Rifle, Colorado reclamation project the cost of transporting the Moab tailings to Klondike Flat might be achieved at approximately $52 million--considerably less than the $94 to $114 million estimated by Atlas. Staff has not been able to find any analysis to support this lower estimate. The total budget for the Rifle reclamation (projected to be completed in May of 1996 is $85.5 million for a total handled volume of 2.83 million cubic meters (3.7 million cubic yards) (J. Metcalf, DOE UMTRAP Office, Albuquerque, New Mexico, personal communication with J. W. Van Dyke, ORNL, November 28, 1995]. These costs at Rifle are for transporting about one-half the volume of tailings (11 miles by truck at Rifle versus 18 miles by rail at Moab) compared to the proposed reclamation at Moab. A simple extrapolation of costs based on the ratio of the Moab tailings volume of 5.96 million cubic meters to the Rifle volume of 2.83 million cubic meters would be 2.1 times $85.5 million or about $180 million. So contrary to the scoping comment that costs might be much lower than Atlas' estimate, this is well above the licensee's cost estimate for the transport alternative of $94 to $114 million.

The same scoping comment suggested that based on the experience at Green River, Utah reclamation project, the reclamation in place alternative might cost about $54 million, three to four times the estimate developed by Atlas. A review by staff indicates that a simple extrapolation of costs from the Green River reclamation is misleading because Green River tailings were not stabilized-in-place, rather they were relocated approximately 500 feet from the original pile (DOE/UMTRA--050510-GRNO-Vol 1.1). Also, this project included significant vicinity property contamination that had to be cleaned-up. A comparison to two other Title I disposal-in-place reclamations with relatively large areas—Ambrosia Lake, New Mexico [45 ha (111 acres)] and Shiprock, New Mexico [29 ha (72 acres)]—indicated that Atlas' estimated costs per acre of reclamation pile were low--one-third and one-half of the costs respectively (J. Metcalf, DOE UMTRAP Office, Albuquerque, New Mexico, personal communication with J. W. Van Dyke, ORNL, November 28, 1995)—i.e. extrapolating these costs to Moab would result in costs of about $30 to $45 million for stabilization in place. However, this type of extrapolation may not account for differences in the specific project requirements such as cleanup of vicinity properties. Also it does not account for the much lower costs that have been experienced in Title II reclamation sites compared to Title I sites (see above). A comparison of cost per acre for reclamation sites (discussed below) suggests that the Atlas cost estimate is very close to the cost per acre developed in the NRC's Generic Environmental Impact Statement on Uranium Milling (NRC 1980). Staff recognizes that comparison with generic cost estimates cannot account for the specific requirements of a project that may increase costs. However, this comparison indicates that the licensee's cost estimate is not outside a reasonable range for what might be typical of this kind of project.

In summary, costs for stabilization-in-place or transport and stabilization-off-site vary significantly. Comparison of the Atlas' cost estimates to extrapolations from other sites may be misleading because of site specific factors. With this qualification in mind, the extrapolations that have been examined above suggest that the costs of both alternatives could be significantly underestimated. However, the cost differential between stabilization-in-place versus transport and stabilization at Klondike Flats would be at least as high as estimated by Atlas and perhaps significantly higher.

5.1.2 Discounting of Costs

To account for the time-value of money (e.g., the profit that can be made by investing money), discounting should be conducted to provide a more accurate comparison of the costs of two or more projects requiring spending over time periods of different length (OMB 1992). For example, given $1 million in 1995 (i.e., constant-worth 1995 dollars), it is more desirable to spread $1 million of payments over 12 years than 4 years. During the 12-year period, more interest could be earned on the unused balance.

The Atlas proposal is assumed to require five years to complete, which includes five 15-week work seasons (Section 4.7.2.1). The Plateau site alternative has been assumed to require 12 years based on the licensee's cost estimate, which includes 1624 weeks for jobsite overhead (CESC 1993, Appendix C, Sheet 1 of 41). The Plateau site alternative could potentially be completed on an expedited schedule (see Sect. 2.2.1.7). Atlas provided cost estimates of both cases in terms of constant 1993 dollars. Staff has reviewed price increases from 1993 to 1995 and has concluded that relative project costs should not be affected by presenting costs in 1993 constant dollars. The Atlas estimates are here discounted (i.e., adjusted downward) using a real discount factor of 7% (obtained from OMB 1992). The midpoint of the project time requirements was used to discount the Atlas estimates of total costs, i.e., 2.5 years for the Atlas proposal and 6.0 years for the Plateau site alternative. The discounted cost estimates are $11 to $13 million for the Atlas proposal and $62 to $75 million for the Plateau site alternative.

Various cost estimates provided in the remainder of this section were obtained by adjusting cost data to 1993 dollars (to account for inflation occurring before 1993) using construction cost indexes published in *The Survey of Current Business* (U.S. Department of Commerce 1994) and then discounting to comparable values.

5.1.3 Cost Estimates in the NRC Generic Environmental Impact Statement

The cost estimate for the Atlas proposal is compared to a project-wide estimate published in the NRC GEIS (NRC 1980). To obtain a per-acre cost for comparison with the GEIS data, the adjusted Atlas estimate of $11 to $13 million was divided by the size of the disposal area of 130 acres. This results in a reclamation cost of $85,000 to $100,000/acre compared to the GEIS estimate of $84,000/acre (inflation-adjusted). The Atlas estimate for stabilization in place is reasonably close. The GEIS generic estimate based on an average, model site would be expected to only roughly indicate actual costs to be expected at any specific site, because of different site-specific conditions.

5.1.4 Cost of Riprap Transport

The Atlas-estimated cost of obtaining riprap (Table 5.1-1) was examined because the cost (1) is over 30% of the $10 million total cost (not including contingency and profit) for the Atlas proposal; and (2) could be increased if smaller trucks are required by truck weight restrictions that may be imposed on Atlas by the state of Utah to minimize impacts on roads (D. Stapley, Utah Department of Transportation, Price, Utah, personal communication with C. H. Petrich, ORNL, July 15, 1994).

Table 5.1-1. Licensee's Estimates of Riprap Costs for the Moab Site

Item	Cost ($)	Cubic meters (cubic yards)
Rip-rap ditches	248,000	11,854 (15,505)
Armor stone, embankment slopes	900,000	38,156 (49,906)
Rockwall toe protection	85,000	2,945 (3,852)
Soil rock matrix (rock)	1,147,000	41,485 (54,260)
Filter rock	877,000	38,804 (50,754)
Total	3,257,000	133,244 (174,277)

Costs were estimated for several different truck sizes and an increased transport distance and were compared to the Atlas estimate (Table 5.1-2). The Atlas estimate is based on a 32-km (20-mile), one-way haul distance and the use of 20-ton, 16 yd^3-capacity trucks that meet weight limits on Utah state highways (CESC 1994a). Other estimates are provided in Table 5.1-2 for smaller trucks with capacities of 4 and 12 yd^3 and for a one-way haul distance of 64 km (40 miles) to illustrate the effect of haul distance on cost. Haul distance was examined because use of alternate truck routes may be an issue depending on public concerns and potential traffic impacts. Longer haul distance and smaller truck capacity resulted in significantly higher estimates of transport costs, which could increase total reclamation cost by 10% to 30%. If this range of higher costs is added to Atlas-estimated cost of $11 to $13 million (discounted), total reclamation cost could be about $12 to $17 million.

The $17 million high-end-of-the-range cost estimate is based on assuming much smaller trucks for hauling rip-rap. Use of smaller trucks would result in less damage and stress on roads and bridges. However, even if the smaller trucks were not acceptable, this represents increased costs at $25 per cubic yard of riprap. This increase would probably be more than enough to cover the cost of rail transport. For instance, the estimated transport cost for excavation, rail transport and examined above suggest that the costs of both alternatives could be significantly underestimated. However, the cost differential between stabilization-in-place versus transport and stabilization at Klondike Flats would be at least as high as estimated by Atlas and perhaps significantly higher.

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The $17 million high-end-of-the-range cost estimate is based on assuming much smaller trucks for hauling rip-rap. Use of smaller trucks would result in less damage and stress on roads and bridges. However, even if the smaller trucks were not acceptable, this represents increased costs at $25 per cubic yard of riprap. This increase would probably be more than enough to cover the cost of rail transport. For instance, the estimated transport cost for excavation, rail transport and

Table 5.1-2. Increased Costs of Smaller Capacity Trucks and Longer Haul Distance

	Average installed cost of rock including hauling (per cubic yard)	Increase from licensee's estimate (discounted)
16-yd^3-capacity truck—20 miles (Atlas estimate)	$15.89	(not applicable)
GEIS estimate	$22.48	$970,000
12-yd^3-capacity truck—40 miles	$21.66	$850,000
4-yd^3-capacity truck—40 miles	$40.88	$3,680,000

off-loading of tailings to the Plateau site is about $8 per cubic yard. It seems reasonable that transport of rock to the proposed site by rail would not exceed the $25 per cubic yard additional cost that has been incorporated into the upper end of the range.

5.1.5 The Plateau Site Alternative

The primary issues examined in this section are the cost of tailings transport by rail and the benefits that could be obtained if tailings were removed from the Atlas site so that the site could be used for commercial purposes.

5.1.5.1 Tailings Transport

The Plateau site alternative would cost $62 to $75 million (discounted Atlas estimate), requiring the rail transport of an Atlas-estimated 7.8 million yd^3 of tailings and contaminated earth. This cost is compared to the costs actually experienced with the Vitro site in Salt Lake City (M. Day, Division of Environmental Response and Remediation, Utah Department Environmental Quality, Salt Lake City, personal communication with J. W. Van Dyke, ORNL, August 11, 1994). Vitro tailings and contaminated materials totaling 2.79 million yd^3 were excavated and transported 129 km (80 miles) by rail to the Envirocare site west of Salt Lake City. Although the rail transport distance for the Plateau site alternative is less than 48 km (30 miles), the per-unit cost of rail transport would be very similar over distances less than 322 km (200 miles).

After discounting and adjusting for inflation, the Vitro project cost about $14/$yd^3$ compared to the discounted Atlas's cost estimate of about $9/$yd^3$. Thus, the Plateau site alternative could be significantly more costly than Atlas estimated. If it cost $14/$yd^3$ as with Vitro, the Plateau site alternative would cost about $109 million (discounted), which is about 60% higher than the $68.5-million midpoint of Atlas's $62 to $75 million estimate (discounted).

5.1.5.2 Commercial Value of the Atlas Site

Estimates in Section 4.7.2.4 indicate that if the tailings were moved instead of stabilized in place valuation of the undeveloped land at the Atlas site could be between about \$12 to \$17 million for residential development and between \$11 to \$16 million for commercial development. However, these values are not discounted and from the perspective of a benefit cost analysis they overstate the increased value of the Plateau site alternative because there could be a long delay (reducing the present value) and/or additional costs could be necessary in order to achieve sufficient reductions in groundwater contamination so that the entire site could be released for unrestricted use (see Section 2.2.1.5).

5.1.6 Conclusion

The difference in discounted costs between the Atlas proposal and Plateau site alternative ranges from \$50 to \$100 million. The lower end of this range reflects the Atlas estimate of tailings transport costs and possibly increased costs of trucking restrictions for hauling rock to the Atlas site. The upper end of the range reflects the per unit transport costs of the Vitro project. If highway restrictions reduce the size of trucks that can be used for riprap transport or increase the riprap transport distance, project costs could increase by 10% to 30% over the \$11 to \$13 million range estimated by Atlas, and the cost of the Plateau site alternative would also increase, depending on the amount of rock required.

5.2 QUANTIFIABLE SOCIOECONOMIC IMPACTS

Neither the Atlas proposal nor the Plateau site alternative would result in long-term socioeconomic impacts on residents of Moab, with the exception of the loss of future commercial use of roughly half of the Atlas site if tailings are left on the site. Truck transport of riprap and clay would result in temporarily increased levels of noise and exhaust and some increased risk of traffic-accidents involving trucks and other road users. Motorists, cyclists, and other road users potentially affected by truck transport of riprap and clay probably do not represent disproportionate numbers of ethnic minorities or individuals of lower economic status.

5.3 THE BENEFIT COST SUMMARY

A summary comparison of the costs of the Atlas proposal and the Plateau site alternative is provided in Table 5.3-1. The major quantifiable difference is in the dollar costs of the two alternatives. The estimated cost of Atlas' proposed in-place disposal ranges from \$11 to \$17 million in present value 1993 dollars. The comparable cost range for transport of the tailings to the Plateau site is \$60 to \$110 million. The ranges of the estimated costs reflect significant uncertainty in the final cost for either alternative. However, notwithstanding this uncertainty, the Plateau site alternative would cost much more than the Atlas proposal.

Table 5.3-1. Benefit Cost Comparison of the Atlas Proposal and Plateau Site Alternative

Item	Atlas proposal	Plateau site alternative
Cost	$11 to $17 Million	$60 to $110 Million
Air quality	Air quality standards would not be violated. No cost is expected.	Not different from Atlas proposal
Land use	Other land uses of the Atlas site would be precluded on roughly half of the site.	Unrestricted use of the Atlas site could be permitted after reclamation is complete. Grazing would be precluded on the Plateau site.
Groundwater	Groundwater would be consumed during reclamation. Tailings leachates do not affect groundwater being used; no cost would occur.	More groundwater would be consumed during reclamation. No groundwater would be affected by tailings leachates after reclamation.
Surface water and aquatic biota	Water quality standards would not be exceeded. No cost to surface water use or use (e.g., fishing) of aquatic biota would be anticipated.	There would be virtually no potential for impact to surface water or aquatic biota.
Wildlife	No population of game animal would be reduced. No impact on economic use of wildlife would be expected.	No significant impact on economic use of wildlife would be expected
Floodplains and wetlands	The loss of a small amount of floodplain and wetland should have no economic impact.	No wetland or floodplain would be affected.
Socioeconomics	Reclamation would produce costs and benefits associated with employment and truck transport. Economic profits associated with population growth would be limited by the unavailability of roughly half of the Atlas site for alternative land uses.	Reclamation would produce costs and benefits associated with employment, truck transport, and rail transport. The Atlas site could eventually be developed for alterative land uses once groundwater cleanup has been completed. No impact would occur at the Plateau site.
Public and occupational health and safety	No significant costs are anticipated (exposures are within guidelines).	No significant costs are anticipated (exposures are within guidelines).
Long-term risk of the hypothetical tailings pile failure	Short-term costs to the local economy would occur, but they cannot be estimated.	No adverse impacts on the local economy should occur.

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Dr. Easterly is the leader of the Health Effects Group at ORNL where he has been employed since 1973. His formal training in physics has allowed him to work in diverse fields which require identification and conceptualization of problems and development of their solution. Dr. Easterly's degree is in physics with a minor in health physics. Essentially all his work experience has been involved in some ways with effects on human health. His current work is directed toward the understanding of human health response to energy and environmental factors and requires the integration of numerous specialty areas. It involves identification and quantification of potential hazards, the development of risk models, and the application of those models for specific purposes. Dr. Easterly was active in the area now known as "health risk assessment" for more than a decade before the phrase became popular.

EDUCATION:

- B.S. in Physics from Mississippi State University in 1966
- Ph.D. in Physics from University of Tennessee in 1972

Myron H. Fliegel
Senior Project Manager
U.S. Nuclear Regulatory Commission
Washington, D.C.

Dr. Fliegel is a senior project manager in the uranium recovery program where he is responsible for managing NRC reviews of licensee actions and activities. He has been involved in environmental aspects of nuclear facilities since his employment by the Atomic Energy Commission in 1974. He reviewed surface and ground water aspects of nuclear power plants, preparing inputs to environmental impact statements and safety evaluation reports. His experience with uranium recovery facilities dates to 1987 when he became Leader of the Uranium Recovery Section.

EDUCATION:

B.S. in Physics from the City College of New York in 1965
Ph.D. in Physical Oceanography and Limnology from Columbia University in 1972

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Mr. Eddlemon is a member of the Environmental Assessment Group at ORNL where he has worked since 1974. An aquatic ecologist, Mr. Eddlemon has prepared analyses and provided other technical support related to surface water and aquatic ecology for more than 40 environmental assessments, impact statements, and reports involving a wide range of technologies and geographical locations. He has also participated as team member or leader in more than 30 comprehensive environmental compliance audits for the U.S. Air Force, U.S. Navy, DOE, and the Food and Drug Administration, and has provided technical support on environmental matters over the past 14 years to DOE's Office of NEPA Oversight and Assistance and other government agencies.

EDUCATION:

B.S. in Zoology from The University of Tennessee-Knoxville in 1970
M.S. in Zoology from The University of Tennessee-Knoxville in 1974

Robert O. Johnson
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Oak Ridge, Tennessee

Dr. Johnson is a member of the Applied Physical Sciences Group at ORNL where he has worked since 1986. Dr. Johnson has prepared the surface water, floodplains, groundwater, geology, and soils sections of twenty-six environmental reports, assessments, and impact statements. His surface water work has included regional and local flood prediction, dam failure analyses, water quality evaluations, open-channel hydraulics, and thermal plume analyses. Dr. Johnson's groundwater work has included flow and contaminant transport of underground, chemically reacting species using analytical, finite-difference, and finite-element methodologies. Dr. Johnson is a member of the American Society of Mechanical Engineers and the Honor Society of Phi Kappa Phi.

EDUCATION:

- B.S. in Mechanical Engineering from the University of Evansville in 1972
- M.S. in Mechanical Engineering from Purdue University in 1975
- Ph.D.in Engineering Science and Mechanics from the University of Tennessee--Knoxville in 1984

Roger L. Kroodsma (retired)
Environmental Analyses Section
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Oak Ridge, Tennessee

Dr. Kroodsma was a member of the Environmental Assessment Group at ORNL from 1974 until his retirement in December 1995. His involvement with environmental assessments dates back to 1973 when he conducted ecological studies under E. P. Odum at the University of Georgia. Dr. Kroodsma's specialties include plant and animal ecology, as well as forest, wetland, and grassland ecosystems. Dr. Kroodsma has served as team leader for fourteen environmental impact statements or environmental assessments; he has participated in the development of 44 other such documents.

EDUCATION:

- B.A. in Biology from Hope College in 1966
- M.S. in Zoology from North Dakota State University in 1968
- Ph.D. in Zoology from North Dakota State University in 1970

Allan T. Mullins (retired)
U.S. Nuclear Regulatory Commission
Washington, D.C.

Allan Mullins was a project manager for the uranium recovery program where he was responsible for reviewing and assessing activities of the Department of Energy on UMTRCA Title I remedial action sites until his retirement in 1995. His original experience with environmental studies began in 1971 and continued until 1984 while employed by the Tennessee Valley Authority (TVA) in the fuels area where he worked on environmental assessments under NEPA, including the management of programs for various coal prospecting, mining, and utilization projects for TVA's coal supply program and for uranium exploration, mining, and milling activities in support of TVA's uranium mineral rights program.

EDUCATION:

- B.S. in Geology from Florida State University in 1957
- M.S. in Geology from Florida State University in 1959

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Mr. Petrich is a member of the Energy and Global Change Analysis Section at ORNL where he has been employed since 1976. Mr. Petrich's technical specialties include aesthetic impact assessment, energy planning, general environmental impact assessment, environmental planning, and resource assessment in developing countries. His current research projects address the aesthetic implications of construction and operation of a scenic parkway in Tennessee, the aesthetic impacts of relicensing hydropower facilities in Montana, the socioeconomic impacts of *in situ* uranium mining in New Mexico, water resource planning in Puerto Rico, and the effects of global climate change on renewable energy resources.

EDUCATION:

- B.S. in Botany from Duke University in 1969
- M.L.A. in Landscape Architecture from the University of Michigan in 1976
- M.B.A. in Business Administration from the University of Chicago in 1995

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Oak Ridge, Tennessee

Dr. Reed is the head of the Environmental Analysis and Assessment Section at ORNL where he has been employed since 1977. His research interests in the environmental assessment process have involved him in numerous projects involving a wide range of technologies and geographic areas. Dr. Reed has served as technical analyst for assessing impacts on terrestrial ecological resources and land use and as project leader for more than 20 environmental impact statements and environmental assessments. He has conducted field research on forest communities in the western United States and eastern Canada, and taught ecology and botany at the University of Ottawa for eight years before coming to ORNL.

EDUCATION:

- A.B. in Botany from Duke University in 1963
- Ph.D. in Botany/Plant Ecology from Washington State University in 1969

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TRANSCOM Project Manager
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Mr. Reich is a member of the Transportation Technologies Group at ORNL where he is the manager of the TRANSCOM Project, a satellite-based transportation tracking and communications system for DOE spent fuel shipments. In his 8 years at ORNL, Mr. Reich has also worked in the Advanced Technologies and Assessments Group where his duties included performing transportation risk assessments, nuclear fuel cycle analysis, development of advanced nuclear reactor concepts, computer simulation and modeling, and computer programming. He is a member of the American Nuclear Society.

EDUCATION:

- B.S. in Nuclear Engineering from the University of Missouri-Rolla in 1986.
- M.S. in Nuclear Engineering from the University of Missouri-Rolla in 1993.

William P. Staub
Research Staff Member
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Dr. Staub is a member of the Applied Geology Group at ORNL where he has worked since 1976. His research interests are geologic hazard analysis, slope stability analysis, and uranium mill tailings management. Dr. Staub is a technical analyst for subsidence and earthquake hazards issues as well as erosion and groundwater issues related to long-term stabilization of tailings. Dr. Staub has authored or co-authored five NUREGS, two journal articles, and five conference papers related to long-term stabilization of uranium mill tailings and in-situ uranium mining. He also participated in the preparation of several environmental impact statements related to uranium mills. Previously, Dr. Staub conducted field research in exploration geophysics in the U.S. mid-west and was an exploration seismologist for an oil company on the U.S. gulf coast and western

North America. Dr. Staub taught engineering geology and applied geophysics at the University of Tennessee and was a consultant to the Geologic Branch, Tennessee Valley Authority, for seven years before coming to ORNL.

EDUCATION:

- B.S. in Geological Engineering from Washington University in 1956
- M.S.in Geology from Washington University in 1961
- Ph.D. in Geotechnical Engineering from Iowa State University in 1969

James W. Van Dyke
Research Associate
Environmental Analysis and Assessment Section
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Mr. Van Dyke is a member of the Human Systems and Technology Group at ORNL, where he has worked since 1978. His work has included projects related to need for power analysis for nuclear and hydroelectric power plants, analysis of rates of return on investment, simulation of economic dispatch within an electric power pool, consideration of the impact of regulations on benefits and costs of energy production, evaluation of economic and social impacts on local communities, evaluation of regulations on management and disposal of low-level radioactive waste, and participation in public negotiation of issues in siting hazardous waste facilities. Prior to coming to ORNL, he worked as an Executive Policy Aid with the South Dakota State Planning Bureau.

EDUCATION:

- B.S. in Economics from Purdue University in 1971
- M.S. in Economics from Colorado State University in 1976

Phillip J. Walsh
Private Consultant
Oak Ridge, Tennessee

Dr. Walsh has been an independent consultant since May 1994. Work during that time has included radiological analysis for ORNL and the DOE Y-12 Plant in Oak Ridge, Tennessee. From May 1989 through April 1994, he was a senior environmental health scientist and corporate scientists for H&R Technical Associates, Inc., where he was a technical resource for staff members conducting safety analyses and risk assessments. From August 1976 through April 1988, he was a staff member, group leader, section head, and division director at ORNL. Research included development of analytical methods and supporting biological research for human health risk analysis. From June 1968 through July 1976, Dr. Walsh was a radiation physicist at the National Institute of Environmental Health Sciences where he participated in theoretical and experimental health effects research on physical factors (ionizing and non-ionizing radiation). He was associate project officer and project officer for contracts on health hazards of uranium mining. He has been involved in radiation (particularly radon) and general chemical dosimetry and risk for over 25 years.

EDUCATION:

- B.S. in Nuclear Physics from North Carolina State University in 1964
- M.S. in Health Physics from the University of North Carolina in 1965
- Ph.D. in Environmental Sciences and Engineering from the University of North Carolina in 1968

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APPENDIX A

Reserved for Comments on the Draft Environmental Impact Statement

APPENDIX B

PRINCIPAL DOCUMENTS SUPPORTING THE ATLAS CORPORATION'S SOURCE MATERIAL LICENSE SUA-917

Atlas Corporation	Date (frequency)
Environmental report (for license renewal)	August 31, 1973
Safety analysis report	November 1974 August 28, 1975
Alternatives study for tailings management and reclamation	October 14, 1977
Conceptual plan for tailings reclamation	July 10, 1981
Environmental report for license renewal	May 1984
Environmental report supplement	April 6, 1993
Geotechnical report for 18-foot embankment raise	September 25, 1984
Mill decommissioning plan	November 1987
Groundwater hydrology detection monitoring program	February 25, 1988
Groundwater detection monitoring program	October 31, 1988
Corrective action plan for mill and tailings	March 1989
Corrective action program reviews	(annual, 1990–present)
Reclamation plan for mill and tailings pile	August 2, 1988
Technical specifications for reclamation plan	January 17, 1989
Reclamation plan for tailings pile	June 4, 1992
Revisions	April 14 and 23, 1993
Environmental monitoring reports	(biannual)
Land use surveys	(annual updates)
ALARA (as low as reasonably achievable) audit reports	(annual 1990–present)

Atlas Corporation	Date (frequency)
Responses to NRC request for information:	
on proposed reclamation plan	April 1993 and January 1994
on reclamation alternatives and groundwater compliance	December 13, 1993
on reclamation plan	January 1994
on reclamation plan for uranium mill and tailings disposal area	June 1994
on groundwater corrective action plan	July 1994
Final Report, Geomorphic, Hydraulic and Lateral Migration Characteristics of the Colorado River, Moab, Utah	May 1994
Responses to NRC Comments on the Moab Fault, Utah	June 1994

Nuclear Regulatory Commission	Date (frequency)
Code of Federal Regulations, 10 CFR Parts 0–199	
Final environmental statement for mill operation	January 1979
Safety evaluation of 18-foot embankment raise	June 28, 1982
Safety evaluation report	February 22, 1988
Environmental assessment for decommissioning	February 22, 1988
License amendment no. 3	November 28, 1988
Technical Evaluation Report for tailings reclamation on the Moab site	July 7, 1993
Environmental Assessment for tailings reclamation on the Moab site	July 1993
Groundwater quality reviews	(biannual)
Corrective action program reviews	(annual)
Technical evaluations of embankment performance	(annual)
Draft Technical Evaluation Report	December 1996

APPENDIX C

SUMMARY LIST OF THE 13 APPENDIX A TECHNICAL CRITERIA IN 10 CFR 40

Criterion	Summary description

1. (a) Maximize remoteness from populated areas.
   (b) Hydrologic and other natural conditions promote immobilization and isolation of contaminants.
   (c) The potential for erosion, disturbance, and dispersion by natural forces is minimal.
2. Avoid proliferation of small waste disposal sites.
3. The prime option for disposal of tailings is placement below grade.
4. (a) Upstream rainfall catchment areas are minimal.
   (b) Topographic features provide good wind protection.
   (c) Embankment and cover slopes must be relatively flat after final stabilization (generally not steeper than about 20% (1 vertical per 5 horizontal).
   (d) A vegetative cover or rock cover must be used to minimize wind and water erosion.
   (e) The tailings are not located near a capable fault that could cause an earthquake larger than that which the impoundment could reasonable be expected to withstand.
   (f) The impoundment design incorporates features to promote deposition of sediments and enhance the thickness of the tailings cover system.
5. (a) A design standard for tailings disposal is the primary groundwater protection standard imposed by the U.S. Environmental Protection Agency (EPA).
   (b) Unless exempted, surface impoundments must have a liner.
   (c) The impoundment must be designed to prevent overtopping.
   (d) Impoundment dikes must be designed to prevent massive failure.
   (e) Hazardous constituents entering the uppermost aquifer beyond the point of compliance must not exceed the secondary groundwater protection standard established by the U.S. Nuclear Regulatory Commission (NRC). The NRC may exclude a constituent from the set of hazardous constituents on a site-specific basis if it finds that the constituent is not capable of posing a substantial present or potential hazard to human health or the environment.
   (f) Alternate concentrations limits (ACLs) may be proposed by the licensee and established by NRC under certain conditions. Numerous factors are listed, which must be considered by NRC when establishing ACLs.
   (g) If secondary groundwater protection standards established by NRC are exceeded, a corrective action program is required.
   (h) Groundwater protection programs must consider the use of liners, appropriate mill process designs, dewatering of tailings, and neutralization of tailings.

Criterion	Summary description
	(i) Actions must be taken to alleviate conditions leading to excessive seepage from tailings.
	(j) The licensee must supply information on tailings composition, soil and geologic conditions, and use of groundwater at and near the site.
	(k) Ore stockpiles must be designed to minimize movement of radionuclides into soils.
6.	Final reclamation of tailings shall provide reasonable assurance of control of radiological hazards for 1000 years to the extent practicable but, in any case, for at least 200 years, and limit releases of radon to an average of 20 picocuries per square meter per second. After placement of the final cover but prior to placement of erosion protection barriers, testing and analysis or other method approved by the Commission shall verify that the radon limit is not being exceeded.
7.	A preoperational monitoring program must be conducted at least one full year prior to any major site construction.
8.	Milling and tailings disposal operations must be conducted so that all airborne effluent releases are reduced to levels as low as is reasonably achievable.
9.	Financial surety arrangements must be established.
10.	A minimum charge of $250,000 (1978 dollars) to cover the costs of long-term surveillance must be paid to the general treasury of the United States or other appropriate agency prior to license termination.
11.	Ownership of byproduct material and land must be transferred to an appropriate federal or state agency, which may permit certain uses of the land.
12.	Site inspections must be conducted by the agency responsible for long-term care of the disposal site.
13.	This criterion provides a list of hazardous constituents whose presence requires the establishment of secondary groundwater protection standards.

APPENDIX D

RESULTS OF THE SCOPING PROCESS

D.1 INTRODUCTION

The environmental impact statement (EIS) for reclamation of the Atlas tailings pile is being prepared in compliance with the National Environmental Policy Act of 1969 (NEPA) and the implementing regulations promulgated by the Council on Environmental Quality (CEQ). The scoping process for the EIS was held in accordance with 10 CFR Part 51, which contains the U.S. Nuclear Regulatory Commission (NRC) requirements for implementing the CEQ regulations. A public scoping meeting was held at Starr Hall in Moab, Utah, on April 14, 1994. About 43 people (not including people who represented government agencies) attended the meeting, and 8 persons gave oral comments. The NRC also invited the public and interested agencies, organizations, and individuals to submit their written suggestions and comments by May 13, 1994, for consideration in the EIS process.

The scoping process provided an opportunity for public participation in identifying the concerns and issues that should be included in the EIS. The primary objectives of the scoping process for the EIS include the following, as required by NRC regulations [10 CFR 5129 (a) (1–8)]:

- define the proposed action to be the subject of the EIS,
- determine the scope of the EIS and the significant issues to be analyzed in depth, and
- identify and eliminate from detailed study issues which are not significant or which are peripheral or which have been covered by prior environmental review.

All comments and suggestions received during the scoping meeting, as well as those submitted to the NRC during the scoping period, were considered. Oral comments at the scoping meeting were transcribed by a certified court reporter, and the meeting transcript was supplemented by materials submitted by the speakers. Comments in the transcript and all written material received were reviewed. Comments were then consolidated and categorized by topic areas.

The draft EIS (DEIS) considers relevant environmental issues raised during the scoping process and will be made available for public comment. The comment period for the DEIS will provide an additional opportunity for interested agencies, organizations, and individuals to provide input into the NRC's environmental review process. Comments received on the DEIS will be considered in the preparation of the Final EIS (FEIS).

In consideration of the scoping comments, this DEIS assesses and compares in detail the potential impacts of (1) tailings reclamation at the Atlas site near Moab, and (2) tailings transport by rail and reclamation at the plateau site near the Redtail Airport northwest of Moab. In addition, the potential impacts of a hypothetical failure of the tailings pile, with a fraction of the tailings entering the Colorado River, is also discussed in the DEIS. Other alternate sites for tailings disposal and alternate tailings transport modes are briefly discussed.

A summary of the scoping comments received from the public and government agencies is provided below.

D.2 TAILINGS CONTENT, RECLAMATION, AND EFFLUENTS

Several comments stated that reclamation in place is not consistent with NRC policy and prior NRC actions involving tailings reclamation, and offered the opinion that NRC should abide by its current policy and not make exceptions for Atlas. Some commenters mentioned specific aspects of the reclamation plan that they felt violated NRC policy, such as slopes being too steep, location on a floodplain, and location near a populated area. Several commenters were concerned that reclamation measures were not adequate and wanted a thicker clay cap, greater riprap protection, a membrane liner, more conservative estimates of tailings moisture content for modeling long-term radon attenuation, design for a 4.5-Richter earthquake, and a more conservative erosion protection plan.

Other commenters wanted a better description of tailings content (i.e., chemical and physical composition); integration of air and water protection; "overdesign" for maximum protection; appropriately coordinated timing of cover placement with the completion of dewatering and groundwater corrective actions; and a reevaluation of the modeling used to determine riprap requirements for flood protection. Other concerns included the flushing of the tailings base by annual flooding of the Colorado River, the permeability of the tailings base, possible tailings pile instability caused by riprap weight on the slimes and alluvial floodplain soils, responsibility for reclamation if Atlas were to go bankrupt, and that getting rock from the La Sal Mountains may not be feasible due to snow, road load limits, and tourist traffic. Commenters were concerned about the release of selenium, radon emissions, lead, and other toxic trace elements.

D3. ALTERNATIVES, IMPACT ASSESSMENT, AND EIS CONTENT

Commenters wanted disposal at an alternate site and the safest, most environmentally sensitive means of tailings disposal consistent with NRC policy. A representative of the state of Utah stated that reclamation in place and disposal at the airport site should be the primary alternatives, and that the box canyon site should be excluded. Commenters also wanted a comprehensive technical analysis and cost and risk comparisons of alternatives and mentioned many factors of concern that should be included in the comparison. They favored transport of tailings by rail. Commenters emphasized that the comparison of alternatives should use up-to-date information, particularly with regard to costs. A representative of the EPA stated that the extra time required to reclaim the tailings at an alternate site would not be inconsistent with the NRC memorandum of understanding with EPA.

Commenters stated that the EIS should assess the long-term risk of exposure pathways, provide adequate up-to-date data to support analyses, include new information from studies that should be conducted (e.g., studies of effects on groundwater and surface water and toxin levels in fish), consider cumulative impacts, quantify impacts to the extent feasible, list required permits, and provide enough information from referenced documents to allow the reader to understand how conclusions were reached.

D.4 GEOLOGY AND SEISMICITY

Commenters want the EIS to discuss the possible magnitude of earthquakes and the effects of the Moab Fault on the tailings pile at its current location compared to reclamation at an alternate site. Commenters stated that the EIS should estimate seismic activity based on a very long time frame and oil production in the vicinity, consider whether the wet floodplain alluvium might amplify the effects of an earthquake, consider the "creeping" effect of the salt layer under the tailings pile, and report on the effects of the October 14, 1993, earthquakes on the tailings pile.

D.5 NATIONAL PARKS AND LAND USE

Several commenters felt that aesthetic effects and contamination from the tailings pile in its current location represent a major threat to national parks and recreation areas and the future of these areas, where visitation is increasing 15% per year. The National Park Service (NPS) will hold the licensee and NRC responsible for damages. A representative of Northwest Pipelines Corporation mentioned that the reclamation plan should be modified to avoid relocation of its pipeline and the utilities of other companies, thus avoiding a high relocation cost.

D.6 METEOROLOGY AND AIR QUALITY

One person maintained that the tailings pile contributed in part to a strong radiation buildup in the valley and canyons of the Moab area during periods of low pressure and strong temperature inversion, and that the tailings should be moved out of this air drainage system. The release of tailings during high winds, remediation of this problem, and effects on Class I and II airsheds were other concerns.

D.7 HYDROLOGY AND RIVER CHANNEL MIGRATION

Many commenters were concerned that the Colorado River could significantly impact the tailings pile by erosion during large floods, flushing of the base of the pile during annual floods, and long-term migration of the river channel into the pile. Comments indicated that information needs to be presented on these topics, including modeling of local velocities in the river at the site, flow of groundwater through the historic channel of Moab Wash under the tailings pile, river stabilization techniques that may be necessary to protect the tailings pile, and estimates of probable maximum floods assuming "paleofloods" and failure of upstream dams. One commenter wanted the EIS to consider the fate of diversion dams near Courthouse Wash and the potential increase in maximum flood level in Moab as a result of obstruction of flows by the tailings pile.

D.8 FLOODPLAINS AND WETLANDS

Concerns included the effects of contamination on nearby wetlands, suspension of the Atlas license until a floodplain/wetlands assessment is prepared, and compliance with the National Flood Insurance Program and Clean Water Act.

D.9 SURFACE WATER QUALITY

Degradation of water quality in the Colorado River was the primary concern of commenters. Concerns mentioned included incremental degradation of water quality, cumulative effects, accumulation of contaminants in river bottom sediments and aquatic biota, and effects on Lake Powell. Studies of contamination rates and contaminant levels were suggested.

D.10 GROUNDWATER

Studies of regional and local groundwater flow were suggested, including a study of whether the Colorado River is a discharge area for bedrock aquifers. Commenters objected to establishing alternate concentration limits to allow higher levels of contamination. Commenters want the EIS to consider leaching of contaminants into groundwater, "pumping" of contaminants from the tailings pile by annual rise of groundwater levels during river flooding, flow of contaminants along the Moab Fault, and the possibility that the clay cap may increase the radon contamination of groundwater. Commenters recommended that the groundwater monitoring program be increased and that a groundwater cleanup plan be submitted to the state of Utah.

D.11 WATER USE

Commenters pointed out the importance of recreational, agricultural, and domestic uses of Colorado River water downstream of Moab. They felt the EIS should consider the effect of a tailings pile washout into the River.

D.12 AQUATIC AND TERRESTRIAL BIOTA AND THREATENED AND ENDANGERED SPECIES

Commenters felt the EIS should consider the risks of contamination of the aquatic and terrestrial food chain, bioaccumulation of contaminants, impacts on productivity in the river and Lake Powell, the risks of a tailings impoundment failure, and effects on fish and wildlife (including threatened and endangered species) eating contaminated food. Impacts could violate the "takings" provisions of the Migratory Bird Treaty Act and result in criminal prosecution. Routine monitoring of fish and studies to determine baseline contaminant levels in aquatic biota and the cause of dead vegetation at the tailings pile were recommended. The U.S. Fish and Wildlife Service (FWS) stated that, for the proposed action and any use of water from the river, formal consultation under the Endangered Species Act is necessary for threatened and endangered fish, the peregrine falcon, and the bald eagle.

D.13 SOCIOECONOMICS, AESTHETICS, AND CULTURAL RESOURCES

Commenters stated that the EIS needs to consider the large transitory human population in addition to the permanent population, and possibly large increases in these populations. Potential aesthetic and contamination-related impacts of the tailings pile on local tourism, the local economy, and the economies of downstream areas depending on use of Colorado River water are major issues. Other comments discussed the need to remove the tailings so the Atlas site can be used for other commercial purposes and concerns for impacts of riprap transport on the town of Castle Valley and travelers on the transport route.

D.14 RADIOLOGICAL ASPECTS AND HUMAN HEALTH

Issues mentioned included radiation effects on people if the pile is reclaimed in place, hazards to workers and the public if the pile is moved, high levels of radiation in groundwater, and that alternate concentration limits in groundwater should not be established. One commenter claimed a high lung cancer rate in Grand County and suggested studies and mitigation measures. Other health concerns included traffic hazards of riprap transport by truck, eating of contaminated fish, and exposure to radiation in areas accessible to the public near the tailings pile.

D.15 COST-BENEFIT ANALYSIS

Many commenters stated that cost estimates for tailings reclamation were obsolete and that new cost estimates should be determined based on up-to-date information and recent experience in tailings transport. Some commenters felt that reclamation at an alternate site might not be more expensive than in-place reclamation; they mentioned a number of costs that might be less at an alternate site (e.g., riprap requirements, clay transport costs, monitoring costs, repairs of damage caused by river flooding, costs of obtaining alternate concentration limits). Commenters want a thorough comparison of the costs of in-place reclamation with reclamation at an alternate site, including information showing how the costs were determined. A few comments stated that potential socioeconomic impacts that could result from river contamination and impacts on tourism should be included in cost comparisons of alternatives.

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APPENDIX E

CONSULTATION LETTERS RECEIVED FROM AGENCIES

Department of Community & Economic Development
Division of State History
Utah State Historical Society

Michael O. Leavitt
Governor
Max J. Evans
Director

300 Rio Grande
Salt Lake City, Utah 84101-1182
(801) 533-3500
FAX (801) 533-3503

September 19, 1994

Carl H. Petrich
Building 4500-N; MS-6206
Oak Ridge National Laboratory
P. O. Box 2008
Oak Ridge, TN 37831-6206

RE: Atlas Tailings Pile, Moab, Utah

In Reply Please Refer to Case No. 93-0324

Dear Mr. Petrich:

The Utah State Historic Preservation Office has received a draft of the section on cultural resources for the EIS and a request for known sites in the alternative reclamation area. No known sites or surveys are located in the Klondike Flat area. Secondly concerning the draft text, our office has no technical comment concerning the background material, good job.

The Utah Preservation Office recommends a survey of the Klondike Flat area.

This information is provided on request to assist in identifying historic properties, as specified in 36CFR800 for Section 106 consultation procedures. If you have questions, please contact me at (801) 533-3555. My computer address on internet is: internet:cedomain.cehistry.jdykman@email.state.ut.us

Sincerely,

James L. Dykmann
Compliance Archaeologist

JLD:93-0324 NRC

State of Utah
DEPARTMENT OF NATURAL RESOURCES
Utah Natural Heritage Program

Michael O. Leavitt
Governor

Ted Stewart
Executive Director

Triad Office
355 West North Temple
3 Triad Center, Suite 450
Salt Lake City, UT 84180-1204
801-538-5428
801-521-0657 (Fax)

8 August, 1994

Mr. Gerald K. Eddlemon
Environmental Sciences Division
Oak Ridge National Laboratory
Oak Ridge, TN 37831

Dear Mr. Eddlemon:

I am writing in response to a request forwarded to me by Utah Division of Wildlife staff within the Southeast Region, which was originally sent by you to Mr. Bill Bates, Regional Habitat Manager.

Our Program was asked to respond to your request with regard to rare plant taxa for your environmental impact statement on the Atlas Minerals Moab Mill tailings pile.

Our database was searched for federally proposed or listed Threatened or Endangered, federal candidates for listing (Category 1 or 2), or otherwise sensitive plant taxa.

Two federal Category 2 candidates for listing are known from areas northwest of Moab, UT near your proposed and alternative disposal sites:

* Astragalus sabulosus occurs on the Mancos Shale Formation and also on the Morrison and Cedar Mountain Shale Formations in your project area. It occurs in the vicinity of upper Courthouse Wash northwest of Moab and then northeast into the Cisco Desert as far west as Cisco. It is endemic to Grand County, Utah, along washes and gullies in low, barren hills in stiff clays and alluvial gravels from sandstone at 4100-5200 feet elevation. It grows in salt desert shrub communities.

* Oreoxis trotteri is endemic to the vicinity of Courthouse Rock in Grand County, UT. At this Courthouse Mesa location, it occurs on the main body of Entrada Sandstone on the east slope of Courthouse Rock and on Navajo Standstone on the flat below. It is most abundant on the white sandstone Moab Tongue of the Entrada Formation. The Moab Tongue is the more resistant "upper crust" of rounded domes across the mesa tops in this area.

Mr. Gerald K. Eddlemon
8 August, 1994
Page 2

Oreoxis trotteri grows in crevices of the Moab Tongue where its exposure, though very much in the open, tends to be more to the north. There are occasional plants that grow in the flat with no protection at all. Less frequently, it is located in alcoves and along cliff bases that are moist and shaded. In these more protected locations plants can be as large as two feet in diameter and can be found growing with such plants as Aquilegia micrantha and Cornus sericia.

Appropriate consideration should be given to these rare plants before siting disposal areas for the Atlas Minerals tailings.

The information in this letter of response is based on existing data known to the Utah Natural Heritage Program at the time of the request. The information should not be regarded as a final statement on the occurrence of any special-status species. Also because the UTNHP database is continually updated and because data requests are evaluated by the type of action, any given response is only wholly appropriate for its respective request.

Please contact our office if you have any questions, require further information, or have additional information needs for other projects.

Sincerely,

Joel M. Peterson,
Information Manager
Utah Natural Heritage Program

United States Department of the Interior

FISH AND WILDLIFE SERVICE

UTAH FIELD OFFICE
LINCOLN PLAZA
145 EAST 1300 SOUTH, SUITE 404
SALT LAKE CITY, UTAH 84115

In Reply Refer To
(ES)

November 2, 1994

Roger L. Kroodsma
Oak Ridge National Laboratory
P.O. Box 2008
Bldg. 1505, Mail Stop 6038
Oak Ridge, Tennessee 37831

Dear Mr. Kroodsma:

The U.S. Fish and Wildlife Service (Service) has reviewed your letter, received September 15, 1994, regarding the preparation of an environmental impact statement (EIS) for the reclamation of the Atlas Corporation uranium mill tailings at Moab, Grand County, Utah.

The Service advises that the following listed threatened or endangered species may occur in the vicinity of the potential project areas:

American peregrine falcon	Falco peregrinus
Humpback chub	Gila cypha
Bonytail chub	Gila elegans
Colorado squawfish	Ptychocheilus lucius
Razorback sucker	Xyrauchen texanus
Jones cycladenia	Cycladenia humilis v. jonesii

The Nuclear Regulatory Commission, as the federal agency permitting this project, should evaluate the proposed activities to determine whether or not any action would affect any listed species or their designated critical habitat. Since this project is a major federal construction activity, requiring preparation of an EIS, you must prepare a Biological Assessment for submittal to the Service. If a determination of "may affect" is made for any listed species or critical habitat, you must request in writing formal consultation from the Assistant Field Supervisor, at the address given above. At that time you should provide this office a copy of the Biological Assessment and any other relevant information that assisted you in reaching your conclusion.

The peregrine falcon nests in the Moab area. No construction activities are allowed within one mile of an active aerie during the breeding season (February 15 - July 31). Local land managing agencies such as the Bureau of Land Management, National Park Service, and State Parks can determine if proposed project activities fall within this zone.

The Jones' cycladenia occurs in the Castle Valley area. The impact of the proposed borrow pit, including access roads and storage areas, on this species, should be determined.

The four fish species occur in the Colorado River system. The proposed project could affect the fish both directly and indirectly. Direct effects could result from sediments and contaminants being deposited in the river during project activities. The Service has discussed these issues in detail in letters to the Nuclear Regulatory Commission dated May 13, 1994 (from this office), and September 1, 1993 (from the Denver Regional office). To date these concerns have not been adequately addressed.

Indirect effects could result from water depletions associated with the project. Under the Recovery Implementation Program (RIP) for the listed fish, any depletion of water, including water used for construction activities such as dust suppression, drilling, and mixing of concrete, from the Upper Colorado River Basin is considered a jeopardy to the fish and thus requires formal consultation with the Service. In March of 1994, critical habitat was designated for the four fish species in the Upper Colorado River Basin (Federal Register Vol. 59 No. 54, March 21, 1994). The Colorado River near Moab was designated critical habitat for the Colorado squawfish and razorback sucker. Depletion of water is also considered to be an adverse modification of critical habitat.

If we can provide any assistance in addressing these concerns, please contact Susan Linner, Fish and Wildlife Biologist, at (801) 524-5001.

Sincerely,

Robert D. Williams
Assistant Field Supervisor

cc: Uranium Recovery Field Office, Denver, CO
ARD, FWE, Region 6, Denver, CO

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APPENDIX F

BIOLOGICAL ASSESSMENT

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

November 1, 1995

Mr. Robert D. Williams
State Supervisor
Fish and Wildlife Service
U.S. Department of Interior
145 E 1300 S #404
Salt Lake City, Utah 84115-5400

SUBJECT: BIOLOGICAL ASSESSMENT RELATED TO THE PROPOSED RECLAMATION OF THE ATLAS MILL TAILINGS SITE IN MOAB, UTAH

Dear Mr. Williams:

Enclosed is the U.S. Nuclear Regulatory Commission's Biological Assessment related to the proposed reclamation of the Atlas Corporation's (Atlas') mill tailings site in Moab, Utah. We conclude that the proposed action is unlikely to adversely affect endangered or threatened species at the population level. However, there is not enough data to conclude that individual Colorado squawfish and razorback suckers, which might be present in the mixing zone adjacent to the tailings site and at downstream deposition areas, will not be affected. We therefore request formal consultation from the Fish and Wildlife Service under the Endangered Species Act.

Atlas holds NRC license SUA-917 for its uranium mill in Moab, Utah. The mill is inoperative and Atlas is required to reclaim the site and the mill tailings in accordance with regulations in 10 CFR Part 40. Atlas' proposed reclamation is currently undergoing review by NRC. In addition, NRC is preparing an Environmental Impact Statement (EIS) related to this proposed action. We plan to include the Biological Assessment, which was prepared for NRC by Oak Ridge National Laboratory, as an appendix to the EIS. We understand that under the formal consultation process, you will prepare a biological opinion within 90 days.

If you have any questions, please contact the NRC project manager for this action, Dr. Myron Fliegel, at (301) 415-6629.

Sincerely,

Joseph J. Holonich

Joseph J. Holonich, Chief
High-Level Waste and Uranium
Recovery Projects Branch
Division of Waste Management
Office of Nuclear Material Safety
and Safeguards

Enclosure: As stated

cc: R. Reed, ORNL

BIOLOGICAL ASSESSMENT OF ENDANGERED AND THREATENED SPECIES THAT MAY BE AFFECTED BY THE PROPOSED RECLAMATION OF THE ATLAS MILL TAILINGS SITE, MOAB, UTAH

Prepared by

G. K. Eddlemon
Environmental Sciences Division

R. M. Reed
Energy Division

October 1995

Prepared for
Office of Nuclear Material Safety and Safeguards
U.S. Nuclear Regulatory Commission

by
OAK RIDGE NATIONAL LABORATORY
Oak Ridge, Tennessee 37831
managed by
LOCKHEED MARTIN ENERGY SYSTEMS, INC.
for the
U.S. DEPARTMENT OF ENERGY
under contract DE-AC05-84OR21400

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BIOLOGICAL ASSESSMENT OF ENDANGERED AND THREATENED SPECIES THAT MAY BE AFFECTED BY THE PROPOSED RECLAMATION OF THE ATLAS MILL TAILINGS SITE, MOAB, UTAH

1. INTRODUCTION

This biological assessment (BA) has been prepared to evaluate the potential impacts on federally listed endangered and threatened species that could result from the proposed reclamation of the Atlas mill tailings site located in Moab, Utah (Fig. 1). Atlas Corporation (Atlas) has applied to the U.S. Nuclear Regulatory Commission (NRC) for an amendment to its existing NRC license covering the Atlas uranium mill and associated activities. The mill no longer operates and is currently being dismantled. The nearby 9.5-million-metric-ton (10.5-million-ton) uranium mill tailings pile covering an area of approximately 52.6 ha (130 acres), needs to be stabilized for long-term disposal. The license amendment would allow Atlas to (1) stabilize the tailings pile for permanent disposal at its current location on the floodplain of the Colorado River at the Moab site; (2) prepare the 162-ha (400-acre) site for closure; and (3) upon satisfactory stabilization of the tailings pile and site closure, discontinue its responsibility for the tailings, which would then be transferred for long-term custodial care to a government agency (probably the U.S. Department of Energy). Atlas has submitted detailed tailings reclamation plans and environmental data to NRC in support of its amendment application.

The NRC is preparing a Draft Environmental Impact Statement (DEIS) to evaluate the environmental impacts of the proposed action of issuing an amendment to the Atlas license. As part of the EIS process and to comply with the Endangered Species Act (ESA) of 1973, as amended, NRC staff contacted the U.S. Fish and Wildlife Service (USFWS) for information on endangered and threatened species that may be affected by the proposed action. In a letter dated November 2, 1994 (see Appendix E of the DEIS), the USFWS identified six species that may occur in the vicinity of the Atlas site; a seventh recently listed species was identified by USFWS in May 1995. In February 1995, the Department of Interior (DOI) provided comments as a cooperating agency on a preliminary version of the DEIS. The DOI comments expressed concern about the data presented in the pDEIS and indicated that additional consultation under the ESA, including preparation of a BA, was needed. In response to DOI concerns, NRC directed Atlas to conduct additional sampling of water quality, sediments, and biota, following guidance developed in April 1995 by DOI, NRC, and Oak Ridge National Laboratory (ORNL) staff. In May 1995, staff contacted the USFWS for additional information and guidance on preparing a BA on the proposed action (S. Linner, USFWS, Salt Lake City, Utah, personal communication with G. K. Eddlemon, ORNL, Oak Ridge, Tenn., May 19, 1995).

The following endangered and threatened species identified by the USFWS as occurring in the vicinity of the proposed project areas are evaluated in this BA:

American peregrine falcon	*Falco peregrinus*
Humpback chub	*Gila cypha*
Bonytail chub	*Gila elegans*
Colorado squawfish	*Ptychocheilus lucius*
Razorback sucker	*Xyrauchen texanus*
Jones cycladenia	*Cycladenia humilis v. jonesii*
Southwestern willow flycatcher	*Empidonax traillii extimus*

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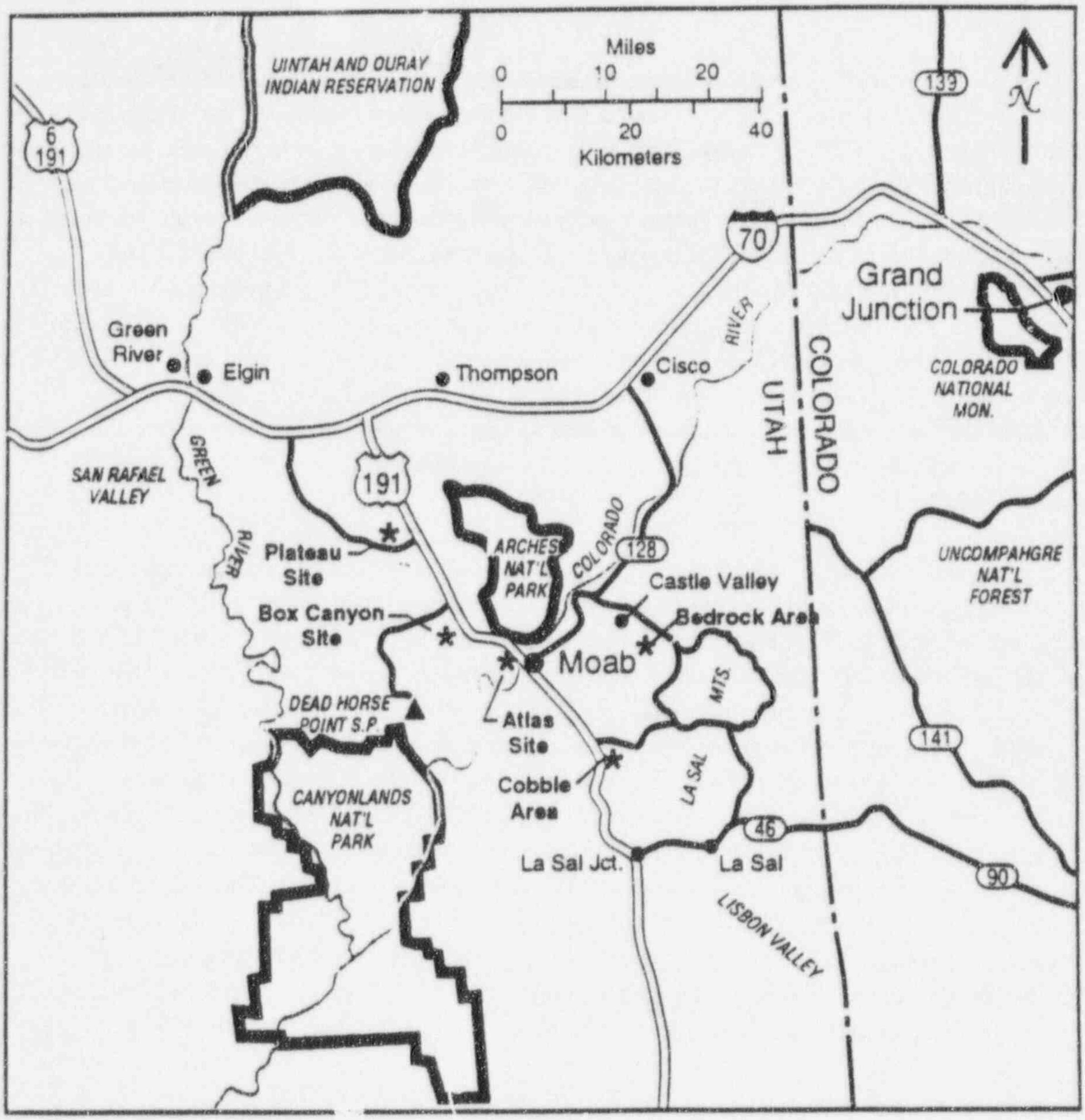

Fig. 1. Regional location of the Atlas Corporation site near Moab, Utah, and the potential borrow areas.

In addition, two Federal Category 2 candidates for listing as threatened species were identified by the State of Utah Natural Heritage Program (J. M. Peterson, Utah Natural Heritage Program, Salt Lake City, Utah, letter to G. K. Eddlemon, ORNL, Oak Ridge, Tenn., August 8, 1994) as being known from areas northwest of Moab near the proposed and alternative sites. These two plant species are *Astragalus sabulosus* and *Oreoxis trotteri*. The possible presence of these Category 2 species and potential impacts to them are addressed in this BA.

Based on the assessment that follows, we conclude that with recommended mitigation, the proposed action is not likely to adversely affect endangered and threatened species in the vicinity of the site. Although the pile is unlikely to adversely affect these species at the population level, the data available for this assessment are not sufficient to support a conclusion that the existing tailings pile does not have an effect on individual endangered Colorado squawfish and razorback suckers that could be present in the mixing zone or downstream deposition areas. This uncertainty can only be resolved by collection of additional data.

2. DESCRIPTION OF THE PROPOSED ACTION

2.1 Description of the Mill Tailings Site

The Atlas Moab mill site is located in Grand County, Utah, on a river terrace on the west bank of the Colorado River about 3.7 km (2.3 miles) northwest of Moab (Fig. 1). The property and facilities were originally owned by the Uranium Reduction Company that was acquired by Atlas Corporation in 1962. Atlas owns approximately 162 ha (400 acres) including the approximately 81 ha (200 acres) on which the mill and tailings are located. Tailings were disposed in the tailings pond from initial start-up in October 1956 until the mill ceased operating in 1984. At various times during its operation, both acid and alkaline leaching were used in ore processing. The pile has five embankments that were raised to the present elevation of 1237 m (4058 ft) above mean sea level (amsl), about 27 m (90 ft) above the surface of the floodplain.

An interim cover has been placed over most of the tailings except at the top center of the pile, where a small pond is located. This area will be covered after the water evaporates. The amount of tailings is estimated to total 9.5 million metric tons (10.5 million tons). The water content of the tailings was reduced to the extent feasible by pumping water from wells in the tailings and discharging the water into the pond. The pumping was completed in early 1994, and the pond is dry except during periods after it receives surface runoff of rainwater. Moab Wash, an ephemeral stream, is located along the north and northeast sides of the tailings pile. Highway 279 and a bluff border the southwest side of the pile (Fig. 1).

2.2 Proposed and Alternative Actions

The purpose of the tailings-reclamation action is to minimize the potential for environmental and public health impacts posed by the existing tailings pile. This purpose can be satisfied only by appropriate stabilization or reclamation of the tailings pile, either at its current location or at an alternate site.

Under the Atlas proposal the tailings pile would be stabilized in its current location, the side slopes of the pile would be reduced to 30% [i.e., 0.9 m (3 ft) vertical per 3 m (10 ft) horizontal] or less to minimize effects of erosion and possible earthquakes. Also, an earth and rock cover system would be installed over the pile to minimize (1) radon escape, (2) infiltration of rain water into the tailings, (3) infiltration of tailings contaminants into groundwater, and (4) tailings erosion potentially caused by surface runoff and flooding of the Colorado River and a nearby ephemeral stream known as Moab Wash. Rock riprap (cobbles and bedrock) and clay required for covering the pile would be transported by truck to the site from several borrow areas, which would likely be located southeast of the town of Castle Valley (riprap), southeast of Moab in Spanish Valley (riprap), and on the Plateau site (clay) about 23 km (14 miles) northwest of the Atlas site (Fig. 2).

An alternative action that is included in the DEIS for comparison purposes would involve moving the tailings and contaminated soils to the Plateau site on Klondike Flats (also a potential borrow area for clay as noted above). The tailings would be transported by conveyor and rail over a period of 6.7–9.4 years. The action would involve constructing a rail spur approximately 4.8 km (3 miles) long, obtaining and transporting riprap material from borrow areas located in Castle Valley and Spanish Valley, transporting mill debris and building materials by truck to the site for disposal with the tailings, and obtaining clay for the cover from the Plateau site and the surrounding area.

3. AFFECTED ENVIRONMENT

3.1 Threatened and Endangered Fish

The USFWS has classified four species of fish native to the upper Colorado River as endangered—the razorback sucker, Colorado squawfish, humpback chub, and bonytail chub (Table 1). Moreover, the USFWS has declared virtually the entire mainstem and associated floodplains of the river to be "critical habitat"—i.e., ". . . specific areas on which are found those physical or biological features essential to the conservation of the species and which may require special management considerations or protection" (59 ***FR*** 13374–13400; March 21, 1994). This critical habitat includes the floodplain and river reach adjacent to the tailings pile. The endangered status of these four species is related to cumulative effects of dams (direct loss of habitat, altered flow and temperature regimes), water diversions, pollutants, and adverse interactions with introduced species.

3.1.1 The Colorado River and Other Surface Waters

The Atlas tailings pile lies on an alluvial terrace (Sect. 2.1) in the 100-yr floodplain of the Colorado River. The principal surface water resource in the area, the Colorado River, meanders within 700 ft (200 m) of the eastern-most extent of the tailings pile. Major tributaries include the Dolores and Green rivers (upstream and downstream, respectively). A 354-ha (875-acre) wetland, the Scott M. Matheson Preserve, lies directly across the river along the east bank. The only other stream potentially under the influence of leachate and runoff from the pile is an ephemeral tributary to the Colorado, Moab Wash, which runs along the northeast side of the pile. The geology and hydrology of the Colorado River system are discussed in more detail in Sect. 3.5.1 of the DEIS.

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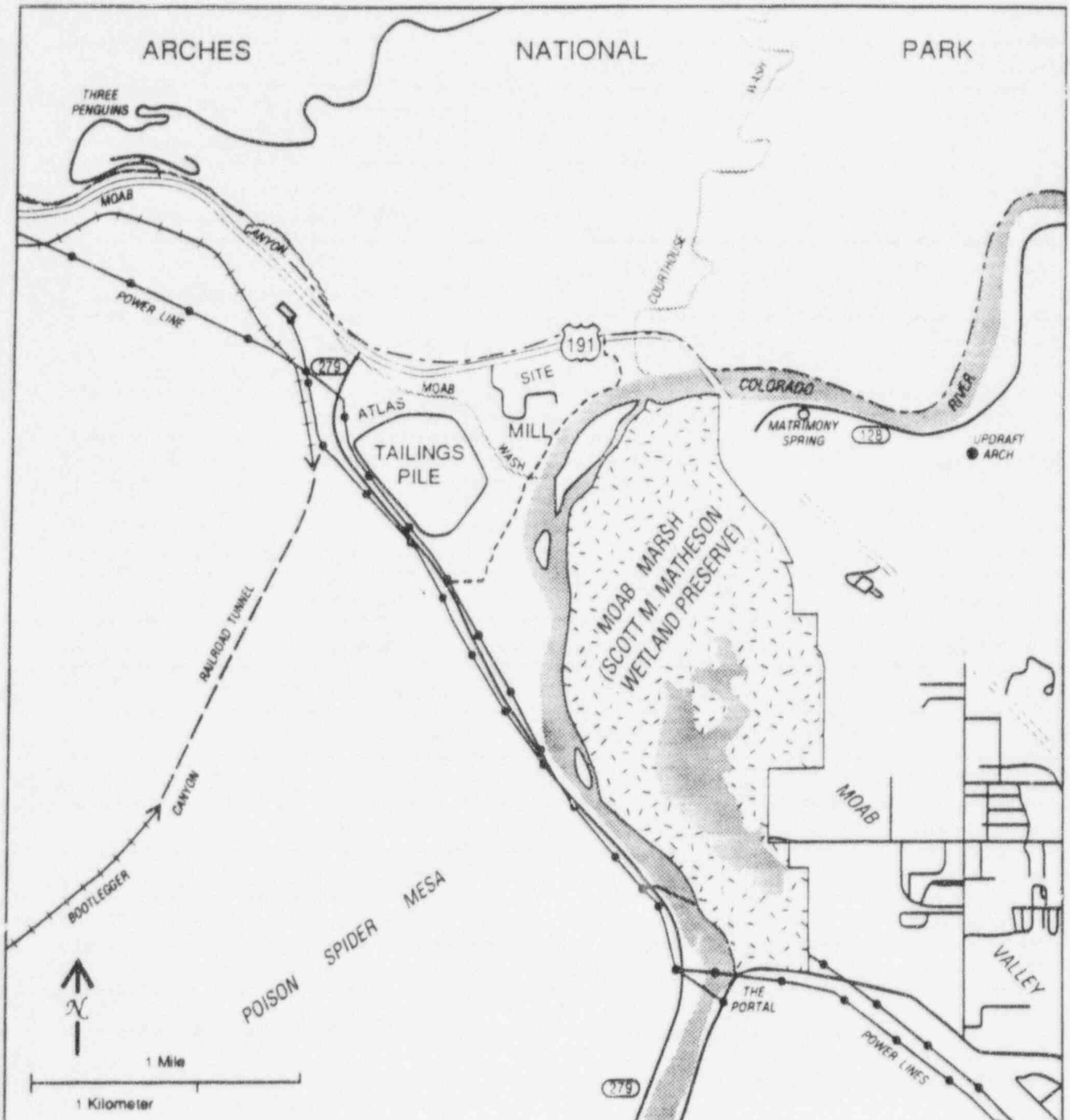

Fig. 2. The Atlas Corporation site and uranium mill tailings pile at Moab, Utah.

Table 1. Fish that occur or may occur in the Colorado River[a] near the tailings pile.

Common name	Scientific name	Status
Colorado squawfish	*Ptychocheilus lucius*	Native to upper Colorado River, Federally listed endangered species
Razorback sucker	*Xyrauchen texanus*	Native to upper Colorado River, Federally listed endangered species
Humpback chub	*Gila cypha*	Native to upper Colorado River, Federally listed endangered species
Bonytail chub	*Gila elegans*	Native to upper Colorado River, Federally listed endangered species
Roundtail chub	*Gila robusta*	Native to upper Colorado River
Speckled dace	*Rhinichthys osculus*	Native to upper Colorado River
Flannelmouth sucker	*Catostomus latipinnis*	Native to upper Colorado River
Bluehead sucker	*Catostomus discobolus*	Native to upper Colorado River
Fathead minnow	*Pimephales promelas*	Introduced species
Longnose dace	*Rhinichthys cataractae*	Introduced species
Carp	*Cyprinus carpio*	Introduced species
Red shiner	*Notropis lutrensis*	Introduced species
Sand shiner	*Notropis stramineus*	Introduced species
Channel catfish	*Ictalurus punctatus*	Introduced species
Black bullhead	*Ictalurus melas*	Introduced species
Rio Grande killifish	*Fundulus zebrinus*	Introduced species
Largemouth bass	*Micropterus salmoides*	Introduced species
Green sunfish	*Lepomis cyanellus*	Introduced species

[a] Sources: Carlson and Muth 1989; Bates 1994; Lee et al. 1980; NRC 1980.

3.1.2 Aquatic Ecology

Aquatic species of the Colorado River in the vicinity of the Moab site, as elsewhere in the river, have had to adapt to physical and chemical conditions that naturally fluctuate widely on a seasonal and even daily basis. These variable conditions include river flow, bottom scouring by sand and silt, temperature, sediment loading, chemical composition, and salinity. Heavy sediment loading, swift currents, and scouring of the sand and silt bottom impose severe limits on algal, invertebrate, and fish diversity in the main channel. Chironomids and oligochaetes are likely to dominate the benthic community of the main channel, but backwater areas, such as the wetland formed by a more or less permanent inundation of the floodplain just downstream and across the river from the tailings pile, would support a much more diverse and more productive benthos. Similarly, rooted macrophytes, along with algae and zooplankton, flourish in the backwaters, but are almost non-existent in the main channel. The backwaters and inundated floodplains often serve as important nurseries and forage suppliers for fish, including the endangered Colorado squawfish (Valdez and Wick 1983). Fish species known or believed to reside in or pass through this reach of the river are listed in Table 1.

Because of human activities (Sect. 4.1.1), many components of the upper Colorado River ecosystem (including the reach near the tailings site) have experienced dramatic changes over the last several decades. An additional important force for change has been the sometimes accidental, but often deliberate, introduction of non-native fish species into the river ecosystem, including carp, channel catfish, various minnow species, and largemouth bass. In addition, the invasion of tamarisk (*Tamrix sp.*) into riparian plant communities on the adjoining floodplains may influence fish habitat in these areas. These introductions, in concert with the physical and chemical alterations of the river, have significantly compromised growth and reproduction of several native species. Non-native species, such as the channel catfish, provide most of the take by fishermen. As reflected by the listing of species in Table 1, at least as many introduced species as native species of fish are now established in the Colorado River.

3.1.3 Colorado Squawfish

The formerly abundant Colorado squawfish, the largest member of the minnow family native to North America, once was found throughout the Colorado River Basin. It has since retreated to the less than 20% of its former range remaining in mainstem rivers and larger tributaries of the upper basin (USFWS 1987; Tyus 1990). An intensive survey by Valdez and Williams (1993) and research by Tyus and Bruce (1991) indicate that the Green River actually produces much higher numbers of Colorado squawfish larvae, young-of-year, and juveniles than does the Colorado River. Even so, these fish occur in the Colorado River reach adjacent to the Atlas tailings pile and use the main channel for spawning migrations and the quiet, shallow backwater areas of Moab Marsh as important nursery habitat (USFWS 1987; Bill Bates, Utah Department of Environmental Quality, Division of Wildlife Services, Salt Lake City, Utah, with G. K. Eddlemon, ORNL, Oak Ridge, Tenn., July 25, 1994; Cooper and Severn 1994). Other such backwaters and eddies occur in this reach during periods of relatively low flow and may also serve as nurseries.

Very young squawfish favor cladocerans, copepods, and other zooplankton for food, while slightly older squawfish prey on small aquatic invertebrates, particularly dipteran larvae in side channels and backwater area (Muth and Snyder 1995). Juveniles, though still keeping to backwater nursery areas, gradually alter their diet increasingly in favor of other fish. Adults prey on other fish in virtually any part of the river (Behnke and Benson 1980). Trammel and Chart (unpublished draft report) found that, in autumn, squawfish tended to prefer deep backwater areas associated with deep scour channels behind large sand bars. They surmised that overwinter survival depends to a large extent on the presence of such deep backwaters. During the rare periods of inundation, lower Moab Wash and the riparian woodland near the toe of the pile potentially provide habitat for squawfish and razorback suckers (Bill Bates, Utah Department of Environmental Quality, Division of Wildlife Services, Salt Lake City, Utah, personal communication with G. K. Eddlemon, ORNL, Oak Ridge, Tenn., July 25, 1994).

Although in the upper Colorado River squawfish reportedly spawn over cobble substrates during the period July through September (McAda and Kaeding 1991), both squawfish and razorback suckers have been known to spawn in early or mid-summer about 3 km (1.9 miles) upstream of the tailings pile as river flow declines and temperatures increase. Seasonal movements for spawning by squawfish are generally fairly limited in distance, but have been known to range as much as 320 km (200 miles) up or down stream (USFWS 1987). When not migrating for the purpose of spawning, or drifting during early growth phases, squawfish appear to have fairly small home ranges (McAda et al. 1994). Within days of spawning, larval squawfish drift out of the spawning areas and into such backwater areas (Tyus 1990) as those near the tailings pile (see previous discussion). Availability of spawning habitat does not appear to be limiting for squawfish populations (McAda and Kaeding 1991).

3.1.4 Razorback Sucker

Razorback suckers are known to spawn over gravel bars and probably also spawn in backwaters. In the past, they have been observed spawning in early and mid-summer within 2 miles upstream of the tailings pile (Bill Bates, Utah Department of Environmental Quality, Division of Wildlife Services, Salt Lake City, Utah, personal communication with G. K. Eddlemon, ORNL, Oak Ridge, Tenn., July 25, 1994). When not spawning, these suckers may be found almost anywhere in the river, including slow runs in the main channel, inundated floodplains and tributaries (such as Moab Wash), eddies and backwaters, sandy bottom riffles, and gravel pits (59 FR 13374–13400). They feed primarily on benthic invertebrates and organic debris, but also on zooplankton (Behnke and Benson 1980). During the rare periods of inundation, lower Moab Wash and the riparian woodland near the toe of the pile may provide important habitat for squawfish and razorback suckers (Bill Bates, Utah Department of Environmental Quality, Division of Wildlife Services, Salt Lake City, Utah, personal communication with G. K. Eddlemon, ORNL, Oak Ridge, Tenn., July 25, 1994).

The razorback sucker appears to continue its serious decline toward extinction. According to Valdez and Williams (1993), an intensive fish survey of the upper Colorado and Green rivers conducted from 1985 through 1988 produced only one razorback sucker, an adult, collected from a large riffle at the mouth of Salt Creek, about 97 river km (60 river miles) downstream of the tailings pile.

3.1.5 Humpback Chub

The humpback chub prefers deep canyon swift water and rapids of the Colorado mainstem and its larger tributaries. The species is, therefore, thought not to occur much farther upstream than Cataract Canyon below the confluence of the Green and Colorado rivers [about 70 km (43 miles) below the Atlas tailings pile] (Bill Bates, Utah Department of Environmental Quality, Division of Wildlife Services, Salt Lake City, Utah, personal communication with G. K. Eddlemon, ORNL, Oak Ridge, Tenn., July 25, 1994); 59 ***FR*** 13374–13400). During the 1985–1988 fish survey of the upper Green and Colorado Rivers, 93 of 108 humpback chubs were collected from Cataract Canyon (Valdez and Williams 1993). Five individuals were also collected from a reach about 30 river kilometers (19 river miles) downstream of the Atlas tailings pile, but Valdez and Williams speculated that they may have drifted down from populations in West Water Canyon and Black Rocks far upstream of the Moab site. Humpback chubs probably spawn in or near their canyon residence area between April and July, depending on water temperature. In addition to the stresses discussed above, population declines have been attributed to parasitism, pollution and eutrophication, altered food base, and fishing pressure. Hybridization with related species may also be a threat to the integrity of the humpback chub (USFWS 1987).

3.1.6 Bonytail Chub

Much like the Colorado squawfish and razorback sucker, the bonytail chub uses mainstem river channels as well as inundated riparian areas. Only five individuals, all from Cataract Canyon several miles below the confluence of the Green and Colorado rivers, were collected in a 1985 through 1988 fish survey (Valdez and Williams 1993). Potential habitat for the bonytail chub may also exist in the reach of the river near the tailings pile, but the actual presence of this rarest of all fishes native to the Colorado Basin has not been confirmed.

3.2 Threatened and Endangered Birds

3.2.1 Southwestern Willow Flycatcher

3.2.1.1 Background

The southwestern willow flycatcher (*Empidonax traillii extimus*) is a small bird that nests in riparian habitats in southern California, southern Nevada, southern Utah, Arizona, New Mexico, western Texas, southwestern Colorado, and extreme northwestern Mexico. The USFWS recently listed this southwestern subspecies of the willow flycatcher as an endangered species (60 ***FR*** 10694–10715, February 27, 1995). The USFWS has not yet designated critical habitat for the subspecies, but it is known to occur in riparian habitats along rivers, streams, or other wetland areas that have dense growths of willow, tamarisk, Russian olive, cottonwood, arrowweed, buttonbush and other deciduous shrubs and trees. Populations of the subspecies have been declining throughout its range due to such factors as loss and fragmentation of riparian habitat; loss of wintering habitat in Mexico, Central America, and perhaps northern South America; invasion of riparian habitat by the exotic tamarisk; brood parasitism by brown-headed cowbirds (*Molothrus ater*); and depredation. (Sogge et al. 1993, Tibbitts et al. 1994). The USFWS states the reasons for listing the southwestern willow flycatcher as endangered to be the extensive loss of breeding habitat, brood parasitism by cowbirds, and lack of protective regulations. In addition to the information provided by the USFWS in their final rule listing the southwestern willow flycatcher as an endangered species, two other publications (Tibbitts et al. 1994, Sferra et al. 1995) provide detailed reviews of the status of the subspecies throughout its range.

3.2.1.2 Utah Records

The northern limit of the southwestern willow flycatcher in Utah is believed to correspond closely to the area comprising Garfield, Kane, San Juan, Washington, and Wayne counties (60 ***FR*** 10694–10715). Records of the southwestern willow flycatcher in southeast Utah (Behle 1960) are all to the south of Grand County. Behle (1960) includes a record of the northern subspecies of willow flycatcher (*Empidonax traillii adastus*) at Moab on June 6–8, 1956, and notes that it was a summer resident. Behle (1985) comments that the dividing line in the intergrading population between the northern subspecies and the southwestern willow flycatcher occurs farther south than Provo. The intergrades of the two subspecies that occur as far south as Moab are closer to the northern subspecies than to the southwestern willow flycatcher. In Utah, the latter is confined to the extreme southern part of the state (i.e., Kane County) (Behle 1985). Willow flycatchers observed in Moab may well be intergrades between the two subspecies or migrants belonging to other subspecies (Behle 1985).

No specific surveys have been done on or in the immediate vicinity of the Atlas mill tailings site, but local observations in June 1995 (S. Bellagambra, The Nature Conservancy, Moab, Utah, personal communication with R. M. Reed, ORNL, Oak Ridge, Tenn., July 17, 1995) upstream and downstream of Moab found 6 willow flycatchers to be present. However, it was not possible to determine to which subspecies these birds belonged or whether they were summer residents or migrants.

3.2.1.3 Potential Habitat at Moab

The Atlas mill tailings pile is located on the 100-year floodplain of the Colorado River (Sect. 2.1). The floodplain area immediately adjacent to the tailings pile is covered by a relatively dense growth of riparian vegetation dominated by tamarisk. This floodplain area has been disturbed over the years, and roads that appear to have been used during the operation of the Atlas mill are present on the floodplain. The riparian area is at least partially flooded during high water periods when snow melt causes the river to rise. Areas of standing water can persist in the riparian zone well into the summer as the river level gradually recedes. The area of riparian habitat within the Atlas property boundary is relatively small (on the order of a 0.5–1 ha (1.2–2.5 acres), but it is contiguous with a larger area of approximately 80 ha (200 acres) that is present as a band along the west side of the river. The slopes of the existing tailings pile above the floodplain currently support a sparse vegetative cover of grasses and shrubs.

Directly across the river from the Atlas site is the Scott M. Matheson Wetlands Preserve (Sect. 2.1). This area, also known as Moab Marsh or Moab Slough, was purchased in 1990–92 by the Nature Conservancy and is 354 ha (875 acres) in extent (Sect. 3.1.2.1). The Preserve is jointly owned and managed by the Nature Conservancy and the Utah Division of Wildlife Resources. The area includes a dense growth of tamarisk immediately adjacent to the river. Other wetland communities that are present in the Preserve include areas dominated by various admixtures of willows, cottonwoods, Russian olive, and other wetland plants, as well as beaver ponds and open marsh. More than 160 species of birds have been observed at the Preserve, and nonavian species such as the river otter and northern leopard frogs are present. Mill Creek and Pack Creek flow into the Colorado River through the southeastern portion of the Preserve. The Preserve is occasionally flooded by the Colorado River, but the frequency and intensity of flooding has been reduced since the development of upstream dams (Cooper and Severn 1994). Facilities associated with Moab's sewage treatment plant are located in the Preserve.

Although the Scott M. Matheson Wetlands Preserve is the most extensive wetland in the Moab vicinity, riparian habitat extends both upstream and downstream along the Colorado River. Fairly extensive development of riparian vegetation is present along both sides of the Colorado River northeast from Moab along Route 128 and also south and southwest along Route 279. The width of the riparian strip varies considerably depending on the narrowness of the canyons. Tamarisk is the most conspicuous dominant in these riparian communities, but willows, cottonwoods, and Russian olives are also conspicuous.

Breeding habitat requirements for the southwestern willow flycatchers include thickets of trees and shrubs about 4–7 meters (13–23 feet) or more in height (Tibbitts et al. 1994). Although southwestern willow flycatchers historically nested in areas dominated by native riparian plants such as willows, buttonbush, and seep willow (*Baccharis*) with a scattered overstory of cottonwood, the subspecies also is known to nest in tamarisk-dominated vegetation (Brown and Trosset 1989; Tibbitts et al. 1994; Sferra et al. 1995). Nesting sites are generally between 10 and 30 m (30 and 100 ft) from the closest point of the river, and nest plants range from 5 to 9 m tall (16 to 30 ft) (Tibbitts et al. 1994). The areal extent of habitat appears to be important, with nesting sites generally located in relatively wide riparian areas. Habitat patch sizes from 0.4 to 0.6 ha (1.0 to 1.5 acres) have been recorded, with nests being located in the wider portions of the habitat patch rather than the narrower stringers (Tibbitts et al. 1994). Breeding sites are located near open water or saturated soil. The breeding season extends from late May and early June through mid to late August, the dates varying with altitude, latitude, and number of broods. The southwestern willow flycatcher feeds on insects and possibly some berries.

Potential habitat for the willow flycatcher in the Moab area is best represented in Moab Marsh across the river from the mill tailings pile. This large marsh offers a diversity of nesting sites, including willows, cottonwoods, Russian olives, tamarisk, and other woody species. Open water areas are present, and the marsh is adjacent to the Colorado River. A recent study of the ecological characteristics of this wetland (Cooper and Severn 1994) indicates that reduced flooding of the wetland by the Colorado River in recent years has reduced the flushing of saline groundwater from the wetland. Thus salts accumulating in portions of the wetland will favor development of halophytic vegetation such as tamarisk and salt grass. The floodplain area immediately adjacent to the Atlas site has been disturbed during the development of the the tailings pile and has been invaded by dense growths of tamarisk that show some indications of stress. Some willow and other woody species are present in these riparian communities, particularly along their upslope edges. Some open water areas are present within the riparian communities during and after flooding. Although willow flycatchers could utilize the riparian communities adjacent to the mill tailings pile as nesting habitat, it is more likely that, if present, the subspecies would nest in the Moab Marsh where conditions appear to be more suitable.

3.2.2 American Peregrine Falcon

The American peregrine falcon (*Falco peregrinus*) is known to nest in the Moab region (R. D. Williams, U.S. Fish and Wildlife Service, Salt Lake City, Utah, letter to R. L. Kroodsma, ORNL, Oak Ridge, Tenn., November 2, 1994) and occasionally hunt for prey in Moab Marsh (Nature Conservancy, undated). The American peregrine falcon is listed as an endangered species under the ESA, but it is currently being considered for delisting (60 ***FR*** 34405–34409, June 30, 1995). The peregrine falcon was first listed as an endangered species in 1970 under the Endangered Species Conservation Act of 1969 after severe population declines occurred throughout its range resulting from the effects of the widespread use of organochlorine pesticides, particularly dichloro-diphenyl-trichloroethane (DDT). The peregrine falcon was subsequently listed as an endangered species under the ESA. A recovery plan for American peregrine falcon populations in the Rocky Mountains and Southwest region (USFWS 1984) was one of four such plans developed to effect the recovery of the species. The plan calls for the direct protection of peregrines and their habitat, action to increase their natural reproductivity, and continuation of captive breeding and releases.

American peregrines falcons in the Rocky Mountain and Southwest region mostly nest on mountain cliffs and/or near lakes and rivers. Cliffs supporting peregrine aeries are generally more than 60 m (200 ft) in height, and nests are commonly situated on ledges or potholes (USFWS 1984). In a survey of physiographic characteristics of peregrine falcon aeries along tributaries to the Colorado River north and east of Moab, Grebence and White (1989) found that peregrines select aeries with mesic microclimate conditions that ameliorate strong solar radiation. Peregrines may begin nesting by mid-March, with eggs being laid in early April. Fledging of the young occurs from mid-June to mid-July, and young may remain in the vicinity of an aerie for several weeks thereafter. Peregrines feed on small- to medium-sized terrestrial birds, shorebirds, and waterfowl. Aeries are generally located within a 16-km (10-mile) radius of an adequate food supply.

Peregrine falcons are known to have nested in the vicinity of the Atlas tailings piles (R. D. Williams, U.S. Fish and Wildlife Service, Salt Lake City, Utah, letter to R. L. Kroodsma, ORNL, Oak Ridge, Tenn., November 2, 1994) , but recent information indicates that the birds have moved further down river beyond the Portals (J. Cresto, Bureau of Land Management, Moab, Utah, personal communication with R. M. Reed, ORNL, Oak Ridge, Tenn., July 12, 1995). Peregrines also are reported to nest within 1.2 km (2 miles) of the site in Arches National Park and along the Colorado River (W. R. Taylor, U.S. Department of Interior, Washington, D.C., letter to A. Mullins, NRC, Rockville, Maryland, February 3, 1995). Peregrine falcons have been observed at Moab Marsh where they undoubtedly prey on the abundant birds life there. No area near the Plateau site is known to be particularly important to peregrine falcons.

3.3 Threatened and Endangered Plants

3.3.1 Jones cycladenia

The Jones cycladenia, a plant species listed by the USFWS as threatened, is known to occur in Castle Valley (R. D. Williams, U.S. Fish and Wildlife Service, Salt Lake City, Utah, letter to R. L. Kroodsma, ORNL, Oak Ridge, Tenn., November 2, 1994), on Bureau of Land Management (BLM) land and from two other areas in Utah (51 ***FR*** 16526–16529, May 5, 1986). In addition, there is an historic record of this species occurring in the Pipe Spring area of Mohave County, Arizona, and Kane County, Utah. The Castle Valley populations are found in mixed desert shrub and pinyon-juniper plant communities at elevations of 1500–1700 m (5000–5600 ft) on sparsely vegetated hills derived from arkosic sandstone of the Permian Cutler Formation. Two populations of about 1000 individuals each have been found on BLM land in Castle Valley (USFWS 1986).

Atlas has identified a proposed riprap borrow area at Round Mountain in Castle Valley (Fig. 1). Atlas also plans to operate a second borrow area in the La Sal Mountains, but it has not disclosed the site of this second area. Round Mountain is on state land and consists of an intrusive igneous cone standing approximately 330 m (1080 ft) above the floor of Castle Valley. The upper slopes of Round Mountain support little or no vegetation. Soils around the base of the Round Mountain are generally classified as Moab very cobbly fine sandy loam (USDA 1991) and have developed on alluvial fans and terrace side slopes that are derived primarily from sandstone and diorite. The land immediately surrounding Round Mountain is grazing land that provides important wintering areas for muledeer. Vegetation around Round Mountain and on its lower slopes is relatively sparse and is dominated by pinyon-juniper communities with numerous, extensive patches of bare earth or rocks. Indian ricegrass, galleta, blackbrush, and fourwing saltbush are interspersed among sagebrush, mormon tea, pinyon pine, Utah juniper, antelope bitterbrush, and birchleaf mountain mahogany.

No surveys for Jones cycladenia have been conducted at the proposed borrow sites at Round Mountain and the La Sal Mountains because specific locations have not yet been identified. Available information on the soils of the Round Mountain area suggests that habitat is not present there because the upper slopes are of igneous origin and the lower slopes are of alluvial origin. No surveys have been conducted for Jones cycladenia at the proposed cobble area in Spanish Valley, in the vicinity of the tailings pile at Moab, or at the Plateau site on Klondike Flats. This species is unlikely to be at these locations because of the absence of arkosic sandstones.

3.3.2 *Astragalus sabulosa*

Astragalus sabulosa is a Category 2 candidate for listing under the ESA. This plant occurs on the Mancos Shale, Morrison, and Cedar Mountain Shale formations in the general area of the project. The species is endemic to Grand County and is known from the vicinity of upper Courthouse Wash, northwest of Moab, and then northeast into the Cisco Desert as far east as Cisco (J. M. Peterson, Utah Natural Heritage Program, Salt Lake City, Utah, letter to G. K. Eddlemon, ORNL, Oak Ridge, Tenn., August 8, 1994). The species is found along washes and gullies in low, barren hills in stiff clays and alluvial gravels from sandstone. It grows in salt desert shrub communities at elevations of 1250–1580 m (4100–5200 ft).

The Plateau site is approximately 23 km (14 miles) northwest of Moab (Fig. 1) and is in the general area described for *Astragalus sabulosa.* Soils at the Plateau site are generally classified as Barx fine sandy loam (USDA 1989) and are characterized as very deep, well drained soil on alluvial fans and fan terraces. Present vegetation in most areas is composed of big sagebrush, spiny hopsage, shadscale, and galleta. No survey has been conducted to determine if *Astragalus sabulosa* occurs at the Plateau site.

3.3.3 *Oreoxis trotteri*

Oreoxis trotteri is also a Category 2 candidate for listing under the ESA. This plant is known from Courthouse Rock in Grand County, approximately 7.2 km (4.5 miles) from the Plateau site. It is endemic to the white sandstone Moab Tongue of the Entrada Formation and Navajo Sandstone in this area (J. M. Peterson, Utah Natural Heritage Program, Salt Lake City, Utah, letter to G. K. Eddlemon, ORNL, Oak Ridge, Tenn., August 8, 1994). No surveys have been conducted for *Oreoxis trotteri* at the Plateau site. Although the species is known to occur relatively close to the Plateau site, geologic maps of the area indicate that the Moab Tongue is not present at the Plateau site. *Oreoxis trotteri* is therefore unlikely to be present at this site.

4. ENVIRONMENTAL CONSEQUENCES

4.1 Threatened and Endangered Fish

4.1.1 Effects of the Tailings Pile in its Existing Condition

The Utah Administrative Code R-317-2-13 (Water Quality Standards) classifies the Colorado River and its tributaries as:

1C Protected as a raw water source for domestic purposes with prior treatment processes as required by the Utah Department of Health;

2B Protected for boating, water skiing, and similar uses, excluding swimming;

3B Protected for warm water species of game fish and other warm water aquatic life, including the necessary aquatic organisms in their food chain; and

4 Protected for agricultural uses including irrigation of crops and stock watering.

The water quality of the Colorado River has declined over the years as human activities in the basin have expanded. Dams and water diversion projects have greatly accelerated water loss through evaporation and consumption, resulting in higher salinities (i.e., total dissolved solids or TDS), altered temperature and flow regimes, and altered nutrient and suspended solids transport (Carlson and Muth 1989; Upper Colorado Region State-Federal Interagency Group 1971). Industrial development (in particular, mining and milling) and rapid urbanization have introduced wastewaters containing a variety of contaminants into the river, including suspended sediments, acid mine drainage, heavy metals, radionuclides, and organic wastes. Table 2 summarizes the results of water quality monitoring upstream and downstream of the tailings pile conducted by the Utah Division of Water Quality and others for approximately the last 10 years. The data in this table reveal a very turbid river of considerable hardness, high suspended solids loading, fairly high salinity for a freshwater river (due to a large extent to high sulfate levels), and often wide fluctuations in the concentrations of all of these constituents.

For most water quality parameters, the data in Table 2 do not indicate that water quality differs appreciably above and below the tailings pile, recognizing however, the limitations of the database—e.g., the relatively small numbers of samples, the high detection levels in some cases, and other factors such as the great distance between upstream and downstream sampling stations [as much as 102 river km (63 mi)]. Possible exceptions include suspended solids, pH, manganese, and gross alpha. Because of the distance between the sampling stations, many other sources, including natural ones, could account for these moderate differences. With regard to suspended solids, over half the difference between upstream and downstream averages can be explained by one exceedingly high measurement at the lower station without a corresponding sample from the upper station until 7 days later. Moreover, a related variable, turbidity, suggests an opposing trend— average turbidity was slightly lower downstream than upstream. Several constituents, including Cd, Cu, Pb, Hg, Zn, ammonia, gross alpha, and gross beta, at least occasionally exceeded state water quality standards for protection of aquatic life both downstream and upstream of the tailings pile. Of these, only gross alpha

Table 2. Summary of water quality[a] of the Colorado River upstream[b] and downstream[c] of the tailings pile. Blank spaces mean no data or standards are available.

Parameter	Upstream mean	Range	Downstream mean	Range	State Standard[d]
Flow (cfs)	13,200	2,620–68,000	13,300	5,200–28,000	
Temperature (°C)	11.7	-0.4–26.1	13.8	0–26.8	27
pH	8.2	7.2–9.0	7.8	6.6–9.0	6.5–9.0
Dissolved O_2 (mg/L)	9.0	5.0–12.9	9.0	5.9–13.5	5.5
Specific conductance (μS/cm)	1,010	270–1,600	890	320–1,500	
Total hardness (mg/L)	330	116–535	302	140–501	
Total dissolved solids (mg/L)	690	230–1,110	600	230–1,070	1,200
Total suspended solids (mg/L)	470	<3 - 3480	930	39–10,000	
Turbidity (NTU)	173	3.5–>1000	165	13–490	+10
Total Kjeldahl nitrogen (mg/L)	0.66	0.1–1.7	0.88	<0.1–3.4	
Ammonia-N (mg/L)	<0.1	<0.1–0.4	<0.08	<0.05–0.24	_[h]
Nitrate-N (mg/L)	0.54	0.13–1.1	0.52	0.11–0.97	4
Sulfate (mg/L)	264	51–520	226	59–460	
Ortho phosphate (mg/L)	<0.13	<0.01–0.66	0.12	<0.01–0.49	
As (μg/L)[j]	<2.8	<0.5–<10	<3.1	<0.5–5.5	190 / 0.017[i]
Cd (μg/L)	<1	<1–3	<1	<1–3	1.1
Cu (μg/L)	<21	<10–49	<20	10–25	12
Fe (mg/L)	3.1	.06–61	3.5	<0.03–11.8	1,000
Pb (μg/L)	<7.9	<5.0–30	<8.4	<3–29	3 2
Mn (μg/L)	156	15–1,000	233	<10–855	
Hg (μg/L)	<0.2	<0.1–<0.33	<0.3	<0.1–1.0	0.012

Parameter	Upstream mean	Range	Downstream mean	Range	State Standard[d]
Mo (μg/L)	<10[e]	<10			
Ni (μg/L)	<2.5[e]	<1–4			160 / 13.4[i]
Se (μg/L)	<4.9	< 2–10	< 4.0	< 2–5	5
Ag (μg/L)	<2.0	<2.0	<2.0	<2.0	0.12
U-natural (pCi/L)	4.5[f]	1.6–8.1[f]	5.1[f]	1.8–12[f]	
V (μg/L)	<6[e]	<6			
Zn (μg/L)	<30	<10–120	<43	10–100	110
Gross alpha (pCi/L)	13	<2–50	16	3–74	15
Gross beta (pCi/L)	<30	<10–81	<27	<5–99	50
Ra-226 (pCi/L)	<1	<0.1–2	<1	0.1–2	5[g]
Ra-228 (pCi/L)	1	1	1	1	5[g]

[a] Except where noted, all data provided by Utah Department of Environmental Quality, Division of Water Quality, Salt Lake City. Each average and range of values represents a sample size of as low as 5 (e.g., Se) to as high as 85 (e.g., total dissolved solids). Blank spaces mean no data or standards are available.

[b] Colorado River above US 191 bridge.

[c] Above Colorado/Green Rivers confluence.

[d] Water quality standards in Utah Administrative Code R317-2; values shown are the most conservative expression of the standard (e.g., 4-day average criterion for aquatic life).

[e] Based on 4 samples during 1985-86 near Cisco, UT, upstream of site (USGS 1986).

[f] From Atlas Corporation Environmental Monitoring Reports for 1989–93.

[g] Total activity for Ra-226 and Ra-228 combined.

[h] Dependent on temperature and pH.

[i] The first (higher) value is for protection of aquatic life; the second (lower) value is for protection of human health.

[j] For trace elements, the acid soluble fraction is given.

averaged higher than the standard—16 pCi/L at the downstream station versus the state standard of 15 pCi/L. Some of the alpha contamination, but not necessarily all, is from natural sources. A small amount of the total alpha count at downstream sampling stations probably comes from the Atlas tailings pile. Other mining and milling operations and tailings piles far upstream near places like Uravan and Grand Junction also are likely contributors to the relatively high gross alpha counts.

Another approach to assessing the contribution of the tailings pile to the water quality of the Colorado River is to calculate movement of leachates out of the pile through groundwater into the river. Table 3 provides estimates of this movement using available data. An estimate of the mass flux of each of several contaminants exhibiting one or more unusually high leachate concentrations was made by multiplying mean tailings leachate concentrations for selected contaminants (i.e., ones that exhibited one or more unusually high measurements) by the estimated flow of leachate to the river. These "tailings leachate" values actually represent concentrations in the contaminated groundwater between the pile and the river. The estimated flow of about 0.63 cfs (280 gpm or 17.8 L/s)] was calculated using a conservatively high TDS concentration of about 150,000 mg/L (NRC 1979) that assumes nearly saturated conditions at the top of the pile) and a TDS concentration of 13,000 mg/L in the contaminated groundwater at the base of the pile. Dividing the resulting estimated mass flux of each contaminant in μg/s or pCi/s by the river flow in L/s produces an estimate of the *contribution* of the tailings pile to the ambient contaminant concentration in the river. These contributions are presented in columns three and four of Table 3 for the mean river flow of 7,770 cfs (220,000 L/s), and the record low flow of 558 cfs (15,800 L/s), respectively. It is assumed that there is no significant contaminant attenuation at work through such mechanisms as sorption and precipitation.

Table 3 shows that at average river flows, the contributions to river contaminant levels from tailings leachate migration are negligible compared to the reported ambient concentrations. With minimal dilution at record low flow conditions, however, uranium, gross alpha (nearly all from uranium and its daughters), ammonia, and molybdenum from tailings could constitute a significant fraction of the river's contaminant concentrations. Only gross alpha and ammonia, however, would be likely to exceed the state water quality standard, and only under low flow conditions (see further discussion below).

The tailings pile is a part of the existing environment. Under existing conditions, an average of about 95 L (25 gal) of contaminant-bearing leachate from the tailings pile migrates via groundwater to the Colorado River each minute. In Table 4, post-dilution concentrations of those contaminants in the river that occurred at sufficient levels in the leachate to be of concern are calculated and compared with ambient river concentrations, state water quality standards, and published toxicity benchmarks for aquatic life (see the discussion in Sect. 3.5.2 of the DEIS) (Suter et al. 1992). This analysis assumes that sorption and other processes that may attenuate contaminant levels are not significant.

Table 4 shows that, even at record low flow (558 cfs), increases in post-dilution contaminant concentrations and resulting total concentrations (leachate contribution plus ambient concentration) are well below both state standards and toxicity benchmarks, with the exception of gross alpha. Under record low flows, and assuming gross alpha levels are not otherwise affected by the conditions leading to such low flows, the contribution of gross alpha could increase the ambient concentration above the state standard of 15 pCi/L (when ambient alpha concentrations are not already above the standard).

Table 3. Selected mean contaminant concentrations in tailings leachate[a], and contribution[b] to the Colorado River following complete dilution at average (7770 cfs) and minimum (558 cfs) river flows.

Contaminant	Tailings leachate concentration	Contributed to river[b] at mean flow	Contributed to river[b] at low[c] flow	Ambient river[d] concentration
U-natural (pCi/L)	3100	0.25	3.5	4.8
Gross alpha (pCi/L)	2700	0.22	3.1	14
Ra-226 (pCi/L)	0.28	2.3 e-5	0.00032	< 1
Ra-228 (pCi/L)	2.1	0.00017	0.0024	1
Mo (µg/L)	1100	0.089	1.2	NS[e]
Ni (µg/L)	< 39	< 0.0032	< 0.044	NS
Se (µg/L)	< 24	< 0.0019	< 0.027	< 5.0
V (µg/L)	< 32	< 0.0026	< 0.036	NS
TDS (mg/L)	12600[f]	1.0	14	690

[a] As measured in groundwater monitoring wells between the pile and river; contaminated groundwater flow assumed to be 0.631 cfs (283 gpm).

[b] Above ambient concentrations.

[c] Minimum recorded flow from 1895–1986 (USGS 1986).

[d] Without contribution from tailings leachate. Sources: Utah Department of Environmental Quality, Division of Water Quality, Salt Lake City; Atlas Corporation Environmental Monitoring Reports for 1989-93.

[e] Not sampled.

[f] Corrected for background (6770 mg/L).

Table 4. Comparison of mean contaminant contributions from tailings leachate[a] to the Colorado River following complete dilution at average (7770 cfs) and minimum (558 cfs) river flows with ambient conditions, standards, and benchmarks.

Blank spaces indicate data are unavailable.

Contaminant concentration	River[b] at mean flow	River[b] at low[c] flow	Utah water quality stds	Benchmarks (aquatic life)	Ambient[g] river conc.
U-natural (pCi/L)	0.25	3.5		47[f]	4.8[i]
Gross alpha (pCi/L)	0.22	3.1	15		14[g]
Ra-226 (pCi/L)	2.3 e-5	0.00032	5[d]		< 1[g]
Ra-228 (pCi/L)	0.00017	0.0024	5[d]		1[g]
Mo (µg/L)	0.089	1.2		880	< 10[h]
Ni (µg/L)	< 0.0032	< 0.044	160	160	< 2.5[h]
Se (µg/L)	< 0.0019	< 0.027	5	35	< 4.9[g]
V (µg/L)	< 0.0026	< 0.036		80	< 6[h]
TDS (mg/L)	1.0	14	1200[e]		630[g]

[a] As measured in groundwater monitoring wells between the pile and river; contaminated groundwater flow assumed to be 0.631 cfs (283 gpm).

[b] Contribution from tailings above ambient concentrations.

[c] Minimum recorded flow from 1895 - 1986 (USGS 1986).

[d] Ra-226 and -228 combined; for protection of agricultural uses.

[e] For protection of agricultural uses.

[f] 142 µg/L (lowest reported chronic value).

[g] Utah Department of Environmental Quality, Division of Water Quality 1994.

[h] Based on four samples from Colorado River near Cisco, upstream of tailings pile (USGS 1986).

[i] Mean of river concentrations reported in Atlas Corporation river monitoring reports for period 11/89 through 6/93.

A dose assessment for a generic fish, invertebrate, and aquatic plant was conducted because (1) ambient gross alpha levels typically hover around the state standard and (2) tailings leachate contributes a potentially significant fraction of the alpha activity in the form of U-238 and its daughters (at least at extremely low river flow). In this assessment, internal dose conversion factors for specific radionuclide/organism combinations generated using the BIORAD computer code (Killough and McKay 1976)] were applied to ambient concentrations of radionuclides reported for the river near the tailings pile. These dose factors account for bioaccumulation of radionuclides by the different organisms. Similarly, dose to organisms from external exposure to these radionuclides was calculated using dose conversion factors compiled from Oak Ridge National Laboratory's EXREM III computer code.

Results of the dose assessments are presented in Table 5. Because the radionuclides of concern are almost exclusively alpha emitters, calculated external annual doses were so small that they did not materially affect the doses shown in the table. The ambient concentrations of Th-230, Pb-210, Po-210, and Ra-226 (all daughters of U-238) used in this analysis are averages of only 6 samples from two stations (one immediately upstream, the other downstream of the tailings pile) over a three year period. This analysis indicates that Po-210 contributes more to total annual dose incurred by fish and invertebrates than do all of the other radionuclides combined, and contributes nearly half of the total dose to aquatic plants. Total dose to fish is estimated at 0.50 rad/yr, while invertebrates incur a much higher dose of almost 80 rads/yr.

To place these values in perspective, the total doses were compared to an interim dose limit for the protection of native aquatic animals set forth by the U.S. Department of Energy (DOE) in DOE Order 5400.5. This interim dose limit is based on the level of radiation exposure below which many researchers of radiation effects on aquatic organisms believe aquatic populations will not be significantly affected—i.e., 1 rad/day (IAEA 1992; National Research Council of Canada 1983). These comparisons of estimated doses to aquatic organisms to the interim dose limit indicate that total doses for all three organism types (i.e., fish, invertebrates, and aquatic plants) are well below DOE's interim dose limit of 1 rad/day (or 365 rads/yr). On the other hand, estimated dose to invertebrates is sufficiently high (21% of the DOE limit) to suggest that local adverse effects are possible at the groundwater-surface water interface before much dilution has occurred. Although it is probably unlikely that any individual fish resides or feeds in this relatively small area for extended periods, it is possible that such individuals could receive potentially harmful doses. Should radionuclides accumulate in the sediments in and downstream of this area, doses to aquatic organisms would be higher still. Moreover, few data are available on Po-210 and Pb-210 in water. Available data indicate these constituents contribute much to total estimated dose. The results of the May 1995 sampling effort by Atlas directed at clarification of this issue are discussed in Sect. 4.1.2 below. These results suggest that, while some enrichment of certain radionuclides in fathead minnows has occurred downstream and adjacent to the pile, doses are well below the highest levels (interim dose limit) thought to be safe for the protection of fish populations.

4.1.2 Implications of May 1995 Sampling Effort

A one day sampling program was proposed by the National Park Service and the USFWS to clarify some of the above uncertainties. This sampling program was partially implemented on May 3, 1995, by WestWater Engineering for the Atlas Corporation. The resulting report "Atlas Corporation Moab Mill Site Colorado River Sampling and Literature Review," describes the sampling program, including objectives, methods and results (WestWater Engineering 1995). Figure 3 shows the location of the sampling stations.

Table 5. Estimated internal radiological dose[a] to aquatic biota in the Colorado River assuming record minimum flow (558 cfs).

Contaminant	Ambient Conc. pC/L (range)	Dose to Fish (rad/yr)	Dose to Invertebrates (rad/yr)	Dose to Plants (rad/yr)
U-natural (pCi/L)	4.8 (1.6 - 12)	0.041	0.41	4.1
Th-230[b]	0.80 (0.1 - 1.4)	0.022	0.36	1.0
Pb-210[b]	2.7 (1.1 - 4.6)	0.15	0.051	0.10
Po-210[b]	3.7 (0.9 - 5.7)	0.190	78	7.8
Ra-226[b]	1 (< 0.5 - 3)	0.10	0.51	5.1
Total	13	0.50	79	18
% of interim limit[c]	87	0.14	21	NA[d]
Gross alpha	14 (< 1 - 83)			

[a] Based on application of dose conversion factors compiled by Killough and McKay (1976).
[b] Ambient concentration based on six samples by Atlas Corporation over a three-year period.
[c] Interim limit set forth by the U.S. Department of Energy at DOE Order 5400.5.
[d] Not applicable.

Fish were collected with a seine. Fathead minnows were preserved for analysis; all other fish were immediately returned to the river. The effort was hampered by time constraints (one day for all sampling) few or no replicates for individual sampling stations coupled with considerable variability among upstream and downstream stations, a rapidly rising river level which flooded backwater areas selected earlier for representative deposition area sampling sites, and the absence of adequate quantities of invertebrates and periphyton so early in the season.

The resulting data nevertheless suggest that, at least for certain contaminants, concentrations in fish and/or sediments were elevated at one or more sampling stations adjacent to or downstream of the pile (Figs. 4–14). These contaminants include arsenic, iron, lead, manganese, mercury, selenium, vanadium, gross alpha, gross beta, lead-210, polonium-210, radium-226, thorium-230, and total uranium. Of the non-radioactive contaminants, only selenium and mercury concentrations in fish at adjacent or downstream stations appear to exceed upstream concentrations by more than a factor of 2 or 3.

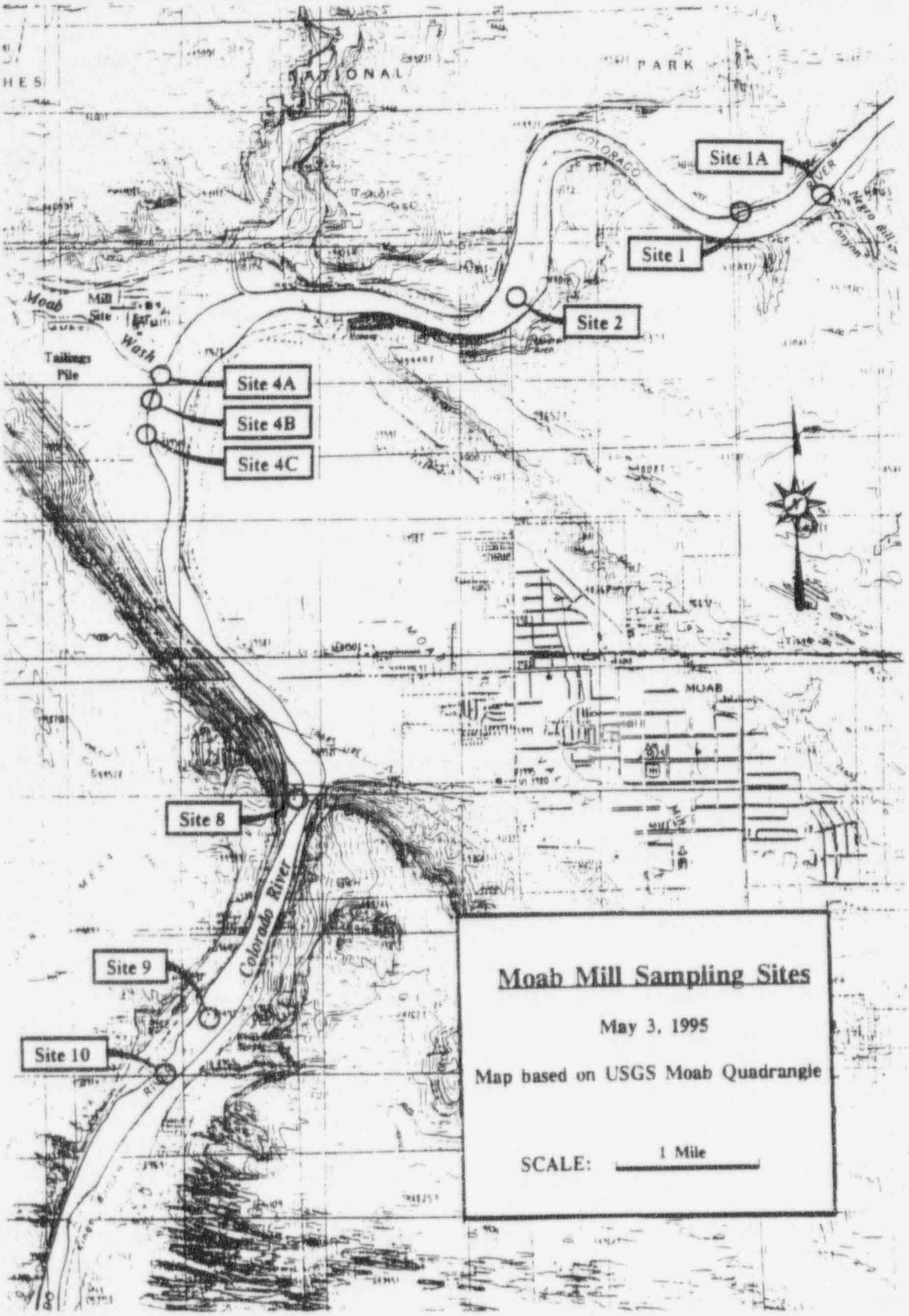

Fig. 3. Location of sampling stations for the May 1995 sampling program in the vicinity of the Moab mill tailings site. *Source:* WestWater Engineering 1995.

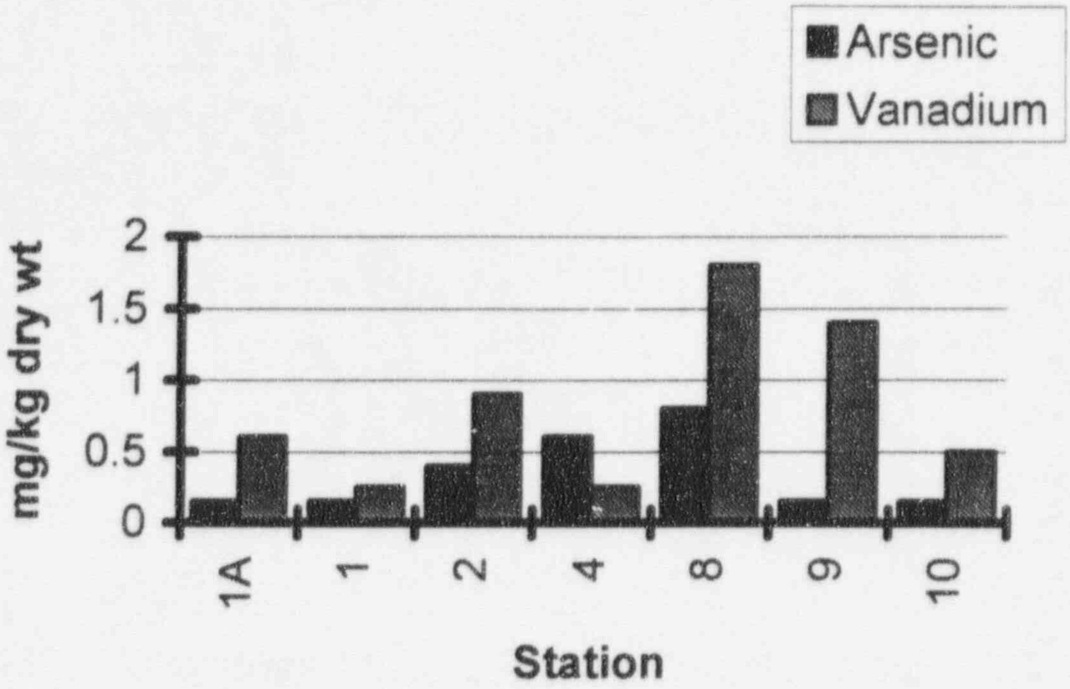

Fig. 4. Arsenic and vanadium concentrations in fathead minnows. *Source:* Westwater Engineering 1995.

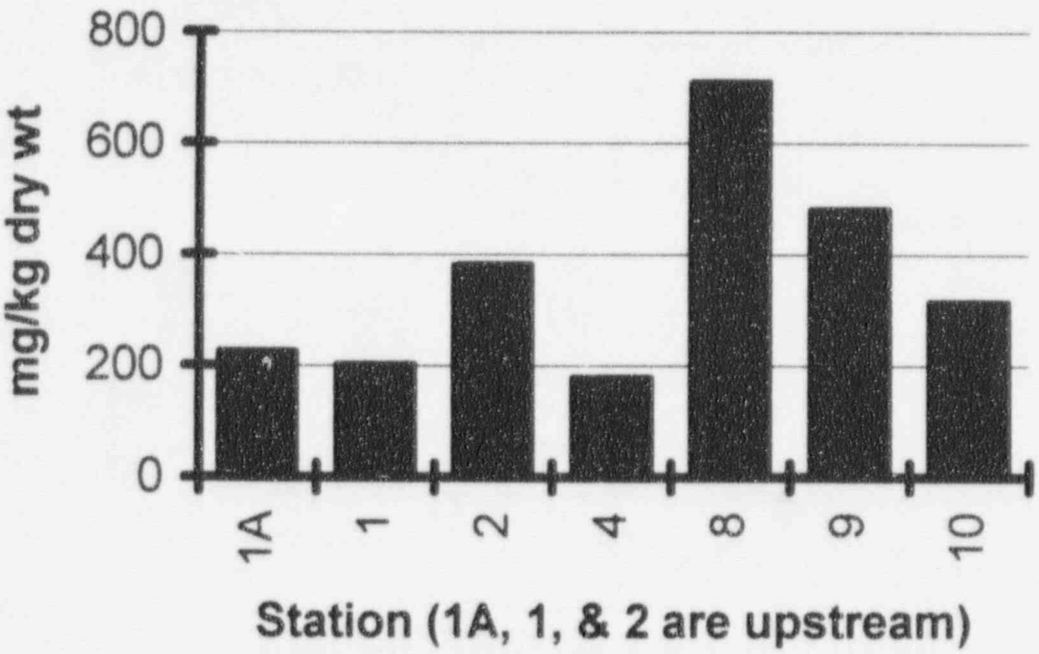

Fig. 5. Iron concentration in fathead minnows. *Source:* WestWater Engineering 1995.

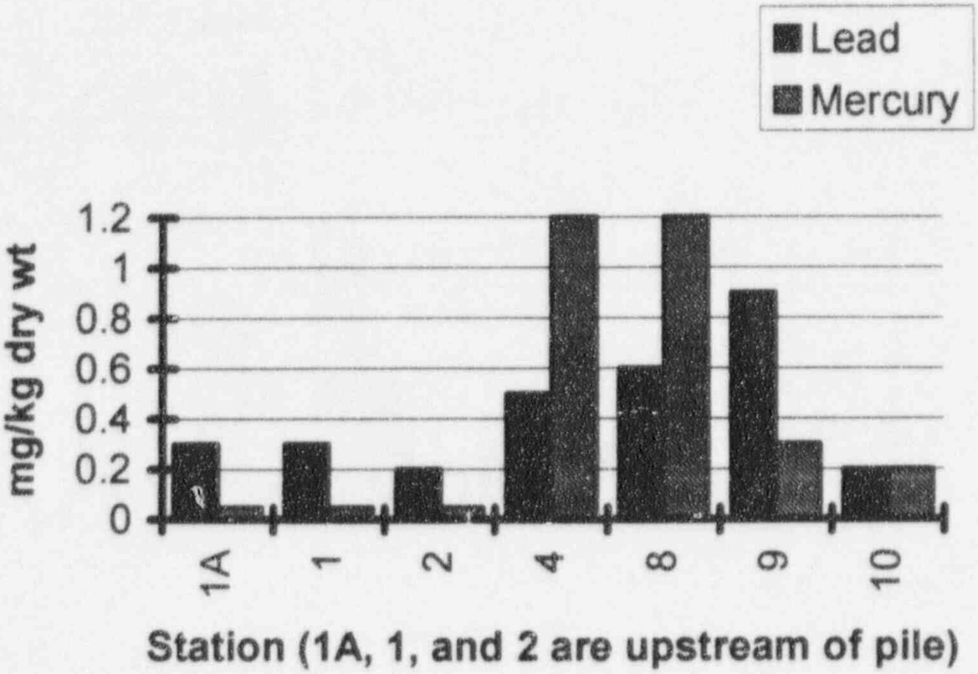

Fig. 6. Lead and mercury concentrations in fathead minnows. *Source:* WestWater Engineering 1995.

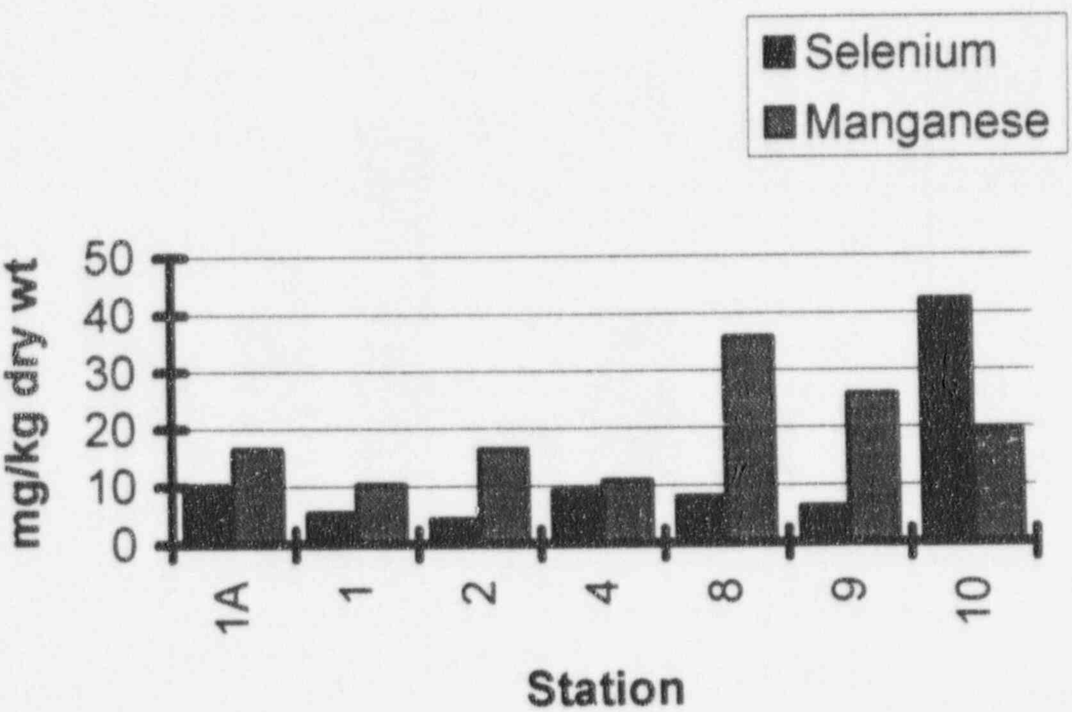

Fig. 7. Selenium and manganese concentrations in fathead minnows. *Source:* WestWater Engineering 1995.

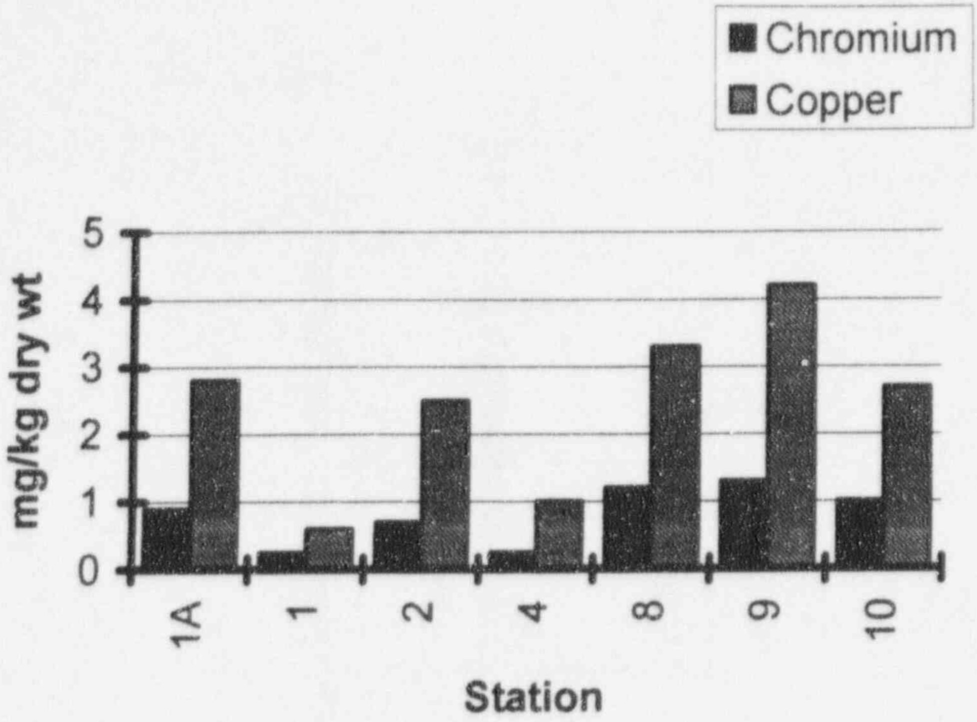

Fig. 8. Chromium and copper concentrations in fathead minnows. *Source:* WestWater Engineering 1995

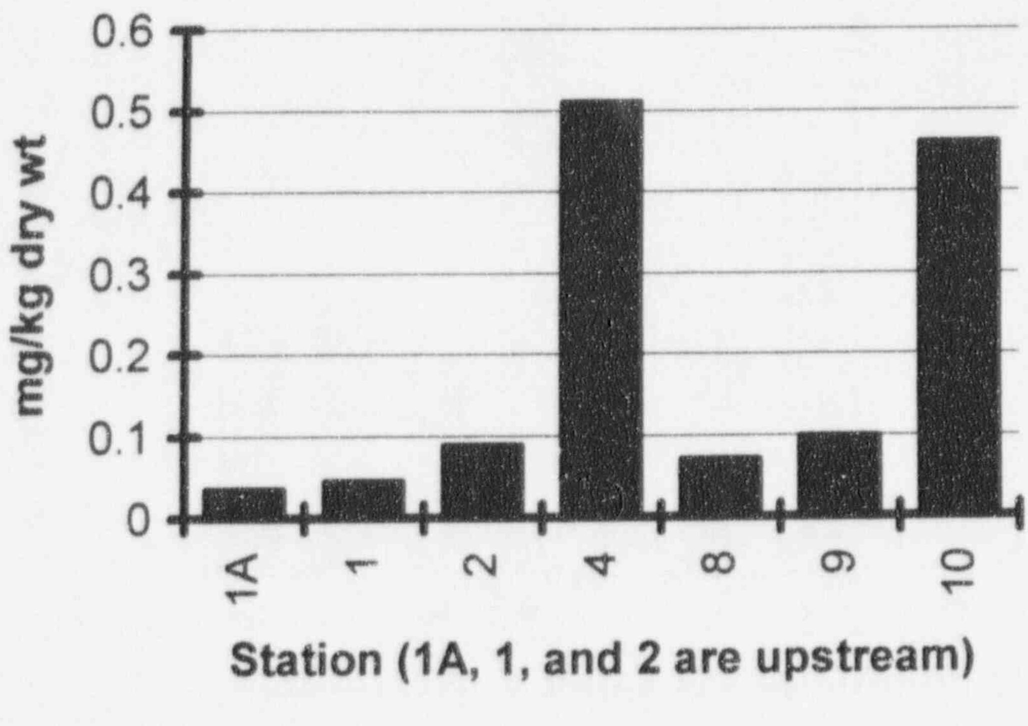

Fig. 9. Total uranium concentrations in fathead minnows. *Source:* WestWater Engineering 1995.

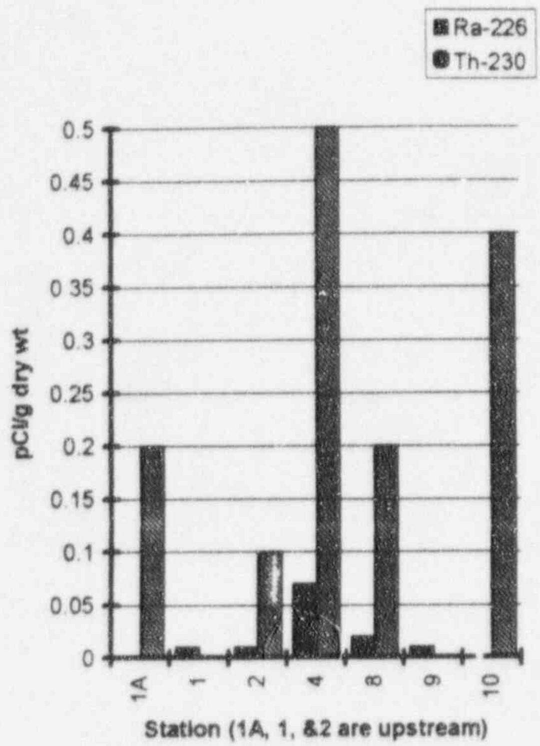

Fig. 10. Thorium-230 and radium-226 concentrations in fathead minnows. *Source:* WestWater Engineering 1995.

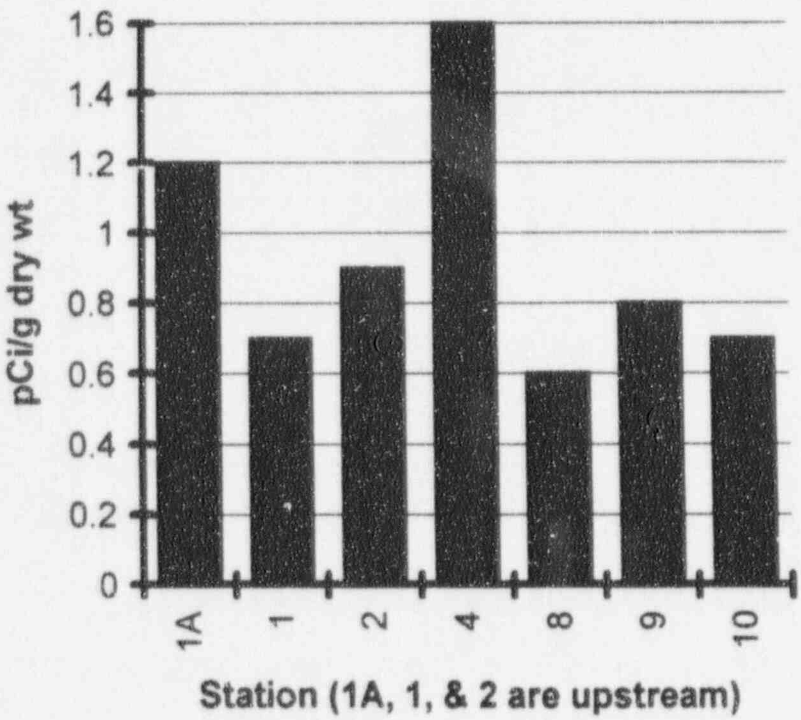

Fig. 11. Radium-228 concentrations in fathead minnows. *Source:* WestWater Engineering 1995.

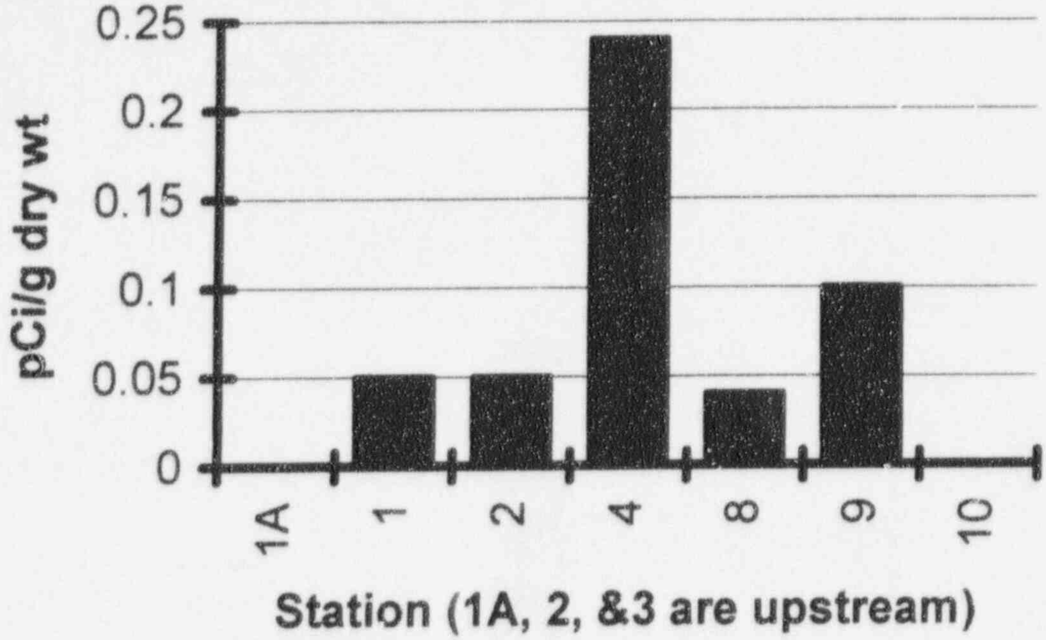

Fig. 12. Lead-210 concentrations in fathead minnows. *Source:* WestWater Engineering 1995.

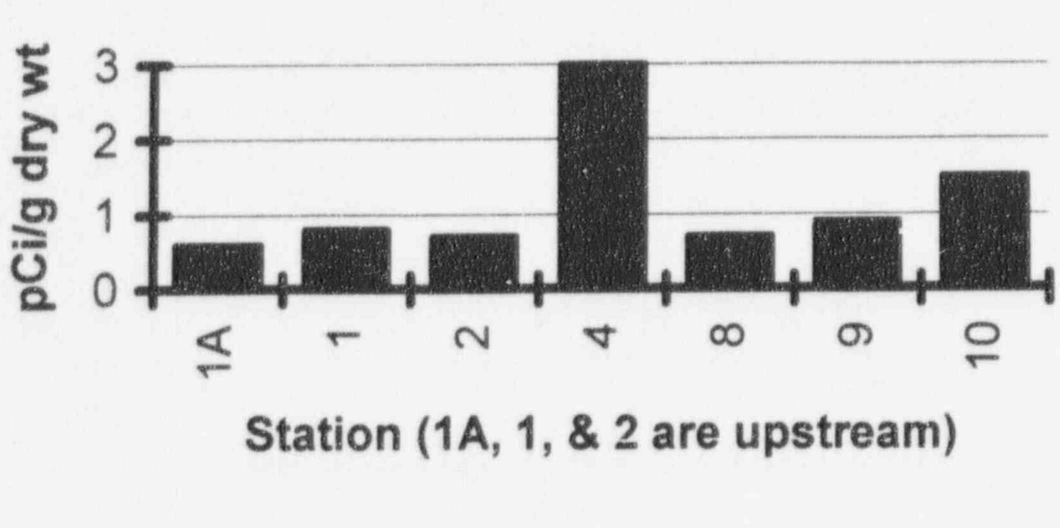

Fig. 13. Polonium-210 concentrations in fathead minnows. *Source:* WestWater Engineering 1995.

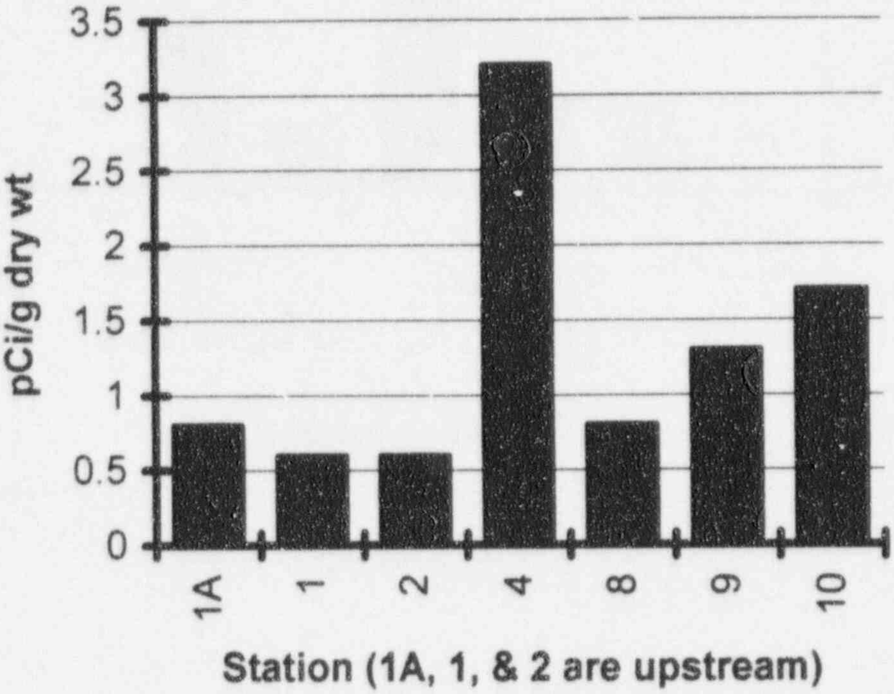

Fig. 14. Gross alpha concentrations in fathead minnows. *Source:* WestWater Engineering 1995.

Arsenic. Except for about twice as much arsenic in a single sediment sample from Station 9 (0.8 mg/kg) as was found at other stations, no trend toward increasing arsenic levels in sediment downstream of the pile is evident. Moreover, 0.8 mg/kg is well below the national mean of 7.4 mg/kg for uncontaminated soils reported by Eisler (1988a). River water concentrations of 9, 6, and 8 µg/kg (sampled only at three substations adjacent to the pile) were somewhat elevated compared to the range of values reported for the Colorado River (≤3 µg/kg) in Table 4.5-1 of the DEIS and for rivers around the nation by Eisler (≤ 3 µg/kg; 1988a). Dvorak (1978), on the other hand, reported a basin-wide average river concentration of 53 µg As/L.

Arsenic body burdens in fathead minnows appear to increase slightly adjacent to the tailings pile (Station 4; 0.6 mg/kg dry wt) and at one station downstream (Station 8; 0.8 mg/kg) of the pile (Fig. 4). These values differ little from the concentrations published by Eisler (1988) for various species of fish, or the geometric mean and 85th percentile concentrations (0.6 and 1.1 mg/kg dry wt respectively) of arsenic reported by Schmitt and Brumbaugh (1990) for whole fish from 109 stations located around the country. In summary, there appears to be little likelihood that arsenic levels in the Colorado River are high enough to harm resident aquatic biota, including the Colorado squawfish and razorback sucker.

Iron. At 10 to 15 mg/L, river water concentrations of iron were very high. These high values, however, are most likely attributable to the fact that the analyses were conducted on whole, unfiltered water containing suspended iron-laden minerals. As shown in Table 4.5-1 of the DEIS, iron concentrations in river water above and below the pile have averaged <40 µg/L over a period of several years.

On the other hand, Fig. 5 indicates enrichment of iron, an essential nutrient, by a factor of 2 or 3 in fathead minnows at downstream sampling Stations 8 and 9 but not at Station 4 adjacent to the tailings pile. No such trends were observed for the sediments. Station 8 fish yielded the highest iron level, 700 mg/kg dry wt. This value is considerably higher than the concentration (155 mg/kg; wet or dry not specified) cited by Dvorak (1978) for fish residing in an ash basin receiving stream or by Bowen (1979) for marine fish (9–88 mg/kg dry wt). Even so, upstream concentrations also exceed these values. There is no evidence that iron in the environment downstream of the tailings pile represents a hazard to fish or other aquatic organisms.

Lead. Fathead minnows collected at Station 4 (adjacent to the pile) and downstream Stations 8 and 9 exhibited elevated lead levels (by up to a factor of 3) compared to all three upstream stations and Station 10 (Fig. 6). However, even the highest concentration, 0.9 mg/L is no higher than the 85th percentile concentration reported by Schmitt and Brumbaugh (1990) for whole fish from 109 sampling stations located around the country. Other studies report comparable or higher mean lead concentrations in fish (Eisler 1988b). Water concentrations at Station 4 (20 µg/L) were within the range of lead values in the Colorado River shown in Table 4.5-1 of the DEIS, and lower than the mean concentration reported by Dvorak (1978) for the Colorado River basin as a whole. Sediment concentrations appeared to be very slightly higher downstream of the pile (11–22 mg/kg), but differed little from U.S. soil concentrations (mean of 20 mg/kg, range of 10–700 mg/kg) as reported by Eisler (1988b). In conclusion, lead concentrations do not appear to represent a threat to resident aquatic biota, including endangered species.

Manganese. The manganese concentration (36 mg/kg dry wt) in whole fathead minnows collected from downstream Station 8 were a little more than twice the upstream concentrations (Fig. 7), while concentrations further downstream at Stations 9 and 10 progressively approached upstream levels. The single sample of fish from Station 4 (adjacent to the pile) yielded a body burden lower than in fish from two of the three upstream stations. The limited published data on background manganese concentrations in freshwater fish range from about 2.6 in *Coregonus clupeaformis* to 12 mg/kg dry wt in *Esox lucius*, corrected from wet weight (Jorgensen et al. 1991). The fact that these values were for eviscerated fish while the fathead minnows were analyzed as whole fish may explain part but not likely all of the difference.

Sediment concentrations of manganese (480 mg/kg) were slightly elevated at Station 9 compared to upstream stations but were below the 1150 mg/kg reported by Salomons and Förstner (1984) for suspended river sediments and 850 mg/kg for shallow water sediments elsewhere. The water concentrations at Station 4 were about 1.5 to 3 times higher than the long-term average for this reach of the river, which is itself relatively high in manganese compared to most unpolluted U.S. surface waters (see Table 4.5-1 of the DEIS; Dvorak 1988; Jorgensen et al. 1991)/ This difference, however, may reflect the presence of suspended manganese-bearing minerals in the whole water samples. In any event, there is little evidence that manganese concentrations in the river approach levels potentially toxic to aquatic biota [e.g. a maximum of 450 µg/L at Station 4 (much of which is probably bound to suspended minerals and not directly available to fish) compared to the lowest reported chronic toxicity value for fish of 1770 µg/L (Suter and Mabrey 1994)].

Vanadium. At up to 1.8 mg/kg dry wt, the body burdens of vanadium in fathead minnows were two to three times higher at downstream Stations 8 and 9 than at upstream stations (Fig. 4). The fish vanadium level was back down to the upstream (or background) concentration at Station 10 (furthest downstream) and not detected at all (MDL = 0.5 mg/kg) at Station 4 adjacent to the pile. Concentrations in both upstream and downstream fish exceeded the 0.14 mg/kg dry wt reported for fish by Jorgensen et al. (1991). Water concentrations at Station 4 (25–34 µg/L) were elevated compared to the very limited USGS (1986) concentrations for Colorado River water upstream of the pile (< 6 µg/L) but not for the mean basin-wide concentration of 105 µg/L (Dvorak 1978). Moreover, given that the Station 4 analyses were on whole water samples, it is likely that much of the vanadium is bound to suspended mineral particles (soils may contain around 100–170 mg/kg vanadium; Bowen 1979; Salomons and Förstner 1984) and not readily bioavailable to aquatic organisms. Sediment concentrations of vanadium (14–22 mg/kg) did not show obvious enrichment downstream of the pile and were far below published values for soils. Based on the above, and the fact that even under lowest flow conditions (as discussed earlier) post-dilution vanadium contributions from the pile are calculated to be very low, it is unlikely that aquatic biota of the Colorado River in the vicinity of the tailings pile would be adversely affected by existing levels of vanadium.

Selenium. The selenium concentration (42 mg/kg dry wt) at the most downstream station (Station 10) was about 6 times the average upstream concentration (Fig. 7). Sediment selenium concentrations (all less than 1.0 mg/kg) did not reflect this disparity, and river water concentrations at Station 4 were below the detection limit of 5 µg/L—this compares to a mean basin-wide river concentration of 10 µg/L as reported by Dvorak (1978). The other downstream stations yielded selenium concentrations in fathead minnows comparable to those for the upstream stations. However, the geometric mean and 85th percentile concentrations of selenium (0.42 and 0.73 mg/kg wet wt respectively; the ratio of wet to dry weight is approximately 4:1) reported by Schmitt and Brumbaugh (1990) for whole fish from 109 stations located around the country were considerably lower than at any of the Colorado River stations reported here (ranging from about 2.6 to 25 times the national mean concentration). Moreover, the selenium concentration reported for Station 10 fish (42 mg/kg dry wt) is comparable to the concentration in red shiners (9.6 mg/kg wet wt) experimentally fed to striped bass in a study by Coughlan and Velte (1989). They reported that striped bass feeding on contaminated shiners showed modified behavior, very slow growth, reduced condition factor, elevated muscle selenium, damage to liver and kidney tissues, and death of all fish within 78 days. Studies summarized in Eisler (1985) showed reduced growth and reproduction in mallard ducks fed diets containing 25 mg/kg selenite, and teratogenic effects in mallard ducklings fed diets containing as little as 10 mg/kg selenite (6.2 mg/kg as selenium). These studies suggest that fish from Station 10 could be toxic to birds preying on these fish or other selenium-contaminated aquatic organisms. Ducks fed up to 5 mg/kg selenite (3.1 mg/kg as selenium) for 3 months showed no adverse effects.

As was generally true for the Utah State data presented in Table 4.5-1 of the DEIS, concentrations of selenium in river water were below the minimum detection limit of 5 µg/L for the analytical techniques used. Thus ambient concentrations in water were well below the National Ambient Water Quality Criterion of 35 µg/L, the lowest reported chronic toxicity value for aquatic organisms of 88 µg/L (Suter and Mabrey 1994), and the mean concentrations for the Colorado River basin of 10 µg/L cited by Dvorak et al. (1978) and Eisler (30 µg/L; 1985). Peterson and Nebeker (1992), however, estimated that concentrations as low as 1 µg/L of selenium dissolved in water could, through bioaccumulation, possibly prove toxic to some piscivorous birds and mammals. Whether the relatively high ambient concentrations reported by the state and published by others in the literature are truly representative of natural selenium levels in the Colorado River basin, or are at least partially the result of anthropogenic activities, is not evident at this time. If representative of natural conditions, then native species of fish and wildlife are presumably adapted to these levels of selenium. If concentrations are artificially enriched, some species possibly are adversely affected by these selenium levels, even to the point of extirpation from entire river reaches having elevated selenium.

These results, in concert with (1) the already high background selenium concentrations measured in Colorado River fathead minnows, and (2) the unusually high concentration measured for Station 10 fish downstream of the pile, suggest that Colorado squawfish and other predators on fathead minnows and other prey organisms could accumulate potentially toxic levels of selenium, at least for individual predators consuming contaminated prey as a large fraction of their diet. Although the reported level of selenium in minnows could be toxic to predators such as other fish and birds if the elevated levels occur over a large area, there are several reasons why the single elevated selenium level in fathead minnows is unlikely to have its source in the tailings pile. First, high background concentrations are certainly not an effect of the pile and may be largely natural; native aquatic species may have developed tolerance of such concentrations. (Note, however, that studies of elevated selenium in milt and eggs of razorback sucker in the Green River by Hamilton and Waddell (1994) suggest that selenium-induced reproductive problems may be a factor in the decline of this endangered fish.) Second, the unusually high selenium concentration reported for fish at Station 10 is based on a single measurement—i.e., no replicate measurements were made. Third, Station 10 is well downstream of at least two other possible sources of selenium, the wastewater treatment plant outfall from the city of Moab, and Mill Creek. Fourth, Station 4 (adjacent to the pile) and downstream Stations 8 and 9 (but upstream of Station 10) did not exhibit elevated selenium concentrations. Finally, Table 4.5-2 of the DEIS indicates that post-dilution selenium contributions from the pile are trivial.

Mercury. Mercury in fathead minnows was not detected at the lowest detection limit of 0.1 mg/kg dry wt at the upstream stations, but ranged from 0.2 to 1.2 mg/kg dry wt at the adjacent and downstream stations (Fig. 6). Concentrations of mercury as high as 1.2 mg/kg dry weight in fish suggest possible mercury pollution of anthropogenic origins. Mercury in water and sediments was undetectable at all stations (detection limit = 0.0002 mg/L for water and 0.1 mg/kg for sediment). Schmitt and Brumbaugh (1990) reported geometric mean, 85th percentile, and maximum concentrations of mercury in whole fish nationwide to be 0.1, 0.17, and 0.37 mg/kg wet wt respectively, or, adjusting for the difference between wet weight and dry weight, approximately 0.4, 0.68, and 1.5 mg/kg dry weight, respectively.

In his synoptic review of mercury hazards to fish, invertebrates, and wildlife, Eisler (1987) summarized results of an earlier survey that indicated a mean mercury concentration for fish in the southwestern United States of only 0.3 mg/kg dry wt (range: <0.2–0.48). Thus the 1.2 mg/kg dry wt reported for fish from Station 4 adjacent to the pile and the nearest station downstream (Station 8) are only slightly lower than the highest concentration reported in Schmitt and Brumbaugh's (1990) nationwide survey, and about 2.5 times the maximum reported by Eisler for fish in the Southwest. Eisler's review also noted that 0.05 to 0.5 mg/kg (wet wt or dry wt was not specified) in the diet were harmful to sensitive birds; and 1.1 mg/kg was harmful to sensitive mammals. The fish at Stations 4 and 8 could therefore be potentially toxic to some predatory birds and mammals should they feed largely on fish and other potentially contaminated organisms from the vicinity of these stations. The potential toxicity of mercury in river water itself cannot be evaluated with any degree of confidence because, although none was detected, the minimum detection limit of 0.0002 mg/L is too high to be certain that Utah water quality standards for the protection of aquatic life (Utah Administrative Code R317-2) and known toxic levels (Suter and Mabrey 1994) are not exceeded.

Interestingly, Eisler (1987) claims that the highest mercury concentrations in whole fish reported for the 1969–1981 period were from a relative of the Colorado squawfish, the northern squawfish (*Ptychocheilus oregonensis*) of the Columbia River Basin. Granting that the presence of major cinnabar deposits and use of mercury in mineral mining in the river basin may be the primary source of mercury in these fish, Eisler (1987) nevertheless speculates that "Northern squawfish may have a natural tendency to accumulate high concentrations of mercury in their flesh —as is well known for older specimens of long-lived predatory fish . . ."

Radionuclides. Total uranium concentrations in fathead minnows collected at Station 4 adjacent to the pile (0.51µg/kg dry wt) and at downstream station 10 (0.46 µg/kg) were up to 10 times the concentrations found at upstream and other downstream stations (ranging from 0.035 to 0.098 µg/kg) (Fig. 9). As with selenium and mercury, no similar trend was evident in the sediment data from this study. However, sediment grab samples taken from the river adjacent to the pile and just upstream of the pile in November, 1994 yielded considerably elevated uranium concentrations in the interstitial (pore) water [0.77 µg/L (530 pCi/L) and 0.28 mg/L (190 pCi/L), respectively) compared to the more typical concentration of the downstream sediment sample [0.016 mg/L (11 pCi/L)]. The high concentrations probably represent partially diluted leachate (groundwater) from the tailings pile which is diluted to near background concentrations on entering the river proper.

Both lead-210 (0.24 pCi/g, or more than 3 times concentrations reported for other stations) (Fig. 12) and polonium-210 (3.0 pCi/g, or 2 to 5 times concentrations reported for other stations) (Fig. 13) were elevated in fathead minnows collected from Station 4 (adjacent to pile) compared to all other stations. Again, sediment concentrations did not reflect this apparent enrichment of lead-210 and polonium-210 in fathead minnows near the pile.

Radium-226 and -228 and thorium-230 (Figs. 10 and 11) show slight, but again statistically untestable, elevations in concentrations in fathead minnows collected near the pile at Station 4. No similar trend was evident from the sediment data. Data for gross alpha and gross beta suggest slight enrichment in fathead minnows but not in sediments from Station 4 and at one or more downstream stations.

To determine whether or not the reported radionuclide concentrations in fathead minnows could be harmful the dose, D, in µrad/day to fish from each of the alpha- or beta-emitting radionuclides was estimated from the following model for approximating internal dose in aquatic organisms of the size range of most fish (IAEA 1976):

$$D = 51\, E_{av} \cdot C$$

where E_{av} = the average energy in MeV of alpha or beta particles emitted per disintegration of a radionuclide (for beta emitters, a correction factor must also be applied based on fish size and maximum beta particle energy); and C = the radionuclide concentration in fish in pCi/g. The results are summarized in Table 6.

Even allowing for some small additional contribution from radionuclides in water and sediments (which would, at most, double the total dose presented in Table 2), the total dose to fish of 1 to 2 mrad/day is clearly well below the 1 rad/day threshold considered potentially capable of producing adverse radiological effects in fish populations. It should be noted that 80% of the total dose is attributed to polonium-210.

Because the relative biological effectiveness (i.e., destructiveness) of a given absorbed dose from alpha radiation in humans is believed to be considerably greater than the same absorbed dose from gamma or beta radiation, a quality factor (Q) of 20, derived from data on radiation effects on human tissues, is usually applied to the absorbed dose to human tissues from alpha radiation. Whether or not it is appropriate to apply such a quality factor to dose assessments for animals including fish is a subject of controversy at this time (J. R. Trabalka, ORNL, personal communication with G. K. Eddlemon, ORNL, August 4, 1995). Even if a Q of 20 is applied to the absorbed dose estimates in fish calculated above (as recommended by Blaylock et al. 1993), the resulting effective dose is still only about 20 to 40 mrad/day, or about 2 to 4% of the recommended 1 rad/day limit for protection of populations of aquatic species.

Conclusions. Based on the analyses presented above, the tailings pile is unlikely to have adverse radiological effects on any of these endangered species under existing conditions, with the following possible exceptions. Near the leachate-contaminated groundwater-surface water interface, pre-dilution concentrations of U-238 and its daughter isotopes may occur at levels sufficiently high to harm local invertebrates and individual members of an endangered fish species should they reside there for long periods of time. Even in these conditions, few fish or invertebrates would be likely to spend long periods at the more contaminated interface. The site-specific data needed to assess effects on biota in these conditions do not exist.

The very limited sampling data available indicates that mercury and selenium concentrations in fathead minnows were anomalously high—high enough to raise concerns about the safety to predators (e.g., endangered fish) of these and other chemically contaminated organisms. It does not appear likely, however, that the pile is the source of most of the selenium (and perhaps most of the mercury as well) found in the single sample of fathead minnows. Although the pile is unlikely to adversely affect these species at the population level, the data available for this assessment are not sufficient to support a conclusion that the existing tailings pile does not have an effect on individual endangered Colorado squawfish and razorback suckers that could be present in the mixing zone or downstream deposition areas.

Table 6. Internal dose to fathead minnows collected May 1995 at Station 4 located at the mouth of Moab Wash next to tailings pile.

Radionuclide	Concentration (pCi/g)	Dose (μrad/day)
U-238	<0.4; assumed = 0.2	44
U-234	0.1	25
Th-230	0.5	97
Ra-226	0.07	40
Ra-228 (beta emitter)	1.6	1.4
Pb-210	0.24	0.46
Po-210	3.0	830
Total		1040

4.1.3 Reclamation Impacts

Construction-related activities during actual reclamation of the tailings pile (whether stabilization in place, or removal to the Plateau site) could adversely, but temporarily, affect water quality of the Colorado River, and possibly other streams as well, through accidental spills and the entry of sediment-laden and contaminated runoff. These activities include soil disturbance from earth moving activities, generation of wastewaters from, for example, equipment washing, and leaks and spills of liquids such as oils and fuels for vehicles. Moab Wash, a natural, shallow channel along the east side of the tailings pile that only rarely carries surface water, would be relocated further to the east to reduce the probability of channel migration into the pile. Development and operation of onsite and offsite borrow areas for clay, soil, sand, and rock riprap could adversely affect streams in the vicinity of such operations. Rain-mobilized soils and small amounts of contaminants may occasionally result in temporary increases in stream concentrations of suspended solids and contaminants, but concentrations in the Colorado River (but not necessarily in smaller streams near borrow areas) beyond a small mixing zone would probably be unmeasurable and of no consequence. It should be noted that the Colorado River naturally experiences large swings in suspended solids and averages nearly 700 mg/L just upstream of the tailings pile. Native aquatic organisms should therefore be adapted to these conditions.

Spills of oils and other liquids could possibly have a noticeable short term effect on surface water quality. In any smaller streams down gradient of borrow areas, however, impacts on water quality of suspended solids and spilled liquids in the absence of appropriate mitigative measures could be more substantial.

Removal of the entire pile to the Plateau site would involve impacts similar to those described above, but the potential for contamination of the Colorado River would be substantially greater. The Plateau site itself has no permanently flowing streams in the area, but, during rare periods of heavy precipitation, a gully south of the proposed alternative site could carry some surface flow to Courthouse Wash, an intermittent stream that eventually joins with the Colorado River many kilometers to the southeast.

The effects of increased suspended solids and siltation on aquatic biota are well documented and include reduction of light penetration and photosynthesis, impairment of respiration (gill function) and feeding, obliteration of spawning sites and microhabitats such as the interstitial spaces of bottom substrates, smothering of benthos and demersal fish eggs, alterations in species composition, and lowered fish production. Because the Colorado River has enormous dilutive capability, and naturally experiences large swings in suspended solids concentrations and turbidity, adverse effects, if any, of reclamation activities on endangered fish would likely be of short duration and limited to a small mixing zone adjacent to and downstream of the site. Moreover, aquatic organisms native to the mainstem of the Colorado River are generally quite tolerant of these conditions. Suspended solids concentrations in this river average nearly 700 mg/L just upstream of the tailings pile. Even these very minor impacts, however, can be substantially reduced through the proper use of runoff control measures including careful grading practices, interception and retention of runoff in adequately sized settling basins, stabilization of soils promptly after disturbance, and use of sediment barriers such as silt fences. Some sediments mobilized by earthmoving operations and rain during reclamation may be contaminated with low levels of trace elements and radionuclides, while accidental spills could introduce oils, cleaning wastes, or other undesirable liquids into the river. Again, dilution in the river would probably reduce concentrations beyond a small mixing zone to acceptable levels, but to better ensure that these contaminants do not exceed safe levels, runoff control measures such as those listed above would be implemented.

Candidate offsite borrow areas for cover and riprap materials include Round Mountain in Castle Valley and alluvial deposits in Spanish Valley. Although endangered fish are unlikely to enter the small ephemeral-to-intermittent streams near these offsite borrow operations, the impacts of increased suspended solids and accidental spills on resident aquatic organisms could be more substantial because the dilution capacity is much lower and some streams may have much lower ambient suspended solids concentrations. Consequently, aquatic biota would be more likely to incur illness, injury, or diminished success in respiration, feeding, mating, growth, and many other functions necessary to sustain populations as well as individuals. For these reasons, early and effective mitigative measures such as interception, retention, and treatment of sediment- and chemical-contaminated runoff would be required to ensure that susceptible streams are adequately protected.

Adverse effects on water quality of both the Colorado River and smaller streams near borrow areas could be largely mitigated by use of (1) adequate drainage controls and retention basins for spills and runoff, (2) prompt implementation of well-planned spill response measures when necessary, (3) where feasible, limiting major earthmoving operations to seasons of low thunderstorm potential, and (4) topographic and vegetative restoration of borrow areas to as close to pre-borrow conditions as possible. Because of the much greater drainage area of Moab Wash compared to the tailings pile itself, it would be very difficult to exercise effective erosion and drainage control during relocation of Moab Wash during and after thunderstorms over the drainage basin. It is therefore especially important that earthmoving activities associated with relocation of Moab Wash be limited to periods of low thunderstorm frequency. It is expected that a National Pollutant

Discharge Elimination System permit will be required for the release of storm water to the river. Compliance with permit conditions will probably require implementation of some or all of the above potential mitigative measures. Specific recommendations for mitigation are presented in Sect. 4.1.5 below.

4.1.4 Post-Reclamation Impacts

Once completed, full implementation of the proposed stabilization of the pile in place would substantially diminish the pathways by which contaminants and sediments enter the Colorado River and Moab Wash—i.e., (1) surface runoff, (2) leachate transport to groundwater, and (3) wind-blown dusts. Stabilization would effectively isolate tailings contaminants from surface runoff and wind. Only small amounts of uncontaminated soils and dusts would be available for transport to the river by these two pathways. Groundwater transport of contaminant-bearing tailings leachate to the river would likely continue but at a reduced rate (perhaps one-half of the existing rate; see Sect. 4.4.2 of the DEIS). Consequently, a concomitant reduction in the rate of contaminant migration to the river would be expected. A net, but hardly measurable, improvement in water quality of the river downstream of the site would result. It follows that the existing effects on water quality and endangered fish, already shown earlier and in Tables 3 through 5 (with the possible exceptions of ammonia, selenium, and mercury) to be of little consequence beyond a small mixing zone, should be negligible after stabilization in place is completed. Before sufficient dilution occurs near the interface (substrate) between the groundwater and surface water, however, it is possible that some invertebrates and small fish residing there, including any endangered species, could incur adverse effects. Thus, implementation of the proposed action would reduce the release of toxic metals from the reclaimed tailings pile. Continued releases of these materials from the rise and fall of groundwater during floods, however, could occur and potentially affect *individuals* of the endangered Colorado squawfish and razorback sucker, if these species actually reside or feed extensively in the mixing zone or in one or more deposition areas downstream. However, adverse effects on the Colorado squawfish and razorback sucker at the population level from the proposed action are unlikely.

Under the alternative proposal to relocate the pile to the Plateau site, contaminant transport to the Colorado River via any of these three pathways should almost disappear. For some unknown time, small amounts of residual contaminants in the groundwater at the existing site would continue to migrate to the river. Furthermore, there are no surface waters on or near the Plateau site other than normally dry gullies that may rarely carry storm runoff.

4.1.5 Recommended Mitigation and Conclusions

Based on our analyses of available data on ground and surface water quality, with the possible exceptions of a very few trace elements (e.g., selenium and mercury) the existing tailings pile does not appear to adversely affect surface water quality and hence the aquatic biota of the Colorado River beyond a small mixing zone near the east bank. Individuals of endangered fish species that may reside for extended periods of time in the mixing zone or, more likely, in some of the downstream deposition areas that offer nursery or feeding habitat, may incur sufficiently high burdens of these contaminants to be harmful. Nevertheless, once completed, both the proposed stabilization in place and the alternative removal of the tailings to the Plateau site would markedly reduce mobilization and transport of contaminants to the river, and therefore reduce any hazards to endangered fish. During actual construction and other activities related to the reclamation process, however, sediment- and contaminant-laden runoff could enter the Colorado River and smaller streams down-gradient of borrow areas. Measurable adverse impacts would likely be limited to water quality and resident aquatic organisms of the small intermittent streams near the borrow areas. Endangered fish are not expected to occur in these small streams.

Based on analysis of the limited data currently available, it appears that both the proposed action and the alternative action would be unlikely to adversely affect any of the endangered fish at the population level. However, should individual Colorado squawfish or razorback suckers reside or feed extensively in the mixing zone or in one or more deposition areas downstream, it is reasonably possible such individuals could be adversely affected under current conditions or under the proposed action.

The following measures are recommended to mitigate potential adverse effects of construction activities related to either reclamation alternative on water quality and aquatic biota of the Colorado River and smaller streams near borrow areas:

- Development and implementation of an effective spill prevention and response plan (and adequate training of personnel in spill prevention and response);
- Interception and storage of sediment- and contaminant-laden runoff through use of adequate drainage control, retention and treatment ponds, silt fences, and other means as necessary;
- Where and when feasible, avoidance of major earthmoving operations during periods of high thunderstorm potential;
- Avoidance of siting potential borrow areas near streams or lakes; and
- Topographic and vegetative restoration of borrow areas to as close to pre-borrow conditions as possible.

With these measures in place, neither the proposed action nor the alternative action is likely to adversely affect Colorado squawfish or razorback suckers at the population level. Additional data on existing contamination levels and the presence of endangered fish species is needed before a conclusion can be reached that individuals of these species are not likely to be affected under current conditions (i.e., no action) or under the proposed action of stabilizing the tailings pile in place.

4.2 Threatened and Endangered Birds

4.2.1 Reclamation Impacts

The southwestern willow flycatcher is unlikely to be present at the proposed borrow areas because riparian vegetation is not well developed in these areas. It could occur, however, in the vicinity of the mill tailings pile at the Atlas site, although there is considerable uncertainty as to whether or not the range of the subspecies extends as far as Moab (Sect. 3.2.1).

Even if the southwestern willow flycatcher is present, impacts of the existing pile on this subspecies are not likely to be significant. The riparian vegetation immediately adjacent to the pile has been disturbed in the past, and the floodplain has been invaded by tamarisk, which now dominates the existing riparian plant community. Although southwestern willow flycatchers may nest in tamarisk communities (Tibbitts et al. 1994), the subspecies prefers riparian habitat dominated by willow, cottonwood, and other native species. The presence of a large area of such habitat at the nearby Moab Marsh makes it unlikely that the existing tamarisk habitat adjacent to the tailings pile would be important to any birds that might be present.

If the southwestern willow flycatcher does nest in Moab Marsh or in riparian areas immediately up and down the river from the tailings pile, noise from reclamation activities associated with either reclaiming the pile in place or moving it to the Plateau site could disturb breeding activities in areas closest to the pile, causing the birds to abandon their nests or relocate. However, such disturbance is not one of the major reasons for the subspecies being listed as endangered.

The American peregrine falcon is known to nest in the vicinity of the Atlas site and feeds on birds in the Moab Marsh. Noise and disturbance associated with reclamation of the tailings pile (either in place or moving it to the Plateau site) could temporarily disrupt peregrine falcons nesting and feeding in the area. The levels of noise and related activities should be similar to those occurring when the mill was active and should have no long-term effect on the use of Moab Marsh as a feeding area for peregrines. In addition, the availability of riparian habitat in Moab Marsh and along the Colorado River corridor, both upstream and downstream of the mill tailings site suggests that peregrines can avoid any significant disruption to their use of the area by feeding in areas somewhat more distant from the pile. Activities at the site during reclamation are sufficiently distant from any known nesting site that impacts to breeding and nesting activities are unlikely to occur. The USFWS has stated that no construction activities are allowed within 1 mile of an active nest (W. R. Taylor, U.S. Department of Interior, Washington, D.C., letter to A. Mullins, NRC, Rockville, Maryland, February 3, 1995).

As discussed in Sect. 4.1.2 above, one-time sampling at stations in the vicinity of the pile found elevated levels of selenium and mercury in fish. These levels could be potentially toxic to predatory birds feeding on fish and other aquatic organisms in the vicinity of the pile (Eisler 1985, 1987) through biological magnification in the foodchain. The fish at Stations 4 and 8 of the May 1995 sampling program (WestWater 1995) could have potentially toxic body burdens of mercury for some predatory birds and mammals that feed largely on fish and other potentially contaminated organisms from the vicinity of these stations. Also, levels of selenium contamination in fish from Station 10 are sufficiently high that they could be toxic to birds preying on these fish or other aquatic organisms. The limited data are not sufficient to conclude that (1) the tailings pile is the source of these elevated levels and (2) the elevated levels observed reflect actual conditions (Sect 4.1.2). Under the proposed action, installation of a permanent cover on the tailings pile would reduce any leaching of these metals from the pile. Under the alternative of moving the pile to the Plateau, any potential source of these metals from the pile would be eliminated.

4.2.2 Post-Reclamation Impacts

Reclamation and stabilization of the pile in place would reduce the movement of leachates out of the pile. Over time desert shrub and grassland vegetation would develop on the slopes, and riparian vegetation would revegetate the floodplain areas disturbed by activities associate with reconfiguring the pile and placing riprap along the base of the slopes. Tamarisk-dominated plant communities are the most likely type of riparian vegetation to develop on the floodplain. This community could provide potential habitat for the southwestern willow flycatcher, but it would not be prime habitat for this endangered species. If the tailings are removed to the Plateau site, the area presently occupied by the tailings pile at the Atlas site would be either revegetated with native species or would be developed for some other type of land use. It is possible that some of this area could become additional riparian habitat that would support such species as the southwestern willow flycatcher or birds that serve as prey for American peregrine falcons.

4.2.3 Recommended Mitigation and Conclusions

The analysis of impacts on the southwestern willow flycatcher and the peregrine falcon indicate that adverse impacts to these species are not likely to occur from either the proposed action of reclaiming the tailings in place or the alternative of moving the tailings to the Plateau site. There is considerable uncertainty about whether the southwestern willow flycatcher is present in the area. To avoid possible impacts from either reclaiming the pile in place or moving it to the Plateau site, a survey for this endangered species should be conducted before initiating any reclamation activities at the existing mill tailings site. The survey should be conducted by a qualified biologist experienced with such work and should be done in consultation with the USFWS following the recently published survey protocols for this species (Tibbitts et al. 1994). The survey would need to be conducted during the breeding season and should include riparian areas adjacent to the tailings pile, Moab Marsh, and areas upstream and downsteam of the site. Should the species be found nesting in these areas, mitigation that prohibits activities in areas where the birds are likely to be during the breeding season should be developed and implemented in consultation with the USFWS.

American peregrine falcons are known to nest on cliffs near the tailings pile. To avoid possible impacts to peregrine falcons, surveys of current aeries within two miles of the tailings pile should be conducted prior to initiation of any reclamation activities. If any aerie is found to be present within 1.6 km (1 mile) of the pile, no construction activities will be allowed during the peregrines breeding season (mid-March to mid July) to avoid impacts on breeding success (W. R. Taylor, U.S. Department of Interior, Washington, D.C., letter to A. J. Mullins, NRC, Rockville, Maryland, February 3, 1995). Under these conditions, the proposed and the alternative actions are not likely to affect the endangered American peregrine falcon.

4.3 Threatened and Endangered Plants

4.3.1 Reclamation Impacts

Although Jones cycladenia may be present at the proposed Round Mountain riprap borrow area in Castle Valley and an unspecified riprap borrow site in the La Sal Mountains, there is no known population of this species at Round Mountain site, and information on soils in the vicinity of Round Mountain indicate that the species is not likely to be present there.

Astragulus sabulosa and *Oreoxis trotteri* are candidates for listing as threatened species under the ESA. *Astragulus sabulosa* could be present at the Plateau site, which is an alternative site for disposal of the tailings and also is a borrow site for clay cover material for reclaiming the pile at its existing location (Sect. 3.3.2). *Oreoxis trotteri* is not likely to be present at the Plateau site because its habitat is associated with the white sandstone Moab Tongue of the Entrada Formation and Navajo Sandstone (Sect. 3.3.3), which is not present at the Plateau site. No surveys have been conducted for these two plant species. Impacts on these species, if present, could involve direct destruction of habitat and populations by excavating and road building, and indirect disturbance from dust and altered drainage patterns.

4.3.2 Post-Reclamation Impacts

Jones cycladenia, *Astragulus sabulosa* and/or *Oreoxis trotteri* are not known to be present in any of the areas affected by the proposed or alternative actions. *Astragulus sabulosa* could be present at the Plateau site. Impacts to any of these species, should they be present, are most likely to occur from direct disturbance of existing populations and habitat. After reclamation has been completed, the likelihood of additional disturbance would be minimal.

4.3.3 Recommended Mitigation and Conclusions

Jones cycladenia could be present at potential borrow areas in Castle Valley and the La Sal Mountains. When specific sites for the borrow areas are identified by the licensee, surveys should be conducted for this species by a qualified botanist in consultation with the USFWS before commencing any activities at these sites. If populations are found to be present, mitigation should be developed to relocate borrow activities to avoid impacts to these populations and to protect the locations of known populations.

Astragulus sabulosa could be present at the Plateau site, but *Oreoxis trotteri* is not likely to be present there. Before initiating any activities at this site, a survey should be conducted for *Astragalus sabulosa* by a qualified botanist in consultation with the USFWS. If populations or individuals are found to be present, mitigation should be developed to avoid impacts to these species.

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APPENDIX G

ENVIRONMENTAL JUSTICE DATA

ENVIRONMENTAL JUSTICE DATA

This appendix contains the tabular data on race and ethnicity of the populations in the various study areas delineated in Figure 4.7-2. The Plateau site has no residents, so there are no data from that area. The screening for environmental justice concern regarding minority populations is based on the data presented in the attached tables. Data on racial and ethnic composition are aggregated to census blocks, the smallest unit for which the U.S. Bureau of the Census collects data. Several blocks together make a block group. The block group numbers in this table correspond to the numbers in Figures 4.7-2 and 4.7-3.

Column headings are abbreviated to accommodate page width limitations. The following is a key to the abbreviations used:

Tract	U.S. Bureau of the Census tract number
Blk#	U.S. Bureau of the Census block number
Tot. Pop.	total population in the given block
White	number of persons who identified themselves as white
% Wh	the percentage of the population in the block that is white
Black	number of persons who identified themselves as black
% Blk	the percentage of the population in the block that is black
Indian	number of persons who identified themselves as American Indian, Eskimo, or Aleut
% Indian	the percentage of the population in the block that is American Indian, Eskimo, or Aleut
Asian	number of persons who identified themselves as Asian or Pacific Islander
% Asian	the percentage of the population in the block that is Asian or Pacific Islander
Other	number of persons who identified themselves as Other race, excluding persons who also identified themselves as Hispanic
% Oth	the percentage of the population in the block that is Other race, excluding percentage who also identified themselves as Hispanic
Hispan	number of persons who identified themselves as being of Hispanic origin, excluding persons who also identified themselves as black, Asian, or American Indian
% Hisp	the percentage of the population in the block that is Hispanic (but not also black, Asian, or American Indian)
Tot. Min	the total number of persons who identified themselves as black, American Indian, Asian, other, and Hispanic (as defined above)
% Min	the percentage of the population in the block that is minority (as defined above)
% Min>State	Is the percentage minority population in the block greater than or equal to the percentage of the minority population in the State of Utah (i.e., is the percentage minority ≥ 8.8%)?
20%pts>State	Is the percentage of the minority population in the block greater than or equal to 20 percentage points more than the percentage of the minority population in the State (i.e., is the percentage minority ≥ 28.8%)?

Minority Populations

Spanish Valley

Tract	Blk#	Tot. Pop.	White	% Wh	Black	% Black	Indian	% Ind	Asian	% Asian	Other	% Oth	Hispan	% Hisp	Tot. Min.	% Min	% Min > State	20 % pts > State
9692	101	0	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9692	102	0	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9692	103C	15	13	86.67	0	0.00	0	0.00	0	0.00	0	0.00	2	13.33	2	13.33	Yes	
9692	303	0	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9692	322	0	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9692	302C	62	60	96.77	1	1.61	0	0.00	0	0.00	0	0.00	1	1.61	2	3.23		
9692	201	0	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9692	304	85	83	97.65	0	0.00	0	0.00	0	0.00	0	0.00	2	2.35	2	2.35		
9692	302A	85	76	89.41	1	1.18	5	5.88	0	0.00	0	0.00	3	3.53	9	10.59	Yes	
9692	202	48	44	91.67	0	0.00	0	0.00	0	0.00	0	0.00	4	8.33	4	8.33		
9692	323	0	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9692	203	120	120	100.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9692	204	38	38	100.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9692	205	0	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9692	207	23	18	78.26	0	0.00	0	0.00	5	21.74	0	0.00	0	0.00	5	21.74	Yes	
9692	206	43	40	93.02	0	0.00	3	6.98	0	0.00	0	0.00	0	0.00	3	6.98		
9692	324	0	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9692	208	50	44	88.00	0	0.00	0	0.00	0	0.00	0	0.00	6	12.00	6	12.00	Yes	
9692	211	40	36	90.00	0	0.00	0	0.00	0	0.00	0	0.00	4	10.00	4	10.00	Yes	
9692	210	0	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9692	213	55	50	90.91	0	0.00	0	0.00	0	0.00	0	0.00	5	9.09	5	9.09	Yes	
9692	212	60	57	95.00	0	0.00	0	0.00	3	5.00	0	0.00	0	0.00	3	5.00		
9692	209	57	53	92.98	0	0.00	0	0.00	0	0.00	0	0.00	4	7.02	4	7.02		
9692	214	46	44	95.65	1	2.17	0	0.00	0	0.00	1	2.17	0	0.00	2	4.35		
9692	302B	7	7	100.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9692	311	5	5	100.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9692	308	48	48	100.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9692	404	47	47	100.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9692	310	28	24	85.71	0	0.00	0	0.00	0	0.00	0	0.00	4	14.29	4	14.29	Yes	

9692	309	3	3	100.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9692	312	14	14	100.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9692	403	44	40	90.91	0	0.00	0	0.00	1	2.27	0	0.00	3	6.82	4	9.09	Yes	
9692	402	0	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9692	406	37	33	89.19	0	0.00	0	0.00	0	0.00	0	0.00	4	10.81	4	10.81	Yes	
9692	313	0	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9692	401	29	25	86.21	0	0.00	4	13.79	0	0.00	0	0.00	0	0.00	4	13.79	Yes	
9692	315	18	14	77.78	0	0.00	0	0.00	0	0.00	0	0.00	4	22.22	4	22.22	Yes	
9692	314	14	12	85.71	0	0.00	0	0.00	0	0.00	0	0.00	2	14.29	2	14.29	Yes	
9692	316	9	8	88.89	0	0.00	0	0.00	0	0.00	0	0.00	1	11.11	1	11.11	Yes	
9692	317	0	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9692	306B	10	10	100.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9692	405	186	163	87.63	1	0.54	7	3.76	0	0.00	0	0.00	15	8.06	23	12.37	Yes	
9692	103A	303	297	98.02	0	0.00	1	0.33	0	0.00	0	0.00	5	1.65	6	1.98		
9692	319	0	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9692	318	4	1	25.00	0	0.00	0	0.00	0	0.00	0	0.00	3	75.00	3	75.00	Yes	Yes
9692	320	13	13	100.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9692	306A	176	154	87.50	0	0.00	14	7.95	0	0.00	0	0.00	8	4.55	22	12.50	Yes	
9692	407	4	1	25.00	0	0.00	0	0.00	0	0.00	0	0.00	3	75.00	3	75.00	Yes	Yes
9692	503	56	35	62.50	0	0.00	17	30.36	1	1.79	0	0.00	3	5.36	21	37.50	Yes	Yes
9692	502	23	18	78.26	0	0.00	0	0.00	0	0.00	0	0.00	5	21.74	5	21.74	Yes	
9692	501	37	37	100.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9692	305	2	1	50.00	0	0.00	0	0.00	0	0.00	0	0.00	1	50.00	1	50.00	Yes	Yes
9692	108	33	32	96.97	0	0.00	0	0.00	0	0.00	0	0.00	1	3.03	1	3.03		
9692	412	14	14	100.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9692	413	0	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9692	410	38	37	97.37	0	0.00	0	0.00	0	0.00	0	0.00	1	2.63	1	2.63		
9692	307	35	33	94.29	0	0.00	1	2.86	0	0.00	0	0.00	1	2.86	2	5.71		
9692	411	13	12	92.31	0	0.00	1	7.69	0	0.00	0	0.00	0	0.00	1	7.69		
9692	504	15	11	73.33	0	0.00	4	26.67	0	0.00	0	0.00	0	0.00	4	26.67	Yes	
9692	505	13	10	76.92	0	0.00	0	0.00	0	0.00	0	0.00	3	23.08	3	23.08	Yes	
9692	506	13	9	69.23	0	0.00	4	30.77	0	0.00	0	0.00	0	0.00	4	30.77	Yes	Yes
9692	110	22	22	100.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9692	109	49	46	93.88	0	0.00	0	0.00	0	0.00	0	0.00	3	6.12	3	6.12		
9692	408	139	116	83.45	0	0.00	18	12.95	0	0.00	0	0.00	5	3.60	23	16.55	Yes	

9692	409	0	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9692	113	0	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9692	105B	0	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9691	417	0	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9692	509	15	10	66.67	0	0.00	2	13.33	0	0.00	0	0.00	3	20.00	5	33.33	Yes	Yes
9692	508	13	12	92.31	0	0.00	0	0.00	0	0.00	0	0.00	1	7.69	1	7.69		
9691	502B	0	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9692	507	23	22	95.65	1	4.35	0	0.00	0	0.00	0	0.00	0	0.00	1	4.35		
9692	111	0	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9692	112	47	44	93.62	0	0.00	0	0.00	0	0.00	0	0.00	3	6.38	3	6.38		
9691	502A	9	9	100.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9691	504A	0	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9692	510	0	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9692	114	105	105	100.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9692	512	36	29	80.56	1	2.78	5	13.89	1	2.78	0	0.00	0	0.00	7	19.44	Yes	
9692	519	2	2	100.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9691	504C	0	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9692	513	60	22	36.67	0	0.00	30	50.00	0	0.00	0	0.00	8	13.33	38	63.33	Yes	Yes
9692	106	0	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9692	518	6	3	50.00	0	0.00	0	0.00	0	0.00	0	0.00	3	50.00	3	50.00	Yes	Yes
9692	511	25	24	96.00	0	0.00	1	4.00	0	0.00	0	0.00	0	0.00	1	4.00		
9692	601	21	21	100.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9692	602	47	45	95.74	0	0.00	0	0.00	0	0.00	0	0.00	2	4.26	2	4.26		
9691	503	2	2	100.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9692	116	62	62	100.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9692	515	35	35	100.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9692	514	52	43	82.69	0	0.00	6	11.54	2	3.85	0	0.00	1	1.92	9	17.31	Yes	
9692	115	41	39	95.12	0	0.00	0	0.00	2	4.88	0	0.00	0	0.00	2	4.88		
9692	521	41	41	100.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9692	520	3	3	100.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9691	416A	0	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9691	501A	0	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9692	603	79	75	94.94	0	0.00	1	1.27	0	0.00	0	0.00	3	3.80	4	5.06		
9692	118	27	24	88.89	0	0.00	0	0.00	0	0.00	0	0.00	3	11.11	3	11.11	Yes	
9692	522	6	6	100.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		

9691	504D	0	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9692	516	36	33	91.67	0	0.00	0	0.00	0	0.00	0	0.00	3	8.33	3	8.33		
9692	605	38	37	97.37	0	0.00	0	0.00	1	2.63	0	0.00	0	0.00	1	2.63		
9691	501B	20	20	100.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9692	117	64	57	89.06	0	0.00	7	10.94	0	0.00	0	0.00	0	0.00	7	10.94	Yes	
9692	119	50	48	96.00	0	0.00	0	[illegible]	0	0.00	0	0.00	2	4.00	2	4.00		
9691	505	0	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9692	604	114	102	89.47	0	0.00	4	3.51	2	1.75	0	0.00	6	5.26	12	10.53	Yes	
9692	523	0	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9691	506	24	22	91.67	0	0.00	1	4.17	0	0.00	0	0.00	1	4.17	2	8.33		
9691	507	0	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9692	607	17	13	76.47	0	0.00	2	11.76	1	5.88	0	0.00	1	5.88	5	23.53	Yes	
9691	508	53	50	94.34	0	0.00	0	0.00	0	0.00	0	0.00	3	5.66	3	5.66		
9692	120	42	38	90.48	0	0.00	0	0.00	0	0.00	0	0.00	4	9.52	4	9.52	Yes	
9691	510	97	89	91.75	0	0.00	1	1.03	0	0.00	0	0.00	7	7.22	8	8.25		
9691	416B	0	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9692	105D	4	4	100.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9692	517	5	5	100.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9692	103B	0	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9692	606	35	27	77.14	0	0.00	6	17.14	0	0.00	0	0.00	2	5.71	8	22.86	Yes	
9691	504E	0	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9691	509	81	77	95.06	0	0.00	0	0.00	0	0.00	0	0.00	4	4.94	4	4.94		
9692	608A	0	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9692	105A	3	3	100.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9692	608C	0	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9692	107A	4	4	100.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9692	609	10	10	100.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9691	511	50	50	100.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9692	105C	0	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9692	107D	0	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9692	608F	58	58	100.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9691	416C	0	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9692	608E	31	31	100.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9692	107C	6	5	83.33	0	0.00	1	16.67	0	0.00	0	0.00	0	0.00	1	16.67	Yes	
9691	512A	0	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		

9692	107B	9	8	88.89	0	0.00	1	11.11	0	0.00	0	0.00	0	0.00	1	11.11	Yes	
9691	504F	0	0	0.00	9	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9691	504B	113	109	96.46	0	0.00	0	0.00	0	0.00	0	0.00	4	3.54	4	3.54		
9691	513B	6	6	100.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9691	512B	0	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9691	375B	200	192	96.00	0	0.00	1	0.50	1	0.50	0	0.00	6	3.00	8	4.00		
9692	608B	6	6	100.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9691	375A	0	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9691	514D	13	12	92.31	0	0.00	0	0.00	0	0.00	0	0.00	1	7.69	1	7.69		
9691	517A	7	7	100.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9691	513A	26	26	100.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9691	416D	0	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9691	515C	0	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9691	514A	48	43	89.58	0	0.00	1	2.08	0	0.00	0	0.00	4	8.33	5	10.42	Yes	
9691	515A	3	3	100.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9692	608D	7	7	100.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9691	519A	0	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9691	520A	3	3	100.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9691	515B	0	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9691	521A	20	19	95.00	0	0.00	1	5.00	0	0.00	0	0.00	0	0.00	1	5.00		
9691	524A	2	2	100.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9691	523A	5	5	100.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9691	517B	11	11	100.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9691	524B	18	12	66.67	0	0.00	6	33.33	0	0.00	0	0.00	0	0.00	6	33.33	Yes	Yes
9691	514B	2	2	100.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9691	519B	4	1	25.00	0	0.00	0	0.00	0	0.00	0	0.00	3	75.00	3	75.00	Yes	Yes
9691	526	26	26	100.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9691	516	23	21	91.30	0	0.00	1	4.35	0	0.00	0	0.00	1	4.35	2	8.70		
9691	514C	10	8	80.00	0	0.00	0	0.00	0	0.00	0	0.00	2	20.00	2	20.00	Yes	
9691	525	18	18	100.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9691	520B	5	5	100.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9691	527	17	17	100.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9691	521B	22	22	100.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9691	523B	20	20	100.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9691	522	22	22	100.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		

9691	528	46	42	91.30	0	0.00	4	8.70	0	0.00	0	0.00	0	0.00	4	8.70		
9691	416E	0	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9691	530	6	6	100.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9691	529	5	5	100.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9691	532	11	11	100.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9691	376	0	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9691	531	27	27	100.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9691	518	95	85	89.47	0	0.00	0	0.00	2	2.11	0	0.00	8	8.42	10	10.53	Yes	
9691	403	38	38	100.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9691	402	0	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9691	379	347	320	92.22	0	0.00	16	4.61	1	0.29	0	0.00	10	2.88	27	7.78		
9691	404	12	9	75.00	0	0.00	0	0.00	0	0.00	0	0.00	3	25.00	3	25.00	Yes	
9691	401	34	34	100.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9691	377	24	24	100.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9691	405	0	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9691	533	0	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9691	378	46	42	91.30	0	0.00	0	0.00	0	0.00	0	0.00	4	8.70	4	8.70		
9691	413	12	12	100.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9691	380	31	30	96.77	0	0.00	0	0.00	0	0.00	0	0.00	1	3.23	1	3.23		
9691	406	67	58	86.57	0	0.00	6	8.96	0	0.00	0	0.00	3	4.48	9	13.43	Yes	
9691	383	3	3	100.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9691	407	0	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9691	382	4	4	100.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9691	381	45	45	100.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9691	408	59	55	93.22	0	0.00	4	6.78	0	0.00	0	0.00	0	0.00	4	6.78		
9691	414	8	8	100.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9691	409	31	26	83.87	0	0.00	0	0.00	0	0.00	0	0.00	5	16.13	5	16.13	Yes	
9691	411	25	17	68.00	0	0.00	0	0.00	0	0.00	0	0.00	8	32.00	8	32.00	Yes	Yes
9691	415	4	4	100.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9691	412	132	129	97.73	0	0.00	0	0.00	0	0.00	0	0.00	3	2.27	3	2.27		
9691	410	92	91	98.91	0	0.00	0	0.00	0	0.00	0	0.00	1	1.09	1	1.09		
9691	430	6	6	100.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9691	429	0	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9691	428	16	16	100.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9691	427	0	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		

9691	431	0	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9691	432	0	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9691	435	0	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9691	434	3	3	100.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9691	433	12	12	100.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9781	107	54	54	100.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
Whole Area		5888	5438	92.36	6	0.10	187	3.18	23	0.39	1	0.02	233	3.96	451	7.66		

Minority Populations
Atlas Tailings Site

Tract	Blk#	Tot. Pop.	White	% Wh	Black	% Blk	Indian	% Ind	Asian	% Asian	Other	% Oth	Hispan	% Hisp	Tot. Min	% Min	% Min > State	20 % pts > State
9691	262	0	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9691	259	0	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9691	263	0	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9692	101	0	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9692	102	0	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9692	301	6	6	100.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9692	321	0	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9692	103C	15	13	86.67	0	0.00	0	0.00	0	0.00	0	0.00	2	13.33	2	13.33	Yes	
9692	303	0	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9692	322	0	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9692	302C	62	60	96.77	1	1.61	0	0.00	0	0.00	0	0.00	1	1.61	2	3.23		
9692	201	0	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9692	304	85	83	97.65	0	0.00	0	0.00	0	0.00	0	0.00	2	2.35	2	2.35		
9692	302A	85	76	89.41	1	1.18	5	5.88	0	0.00	0	0.00	3	3.53	9	10.59	Yes	
9692	202	48	44	91.67	0	0.00	0	0.00	0	0.00	0	0.00	4	8.33	4	8.33		
9692	323	0	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9692	203	120	120	100.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9692	204	38	38	100.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9692	205	0	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9692	207	23	18	78.26	0	0.00	0	0.00	5	21.74	0	0.00	0	0.00	5	21.74	Yes	
9692	206	43	40	93.02	0	0.00	3	6.98	0	0.00	0	0.00	0	0.00	3	6.98		
9692	324	0	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9692	208	50	44	88.00	0	0.00	0	0.00	0	0.00	0	0.00	6	12.00	6	12.00	Yes	
9692	211	40	36	90.00	0	0.00	0	0.00	0	0.00	0	0.00	4	10.00	4	10.00	Yes	
9692	210	0	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9692	213	55	50	90.91	0	0.00	0	0.00	0	0.00	0	0.00	5	9.09	5	9.09	Yes	
9692	212	60	57	95.00	0	0.00	0	0.00	3	5.00	0	0.00	0	0.00	3	5.00		
9692	209	57	53	92.98	0	0.00	0	0.00	0	0.00	0	0.00	4	7.02	4	7.02		
9692	214	46	44	95.65	1	2.17	0	0.00	0	0.00	1	2.17	0	0.00	2	4.35		

9692	302B	7	7	100.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9692	311	5	5	100.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9692	308	48	48	100.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9692	404	47	47	100.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9692	310	28	24	85.71	0	0.00	0	0.00	0	0.00	0	0.00	4	14.29	4	14.29	Yes	
9692	309	3	3	100.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9692	312	14	14	100.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9692	403	44	40	90.91	0	0.00	0	0.00	1	2.27	0	0.00	3	6.82	4	9.09	Yes	
9692	402	0	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9692	406	37	33	89.19	0	0.00	0	0.00	0	0.00	0	0.00	4	10.81	4	10.81	Yes	
9692	313	0	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9692	401	29	25	86.21	0	0.00	4	13.79	0	0.00	0	0.00	0	0.00	4	13.79	Yes	
9692	315	18	14	77.78	0	0.00	0	0.00	0	0.00	0	0.00	4	22.22	4	22.22	Yes	
9692	314	14	12	85.71	0	0.00	0	0.00	0	0.00	0	0.00	2	14.29	2	14.29	Yes	
9692	316	9	8	88.89	0	0.00	0	0.00	0	0.00	0	0.00	1	11.11	1	11.11	Yes	
9692	317	0	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9692	306B	10	10	100.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9692	405	186	163	87.63	1	0.54	7	3.76	0	0.00	0	0.00	15	8.06	23	12.37	Yes	
9692	103A	303	297	98.02	0	0.00	1	0.33	0	0.00	0	0.00	5	1.65	6	1.98		
9692	319	0	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9692	318	4	1	25.00	0	0.00	0	0.00	0	0.00	0	0.00	3	75.00	3	75.00	Yes	Yes
9692	320	13	13	100.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9692	306A	176	154	87.50	0	0.00	14	7.95	0	0.00	0	0.00	8	4.55	22	12.50	Yes	
9692	407	4	1	25.00	0	0.00	0	0.00	0	0.00	0	0.00	3	75.00	3	75.00	Yes	Yes
9692	503	56	35	62.50	0	0.00	17	30.36	1	1.79	0	0.00	3	5.36	21	37.50	Yes	Yes
9692	502	23	18	78.26	0	0.00	0	0.00	0	0.00	0	0.00	5	21.74	5	21.74	Yes	
9692	501	37	37	100.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9692	305	2	1	50.00	0	0.00	0	0.00	0	0.00	0	0.00	1	50.00	1	50.00	Yes	Yes
9692	108	33	32	96.97	0	0.00	0	0.00	0	0.00	0	0.00	1	3.03	1	3.03		
9692	412	14	14	100.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9692	413	0	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9692	410	38	37	97.37	0	0.00	0	0.00	0	0.00	0	0.00	1	2.63	1	2.63		
9692	307	35	33	94.29	0	0.00	1	2.86	0	0.00	0	0.00	1	2.86	2	5.71		
9692	411	13	12	92.31	0	0.00	1	7.69	0	0.00	0	0.00	0	0.00	1	7.69		
9692	504	15	11	73.33	0	0.00	4	26.67	0	0.00	0	0.00	0	0.00	4	26.67	Yes	

9692	505	13	10	76.92	0	0.00	0	0.00	0	0.00	0	0.00	3	23.08	3	23.08	Yes	
9692	506	13	9	69.23	0	0.00	4	30.77	0	0.00	0	0.00	0	0.00	4	30.77	Yes	Yes
9692	110	22	22	100.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9692	109	49	46	93.88	0	0.00	0	0.00	0	0.00	0	0.00	3	6.12	3	6.12		
9692	408	139	116	83.45	0	0.00	18	12.95	0	0.00	0	0.00	5	3.60	23	16.55	Yes	
9692	409	0	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9692	113	0	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9691	417	0	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9692	509	15	10	66.67	0	0.00	2	13.33	0	0.00	0	0.00	3	20.00	5	33.33	Yes	Yes
9692	508	13	12	92.31	0	0.00	0	0.00	0	0.00	0	0.00	1	7.69	1	7.69		
9691	502B	0	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9692	507	23	22	95.65	1	4.35	0	0.00	0	0.00	0	0.00	0	0.00	1	4.35		
9692	111	0	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9692	112	47	44	93.62	0	0.00	0	0.00	0	0.00	0	0.00	3	6.38	3	6.38		
9691	502A	9	9	100.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9691	504A	0	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9692	510	0	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9692	114	105	105	100.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9692	512	36	29	80.56	1	2.78	5	13.89	1	2.78	0	0.00	0	0.00	7	19.44	Yes	
9692	519	2	2	100.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9691	504C	0	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9692	513	60	22	36.67	0	0.00	30	50.00	0	0.00	0	0.00	8	13.33	38	63.33	Yes	Yes
9692	518	6	3	50.00	0	0.00	0	0.00	0	0.00	0	0.00	3	50.00	3	50.00	Yes	Yes
9692	511	25	24	96.00	0	0.00	1	4.00	0	0.00	0	0.00	0	0.00	1	4.00		
9692	601	21	21	100.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9692	602	47	45	95.74	0	0.00	0	0.00	0	0.00	0	0.00	2	4.26	2	4.26		
9691	503	2	2	100.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9692	116	62	62	100.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9692	515	35	35	100.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9692	514	52	43	82.69	0	0.00	6	11.54	2	3.85	0	0.00	1	1.92	9	17.31	Yes	
9692	115	41	39	95.12	0	0.00	0	0.00	2	4.88	0	0.00	0	0.00	2	4.88		
9692	521	41	41	100.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9692	520	3	3	100.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9691	416A	0	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9691	501A	0	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		

9692	603	79	75	94.94	0	0.00	1	1.27	0	0.00	0	0.00	3	3.80	4	5.06		
9692	522	6	6	100.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9691	504D	0	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9692	516	36	33	91.67	0	0.00	0	0.00	0	0.00	0	0.00	3	8.33	3	8.33		
9692	605	38	37	97.37	0	0.00	0	0.00	1	2.63	0	0.00	0	0.00	1	2.63		
9691	501B	20	20	100.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9691	505	0	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9692	604	114	102	89.47	0	0.00	4	3.51	2	1.75	0	0.00	6	5.26	12	10.53	Yes	
9692	523	0	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9691	506	24	22	91.67	0	0.00	1	4.17	0	0.00	0	0.00	1	4.17	2	8.33		
9691	507	0	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9692	607	17	13	76.47	0	0.00	2	11.76	1	5.88	0	0.00	1	5.88	4	23.53	Yes	
9691	508	53	50	94.34	0	0.00	0	0.00	0	0.00	0	0.00	3	5.66	3	5.66		
9691	510	97	89	91.75	0	0.00	1	1.03	0	0.00	0	0.00	7	7.22	8	8.25		
9691	416B	0	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9692	517	5	5	100.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9691	504E	0	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9691	509	81	77	95.06	0	0.00	0	0.00	0	0.00	0	0.00	4	4.94	4	4.94		
9692	608A	0	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9691	511	50	50	100.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9691	416C	0	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9691	512A	0	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9691	504F	0	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9691	504B	113	109	96.46	0	0.00	0	0.00	0	0.00	0	0.00	4	3.54	4	3.54		
9691	517A	7	7	100.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9691	416D	0	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9691	295	0	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9691	421	3	3	100.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9691	418	0	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
Whole Area		3722	3405	91.48	6	0.16	132	3.55	19	0.51	1	0.03	159	4.27	317	8.52		

Minority Populations
Round Mountain Site

Tract	Blk #	Tot. Pop.	White	% Wh	Black	% Blk	Indian	% Ind	Asian	% Asian	Other	% Oth	Hispan	% Hisp	Tot. Min	% Min	% Min > State	20 % pts > State
9691	328	0	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9691	337	0	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9691	331B	40	37	92.50	0	0.00	0	0.00	0	0.00	0	0.00	3	7.50	3	7.50		
9691	332	7	7	100.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9691	335	6	6	100.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9691	333	5	3	60.00	0	0.00	0	0.00	0	0.00	0	0.00	2	40.00	2	40.00	Yes	Yes
9691	331C	0	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9691	334	5	5	100.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9691	331A	187	177	94.65	0	0.00	3	1.60	1	0.53	0	0.00	6	3.21	10	5.35		
9691	336	1	1	100.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9691	339B	0	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9691	338	0	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9691	340C	0	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9691	340A	0	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9691	339A	0	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9691	341A	0	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9691	331D	0	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9691	340B	0	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9691	369	0	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9691	341B	12	12	100.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9691	370	0	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
9691	371	0	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00		
Whole Area		263	248	94.30	0		3	1.14	1	0.38	0		11	4.18	15	5.70		

NRC FORM 335 (2-89) NRCM 1102, 3201, 3202

U.S. NUCLEAR REGULATORY COMMISSION

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(See instructions on the reverse)

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Draft Environmental Impact Statement Related to Reclamation of the Uranium Mill Tailings at the Atlas Site, Moab, Utah

Source Material License No. SUA 917
Docket No. 40-3453
Atlas Corporation

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5. AUTHOR(S)

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Draft Environmental Impact Statement

7. PERIOD COVERED (Inclusive Dates)

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Washington, DC 20555-0001

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Division of Waste Management
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U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

10. SUPPLEMENTARY NOTES

Docket No. 40-3453

11. ABSTRACT (200 words or less)

This Draft Environmental Impact Statement (DEIS) has been prepared by the Nuclear Regulatory Commission (NRC), Office of Nuclear Material Safety and Safeguards, to address potential environmental impacts associated with a request by Atlas Corporation to amend its existing NRC License No. SUA-917 to reclaim an existing uranium mill tailings pile near Moab, Utah. The proposed reclamation would allow Atlas to (1)reclaim the tailings pile for permanent disposal and long-term custodial care by a government agency in its current location on the Moab site, (2) prepare the 162-ha (400 acre) Moab site for site closure, and (3) relinquish responsibility of the site after having its NRC license terminated. The DEIS describes and evaluates (1) the purpose of and need for the proposed action, (2) alternatives considered, (3) potentially affected environmental resources, (4) environmental consequences of the proposed action, and (5) costs and benefits associated with reclamation alternatives. Public and agency comments on this DEIS will be considered in the Final Environmental Impact Statement.

12. KEY WORDS/DESCRIPTORS (List words or phrases that will assist researchers in locating the report.)

Atlas, uranium, mill tailings, Moab, reclamation, uranium mill, tailings

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