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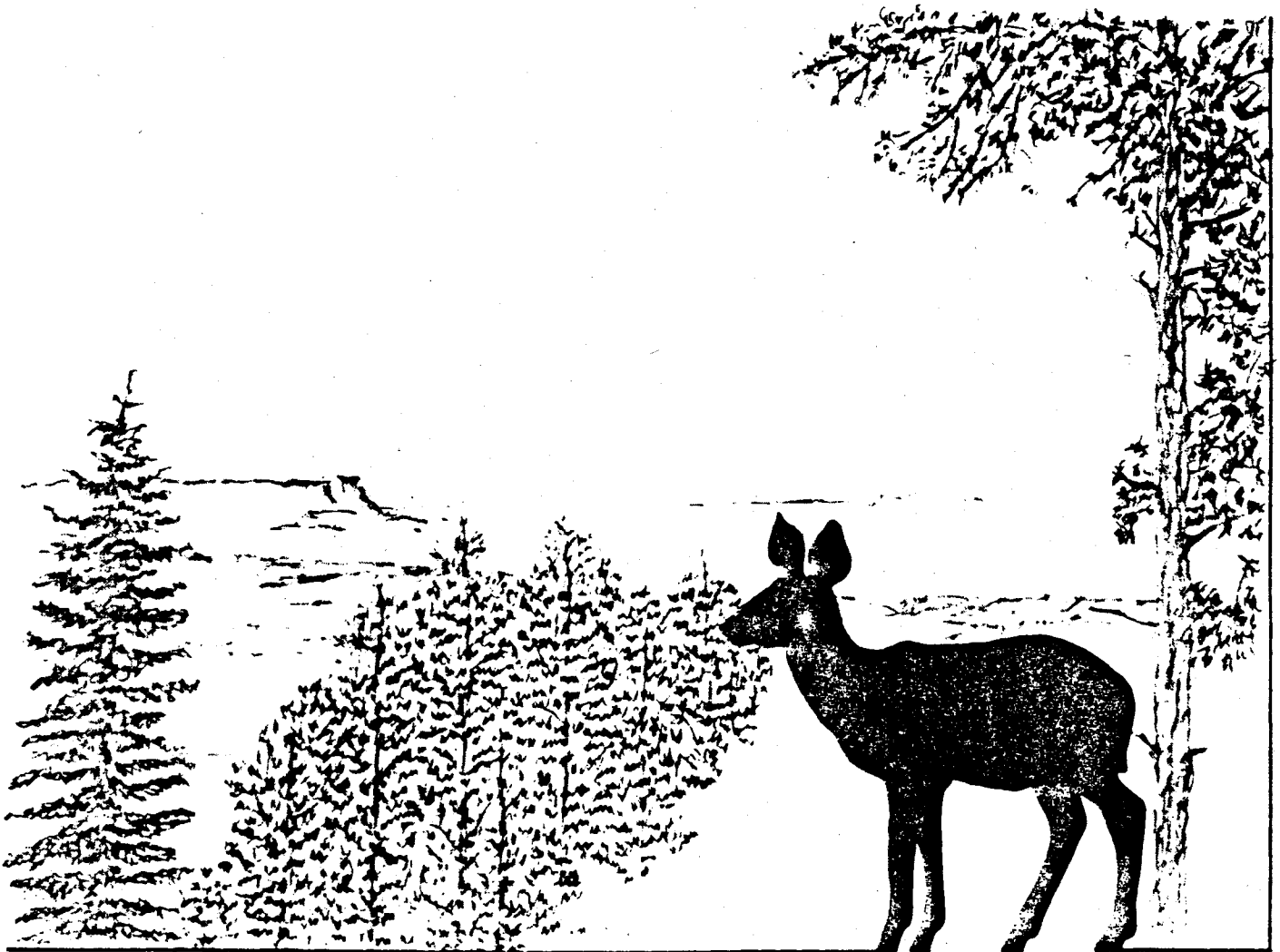
Southwestern
Region

Kaibab National
Forest

August 1986



Final Environmental Impact Statement Canyon Uranium Mine



ENVIRONMENTAL IMPACT STATEMENT
CANYON URANIUM MINING PROPOSAL
COCONINO COUNTY, ARIZONA

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ABSTRACT

This EIS is in response to an initial application in October 1984 by Energy Fuels Nuclear, Inc. to develop a uranium mine south of the Grand Canyon on the Tusayan Ranger District of the Kaibab National Forest. Three alternatives to the proposed development are presented and analyzed along with a No Action Alternative to continue the current management activities in the area. This EIS meets the requirements of the National Environmental Policy Act (NEPA).

Appendices A through F to the Draft EIS were printed separately and are available for loan at public libraries or local Forest Service offices.

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SUMMARY

1. PURPOSE OF AND NEED FOR ACTION

In October 1984, Energy Fuels Nuclear, Inc. (EFN) submitted to the U.S.D.A. Forest Service, Kaibab National Forest, a Plan of Operations to mine uranium on unpatented mining claims on the Tusayan Ranger District. The proposed mine is located in Coconino County Arizona, approximately 6 miles south of Tusayan. The discovery of this ore body was made during an earlier exploratory drilling program approved by the Forest.

The proposed Canyon Mine would involve disturbance of approximately 17 acres for the mine shaft and surface facilities, plus some new or improved roads within the Forest, depending on which ore transportation route is ultimately selected. The ore would be hauled to the licensed mill at Blanding, Utah.

The federal action considered in this document is the approval by the Forest Supervisor, Kaibab National Forest, of a Plan of Operations for the Canyon Mine (Appendix A) with reasonable mitigation measures that are in addition to those proposed by EFN. The Supervisor's decision may be to approve the Company's plan as proposed or to require modification of the plan.

2. SCOPING AND EIS PROCESS

A primary objective of this Environmental Impact Statement (EIS) is to disclose for both Forest Service officials and the public, information sufficient to permit a reasoned evaluation of the environmental aspects and implications of implementing a range of project alternatives.

An evaluation of the extensive public review of the Canyon Mine proposal indicated significant public concern about uranium mining in Northern Arizona. Although much of this concern is based on opposition to the eventual uses of uranium, there are also many concerns related to the effects of uranium mining on the human, physical, and biological environment.

After intensive screening and evaluation, ten issues and concerns were identified for analysis in the EIS. These issues and concerns were used in the formulation and evaluation of alternatives and assessment of impacts. To varying degrees,

these issues and concerns are the focus of this EIS. However, other issues and impacts are identified and discussed as appropriate.

1. What social and economic impacts will the uranium mine have on the local communities and Coconino County?
2. What reclamation measures will be required for site restoration?
3. Can proponent-incurred project costs be held to a reasonable level?
4. What impacts will the mining operation have on important wildlife habitats?
5. What effect will the mining activities have on forest vegetation?
6. What effect will the mining activities have on visual quality of the Kaibab Forest, State Highway 64, and the Grand Canyon?
7. What effects will the mining activities have on the air quality of the surrounding area?
8. What impacts will the mining transportation system have on the local environment and the management of National Forest System Lands?
9. What impacts will the mining activities have on the soil, and surface and subsurface water quantity and quality?
10. What impacts will mining and ore transportation have on Indian religious sites and practices?

Following scoping, the Draft Environmental Impact Statement (DEIS) was prepared for the Canyon Mine. The DEIS was transmitted to EPA and the public on February 28, 1986. The public comment deadline was May 1, 1986 though substantive comments received after that date were also considered and are included in the EIS to the maximum extent possible. The DEIS considered five alternatives in detail, including the No Action Alternative and four operational alternatives. Those alternatives are described in detail in Chapter 2.

The EIS has been revised to reflect the comments received on the DEIS. Important changes include:

1. Addition of Indian religious concerns as an issue and concern.

The potential impact of the Canyon Mine on Indian religious sites and practices was considered in the DEIS in conjunction with a general analysis of impacts on American Indians. Comments on the DEIS by the Hopi and Havasupai Tribes alleged that religious sites and practices would be adversely affected by the Canyon Mine, a concern which was not raised by the Tribes during scoping or earlier consultation with the Tribes. Based on those comments and continuing consultation with the affected Tribes, the Forest Service has added Indian religious concerns to the list of issues evaluated in detail by the EIS. The text of the FEIS includes an expanded discussion of Indian religious sites and practices in the affected area. The Forest Service has also requested a meeting with tribal representatives at the proposed mine site to identify any specific sacred sites that might be disturbed by mining activity. To date, neither Tribe has committed to a visit to the mine site. Consultation with the Tribes regarding religious concerns will continue beyond completion of the NEPA process.

2. Expanded discussion of potential groundwater impacts.

Several comments expressed concern about potential depletion or contamination of groundwater resources in the area, including potential impacts on seeps and springs which flow from underground aquifers. The DEIS evaluated the impacts on surface and subsurface water as a major issue and concern. The DEIS concluded that adverse impacts either during or after mining operations were extremely unlikely. In response to public comments, the FEIS includes an expanded discussion and analysis of groundwater conditions and potential impacts. The additional analysis confirms the conclusion of the DEIS that no adverse impacts are expected. The Preferred Alternative includes a monitoring well at the mine site. If groundwater is present at the site, the well will disclose any unanticipated changes in water quality resulting from mine operations.

3. **ALTERNATIVES CONSIDERED
INCLUDING THE PROPOSED ACTION**

The major issues and concerns identified through the scoping process, management concerns of affected State and Federal agencies and pertinent legal and regulatory requirements were used in developing suitable alternatives for analysis. The

alternatives to be considered in detail represent a reasonable range of opportunities that address the significant issues and concerns. Briefly the five alternatives developed are:

1. No action, or disapproval of the Plan of Operations.. This alternative provides baseline data against which the impacts of the following alternatives can be compared.
2. Plan of Operations as proposed by EFN which includes using Haul Route #1 along the north boundary of Tusayan Ranger District and south of the Grand Canyon National Park; shortest distance overhead powerline; pooled worker transportation; ten 20-ton ore trucks per day to the Blanding, Utah mill; 5 to 10 year mining period; holding ponds for mine-yard runoff; 6-foot chainlink security fence; runoff channels around mine yard; and potable water from ground water or trucked from Williams.
3. Proposed Plan of Operations with the following modifications: monitoring of air, soil and water; equivalent wildlife habitat replacement; use either haul route #1 or #2 along the northern boundary of the Tusayan Ranger District; modified diversion channels with dikes; and construction of a 35-car parking lot.
4. Proposed Plan of Operations with the following modifications: monitoring of air, soil and water; equivalent wildlife habitat replacement; construction of haul route #5 off the east end of the Coconino Rim escarpment; and an overhead powerline along access road.
5. Proposed Plan of Operations with the following modifications: monitoring of air, soil and water; buried powerline along access road; minimize road construction by use of haul route #7 near SP Crater (pending right-of-way acquisition across 20 miles of State and private land), or haul route #6 which utilizes State Highway 64 south to I-40, east to US 89, north on US 160 and 191 to Blanding, Utah.

The intent of the general constraints, guidelines and mitigation measures contained in each alternative is to ensure that adverse environmental impacts are avoided or minimized during construction and operation of the project, and during reclamation after mine closure. These requirements also aid in the process of identifying the Preferred Alternative.

4. PREFERRED ALTERNATIVE

No Preferred Alternative was identified in the DEIS. Based on the analysis in the DEIS and public comments received in response to the DEIS, Alternative 5 has been selected as the Preferred Alternative with one minor modification. Alternative 5 included a buried powerline along the access road to the mine site; the Interdisciplinary Team concluded that, given the relative temporary nature of the project, burying the powerline would increase costs significantly with no corresponding environmental benefits and the Interdisciplinary Team has therefore, substituted an above ground powerline.

The operational elements of the Preferred Alternative are:

1. Expanded monitoring of soil, air and water (described in Sections 2.5.10 and 2.5.11);
2. Modified surface water diversion structure (Section 2.5.12);
3. Use of haul route #6 (the all highway route described in Section 2.2.1.1) or haul route #7 (the SP Crater road described in Section 2.2.1.1);
4. An overhead powerline from Highway 64 following the access road to the mine site (Section 2.2.1.1);
5. Transportation of mine workers by the company (Section 2.2.1.1); and
6. The mitigation measures applicable to all alternatives (described in Section 2.5) including equivalent acre replacement of disturbed wildlife habitat and relocation of key wildlife waters.

The DEIS noted that "Generally, no environmental impacts have been identified in any alternative which cannot be mitigated to a substantial extent." This conclusion is still valid. However, the Preferred Alternative represents the combination of operational components, mitigation measures and haul routes which minimize potential impacts and best responds to the issues and concerns identified in the EIS.

5. CONCLUSION

Adverse environmental impacts identified with past uranium mine activities in Northeastern Arizona and Northwestern New Mexico, such as radionuclide contamination of surface and ground water, radon gas emissions affecting the health of mine workers and a general degradation of the environment, can be minimized by

implementation of the monitoring, mitigation measures and operating procedures required in Alternatives 2, 3, 4 and 5. The Preferred Alternative includes all of the monitoring and mitigation measures evaluated in the EIS.

Throughout most of the analyses, potential impacts were analyzed by assuming extreme conditions in order to assure maximum confidence in the results of the analysis.

There do not appear to be any significant adverse radiological impacts on the environment from the Canyon Mine Project. This conclusion is based on evaluation of existing and projected radiation, radon and dust emissions levels, the requirements of the Clean Water Act and the water quality permits applicable to the mine, and the fact that no discharge from the mine is anticipated.

During mine operation the direct radiation from the ore piles will probably not be measurable at distances greater than a few hundred meters from the mine site. In any event, it should not be possible to distinguish the mine induced radiation from the variations in the natural radiation environment which currently exist in the vicinity of the site.

Changes in radon gas levels in the community of Tusayan from the Canyon Mine are projected to be too small to detect and will remain within normal radon level fluctuations existing in the environment.

Ore transport to the mill will not expose inhabitants along the haulage route to any measurable increase in radiation. A few accidents may occur during the life of the mine when ore spillage occurs. A thorough and timely cleanup of any spills will not pose a health hazard from the radiation of the ore.

An extreme flood event exceeding that to be expected once every 500 years, followed by a total loss of the mine site diversion structures, could release several Curies of radioactivity from the ore piles to the downstream wash. However, residual contamination would be removed and returned to the mine yard. There would be no health hazard. The mine site is being designed to preclude accidental discharges to the wash; however, if an accidental release occurs, the impact must be assessed immediately and cleanup effected if the situation warrants.

Social and economic impacts will likely be felt the most in the community of Williams and are generally considered to be beneficial because of increased employment. Population increases or other development in Tusayan will probably be discouraged by lack of housing, a limited water supply and a

small existing work force. However, because the resources of the town are limited, even small increases in population will result in noticeable impacts.

Development of the mine site could slightly reduce the amount of land available for Indian religious practices, including hunting and gathering activities. However, mine development is not expected to affect the current level of Indian religious practices in the area. An archeological review of the site and consultation with affected Tribes have failed to disclose any specific sacred sites or properties which would be disturbed by any of the alternatives.

In comments regarding other proposed actions on the Kaibab National Forest, the Hopi Tribe has expressed a belief that the earth is sacred and that it should not be subjected to digging, tearing or commercial exploitation. While this conflict has not been raised directly in relation to the Canyon Mine, it is acknowledged that commercial use of the Forest within the area of Hopi ancestral occupancy is inconsistent with these stated religious beliefs.

Wildlife habitat on the Tusayan Ranger District or near vacant State and privately owned lands along haul route #7, can be adversely affected by the development of the mine site, improvement of the required haul routes and increased traffic flows over these routes. The additional mitigation measures developed in Alternatives 3, 4 and 5 should be more effective in reducing these impacts than measures described in Alternative 2.

The use of state highways for haul route #6 in Alternative 5 should have no measurable impacts on adjacent wildlife habitat since the increase in traffic level resulting from the 10 ore trucks would be insignificant when compared to the 2800-3800 average daily traffic that is already using these routes.

The possibility of significant ground water contamination from the mine is remote. Ground water flows, if they exist, are likely to be at least 1,000 feet below the lower extremities of the mine. This, plus the low potential for encountering groundwater in the mine, effectively eliminates the possibility of contaminating the Redwall-Muav aquifer. Groundwater flows, if present, will be monitored by a test well drilled at the site. Water samples will be taken, and if contamination is found, the well will be pumped and the water will be held on site or discharged in accordance with the Clean Water Act.

Data and information contained in this EIS indicates that neither the Grand Canyon National Park nor Havasupai Indian

Reservation should be affected either directly or indirectly by the development of the Canyon Mine. This conclusion is further supported from the apparent lack of any environmental degradation (other than visual impacts and the obvious inconsistent land use) caused by the operation of the Orphan Uranium Mine, located 2 miles west of Grand Canyon Village on the south rim of the Grand Canyon. It was active during the period from 1956 to 1969, under regulatory guidelines much less restrictive than those which exist today. Radionuclide contamination of air, soil or water from the Orphan Mine has not been identified. For comparative purposes, the proposed Canyon Mine is some 13 air miles from the rim of the Grand Canyon. Implementation of mitigation measures in Alternatives 2-5 will minimize the likelihood of any adverse environmental impacts on the Grand Canyon National Park.

Alternatives 3, 4, and 5 provide for postoperational monitoring of the air, soil and water resources. Data will be compared to preoperation baseline data to determine if any significant environmental changes are occurring.

In summary, an evaluation of the development of the Canyon Mine has not identified any environmental impacts of Alternatives 2-5 which cannot be mitigated to a substantial extent through the implementation of the additional mitigation measures identified in the Plan of Operations and Alternatives 3, 4 and 5.

Comparison of Alternatives for Resolution of Issues and Concerns

None of the project alternatives fully resolves all of the identified issues and concerns (IC's). However, by implementing the mitigation measures identified in Section 2.5, Alternatives 3, 4 and 5 are considered environmentally acceptable by the Forest Service. Alternative 5, with the substitution of an overhead power line, has been selected as the Preferred Alternative.



IC #1-Social and economic impacts on the community of Williams and Coconino County as a whole are considered by the Forest Service to be beneficial and virtually the same for Alternatives 2-5.

If the No Action Alternative were implemented, there would be no change in current levels of employment, income, tax revenue or output as a result of the Canyon Mine. Demand for public services would remain at current levels. No cultural resource sites would be identified or disturbed by mine development or road improvement or construction.



IC #2-Reclamation measures required at the mine site are judged by the Forest Service to be satisfactory in Alternatives 2-5 although measures called for in Alternatives 3-5 are more comprehensive and oriented toward improving wildlife habitat at the mine site upon its closing. Under the No Action Alternative, of course, no reclamation would be required at the Canyon Mine site.



IC #3 -The least cost alternative is Alternative 2. Alternatives 3-5 indicate increased expenditures of \$360,000 to \$1,300,000 can be expected depending on the haul route used and mitigation measures required. Increased expenditures are generally associated with mitigation requirements. The No Action Alternative would result in no construction or development costs, however, the costs of exploration and environmental review could not be recovered by EFN.



IC #4-Wildlife habitat will be affected to varying degrees in all alternatives depending on the ore haulage route used. Alternative 5 has the least impact on wildlife. Alternative 2 would have the greatest impact because of a lack of mitigation requirements. Mitigation measures in Alternatives 3 and 4 should be effective in reducing the adverse impacts on wildlife resulting from increased road traffic.

Alternatives 3-5 all call for "equivalent habitat replacement" resulting from the Forest's assumptions about the impacts of decreased habitat utilization caused by the mine and expanded transportation system. Alternative 3 also includes a proponent choice of road closure during May and June in lieu of habitat replacement.

The No Action Alternative would have no impact from mining or ore transport on wildlife or wildlife habitat and would require no mitigation. Any benefits associated with construction of alternative wildlife waters or replacement habitat would not be realized.



IC #5-Implementation of Alternatives 2-5 will have a negligible and insignificant effect on the make-up of vegetative types now present on the Tusayan Ranger District. The No Action Alternative would have no impact on vegetation at the Canyon Mine site.



IC #6-Visual quality associated with the Grand Canyon will not be affected by the development of the Canyon Mine regardless of the alternative selected for implementation. Alternatives 2-5 will alter the short term visual quality at the mine site. Reclamation measures should effectively restore the area to its present characteristic landscape.

Haul route selection will have a limited effect on the scenic qualities on the Tusayan Ranger District. Implementation of Alternative 4 would have the greatest effect by constructing a road off the Coconino Rim in a location that would be visible to travelers going to and from the Grand Canyon using the east Highway 64 entrance. The No Action Alternative would have no impact on the visual quality of the area near the mine site.



IC #7 -Implementation of Alternatives 2-5 will have no appreciable effect on the air quality, which includes particulates, radon gas, or radioactive dust, at either the Grand Canyon or the community of Tusayan. Increases in particulate matter will be site specific along haul routes and at the mine site itself and are expected to be well within air quality standards. Current levels of air quality in the vicinity of the Canyon Mine site and haul routes would be unchanged by the No Action Alternative.



IC #8-Implementation of Alternative 5 and use of either the SP Crater haul route or the State Highway system would minimize impacts on National Forest resources and general forest environmental setting. It would, however, transfer the use, and resulting impacts, to private and State lands and existing highway systems at a greater cost to EFN. It is felt the environmental impacts on adjacent lands would be less than the overall impacts associated with the transportation routes identified in Alternatives 2, 3 or 4 if either of these routes are used.

The haul route identified in Alternative 4 would be most cost effective in providing a road that would meet long term management needs in the event other mines are developed in the eastern quadrant of the Tusayan Ranger District.

Haul routes included in Alternatives 2 and 3 are the most cost effective routes for hauling ore from the Canyon Mine to the mill in Blanding, Utah.

No ore would be transported under the No Action Alternative.



IC #9-Mitigation measures and operational procedures included in Alternatives 3-5 will reduce the possibility of radionuclide contamination to surface or subsurface water sources, and identify any contamination at the earliest possible time. Alternative 2 does not include air, water and soil monitoring requirements to insure the operational designs of the mine are functioning properly. Under the Alternative 1, current parameters for water quantity and water quality would remain unchanged at the mine site. Soil resources at the mine site would not be affected.

Neither the water quality on the Havasupai Indian Reservation nor the Grand Canyon National Park should be environmentally affected by the development of this mine under Alternatives 2-5. The Havasupai Reservation is located about 35 miles downstream from the mine site. A documented 100-year flood dissipated because of topographic features, about 14 miles downstream and 20 miles above the Reservation. Mitigation measures taken at the mine site would prevent any significant downstream radionuclide contamination in the event of an extreme flood occurrence.



IC #10 -Implementation of Alternatives 2-5 will have no demonstrable effect on Indian religious sites and practices. Consultation with the Hopi and Havasupai Tribes has not identified any specific sacred site which would be disturbed by the development of the mine or any of the haul route options. Similarly, a detailed archeological review of the site has disclosed no sites of religious significance.

In comments regarding other proposed actions on the Kaibab National Forest, the Hopi Tribe has expressed a belief that the earth is sacred and that it should not be subjected to digging, tearing or commercial exploitation. While this conflict has not been raised directly in relation to the Canyon Mine, it is acknowledged that commercial use of the Forest within the area of Hopi ancestral occupancy is inconsistent with these stated beliefs.

Development of the mine site (Alternatives 2-5) and haul route options requiring new construction (Alternatives 2-4) could slightly reduce the land area available for Indian religious practices. However, the current level of religious activity is not expected to be curtailed by any alternative nor will access to any religious sites or areas be restricted. Furthermore, there is no physical evidence of Indian religious activity at the mine site. The development of the mine is not expected to significantly burden the traditional religious beliefs of either the Hopi or Havasupai Tribes.

The Preferred Alternative will include only the limited impacts associated with development of the mine site, as the haul route options included in the Preferred Alternative do not include any new road construction or significant reconstruction.

The No Action Alternative would have no impact on Indian religious sites or practices. The Hopi and Havasupai Tribes have expressed a preference for the No Action Alternative.

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CHAPTER 1

PURPOSE OF AND NEED FOR ACTION

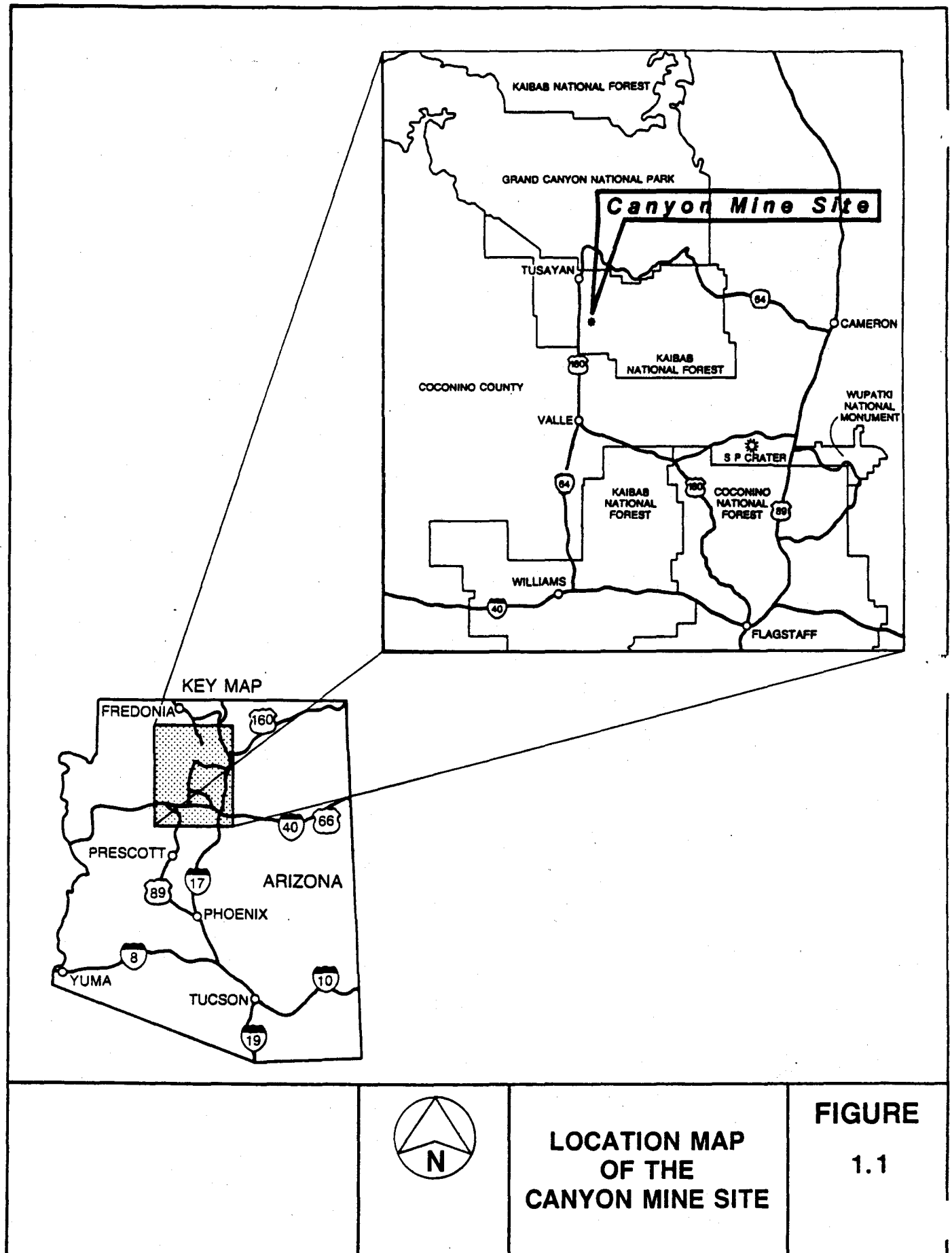
1.1 INTRODUCTION AND NEED FOR ACTION

In October 1984, Energy Fuels Nuclear, Inc. (EFN) submitted to the U.S.D.A. Forest Service, Kaibab National Forest, a Plan of Operations to mine uranium on unpatented mining claims on the Tusayan Ranger District, approximately 6 miles south of the village of Tusayan (Fig. 1.1). The discovery of this ore body was made during an earlier exploratory drilling program approved by the Forest.

Ore to be mined at the Canyon Mine is initially found at a depth of 900 feet below the surface in a breccia pipe occurring in the Coconino Sandstone geologic formation. The pipe extends downward another 500 feet into the Supai Formation or to a depth of approximately 1,400 feet below the surface. The ore will be extracted from a single 8 foot by 18-foot vertical shaft which parallels the ore bearing breccia pipe. A second 8-foot diameter ventilation and emergency escape shaft will also be drilled.

The proposed Canyon Mine would involve disturbance of approximately 17 acres for the mine shaft and surface facilities, plus some new or improved roads within the Forest, depending on which ore transportation route is ultimately selected. The ore would be hauled to EFN's licensed mill at Blanding, Utah, which has a daily design capacity that far exceeds scheduled ore production from the known uranium deposits being developed by EFN, including the proposed Canyon Mine. Estimated ore production from the Canyon Mine will comprise about ten percent of the total mill processing capacity.

Initial public input on the Canyon Mine proposal was sought during the months of December 1984 through February 1985, to determine the degree of public interest in the proposal and appropriate level of environmental review. A letter soliciting public comment which summarized the Plan of Operations, the NEPA process, and legal authorities applicable to the project, was mailed to federal, state and local government agencies, affected Indian tribes, the news media, and over 1,700 individuals on the Kaibab National Forest mailing list who have expressed an interest in mineral development or environmental documents.



Over 200 letters were received by the Forest Service in response to requests for written comment. Analysis of these comments, along with input received at several public meetings, made it clear there was substantial public concern and controversy about this uranium mine proposal and its potential effects on the quality of the human environment and that an environmental impact statement should be prepared.

The Canyon Mine is located on one of many mining claims filed in Northern Arizona, and Energy Fuels is only one of several companies who have located such claims. The uncertainty of the depressed domestic uranium market and many problems associated with the detection of breccia pipe deposits make it impossible to predict the level of future mining activity and specific future mine locations. There are no mining proposals except the Canyon Mine at this time, but it is likely that exploration and mining activity will continue in several locations in Northern Arizona south of the Grand Canyon, for the foreseeable future. Each uranium mining proposal should generate similar issues and have similar environmental impacts. A complete analysis of the Canyon Mine through an environmental impact statement (EIS) will provide data and experience useful in evaluating future mining proposals. Furthermore, the data generated by an EIS and subsequent monitoring of the mining operations will enable the Forest Service to better evaluate the potential of any cumulative impacts associated with additional mines.

A primary objective of this EIS is to disclose for both Forest Service officials and the public, information sufficient to permit a reasoned comparison of the environmental impacts of implementing a range of reasonable project alternatives.

The federal action considered in this document is the approval by the Forest Supervisor, Kaibab National Forest, of a Plan of Operations for the Canyon Mine (Appendix A) and the establishment of reasonable mitigation measures that are in addition to those proposed by EFN. The Supervisor's decision may be to approve the Company's plan as proposed or to require modification of the plan.

1.1.1 Statutory and Regulatory Authorities

The general mining laws provide a statutory right to explore and extract certain minerals from National Forest System lands. The minerals subject to the general mining laws are called locatable minerals; uranium is one such mineral. The Forest Service is directed to integrate, consistent with multiple-use management principles, the exploration, development and removal of locatable minerals with the use and

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conservation of other resources. This policy is consistent with various legislative mandates including the Organic Act, Mining and Minerals Policy Act, Federal Land Policy and Management Act, and most recently, the National Materials and Mineral Policy, Research and Development Act. The Forest Service does not have the discretionary authority to deny access for the purpose of prospecting for and extracting minerals on those National Forest System Lands that are open to mineral entry.

The Forest Service is not authorized to manage locatable mineral resources on National Forest System Lands. However, the Forest Service is concerned with methods and techniques of prospecting, exploration, mining, or mineral processing to the extent that certain methods or techniques have greater or lesser environmental impacts.

It is the responsibility of the Forest Service to review and where necessary, modify proposed plans of operations for the development of a mine. Review and modification of plans is to insure that the mining operations will be conducted in a manner which minimizes, prevents, mitigates, or repairs adverse environmental impacts on National Forest system lands. The Forest Service does not have the authority to categorically deny reasonable operations proposed under the mining laws.

A brief summary of some laws and regulations relevant to the proposed action follows.

Statutory Authorities

(1) General Mining Law of 1872

EFN has the statutory right under U.S. Mining Law (30 U.S.C. 21-54) to enter on open National Forest System lands for the purpose of conducting exploration and mining activities. Development of a mine is subject to approval of a Plan of Operations and the Forest Service must adhere to the provisions of the National Environmental Policy Act (NEPA) and 36 CFR 228 before approving, approving with conditions, or denying a Plan of Operation.

As enacted and interpreted, the General Mining Law expressly incorporates the "free access" principle of mineral entry on public lands:

Except as otherwise provided, all valuable mineral deposits in lands belonging to the United States shall be free and open to exploration and purchase . . .

(2) Organic Administration Act of June 4, 1897

This is the Act that eventually created the National Forest System. The Act specifically mentions the mineral resource

. . . Nor shall anything herein prohibit any person from entering upon such forest reservation for all purposes, including that for prospecting, locating, and developing the mineral resources thereof: Provided, that such persons comply with the rules and regulations covering such forest reservations.

Court decisions have interpreted this to mean that the national forests are open for entry "for all proper and lawful purposes, including that of prospecting, locating and developing the mineral resources thereof." 16 U.S.C. 478.

(3) Mining and Minerals Policy Act of 1970

This Act establishes policy for the Federal Government related to all types of mineral activity and specifically addresses the development of domestic sources of uranium.

Sec. 2. The Congress declares that it is the continuing policy of the Federal Government in the national interest to foster and encourage private enterprise in (1) the development of economically sound and stable domestic mining, minerals, metal and mineral reclamation industries, and (2) the orderly and economic development of domestic mineral resources, reserves, and reclamation of metals and minerals to help assure satisfaction of industrial, security and environmental needs . . .

For the purpose of this Act, 'minerals' shall include all minerals and mineral fuels including oil, gas, coal, oil shale and uranium.

(4) Federal Land Policy and Management Act of 1976

This Act contains provisions which directly relate to minerals.

Congress declares that it is the policy of the United States that . . . the public lands be managed in a manner which recognizes the Nation's need for domestic sources of minerals . . .

(5) National Materials and Minerals Policy, Research and Development Act of 1980

This Act had the purpose of reinforcing and expanding previous laws passed by Congress dealing with the need for a continuous supply of mineral materials necessary to

maintain National security, economical well-being, industrial production, etc.

Forest Service Regulatory Authorities

Regulations protect the surface resources of the National Forests during mining and prospecting operations and provide for rehabilitation of lands afterward. The regulations are currently found in 36 CFR Part 228 - Minerals. They apply to National Forest System lands subject to location and entry under the mining laws.

Among the major provisions of these regulations pertinent to this EIS are the following:

- * All operations under the General Mining Law must be conducted, insofar as feasible, to minimize adverse environmental impacts on the National Forests, and take into consideration requirements for meeting Federal, State, and local air and water quality standards and solid waste disposal; harmony with scenic values; protection of fish and wildlife habitats; and minimization of road construction damage.
- * The plan of operations must also show what steps the operator will take for feasible rehabilitation of the area when the prospecting or mining is completed.
- * Upon filing the plan of operations, the operator may be required to furnish a bond commensurate with the expected cost of rehabilitating the area.
- * The plan of operations must be approved by the authorized forest officer before any operations are conducted.

In analyzing each plan for approval, the forest officer will consider the economics of the operation along with other factors in determining the reasonableness of the requirements for surface resource protection. The Forest Service will assess the environmental impacts of the proposed operation, reasonable alternatives, and prepare any environmental documents that might be required under the National Environmental Policy Act.

1.2 SCOPING PROCESS

Public involvement is necessary in the environmental analysis process in order to identify issues and concerns relating to environmental impacts of the proposed action. The issues and concerns are then used to define and formulate alternatives that specifically address these issues and concerns. Issues raised by the public and federal and state agencies serve as a basis for comparison of the alternatives. Laws, regulations, and land management directives are also considered in order to frame issues, formulate alternatives and determine the overall scope of the evaluation.

Following EFN's submission of the Plan of Operations, more than 100 copies of the plan were distributed to interested parties. The proposal received extensive media coverage. More than 30 articles concerning the proposal appeared in area newspapers and magazines between October 1984 and May 1985. Following the decision to prepare an EIS, a "Notice of Intent" was published in the Federal Register on April 30, 1985. Then, over 2,000 scoping letters were distributed by the Forest Service to federal state and local government agencies, Indian tribes, news media and interested individuals in preparation for a public scoping session held in Flagstaff on May 15, 1985.

As a result of the analysis of the earlier public comments and agency discussion, eleven preliminary areas of concern were identified. The EIS scoping session, as well as written comments received in response to the scoping letter, was used to further refine these issues and concerns and to identify any new ones which may have been overlooked.

An evaluation of the extensive public review of the Canyon Mine proposal indicated significant public concerns about uranium mining in Northern Arizona. Some comments were directed to issues clearly within the potential impacts of the project, such as impacts on wildlife. Others, such as nuclear proliferation, were less directly associated with it. All of the issues and concerns raised by the public were screened to determine which were appropriate for consideration in this document as part of the NEPA process. It was determined that comments which dealt with the desirability of nuclear power or other uses of processed uranium, or disposal of high level nuclear wastes would not be addressed by this document because the impact of this proposal on such issues is too far removed for meaningful analysis. Similarly, detailed consideration of issues such as the health of uranium miners or the history of uranium mining in other areas such as Grants, New Mexico, also were determined to be beyond the scope of this analysis.

As a result of the scoping process, ten issues and concerns were identified that to a greater or lesser extent are the focus of this EIS. These issues and concerns were used in the formulation and evaluation of alternatives. The ten issues and concerns (IC's) are:

- IC #1. What social and economic impacts will the uranium mine have on the local communities and Coconino County?
- IC #2. What reclamation measures will be required for site restoration?
- IC #3. Can Company-incurred project costs be held to a reasonable level?
- IC #4. What impacts will the mining operation have on important wildlife habitats?
- IC #5. What effect will the mining activities have on forest vegetation?
- IC #6. What effect will the mining activities have on visual quality of the Kaibab Forest, State Highway 64, and the Grand Canyon?
- IC #7. What effects will the mining activities have on the air quality of the surrounding area?
- IC #8. What impacts will the mining transportation system have on the local environment and the management of National Forest System Lands?
- IC #9. What impacts will the mining activities have on the soil, and surface and subsurface water quantity and quality?
- IC #10. What impacts will mining activities and ore transportation have on Indian religious sites and practices?

1.2.1 Issues and Concerns Not Covered as Separate Items in the Analysis

During the scoping process, several concerns were raised which are not analyzed as a separate issue in this document. These concerns will be analyzed, but integrated into the discussion of other related issues. For example, radiation and mitigation measures surfaced throughout the public involvement process as major concerns. These concerns are relevant to many issues

such as effects of the mining operation on air quality, surface and subsurface water quality and reclamation measures. Similarly, monitoring requirements and questions related to impacts on the Grand Canyon are considered under each appropriate issue and concern.

1.2.2 Cumulative Effects

Considerable interest was generated under the general topic of addressing potential cumulative effects of multiple mines on the environment and local population. The question most often asked in this regard, was "how many mines will be too many for the physical and biological environment to support without seriously affecting the human environment?"

The potential for uranium mining on the Tusayan Ranger District of the Kaibab National Forest south of the Grand Canyon, is uncertain and problematical. While literally thousands of mining claims have been filed in the Tusayan area, this has little relation to the number of mines that may ultimately be developed. There are no known proposed mines other than the Canyon Mine, on the Tusayan Ranger District south of the Grand Canyon. The highly speculative nature of mineral prospecting and exploration, the fact that mining claims are located prior to discovery of a mineral deposit, the current depressed conditions of the domestic uranium market and the highly localized nature of breccia pipe deposits, all contribute to the difficulty in predicting the extent of future uranium developments. Because the exact schedule and location of future mining is not possible to predict, this EIS analyzes potential cumulative impacts by hypothesizing the addition of several new mines in the area, developed concurrently with the Canyon Mine.

The analysis for the Canyon Mine is based on a site specific proposal. Based on components of the proposal, effects of the mine operation on various resource values specific to the mine site and affected area can be estimated. Upon implementation, intensive monitoring of the mine operation will allow assessment and verification of estimated impacts, and the relative effectiveness of prescribed mitigation measures. The results can then be used for estimating individual and cumulative impacts of successive mine developments, as can the information and data contained in specific technical reports found in the Appendices.

If, in the future, additional mines are proposed in the general area, data gathered through monitoring of the Canyon Mine will greatly assist in the estimation of impacts of future site

specific proposals. It is therefore apparent that monitoring of environmental effects of the Canyon Mine is desirable.

1.3 PERMITTING PROCESS

There are a number of federal, state and local regulatory permits, controls and constraints which apply to the proposed Canyon Mine. The following list describes the primary permits and approvals necessary for implementing the proposed project. EFN must comply with all applicable requirements. Additional permits and approvals may also be necessary during the life of the project.

FEDERAL

<u>Permit or Approval</u>	<u>Responsible Agency</u>
Approve Plan of Operations (36 C.F.R. Part 228)	U.S.D.A. Forest Service
Approve Rights-of-way or Special Uses on National Forest System Lands (36 C.F.R. Part 251)	U.S.D.A. Forest Service
Consult with U.S. Fish and Wildlife Service in compliance with Endangered Species Act (16 U.S.C. 1531, et seq., 50 C.F.R. Part 402)	U.S.D.A. Forest Service
Consult with Arizona State Historic Preservation Office in compliance with National Historic Preservation Act (16 U.S.C. 470 et seq., 36 C.F.R. Part 800)	U.S.D.A. Forest Service
Consult with affected Indian tribes in compliance with American Indian Religious Freedom Act (42 U.S.C. 1996)	U.S.D.A. Forest Service
Issue National Pollutant Discharge Elimination System (NPDES) Permit, if necessary	U.S. EPA, Arizona State Department of Health Services

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Issue National Emission Standards for Hazardous Air Pollutants (NESHAPS) permit for Radon-222 emissions from underground uranium mines. [50 Fed. Reg 15 386 (1985)] (to be codified at 40 C.F.R. Part 61)

U.S. EPA

Comply with Mine Safety and Health Standards for Metal and Non-Metal Underground Mines (30 C.F.R. Part 57)

U.S. Mine Safety and Health Administration
Arizona State Mine Inspector

Comply with Federal Motor Carrier Regulations (49 C.F.R. Parts 390-393, 395 - 397)

Arizona State Department of Transportation

Comply with Hazardous Materials Hauling Regulations (49 C.F.R. Parts 171-173, 177, 178) (Notification of ore spills.)

Arizona State Department of Transportation

STATE OF ARIZONA

Permit or Approval

Responsible Agency

Groundwater Quality Protection Permit [A.R.S. 45-511 to 45-528 (1985) and A.R.S. 36-1859 (1986)]

Arizona Department of Health Services, Division of Environmental Health Services

Construction Approval of on-site water and wastewater systems [A.R.S. 36-1881 and A.R.S. 36-132(8) (1984)]

Arizona Department of Health Services, Division of Environmental Services

Well Permit [A.R.S. 45-999 (1984)]

Arizona Department of Water Resources

Notification of Operation

Arizona Department of Revenue

Arizona Motor Carrier Safety Regulations (Title 28, Sections 2401-2405)

Arizona Department of Transportation

C491

COCONINO COUNTY

Building Permit for on-site
facilities

County Building
Inspector

Approval of on-site wastewater
system

County Health
Inspector

1.4 UNITS OF MEASURE FOR ESTIMATING RESOLUTION OF ISSUES AND CONCERNS

The following is a table of units which were used to estimate how well each alternative resolves the issues and mitigates the concerns. They provided the analytical basis for the selection of the Preferred Alternative. Not all issues and concerns can be quantified. These are described in narrative form and can be qualitatively compared.

Issue or Concern

Units of Measure

1. Social & Economic Impacts

a. Local & Regional Economic Impacts

-change in employment
(primary and secondary
-number of jobs
affected)

-changes in total annual
income for Coconino
County (\$)

-changes in total annual
gross output for
Coconino County (\$)

-annual tax revenues
(sales, property and
severance) (\$)

b. Effect on Williams Water Supply

-total storage capacity
(ac.-ft.)

-potable City consumption
(ac.-ft./yr.)

-Canyon Mine projected
needs (ac. -ft./yr.)

- change in City's annual demand caused by the mine (%)
- c. Cultural Resources
 - relative archeological site density along transportation corridor
- d. Social Impacts
 - lifestyle, beliefs, and attitudes
 - population change
- e. City & County Infrastructure
 - 1) School Enrollment -enrollment
 - 2) No. of Police -number of police
 - 3) Fire Protection -amount
 - 4) Medical Facilities -amount
 - 5) Housing -amount
- 2. Reclamation of Mine Site
 - a. Need for Reclamation -area requiring restoration (acres)
 - b. Measures/Methods
 - revegetation
 - mixture (species)
 - application (type)
 - stabilization of stockpiled topsoil (narrative)
 - surface facilities removal (narrative)
 - radioactive waste disposal (narrative)
 - c. Reclamation Bond Assessment
 - amount (\$)
 - (narrative)

3. Project and Mitigation Costs

- a. Transportation
 - hauling (\$)
 - construction (\$)
 - maintenance (\$)
- b. Monitoring
 - radiation:
 - air, soil, & water (\$)
 - groundwater:
 - well construction (\$)
 - water sampling (\$)
- c. Equivalent Habitat Improvement
 - key waters:
 - relocation (\$)
 - create equivalent acres of foraging areas (\$)
- d. Site Reclamation
 - total costs (\$)
- e. Worker Transportation
 - total costs (\$)
- f. Cultural Resource Mitigation
 - total costs (\$)
- g. Powerline
 - total costs (\$)
- h. Right-of-Way Acquisition
 - total costs (\$)
- i. Total Project Costs
 - net discounted cost (NDC)(\$)

4. Impacts on Wildlife

- a. Elk Calving Habitat
 - acres potentially impacted (within .5 mi. of road)
- b. Deer, Antelope & Turkey Fawning/Nesting Habitat
 - acres potentially impacted
- c. Elk Migration Routes
 - percent of population potentially impacted
- d. Habitat Lost From New Road Construction
 - acres taken out of production
- e. Big Game Foraging Habitat
 - acres directly impacted
- f. Key Waters
 - number of waters impacted

- percent of key waters in affected area (%)
 - g. Total Acres of Habitat Replacement
 - equivalent acres required (ac.)
- 5. Effect on Vegetation
 - a. Loss of Grazing Capacity and Timber Production
 - 1) Grazing Capacity
 - district total (AUM's)
 - amount lost (AUM's)
 - amount lost (%)
 - 2) Timber Volume
 - district annual allowable cut (AAC) (MBF/yr.)
 - amount (ACC) lost (MBF/yr.)
 - amount (AAC) lost (%)
 - b. Loss of Vegetation
 - 1) Ponderosa Pine
 - district total (acres)
 - amount lost (acres)
 - amount lost (%)
 - 2) Pinyon-Juniper
 - district total (acres)
 - amount lost (acres)
 - amount lost (%)
 - 3) Forest Vegetation Similar to Mine Site
 - district total (acres)
 - amount lost (acres)
 - amount lost (%)
 - c. Threatened, Endangered and Sensitive Plant Species
 - species present & amount of impact (narrative)
- 6. Effect on Visual Quality of the Grand Canyon, and Kaibab National Forest
 - a. Impacts on Viewed Landscape
 - Forest Service visual quality objectives (narrative)
 - b. Impacts on Grand Canyon National Park and State Highway 64
 - changes in visual quality

7. Effect on Air Quality at
Grand Canyon, Tusayan, and
Mine Site

a. Predicted Impacts on
Air Quality

-predicted impacts of
fugitive dust and radon
gas emissions on air
quality at Grand Canyon
National Park
(narrative)

-predicted impacts of
fugitive dust and radon
gas emissions on air
quality at mine site,
Tusayan and along haul
routes

Radon: (pCi/L)
average for western U.S.
projected levels at:
Owl Tank
Tusayan

Particulates: (ug/m3)
NAAQS standards
current levels
projected levels
1) mine site
2) haul routes

Radioactive Dust:
current levels
(narrative)
projected levels
(ug/m³)

b. Monitoring

-requirements (narrative)

8. Effects of Transportation
Route Selection

a. Road Construction

-new construction (miles)
-reconstruction (miles)

b. Hauling Distance

-to Cameron (ton/miles)

c. Integration with Potential
Future Forest Resource
Management Needs

-degree of integration
(narrative)

- d. Surfacing Material
 - total required (vol. in cu. yd. & surface acres disturbed)
 - e. Traffic Use on Haul Route
 - seasonal average daily traffic count before project construction
 - projected average daily traffic count after project construction
 - increase in traffic (%)
 - f. Monitoring
 - traffic count after project implementation
 - radiometric surveys along haul roads (Y/N)
 - g. Wildlife
 - potential increase in impacted area of key wildlife habitat (ac.)
9. Impacts on Soil and Water Resources
- a. Radionuclide contamination of downstream lands and waters by flooding of ore stockpiles at Mine Site
 - diversion channel capacity (cfs)
 - expected 500-yr. flood peak (cfs)
 - potential of flood waters reaching ore stockpiles (narrative)
 - potential of 100-yr. flood reaching lower portion of Cataract Creek (narrative)

- sampling for change from baseline surface water quality (pCi/L):
 - Arizona statewide average
 - gross alpha
 - gross beta
 - Ra-226
 - current levels at Owl Tank
 - gross alpha
 - gross beta
 - Ra-226
 - Uranium

- sampling for changes from soil baseline radionuclides (pCi/L)
 - gross alpha
 - gross beta
 - Ra-226
 - Uranium

b. Possible Groundwater Contamination by Radionuclides

- sampling for change from baseline quality at Redwall Springs in Grand Canyon and Havasu Canyon current levels:
 - gross alpha (pCi/L)
 - gross beta (pCi/L)
 - Ra-226 (pCi/L)
 - Uranium (pCi/L)

10. Impacts on American Indian Religious Concerns

a. Direct Impact on Religious Sites

-Number of sites affected

b. Continued Access to Religious Sites

-Number of sites affected

c. Gathering of Ceremonial Plants, Animals and Herbs

-Acres of land temporarily lost to religious activities.

d. Compatibility with Traditional Religious Beliefs

Consistency with stated beliefs (narrative)

CHAPTER 2

ALTERNATIVES CONSIDERED INCLUDING THE PROPOSED ACTION

2.1 INTRODUCTION

This chapter provides a general but concise description of the action proposed by EFN and a range of reasonable alternatives. The project was broken down into its operational components (separate elements that, when joined together, form complete project alternatives). Each operational component was then discussed, reviewed and screened by the Forest Service Interdisciplinary Team during the preparation of the EIS, in order to effectively reduce the number of alternatives to those which would be financially and technically feasible and environmentally acceptable.

The major issues and concerns identified through the scoping process, management concerns of affected State and Federal agencies, pertinent legal and regulatory requirements and other relevant public comments were used in developing suitable alternatives for analysis. The alternatives to be considered in detail represent a reasonable range of opportunities that address the significant issues and concerns.

2.2 FORMULATION OF ALTERNATIVES

On November 29, 1978, the Council on Environmental Quality issued "Final Regulations for Implementing the National Environmental Policy Act" (NEPA) (Federal Register, Vol. 43, No. 230). In July 1979, the U.S. Department of Agriculture Forest Service issued Implementation Procedures for the National Environmental Policy Act (Revised November 1981, July 1982 and June 1985), which further defines Forest Service procedures. The regulations are intended to provide federal agencies with efficient, uniform procedures for translating the law into practical action.

The regulations direct that a reasonable range of alternatives be developed, and that alternatives are fully and impartially discussed and evaluated to disclose the environmental consequences of implementation of the proposed action and alternatives to the proposed action. One objective of the Forest Service is to develop a reasonable alternative which minimizes the environmental effects of project implementation.

The alternatives considered in detail can be used to estimate varying degrees of biological and physical effects which may result from mining operations. Generally, no environmental impacts have been identified in any alternative which cannot be mitigated to a substantial extent through the implementation of environmental mitigation measures.

Section 2.4 describes the alternatives evaluated and the mitigation measures unique to the particular alternative, while Section 2.5 provides a description of mitigation measures common to all alternatives.

2.2.1 Independent Operational Mine Components Considered in the Development of Alternatives

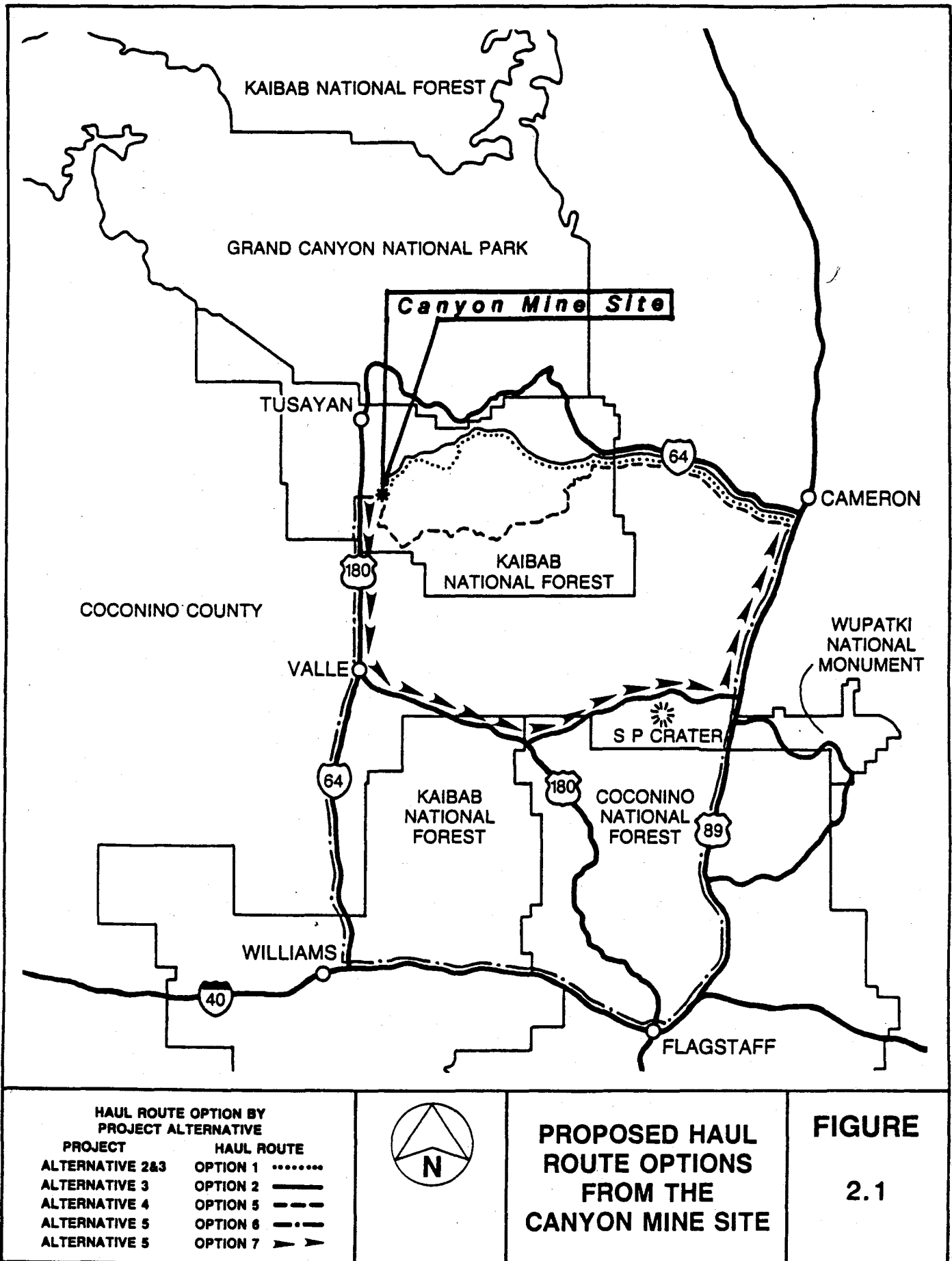
A mining project generally lends itself to analysis by operational components. Operational components are those separate elements that when joined together, form complete project alternatives (e.g. alternative mining methods, haul routes, etc.). The comments received during the scoping process were also frequently aimed at specific components. All reasonable component alternatives identified from the proposed Plan of Operations were considered in the component analysis. Independent operational components considered were:

1. Haul routes
2. Utility corridors
3. Transportation of workers
4. Sewage
5. Method of ore transport
6. Mine production rate
7. Method of mining
8. Potable water
9. Site configuration

Variations in location and geographic setting were considered for all design and operational components except the actual mine site., which is fixed by the ore body and claim ownership and control.

2.2.1.1 Operational components requiring separate alternative analysis

Each operational component was evaluated based on its potential to produce environmental effects.



PREFERRED ROUTE
CANYON MINE SITE
LICENSED MILL



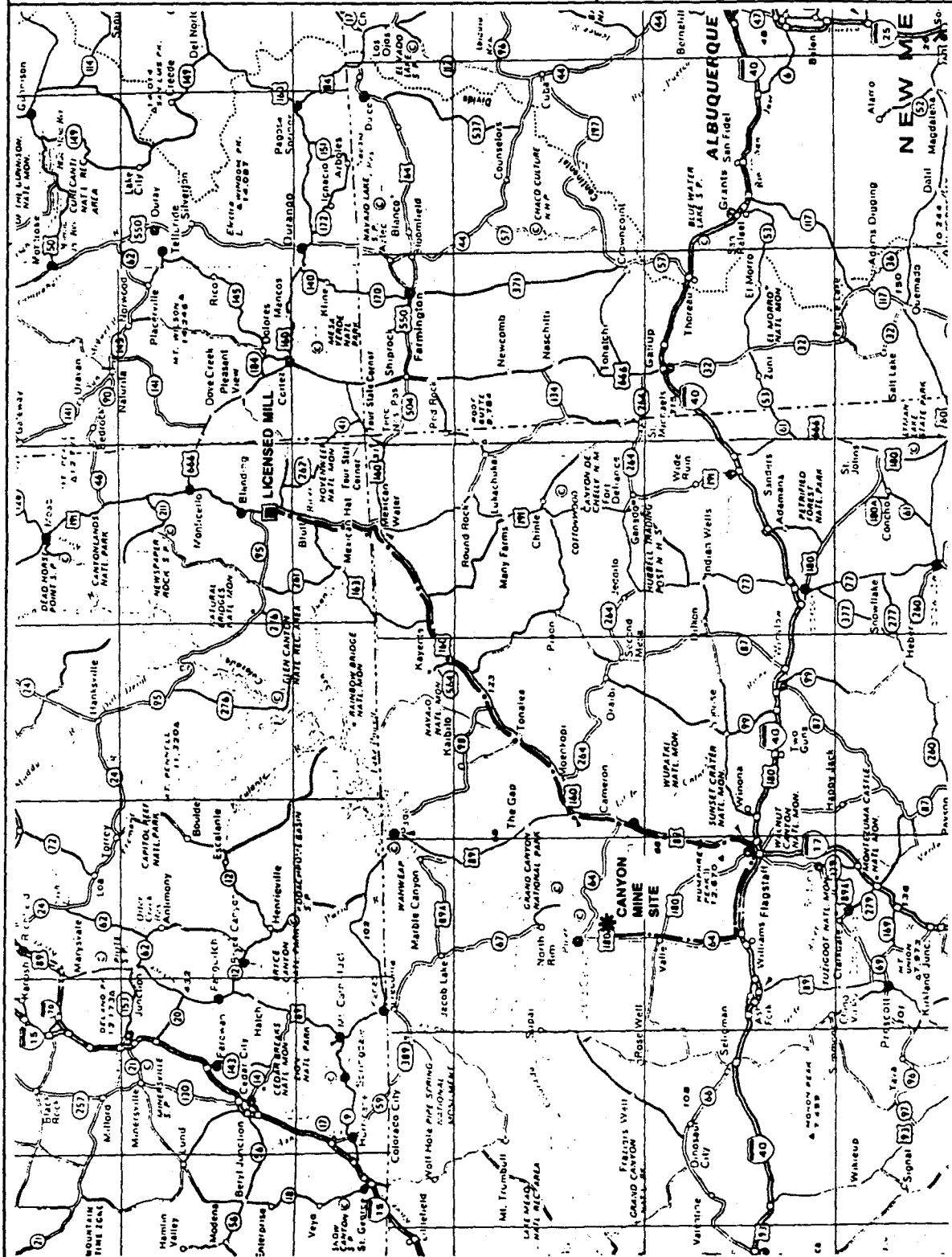
PREFERRED
HAUL ROUTE
OPTION

FIGURE

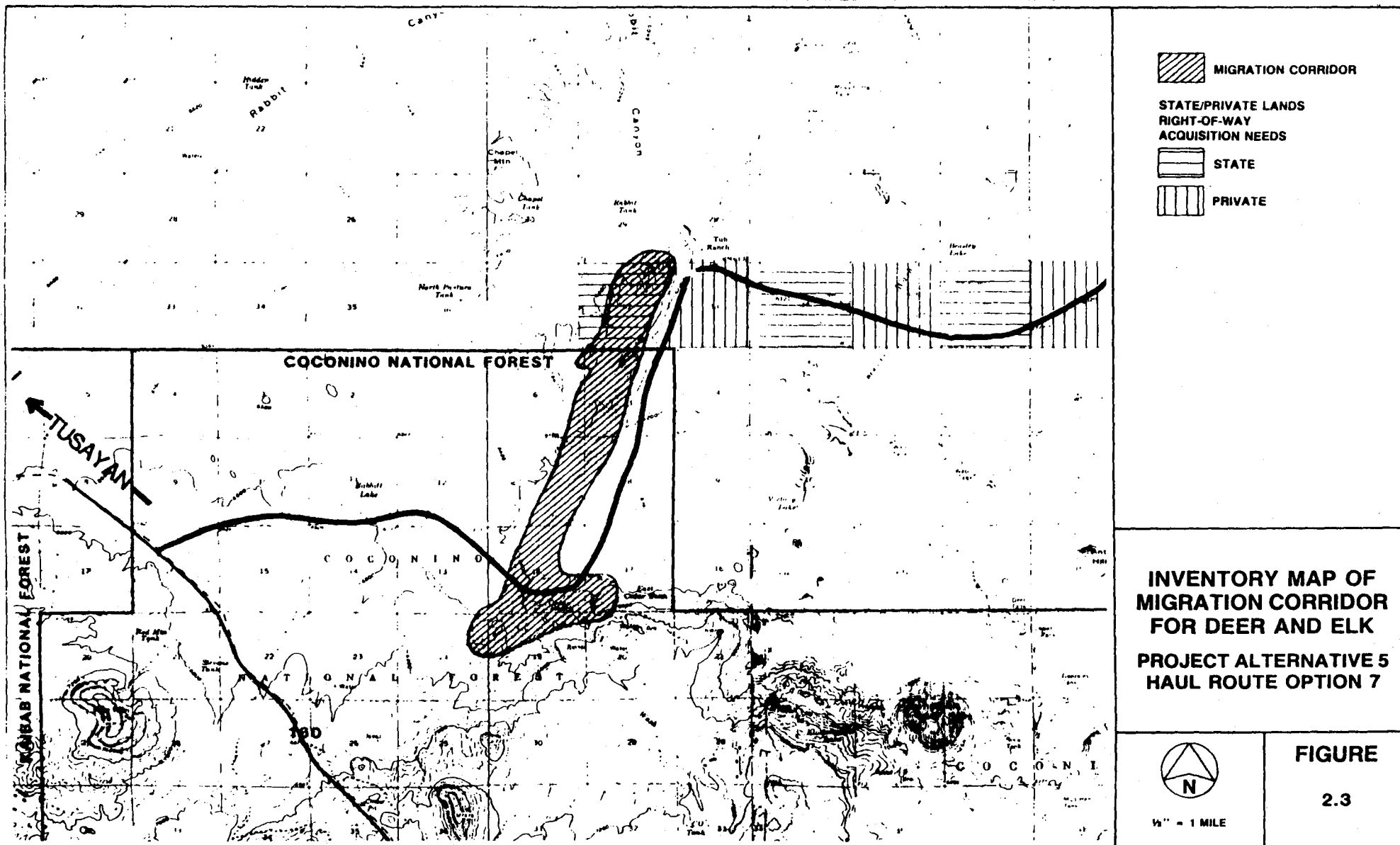
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1 1/4" = 1 MILE



6502



(1) Haul routes.

Development of new or improvement of existing transportation systems on National Forest System lands have the potential of altering the general forest environment and setting. Consequently, proposed changes in existing transportation systems are viewed as having implications on the existing management of the Tusayan Ranger District.

A detailed analysis of the possible haul routes in the transportation component was undertaken, in order to identify the most effective haul routes (Appendix B). The analysis considered costs as well as environmental consequences to narrow the range of feasible haul route options. This was accomplished by comparing ore hauling routes to the individual issues that could be affected by changes in these routes. Figure 2.1, 2.1A, 2.2 and 2.3 are maps of the routes by assigned number. Table 2.1 lists the amount of new construction and reconstruction needed on each route.

Route #1 is the northern route south of the north Forest boundary proposed by EFN in the Plan of Operation. There will be a slight realignment near Hull Cabin.

Route #2 involves slight modifications to route #1, including realignments north of the mine site to avoid the Hull Cabin area.

Route #3 is the shortest alignment that could be devised without excessive new road construction. Route #3 requires new road construction to drop off the Coconino Rim escarpment near Newt Lewis Tank.

Route #4 incorporates a southern alignment to avoid key wildlife habitats, and then turns north and links up with route #3 at the Coconino Rim. Route #4 requires the same construction as in route #3 to drop off the Coconino Rim.

Route #5 traverses the southern portion of the Tusayan Ranger District. It requires new road construction off the Coconino Rim near the eastern boundary. This route was considered based on the possibility of future mining in the eastern quadrant of the Tusayan Ranger District. It is included to evaluate the environmental impacts and cost effectiveness of such a route in the event additional mines are proposed.

Route #6 involves almost entirely all highway haulage, except for the 4.8 miles from the mine site to State Highway 64. It eliminates the need for extensive new road construction.

Route #7 is a southern route that utilizes highway hauling and an existing road across State and private lands near SP Crater. It also minimizes road construction on the Forest and avoids most of the key wildlife habitats and waters.

TABLE 2.1 -- Haul Route Lengths and Comparison of Construction Needs by Haul Route

Route Number	New Construction	Reconstruction	Total ¹
	-----miles-----		
1	3.6	23.9	27.5
2	4.1	21.3	25.4
3	4.4	19.6	24.0
4	4.4	30.0	34.4
5	2.9	30.6	33.5
6	-0-	4.8	4.8
7	-0-	29.8	29.8

¹Total length on Forest roads (off black-top).

Haul Route Evaluation

As a result of the evaluation shown in Table 2.2, five potential haul corridors were identified which will be incorporated as discrete component parts in the analysis of the four project alternatives.

Without a sophisticated weighting analysis of the various issues, any numerical ranking of the potential routes would be meaningless. The routes are thus ranked subjectively as providing a low, medium, or high resolution of the affected issue. These ratings are only meant to show relative impacts of the haul route options.

TABLE 2.2 -- Screening Matrix For Transportation Component

Issue	Haul Route Option						
	1	2	3	4	5	6	7
IC#3, Costs minimized:							
-maintenance	M ¹	M	L	L	L	H	H
-construction	M	M	L	L	L	H	H
-haul costs	H	H	H	M	M	L	L
IC#4, Wildlife							
-elk calving areas	L	M	L	H	H	H	H
-key big game areas	L	M	L	L	H	H	M
-key waters	M	M	H	L	M	H	H
IC#5, Vegetation (loss of comm. timber)	M	L	M	M	H	H	H
IC#6, Visual Quality	M	M	L	L	L	H	H
IC#7, Air Quality (potential to affect air quality at Grand Canyon)	M	M	M	M	H	H	H
IC#8., Transportation							
-compatibility with potential future Dist. mgt. needs	H	H	L	L	H	N/A	N/A
-minimize impacts on private & State lands	H	H	H	H	H	H	L
IC#10, Indian Concerns							
-compatibility with religious sites and practices	M	M	M	M	M	H	H

¹Ranking: H = High resolution of the issue
M = Moderate resolution of the issue
L = Low resolution of the issue

Rankings reflect impacts from new road construction, impacts from increased traffic flows associated with improved roads, and impacts from road use that displaces wildlife (Appendices B and C).

Haul routes #3 and #4 were eventually dismissed from further consideration because the new road construction necessary to implement these haul route options would create more environmental impacts on wildlife, recreation and visual qualities than would the use of existing transportation corridors.

Route #6 was evaluated as an optional component under the same alternative as route #7. Use of this route would be done in compliance with existing State and Federal transportation regulations.

Route #5, while not being as cost effective to EFN in this particular evaluation, was retained as a viable option since it avoids most key wildlife areas and could possibly serve future Forest management needs in a cost effective manner.

Routes #1, #2, and #7 were retained since they are reasonable from a cost standpoint, and environmental and social impacts could effectively be minimized through monitoring and mitigation measures.

Because of their similarity, Routes #1 and #2 are considered collectively under Alternative 3. Routes #6 and #7 are also similar and therefore both considered under Alternative 5. Routes #6 and #7 are designed to minimize road construction.

As a result of the screening analysis, five haul routes, #1, #2, #5, #6 and #7, were selected for detailed evaluation in project alternatives. These corridors may also include some internal alignment variations to prevent resource conflicts or reduce costs.

(2) Utility corridors

Utility corridors were evaluated because of their potential impacts on wildlife, surface disturbance and effects on visual resources through the removal of vegetation.

Three utility corridor options were considered: 1) overhead 3-phase 12.5KW powerline starting at the existing 69KW line just east of U.S 64 and following the shortest access to the mine site, 2) buried cable from Highway 64 along Forest Roads 305 and 305A to mine site, 3) overhead powerline from Highway 64 along Road 305 and 305A to the mine site, and 4) electrical generators at the mine.

Utility option 4 was eliminated due to the relative high cost with no apparent environmental advantages. While eliminating the need for a new utility corridor clearing, this option creates additional environmental concerns related to fuel storage, noise and air pollution from on-site power generation.

Because of their potential environmental effects, utility options 1-3 are evaluated as discrete parts of Alternatives 2-5.

(3) Transportation of workers

The transportation of mine workers was evaluated because of the potential for impacts resulting from increased traffic and a parking lot at the mine site.

The nearest available housing for mine workers is in Williams, a distance of 45 miles one-way from the Canyon Mine site. Some form of pooled transportation would seem to be a logical choice; however, the option of driving personal autos was considered as part of Alternative 3 because this preference by the mine workers may exist.

2.2.1.2 Description of independent operational components common to Alternatives 2-5

The component evaluation procedure eliminated those components which were of little or no consequence to the environment. These component parts did not have the potential to create measurable environmental consequences, and did not significantly affect issue resolution either by themselves or collectively; therefore, they did not warrant separate project alternative analyses. Project alternatives were analyzed with most such components identical or only slight modifications.

(1) Holding ponds

Waste rock generated during shaft sinking, development and mining will be removed and stockpiled on the surface in the waste disposal areas, to the extent such material cannot be utilized for road maintenance, dike construction, or utilized in the construction of the mine yard. Ore will be stockpiled on the surface near the shaft until shipment to a mill takes place. Since local precipitation will be in contact with this uranium ore, all surface runoff within the mine yard, as well as all water encountered during mining which cannot be utilized in the mining operation, will be collected and retained on-site in holding ponds until it evaporates or until it meets the discharge standards under the NPDES permit.

The holding pond(s) (Appendix B) must be adequate to receive local runoff from a 100 year thunderstorm event, plus normal annual runoff and water that may be pumped from the mine. The volume of water in the pond(s) must be maintained at a level that will allow a reserve pond volume to accommodate unforeseen and normally expected runoff events (Appendix B and Sec. 2.5.12).

The holding pond(s) would only be discharged in exceptional circumstances in accordance with the NPDES permit. Exact pond volume will depend on the amount of water encountered during the shaft sinking operation.

(2) Sewage

Sewage at the mine can be handled by using vault toilets, or by installing a leach field sewage system if sufficient water is available.

(3) Method of ore transport

In the early stages of identifying haul routes options, consideration was also given to transporting the ore by helicopter or rail. Both methods were deemed unreasonable due to exorbitant costs. Trucking was determined to be the only viable method. Specific haul routes are considered in detail in the four project alternatives.

(4) Mine production rate

The proposed Operating Plan calls for an average production rate of 200 tons/ day for the life of the mine. Although a number of production rates could be proposed, reasonable variances in these rates would not appreciably affect the impacts of the mine on the environment.

(5) Method of mining

Ore to be mined at the Canyon deposit occurs at a minimum depth of 900 feet. Open pit mining is not considered a reasonable alternative for this deposit as it is not economically feasible and would create greater surface disturbance and environmental impacts. In-situ leaching is not feasible because water is not available for injection and recovery wells. Underground mining is considered to be the only viable method.

Access to the deposit will be by a vertical shaft located northeast of the deposit in the area of operations as shown on Plate 2, Appendix A. This shaft will be sunk utilizing either a surface drill rig or by conventional methods using drilling and blasting.

After the vertical shaft has been sunk to a depth of approximately 1,400 feet below the surface and paralleling the breccia pipe, workings will be driven toward the deposit at various levels off the main shaft. The highest level of the mine will be located approximately 900 feet below the surface in the Coconino Formation and the lowest level is expected to be approximately 1,400 feet below the surface in the Supai Formation.

Once the initial underground drilling program has fully delineated the extent of the ore deposit, the lower level will be driven underneath the deposit due south to a point just outside of the furthest extent of the ore reserve. At this point, a vertical ventilation shaft will be drilled from the surface to connect with the workings. The ventilation shaft is used to exhaust air, thereby creating adequate airflow throughout the mine workings and, in addition, providing a second exit or escapeway from the mine in the event of an emergency. The ventilation shaft will be drilled using a one-foot diameter pilot hole from the surface to intersect the lowest elevation level. An eight-foot diameter upward reaming bit will then be attached to the drill pipe and the vertical ventilation shaft drilled upward to the surface.

Raises or vertical workings within the mine will connect the various mining levels within or very near the deposit. At various elevations from these raises, sublevel workings will be driven off to extract ore from the deposit. The broken ore will be dropped down raises, designed for such use, to draw points on the lower level. The ore will be hauled to the shaft, placed in skips and hoisted to the surface.

(6) Potable water

A water source of a few gallons per minute is needed for sanitation and underground drilling. At the start of activities, water will be trucked to the site. It is hoped that drilling the mine shaft may generate a flow of a few gallons per minute of water from the base of the Coconino Formation at a depth of approximately 1,000 feet. The ground water well that will be drilled to the Redwall formation at 2,500 to 3,000 feet is a second possible source of water although its primary purpose is for monitoring groundwater quality below the ore body. If neither of these sources produce water, trucking water from Williams or Bellemont will continue throughout the operation of the mine.

(7) Site configuration

Alternative configurations of facilities at the mine site were eliminated due to a lack of measurable and meaningful differences associated with alternative locations for on-site facilities. For example, the buildings or the holding ponds could be relocated within the project area but the change in environmental impacts to the area would be minimal.

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2.3 ALTERNATIVES ELIMINATED FROM DETAILED CONSIDERATION

The range of alternatives is relatively fixed in the case of a mining proposal on public land. Under certain circumstances, however, several alternatives other than modifications to the proposed Plan of Operation can be considered. Two alternatives that were initially considered as possible agency actions, but were dropped from further consideration, were withdrawal of land from mineral entry, and patenting (fee title ownership of mine site) of the lands in the area of the Canyon Mine by EFN.

It is national policy that public lands be open to mineral exploration and development unless there is some overriding need for protection of a surface resource(s) such as in the case of municipal watersheds, wilderness areas, or critical habitat for threatened and endangered species. And in addition, withdrawals must exempt any previous valid existing claims. It is therefore obvious that withdrawal is not a reasonable alternative for consideration.

Patenting of a mining claim is a discretionary option available to the claimant. EFN could apply for a patent from the United States, conveying fee title to the land encompassed by the claim. While such an action would change the legal relationships, it is probable that EFN would proceed with the mine as outlined in the proposed Plan of Operation. Forest Service authority would then be limited to the selection of haul routes and the mitigation measures associated with these routes. The patent alternative would not be advantageous to the Forest Service, because inholdings of private land are difficult to administer. Furthermore, the degree of monitoring for certain environmental impacts could possibly be lessened, at least within the patented mine site.

Other non-project alternatives were considered but eliminated from detailed consideration as remote, speculative and conjectural, providing no additional information which could aid the public or the Forest Service in considering the impacts of the proposed Canyon Mine. Furthermore, none of these alternatives would meet the need expressed by the applicant. Alternatives considered but eliminated as unreasonable in this context include energy conservation, alternative energy development (both fossil fuel and renewable resources) and obtaining uranium from other sources including opening new mines in other locations or reopening existing mines that have been closed due to economic circumstances.

2.4 ALTERNATIVES CONSIDERED IN DETAIL

The following alternatives have been developed to evaluate a reasonable range of project alternatives and to display the potential environmental consequences which may result from their implementation. The ultimate objective of this evaluation is to select a reasonable alternative or alternatives which address the identified issues and concerns and mitigate the effects of project implementation.

Alternative #1 - No Action Alternative

The No Action Alternative, for the purposes of this environmental evaluation, would involve disapproval of the Plan of Operations for the Canyon Mining Project. The plan would be returned stating the reasons for disapproval and request the proponent to submit a new plan that would meet the environmental and administrative constraints. While the Forest Service can require or impose reasonable environmental controls or conditions on an operating plan, they do not have the authority to disapprove a reasonable operating plan for a mining operation which will be conducted in a reasonable and apparently environmentally responsible manner (re: General Mining Law and 36 CFR 228). The use of this alternative, however, is consistent with previous Forest Service administrative decisions to treat the no action mining alternative as the no project option. It provides a sound baseline against which all other options can be compared.

For purposes of comparing alternatives and projecting environmental consequences, it is assumed that the No Action Alternative (disapproval of the Plan of Operations) will mean that no uranium mine will be developed at the Canyon Mine site. However, because EFN has contractual obligations and a need for uranium ore, disapproval of the Plan of Operations may encourage EFN to expand or accelerate its existing exploration program. If such exploration results in the discovery of a suitable ore body, implementation of the No Action Alternative could lead to the development of a mine at a different site. That site, and any impacts associated with such development, cannot be anticipated or predicted based on present knowledge. A subsequent mine proposal would, however, be subject to environmental review.

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Alternative #2 - Proposed Plan of Operations Using Hull Cabin Haul Route #1

This alternative involves the approval of the Plan of Operations as submitted by the proponent, EFN (Plan of Operations, Appendix A). The ore body at the Canyon Mine will be mined over a period of 5 to 10 years. The mining activities as proposed would require surface facilities within the area of operations encompassing approximately 17 acres, installation of a shortest-route overhead electric power line to provide power to the project area, and the utilization and upgrading of existing roads for access and ore haulage.

Prior to the construction of the mine yard, topsoil within the area of operations will be removed and stored in the form of a dike, for use in final reclamation activities. Several water diversion structures will be constructed and maintained by EFN to ensure that no surface runoff from outside the area of operations is allowed to enter. Surface drainage from the mine yard will flow into several holding ponds constructed within the area of operations. All surface runoff within the area of operations and all water encountered during the operations which cannot be utilized in connection with mining will be held on site in these holding ponds until it evaporates or until it meets the discharge standards of the Arizona Department of Health Services and the United States Environmental Protection Agency.

A portion of the mine yard will be used to stockpile up to 20,000 tons of ore prior to shipment to a mill for processing. Ore pads will be constructed to prevent leaching of mineral values contained within the ore grade material into the soil. At the conclusion of mining, all uranium ore which is uneconomical to process, will be hauled from the site to a previously approved location, or disposed of underground in the mined-out workings.

Ore haulage from the area of operations will take place along existing Forest Service roads, which are located south of the Grand Canyon National Park boundary (Fig. 2.1). Some realignment and upgrading will be necessary to improve the transportation system haul routes to acceptable standards. This work will be the responsibility of EFN. They will also share in the required maintenance of the Forest Service roads used during the ore haulage in proportion to use by EFN and other road users. Once ore production begins, it is anticipated that on the average, 10 ore trucks per day will enter, and 10 ore trucks per day will leave the area of operations. Ore haulage will be by trucks that meet the

Arizona Highway weight restrictions. Each load will be covered with a tarpaulin to prevent loss of material in transit.

After development work is completed, the mine will be operated at an average rate of 200 ton-per-day for approximately five years. Planned underground exploration may increase the tonnage to be mined and consequently, extend the operation's life by a number of years. Employment at the mine during the first few years of development will range from 15 to 30 personnel. As production capacity grows, employment could reach an estimated high of approximately 35 men at the 200 ton-per-day rate. A few experienced miners and supervisors will be transferred from existing EFN operations, but the majority of the work force will be hired locally.

At the end of all mining activities, EFN will remove all structures, clean the area of operations, seal the mine entrance, and reclaim all disturbed areas. After the removal of all equipment, the main shaft and vent shaft will be sealed in a manner approved by the appropriate regulatory agencies. The mine yard will be radiometrically surveyed and cleaned up to the extent dictated by regulations applicable at the time of closure or to the general range of naturally occurring background concentrations in the area if no such regulations then exist. The area of operations and all disturbed areas will be recontoured to blend with the surrounding topography. Previously stockpiled topsoil will then be spread evenly over the entire area of operations and revegetated.

All independent operational mine components described under Sec. 2.2.1.2 above, would be part of this alternative.

Alternative #3 - Proposed Plan of Operations with Monitoring of Soil, Air and Water; Equivalent Acre Wildlife Habitat Replacement and Relocation of Wildlife Waters., Hull Cabin Haul Route 1 and 2; Shortest Distance Overhead Powerline.

Alternative 3 is comprised of those independent operational mine components common to all alternatives described under Section 2.2.1.2, with several additional features:

- 1) modified surface water diversion structure design (2.5.12);
- 2) expanded monitoring program (2.5.10 and 2.5.11);
- 3) option to use haul routes #1 or #2, and the option to restrict hauling during May and June in lieu of wildlife habitat replacement for identified elk calving areas (2.5.14); and

- 4) private-car parking lot of .2 acre for 35 vehicles (Appendix B).

Alternative #4 - Proposed Plan of Operations with Monitoring of Soil, Air, and Water; Relocation of Wildlife Waters and Equivalent Acre Wildlife Habitat Replacement; Construct Coconino Rim Haul Route #5.

Alternative 4 is comprised of those independent operational mining components common to all alternatives that are described under Section 2.2.1.2, with several additional features:

- 1) modified surface water diversion structure design (2.5.12);
- 2) expanded monitoring program (2.5.10 and 2.5.11);
- 3) use of haul route #5 to lessen wildlife impacts and optimize future potential transportation system needs (Table 2.2);
- 4) overhead powerline along access road; and
- 5) Company provided common transportation for employees to and from mine site.

Alternative #5 - Proposed Plan of Operations with Monitoring of Soil, Air, and Water; Equivalent Acre Wildlife Habitat Replacement and Relocation of Wildlife Waters; Use S.P. Crater Haul Route #7 (Pending Right-of-Way Acquisition Across 20 Miles of State and Private Lands), or utilization of State and Federal highways over Haul Route #6.

Alternative 5 is designed to minimize road construction and reduce changes in the environmental setting associated with development of ore transportation routes. It is comprised of those independent operational mining components common to all alternatives that are described under Section 2.2.1.2, with several additional features:

- (1) modified surface water diversion structure design (2.5.12),
- (2) expanded monitoring program (2.5.10 and 2.5.11);
- (3) use of haul route #6 (all highway) or #7 (if rights-of-way across State and private lands can be acquired);
- (4) buried powerline along access road; and
- (5) Company provides common transportation for employees to and from mine site.

Road Construction standards, maintenance requirements, Right-of-Way fees, and other items requiring special attention will be mutually agreed upon by EFN, State of Arizona, and private land owners.

Preferred Alternative

No Preferred Alternative was identified in the DEIS. Based on the analysis in the DEIS and public comments received in response to the DEIS, Alternative 5 has been selected as the Preferred Alternative with one minor modification. Alternative 5 included a buried powerline along the access road to the mine site; the Interdisciplinary Team concluded that burying the powerline increases costs significantly with no corresponding environmental benefits. The Interdisciplinary Team has, therefore, substituted an aboveground powerline.

The operational elements of the preferred alternative are:

- 1) Expanded monitoring of soil, air and water (described in Sections 2.5.10 and 2.5.11);
- 2) Modified surface water diversion structure (2.5.12);
- 3) Use of haul route #6 (the all highway route described in Section 2.2.1.1) or haul route #7 (the SP Crater road described in Section 2.2.1.1);
- 4) An overhead powerline from Highway 64 following the access road to the mine site (2.2.1.1);
- 5) Transportation of mine workers by the company (2.2.1.1); and
- 6) The mitigation measures applicable to all alternatives (described in Section 2.5) including equivalent acre replacement of disturbed wildlife habitat and relocation of key wildlife waters.

The DEIS noted that "Generally, no environmental impacts have been identified in any alternative which cannot be mitigated to a substantial extent." This conclusion is still valid. However, the Preferred Alternative represents the combination of operational components, mitigation measures and haul routes which are expected to minimize potential impacts and best responds to the issues and concerns identified in the EIS.

The reasons for selecting the specific components of the Preferred Alternatives are as follows:

- 1) Expanded Monitoring -- The air, soil and water monitoring program responds to issues and concerns raised during scoping and evaluated in the DEIS (IC #7, IC #9) and to comments on the DEIS. The

groundwater monitoring well, while expensive, is an important element of the monitoring/mitigation strategy as it assures that important water sources, including springs which are sacred to the Hopi and Havasupai, will not be adversely affected by the Canyon Mine. The monitoring program also responds to the fear of radioactive contamination of air, water and soil expressed by some members of the public. Finally, the results of the monitoring program will provide important data for the evaluation of future mining proposals in the area, if any.

- 2) Modified Surface Water Diversion -- The alternative flood diversion plan is clearly superior. It provides for increased flood control capacity (a 500-year event) with less surface disturbance at the mine site.
- 3) Haul Routes -- The Preferred Alternative offers EFN the choice of two haul routes -- haul route #6, the all highway route through Williams and Flagstaff, and haul route #7, the SP Crater road which crosses private and state lands south of the Kaibab National Forest. Either haul route option minimizes potential impacts on wildlife (Table 2.7.), cultural resources and Grand Canyon National Park. These benefits, however, create substantial increased costs for the applicant. Haul route #6 is the longest route, resulting in the highest hauling costs. Haul route #7 is the next most expensive option and will also require that EFN acquire state and private rights-of-way at additional costs.

These haul route options were selected for the Preferred Alternative, despite the increased costs, for three reasons. First, this alternative is most responsive to public comments. Second, while it is believed that the impacts of any haul route option evaluated in the EIS can be successfully mitigated, this alternative creates the least potential for adverse impacts. Finally, and most importantly, this alternative provides the most flexibility for future transportation decisions and precludes an irrevocable commitment of resources to road construction or improvements which might foreclose future transportation options. As the EIS notes, future uranium mines in this region are possible, however, it is impossible to predict the specific sites of any future mines. The selection of the Preferred Alternative, which uses existing roads and minimizes new construction, will allow reconsideration of ore

transportation routes when future mines, if any, are proposed. Selection of this alternative also allows future decisionmakers to consider the option of consolidating or dispersing ore truck traffic to minimize transportation costs and environmental impacts.

- 4) Overhead Powerline -- Alternative 5 includes a buried powerline along the access road to the mine site. Burying the powerline substantially increases project costs (Table 2.6) without any corresponding environmental benefit. Accordingly, Alternative 5 has been modified for purposes of the Preferred Alternative to include a surface powerline following the access road to the mine site.
- 5) Transportation of Mine Workers -- Company transportation of mine workers is preferable to private transportation because it reduces surface disturbance (no large employee parking lot is required), access to the mine site and traffic to and from the mine.
- 6) Wildlife Mitigation -- While the potential wildlife impacts of Alternative 5 are small, any loss of key wildlife habitat should be mitigated. Implementation of the Preferred Alternative will require that EFN replace the 32 acres of big game foraging habitat lost at the mine site and replace one key watering area. In addition, operating restrictions may be placed on the use of haul route #7 to avoid potential impacts on elk migration.
- 7) Other Mitigation -- Other mitigation measures, including management of ore transportation, reclamation and fire protection (see Section 2.5) are common to all project alternatives, including Alternative 5. All of those measures are incorporated in the Preferred Alternative.

2.5 MITIGATION MEASURES

Management constraints and guidelines, corresponding mitigation, and monitoring and control measures needed "to ensure that the final actions conform to all other applicable laws relating to Forest Service activities" are discussed in this chapter, as directed by the Forest Service NEPA Procedures

Handbook (FSH 1909.15 6/85). The intent of the general constraints, guidelines, and mitigation measures is to ensure that adverse environmental impacts are avoided or minimized during construction and operation of the project, and during reclamation following mine closure.

Special attention was directed toward (1) controlling drainage, reducing erosion and sedimentation potential, and offsite radionuclide contamination from the mine area, waste piles and roads, and (2) mitigating the effects of the selected ore haulage route.

Monitoring programs were designed to mitigate public and resource management concerns, and to verify the projected effects of project implementation. These programs concentrate on air, soil and surface and ground water quality monitoring.

2.5.1 Regulatory Requirements

Operations of the proposed Canyon Mine will be subject to legal and regulatory requirements imposed by federal and state law. The question of applicable environmental standards was raised at the public scoping meeting. While these standards are not technically mitigation, in response to those questions important statutes and requirements that limit to some extent the magnitude of any impacts of mining, are summarized in this section.

Clean Water Act

Water quality is regulated by the Environmental Protection Agency and the State of Arizona. The Canyon Mine has applied for a National Pollutant Discharge Elimination System (NPDES) permit under Section 402 of the Clean Water Act to regulate any discharge from the mine site. EPA and the State share responsibility to insure compliance with that permit. Before the permit is granted, the State of Arizona must certify that the discharge from the mine site, if any, will comply with Arizona water quality standards. The permittee has an affirmative duty under the permit to notify EPA of any incident of noncompliance which may endanger health or environment. EPA retains authority to inspect the mine site or company records to insure compliance with the permit. Noncompliance with the conditions of the permit subject Energy Fuels to substantial civil and criminal penalties under Section 309 of the Act. Citizens' suits are also possible to ensure compliance.

The federal Clean Water Act regulates the discharge of pollutants into surface waters. The Canyon Mine must receive a National Pollution Discharge Elimination System (NPDES) permit from the EPA in order to release any water from the mine site. Although EFN does not anticipate encountering significant quantities of groundwater at the site, the company applied for an NPDES permit on December 20, 1984, for the possible discharge of mine drainage water.

The proposed mine is a "new source" under EPA regulations. Pursuant to Section 511 of the Clean Water Act, the issuance of an NPDES permit to a new source is subject to the environmental review requirements of NEPA. EPA is meeting its obligations under NEPA by cooperating with the Forest Service in the preparation of this EIS. A final NPDES permit for the Canyon Mine cannot be issued until at least 30 days after the date of issuance of the FEIS. Prior to issuing an NPDES permit, EPA must also make a proposed permit available for public review and comment, and provide the opportunity for a public hearing if there is significant public interest.

An NPDES permit for the discharge of mine drainage from a uranium mine must contain effluent limitations established under national EPA guidelines for the Ore Mining and Dressing Point Source Category at 40 CFR Part 440, Subpart C. These guidelines contain limitations on carbonaceous oxygen demand, zinc, dissolved radium 226, total radium 226, uranium, pH, and total suspended solids. In addition, all NPDES permits must contain any more stringent limitations necessary for achieving compliance with State Water Quality Standards.

The applicable Arizona State Water Quality Standards are those radiochemical standards which apply to all Arizona surface waters, and specific standards for trace substances which are based upon the protected uses of the receiving waters. The radiochemical standards are found at A.C.R.R. 9-21-204.B. and are based on federal drinking water standards. The protected uses of the receiving waters are those which are designated for the nearest downstream surface water segment listed in Appendix A of R9-21-208. The nearest designated surface water segment downstream of the proposed discharge point is Cataract Creek (tributary to Havasu Creek). The protected uses of this segment are: Aquatic and Wildlife (cold water fishery), Full Body Contact, Agricultural Irrigation, and Agricultural Livestock Watering. As no discharges will be permitted which do not meet these standards, authorized discharges will have no adverse environmental impact, and it is recommended that a permit be issued.

Under NPDES permits, facilities are required to sample their discharges and report pollutant concentrations to EPA and the Arizona Department of Health Services (ADHS). Such reports are public information. Permitted facilities are inspected regularly for compliance with the Clean Water Act. NPDES permits give EPA and ADHS personnel right of entry for inspection and sampling. Violation of the Clean Water Act are subject to civil penalties of up to \$10,000 per day, with higher penalties for willful or negligent violations.

Cultural Resource Protection Laws

Cultural resources are protected pursuant to a number of Federal laws, the most important of which are the Antiquities Act of 1906 (16 USC §§ 431-433), National Historic Preservation Act of 1966 as amended in 1980 (16 USC §§ 470-470a), Historical and Archaeological Data Preservation Act of 1974 (16 USC §§ 469-469h), American Indian Religious Freedom Act (42 USC § 1996) and the Archaeological Resource Protection Act of 1979 (16 USC §§ 470aa-470ll). Generally, the acts require consultation and/or surveys and other investigations of significant cultural resources and attempt to protect such resources from theft, vandalism, removal or other direct or indirect adverse impacts, by data recovery, site recovery or avoidance.

Clean Air Act

The EPA has promulgated standards to protect the public from exposure to Radon-222 emissions under authority of Section 112 of the Clean Air Act. These regulations call for bulkheading (sealing-off) abandoned areas of a mine, in order to reduce radon-222 emissions to the above ground air. These requirements are specified at 40 CFR Part 61. Airborne radiation from the Canyon Mine is discussed in Section 4.2.5.2, and Appendix E.

Endangered Species Act

Protection of threatened or endangered species occurs under the Endangered Species Act. (16 USC § 1531 *et seq.*). Section 7 of that Act generally prevents the Forest Service from authorizing any action that is likely to jeopardize the continued existence of any endangered or threatened species or result in the destruction or adverse modification of its critical habitat. Section 9 of that Act prohibits EFN from taking, hunting, harassing, killing or harming any wildlife species listed as endangered. Section 11 of the Act imposes substantial civil and criminal penalties for knowing or willful violations of the Act. Citizen suits are also available to ensure compliances.

Mine Safety and Health Act

Mine safety and health is regulated by the Federal Mine Safety and Health Administration and the Arizona State Mine Inspector. The Mine Safety and Health Administration imposes substantive standards for mine construction and operation, in 30 CFR § 57, "Safety and Health Standards--Metal and Non-Metal Underground Mines," and retains authority for inspection of mines and enforcement of its standards. Any incidents of noncompliance may give rise to civil and criminal penalties. The Arizona State Mine Inspector has similar authority. He applies the safety and health standards of Chapter 3 of Title 27 of the Arizona Statutes.

American Indian Religious Freedom Act

The American Indian Religious Freedom Act requires that Federal Agencies consider Native American beliefs and practices in the formulation of policy and approval of actions. The intent of the Act is to insure for traditional Native religions the same rights of free exercise enjoyed by other religions. However, it does not afford Indian religions a more favored status than other religions, but only insures equal treatment. The Act does not mandate protection of Tribal religious practices to the exclusion of all other courses of action. It does require that Federal actions be evaluated for their impacts on Indian religious beliefs and practices.

2.5.2 Reclamation Plan

The Reclamation Plan for the Canyon Mine Project is described in the Plan of Operations in Appendix A and supplemented by the Forest Service in Appendix B. The objective of the plan is to restore the approximately 17-plus acres of land disturbed by the mining operation and the mine entrance road, to as near natural a condition as possible after the mine is closed. The plan outlines a program for returning the disturbed area to vegetative productivity.

Prior to the construction of the mine yard, topsoil within the area of operations will be removed and stored for use in final reclamation activities. Storage will be in the form of a dike around the northern perimeter of the yard.

At the end of mining activities, EFN will remove all structures, clean the area of operations, seal the mine entrance and reclaim the disturbed areas. After the removal of all equipment, the main and vent shafts will be sealed in a manner approved by the appropriate regulatory agencies. The

mine yard will be radiometrically surveyed and cleaned-up to the extent dictated by regulations applicable at the time of closure. The area of operations and all disturbed areas will be recontoured to blend with the surrounding topography. Previously stockpiled topsoil will then be spread evenly over the entire area of operations and revegetated.

EFN will be required to provide a performance and reclamation bond of \$100,000 before mining activities start. The amount of this bond was determined by using cost estimates in Appendix B (p. 13) and adding a contingency amount based on inflation and possible estimating error, then discounted over a 7-year planning horizon.

The reclamation plan will be updated prior to closure, utilizing any revised forest land use objectives, new technology and operating experience.

2.5.3 Visual Impacts

The mine head frame and support facilities will be painted with earth tone colors. Implementation of this mitigation measure will be ensured by ongoing review by the Forest Service.

2.5.4 Public Safety

A 6-foot chainlink security fence with lockable gates will be constructed on the outside edge of the top of the 4-foot dike that surrounds the area of operations. All gates will be locked during periods of inactivity at the mine. Signs will be posted on all sides of the fenced perimeter to indicate "no trespassing," and "uranium mine." Energy Fuels will maintain the integrity of this fencing as well as monitor other aspects of the safety and security program. Federal safety inspection requirements, administered by the State Mine Inspector through the Mine Safety and Health Administration, will ensure that a safe working environment is maintained.

2.5.5 Ore Haulage Control

All ore trucks will be covered with a tarpaulin to prevent loss of material in transit. The tarpaulin will be lapped over the sides of the truck bed approximately one foot and secured every 3 or 4 feet with a tiedown rope. In the event of a truck accident that causes ore spillage, Energy Fuels will take

immediate aggressive action to: 1) notify Arizona or Utah Departments of Public Safety and Transportation, 2) notify appropriate tribal councils and the Bureau of Indian Affairs, if the ore spill occurs on Indian lands, and 3) clean up any spilled material. All uranium ore will be removed from the spill site within two working days of the time of the spill, unless the appropriate Federal and State agencies deem that such action is prevented by conditions beyond the control of Energy Fuels. In any event, all State and Federal cleanup standards relating to spillage of the ore will be strictly adhered to.

2.5.6 Air Quality

Ore stockpiles will be managed at all times to eliminate the potential for wind dispersed radioactive dust. This may require management of the stockpiled ore by wetting or chemical treatment. In project alternatives that incorporate the following sections of roads, excessive dust will be controlled by appropriate dust abatement methods: Forest Service Road 302 from the junction of Forest Service Road 2723 to the junction of Forest Service Road 307; Forest Service Road 307 from the junction of Forest Service Road 302 to the junction of Forest Service Road 2804.

2.5.7 Noise

The project will be designed and operated in a manner to reduce noise to the lowest practical levels. All equipment will be carefully maintained to achieve the lowest practical noise levels (e.g., replacing worn-out mufflers, tightening loose parts, etc.).

2.5.8 Erosion Control

Erosion from all access and haul roads and the area of operations that are disturbed during construction activities will be controlled by revegetating these areas immediately after construction. Stabilization of the stockpiled topsoil will also be accomplished by revegetation. The outside slopes of the dikes that surround the mine yard will be riprapped with barren rock fragments taken from the mine during shaft construction. These fragments should exceed six inches on any one face.

The following species and application rates are recommended for revegetation of disturbed areas:

Species	Percent in Mix		Lbs./Acre for 25 seeds per sq. ft.	Pounds Needed In Mixture
Crested Wheat	30	X	6.4	= 2
Pubescent Wheatgrass	30	X	15.4	= 4.5
Smooth Brome	25	X	9.8	= 2.5
Yellow Sweet Clover	15	X	4.6	= 1
Lbs. of mix. for 25 seeds/ft. (pure live seed) = 10 lbs./ac.*				

*Application rate is for drilling; for broadcasting double this rate.

Drill the following browse species separately:

Four-wing saltbush	4 lbs./ac.
Winterfat	4 lbs./ac.

The following general guidelines will be followed as a part of the erosion control mitigation measures:

1. Construct drainage on relocated roads in accordance with forest Service standards.
2. Minimize changes in configuration of existing drainage courses around the mine perimeter.
3. Improve drainage channels in the immediate area of the mine site by removing obstructions to increase channel capacity.
4. Revegetate all disturbed areas as soon as possible. Reseed previously reclaimed areas if necessary until a vigorous vegetative cover is established.
5. The minimum elevation of the base of the ore pads at the southern end of the yard, will be at the height of the top of the dike ... well above the 500-year-flood high-water level.
6. All abandoned roads outside the mine perimeter will be brought to original grade, ripped, water barred and revegetated.
7. The dike and the primary drainage courses in the vicinity of the mine will be routinely maintained to ensure their integrity at all times.

2.5.9 Fire Protection

The riprapped dike slopes surrounding the mine yard will be maintained as a fire break. A water storage tank of 12,000 gallon capacity and fire extinguishers as required by OSHA, will be maintained on-site in case of structural or wildland fires. Project personnel will be instructed in appropriate fire suppression techniques.

2.5.10 Radiological Monitoring Before and During Mine Operation

Under CEQ regulations, monitoring of impacts may be treated as mitigation. The following monitoring is contemplated as part of the proposed action or the alternatives.

The radiological monitoring program involves collection of appropriate data before the mine is operational. Additional measurements will be made as needed during mine operation and in the event of an accidental release of radioactivity to the downstream wash. A final survey will be conducted at the time the mine is closed to assess the impact of the mine, if any, on the project area.

Preoperational Baseline Information

The preoperational baseline data collection program will last one year prior to ore production and will involve background measurements of direct gamma radiation, radon gas and progeny concentrations, and radioactivity concentrations in air, soil and water.

Direct gamma radiation measurements will be obtained by duplicate independent monitoring devices and at a minimum of 12 locations. Dosimeters will be exchanged quarterly and provide cumulative dose information. Readings from a pressurized ion chamber and a scintillometer will be recorded whenever the dosimeters are exchanged. The monitoring sites are described below and shown in Figure 2.4. Measurements to date are reported in Appendix E.

Mine Sites	Eight compass headings and a special additional location in the wash immediately south of site. Each site is approximately 1/4 mile from proposed mine shaft.
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Owl Tank	In center of wash just north of tank.
Tusayan	Grand Canyon Airport.
Tusayan	Tusayan Ranger District Office.

Radon measurements have been and will be performed quarterly using an instrument which obtains independent measurements of radon gas concentrations and the daughter product "working level" exposure. Measurements will be made at the mine site, Tusayan and other locations as deemed necessary.

Water samples have been and will be collected from the wash and Owl Tank semiannually, based on availability of water. Additional samples will be collected at Havasu Springs, Indian Gardens, and Blue Springs. Results to date are reported in Appendix F.

Soil samples have been and will be collected from the sites listed here and shown in Figure 2.4. Results to date are reported in Appendix E.

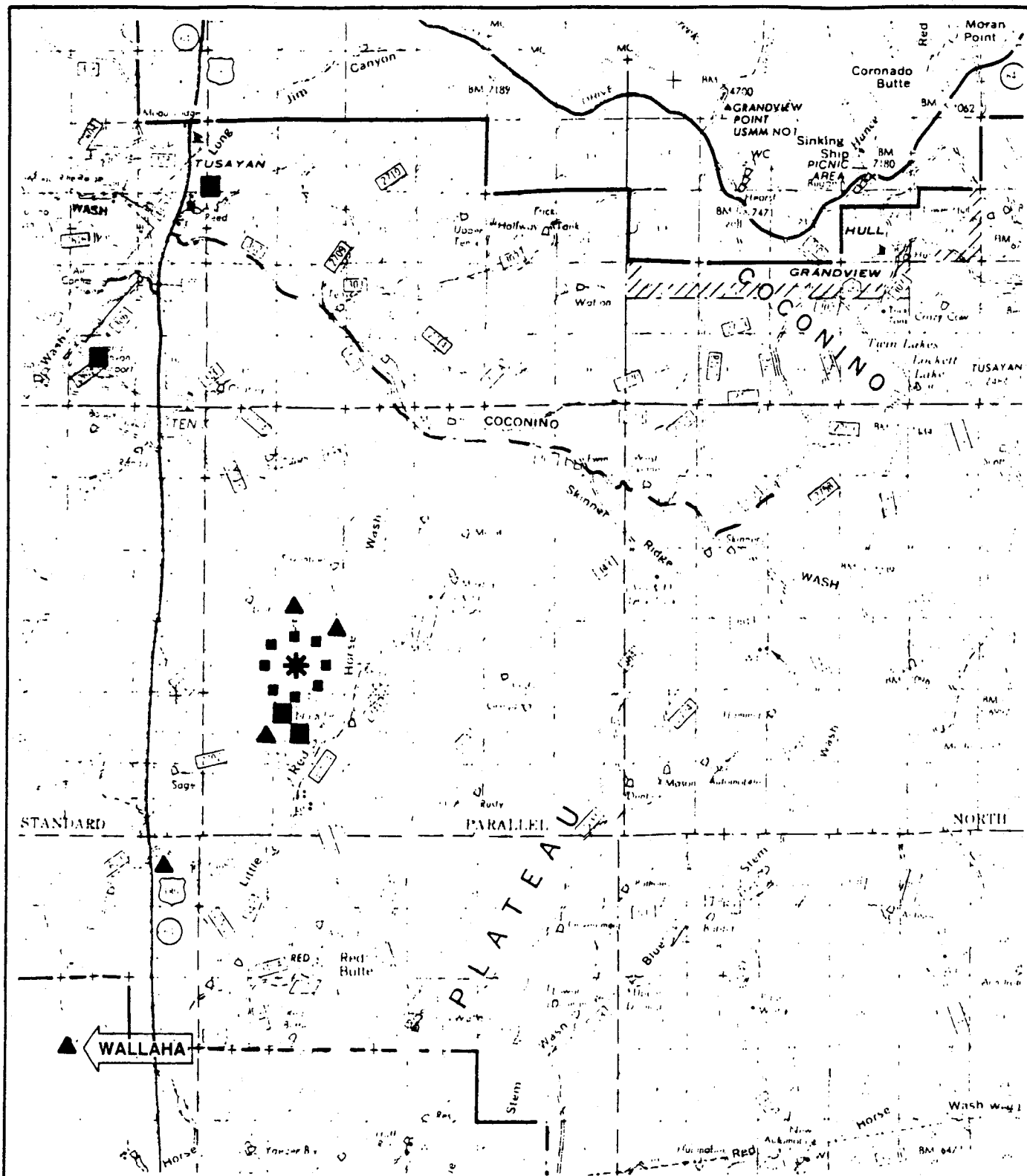
- Upwash north of Canyon Mine Site (background)
- Upwash northwest of Canyon Mine Site (background)
- Downwash immediately below Canyon Mine Site
- Owl Tank
- Little Red Horse Wash at U.S. Highway 180
- Big Red Horse Wash at east-west dirt road (unnamed)
crossing just west of north-south railroad spur, and
approximately 1 mile west of Willaha ranch-house ruins.

Operational Measurements

After the mine is in operation, the quarterly dosimetry measurements, pressurized ion chamber, and scintillometer measurements will continue at the 12 established sites. Additional sites may be established along the haulage route.

Based on time and need, radon measurements will continue at Tusayan and will be rotated among other sites such as Owl Tank, the ore and waste piles, in the mine office, and atop the exhaust vent. The objective will be to collect sufficient radon information to determine whether any measurable increase occurs at Tusayan.

Soil and water samples will be collected until such time as sufficient data is available to delineate possible radionuclide increases from accidental releases and to ensure that ground water, if present, will not be adversely impacted. Thereafter, except for water from the mine well and soil from the survey



- BACKGROUND RADIATION SITES AROUND PROPOSED MINE
- ADDITIONAL BACKGROUND RADIATION SITES
- ▲ SOIL COLLECTION SITES
- * CANYON MINE SITE



1/2" = 1 MILE

RADIOLOGICAL MONITORING SITES

FIGURE

2.4

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location immediately downwash from the mine yard, routine soil and water sampling should not be needed unless some extraordinary event dictates additional samples be taken.

Whenever a haulage accident occurs, a radiological report will be prepared. The report will contain such information as the amount of material spilled, the extent of area affected, measures taken to provide an adequate cleanup, results of the final radiological survey, and estimates of any possible non-occupational exposures.

Following any storm event where the surface water control features fail, the flooded area downstream from the mine site would be radiometrically surveyed. Any soil showing radiation levels above baseline measurements would be removed and returned to the mine site.

2.5.11 Groundwater Monitoring

A water well to the Redwall-Muav aquifer will be constructed and tested at the Canyon Mine site prior to the intersection of ore by mining operations. If groundwater is yielded, the well would be completed with blank and steel casing, and a standard 5-day single borehole pumping test, followed by a 5-day recovery period, would be conducted to determine aquifer permeability and to obtain groundwater samples for laboratory chemical analyses. After the pumping test program is complete, the well would be equipped as a water supply and groundwater monitoring well. Water samples for chemical analyses will be obtained at 3-month intervals during the first year of the sampling program. After results for the first year are analyzed, the frequency of sample collection may be modified. The water samples will be analyzed for routine constituents, trace elements, gross alpha and beta radiation, uranium and radium 226.

In the event that groundwater becomes contaminated during the mining operations, continuous pumping will be maintained until critical constituents are reduced to drinking water standards or to within ten percent of ambient concentrations, or to some comparable standard approved by the Forest Service. The pumped water will be stored in the mine yard ponds and discharged only when it meets NPDES standards. With the drawdown that occurs as a result of pumping, no contaminants should leave the area in the groundwater since all flow would be directed toward the well.

If groundwater is not yielded from the Redwall-Muav aquifer at the mine site, the test borehole will be plugged and abandoned in accordance with requirements for the Arizona Department of Water Resources.

2.5.12 Surface Floodwater Control at Mine Site

The adequacy of the proposed flood channels at the mine site was investigated as part of the hydrologic studies that tracked the disposition of flood flows through the mining area toward the Havasupai Reservation. Based on the specifications given in the proposed Plan of Operations, the proposed flood channels were adequate for at least a 100-year flood event. However, there was concern raised about locating an artificial channel along the sideslope at the east side of the mine yard. An alternative to this proposal was drafted (Appendix D) by the consulting hydrologist. This modified design would increase the flood carrying capacity of the channels to handle a 500-year event and would preclude the possibility of runoff from local intense storms from either entering or leaving the operating site, thereby eliminating the potential of downstream radionuclide contamination from ore stock piles. Construction of these channels will require less surface disturbance than the original proposal. The original diversion proposal is a part of Alternative 2. This modified proposal has been incorporated into Alternatives 3-5.

Holding pond(s) in the mine yard must be adequate to receive local runoff from a 100-year thunderstorm event, plus normal annual runoff and water that may be pumped from the mine. The volume of water in the pond(s) must be maintained at a level that will allow a reserve pond capacity to accommodate unforeseen and normally expected runoff events. With these factors taken into consideration, a pond volume of about 6 acre-feet is recommended, with no more than 3 acre-feet of storage used at any time. The ponds must be lined with plastic or impervious material to prevent percolation into the substrate. (See Appendices B & D for detailed discussion of mine-yard runoff).

Average annual potential evaporation at the mine site is estimated to be greater than 50 inches per year. A pond having a surface area of one acre and a depth of 4 feet can be expected to lose most of its capacity to evaporation each year. Thus, one storage facility of this capacity could be used to hold water pumped from the mine and runoff from the portion of the mine yard which contains ore. A second storage facility could be used to collect non-contaminated runoff from within the yard, and would be discharged in accordance with the NPDES permit. Exact pond volume will depend on the amount of water encountered during the shaft-sinking operation.

Prior to stockpiling ore, EFN will construct an ore pad at least one foot thick. This pad will prevent leaching of mineral values from the ore into the soil as a result of rainfall.

2.5.13 Traffic Control

Traffic control will be needed for ore trucks entering State Highway 64 from Forest Road 305, when the highway haul options are used.

2.5.14 Wildlife Mitigation

The following are recommended methods of mitigating potential wildlife impacts:

1. Mine Site:
Improve and rehabilitate an alternate 32-acre foraging area. Create a forage opening in the pinyon-juniper woodland by mechanically removing trees and brush and seeding with desired species. See Appendix C, page 25 for details.
2. Elk Calving Areas:
Construct one reliable wildlife water source on the Tusayan District. (The water source will be located in an area with suitable forage and cover, and will be fenced to exclude livestock. See Appendix C for details.) Closing the affected road section to all traffic during the calving season (May 1-June 30) may be used as an alternative to construction of a wildlife water source.
3. Key Waters:
Important wildlife waters impacted by the haul road traffic will be relocated. For each impacted key water source, one earthen tank will be constructed in a suitable location away from roads. All new tanks will be fenced to exclude livestock.
4. New Road Construction:
Improve and rehabilitate an alternate foraging area equivalent to the number of acres removed from production by new road construction (in addition to "1" above).

2.5.15 Raptor Protection

Overhead powerlines must have a 60-inch minimum separation of wires.

2.5.16 Pooled Worker Transportation

Employees will be provided transportation to and from the mine site by a Company van or bus. Driving of individual vehicles to the mine will be discouraged.

Table 2.3 summarizes the mitigation measures that apply to the different alternatives.

TABLE 2.3 -- Mitigation Measures That Apply to Project Alternatives

MITIGATION MEASURE	Alternative #			
	2 ¹	3	4	5
1. Compliance with laws, and regulations	X ²	X	X	X
2. Mine site reclamation	X	X	X	X
3. Visual resource	X	X	X	X
4. Public safety controls	X	X	X	X
5. Ore haulage control (spills)	X	X	X	X
6. Air quality management		X	X	X
7. Noise management		X	X	X
8. Erosion control	X	X	X	X
9. Fire protection		X	X	X
10. Radiological monitoring		X	X	X
11. Groundwater monitoring		X	X	X
12. Surface runoff diversion	X	X	X	X
13. Control of truck access at SR 64				X
14. Wildlife mitigation				
a. replacement foraging area		X	X	X
b. new water source to offset loss of elk calving habitat near haul road <u>or</u> close road during calving season		X		
c. construct replacement waters impacted by haul route		X	X	X
15. Raptor protection		X	X	X
16. Pooled worker transportation	X		X	X

¹The mitigation measures that are marked under this alternative were proposed by EFN in the original Plan of Operations.

²An "X" indicates that the listed mitigation measure is specified as part of that alternative.

2.6 COMPARISON OF ALTERNATIVES

Under Alternative 1, No Action, the Forest Service would reject the Proposed Plan of Operations. No mine would be allowed and no roads constructed or improved. The No Action Alternative is intended to provide baseline data relevant to the issues and concerns, against which the impacts of the other four alternatives can be compared. Implementation of this alternative is in direct conflict with the general mining laws and Secretary regulations which provide a statutory right to pursue a reasonable mining operation, and also provide the Forest Service the authority to require reasonable environmental controls.

The following tables display the effects of each alternative against the identified issue and concern. A narrative discussion relates those effects which could not be quantified.

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TABLE 2.4 SOCIO-ECONOMIC IMPACTS ON COCONINO COUNTY



ISSUE OR CONCERN	UNITS OF MEASURE	Preferred Alternative				
		ALTERNATIVE 1 NO ACTION (BASELINE DATA)	ALTERNATIVE 2 PROPOSED PLAN OF OPERATION (P.P.O.) USING HULL CABIN HAUL ROUTE TO CAMERON (ROUTE #1)	ALTERNATIVE 3 P.P.O.; MIT. WILDLIFE; MONITOR SOIL, WATER & AIR; USE HAUL RTS. 1 OR 2; SHORTEST DIST. OVERHEAD POWERLINE; 35-CAR PARKING LOT	ALTERNATIVE 4 P.P.O.; WILDLIFE MIT- IGATION; MONITORING AIR, SOIL & WATER; COC. RIM ROUTE #5; OVERHEAD POWERLINE ALONG ACCESS ROAD	ALTERNATIVE 5 P.P.O.; MONITORING AIR, S&W; WILDLIFE MITIGATION USING HAUL ROUTE #6 (ALL HIGHWAY) OR ROUTE #7 (SP. CRATER) TO MINIMIZE ROAD CONSTRUCTION
Local and Regional Economic Impacts	Change in Employment (primary and secondary - number of jobs affected)	-0-	Williams +58 Coconino Co. +102 (occurs over 1-5 yr)	-----same for all Alternatives-----		
	Changes in Total Annual Income For Coconino County (\$)	-0-	3,086,900 +0.52%	3,086,900 +0.52%	3,086,900 +0.52%	3,086,900 +0.52%
	Changes in Total Annual Gross Output for Coconino County (\$)	-0-	3,925,400 +0.16%	3,925,400 +0.16%	3,925,400 +0.16%	3,925,400 +0.16%
	Annual Tax Revenues (Sales, Pro- perty and severance) (\$)	-0-	297,500	297,500	297,500	297,500
Effect on Williams Water Supply	Total Storage Capacity (ac.ft.)	2,750				
	Potable City Consumption ^{1/} (ac.ft./yr.)	350				
	Canyon Mine Projected Needs (ac.ft./yr.)		8	8	8	8
	Change in City's Annual Demand(%)		2.3	2.3	2.3	2.3
Cultural Resources ^{2/}	Relative Archeological Site Den- sity along Haul Routes	No Effect	Low	Low	High	Low to moderate
Social Impacts	Lifestyle, Beliefs and Attitudes	No Effect	Most employment should come from existing labor pool in Williams, provided employment qualifications can be met. For some people who fear radiation or covet solitude, the existence of a uranium mine may change their attitude and beliefs regarding the project area.			
	Population Change	No Effect	Population of Williams or Coconino County will not change appreciably as a result of the mine.			
City & County Infra- structure						
a) School Enrollment	Enrollment	No Effect	A small increase in school enrollment at Williams would have no impact. Excess capacity now exists.			
b) No. of Police	Number of Police	No Effect	No significant change anticipated.			
c) Fire Protection	Amount	No Effect	No change required.			
d) Medical Facilities	Amount	No Effect	Adequate emergency medical facilities available in Grand Canyon Village and Williams.			
e) Housing	Amount	No Effect	Adequate housing exists in Williams. None available in Tusayan.			

^{1/} Includes all water sold by the City of Williams to all customers, local and otherwise. Design capacity is 1120 ac-ft/yr. (Data from the City of Williams Draft Comprehensive Plan, 1985)

^{2/} Low site density = <9 sites/mi.², moderate density = 9-25 sites/mi.², high density = >25 sites/mi.².

TABLE 2.5 RECLAMATION OF MINE SITE

**Preferred Alternative**

ISSUE OR CONCERN	UNITS OF MEASURE	ALTERNATIVE 1 NO ACTION (BASELINE DATA)	ALTERNATIVE 2 PROPOSED PLAN OF OPERATION (P.P.O.) USING HULL CABIN HAUL ROUTE TO CAMERON (ROUTE #1)	ALTERNATIVE 3 P.P.O.; MIT. WILDLIFE; MONITOR SOIL, WATER & AIR; USE HAUL RTS. 1 OR 2; SHORTEST DIST. OVERHEAD POWERLINE; 35-CAR PARKING LOT	ALTERNATIVE 4 P.P.O.; WILDLIFE MIT- IGATION; MONITORING AIR, SOIL & WATER; COC. RIM ROUTE #5; OVERHEAD POWERLINE ALONG ACCESS ROAD	ALTERNATIVE 5 P.P.O.; MONITORING AIR, S&W; WILDLIFE MITIGATION USING HAUL ROUTE #6 (ALL HIGHWAY) OR ROUTE #7 (SP CRATER) TO MINIMIZE ROAD CONSTRUCTION
Need for Reclamation	Area Requiring Restoration (ac.) ^{1/}	NA	17	17	17	17
Measures/Methods	Revegetation -mixture (species) -application (type)	NA NA	Seeding of all disturbed sites will be accomplished as specified in Section 2.5, for erosion control.			
	Stabilization of Stockpiled Topsoil (narrative)	NA	Not required	Stockpiled top soil will be seeded with the same application specified in Section 2.5.8 for erosion control.		
	Surface Facilities Removal (narrative)	NA	All improvements will be removed from the mining site.			
	Radioactive Waste Disposal (narrative)	NA	The mine yard will be radiometrically surveyed and any material found which exceeds normal background levels will be removed from the area, backfilled into the shaft or hauled from the Project Area.			
Reclamation Bond	Amount (\$)	NA	-0-	100,000	100,000	100,000

^{1/} Minor amounts of road obliteration will be required during construction of haul route. These amounts are not included here. Similarly a small amount of restoration is required in the utility corridor, but since this is constant and insignificant, it is not included in this table.

TABLE 2.6 PROPONENT INCURRED PROJECT AND MITIGATION COSTS ^{1/}**Preferred Alternative**

ISSUE OR CONCERN	UNITS OF MEASURE	ALTERNATIVE 1 NO ACTION (BASELINE DATA)	ALTERNATIVE 2 PROPOSED PLAN OF OPERATION (P.P.O.) USING HULL CABIN HAUL ROUTE TO CAMERON (ROUTE #1)	ALTERNATIVE 3 P.P.O.; WILDLIFE MITIGA- TION; MONITOR WATER, AIR AND SOIL; USING HAUL RTS 1 OR 2; SHORTEST DIST- ANCE OVERHEAD POWERLINE		ALTERNATIVE 4 P.P.O.; WILDLIFE MITI- GATION; MONITORING AIR, SOIL & WATER; COC. RIM ROUTE #5; OVERHEAD POWERLINE ALONG ACCESS ROAD	ALTERNATIVE 5 P.P.O.; MONITORING AIR, S&W; WILDLIFE MITIGATION USING HAUL ROUTE #6 (ALL HIGHWAY) OR ROUTE #7 (SP CRATER) TO MINIMIZE ROAD CONSTRUCTION	
				Route #1	Route #2		Route #6	Route #7
Transportation	Hauling (\$)	-0-	2,790,000	2,790,000	2,693,200	3,351,000	4,866,800	3,940,080
	Construction (\$)	-0-	1,371,400	1,371,400	1,328,700	1,920,500	225,600	643,906
	Maintenance (\$)	-0-	192,500	192,500	177,800	227,500	33,600	208,600
Monitoring	Radiation:							
	Air, Soil and Water (\$)	-0-	-0-	70,000	70,000	70,000	70,000	70,000
	Groundwater:							
	Well Construction (\$)	-0-	-0-	250,000	250,000	250,000	250,000	250,000
Equivalent Habitat Improvement	Water Sampling (\$) ^{2/}	-0-	-0-	42,000	42,000	42,000	42,000	42,000
	Key Waters:							
	Relocation (\$) ^{3/}	-0-	-0-	34,080	25,560	25,560	8,520	8,520
	Create Replacement ^{4/} Foraging Area (\$)	-0-	-0-	6,840	6,910	6,680	6,170	6,170
Site Reclamation	Total Costs (\$)	-0-	72,320	72,320	72,320	72,320	72,320	72,320
Worker Transport. ^{5/}	Total Costs (\$)	-0-	51,300	3,600	3,600	51,300	51,300	51,300
Cultural Resource Mitigation	Total Costs (\$) (incl. haul route clearance)	-0-	11,550	11,550	11,340	12,150	9,280	11,500
Powerline	Total Costs (\$)		90,200	90,200	90,200	236,100	309,600	309,600
Right-of-Way Acquisi- tion	Total Costs (\$) (incl. survey)	-0-	-0-	-0-	-0-	-0-	-0-	12-30,000
Total Project Costs	Net Discounted Costs (\$) ^{6/}	-0-	3,398,282	3,760,971	3,643,962	4,785,699	4,242,417	4,102,632

^{1/} Some costs are one-time expenditures, such as road construction and reclamation; others are recurring annual costs; all are shown here as total project costs, based on 2 pre-mining & 5 mining years. Cost estimates are based on data from contractors, trade journals, etc., and are for comparison only. Actual costs could vary significantly from these estimates.

^{2/} Prior to the start of mining operations samples will be taken at the Redwall-Muav springs every 6 months for 18 months. After the groundwater well has been drilled, and if it produces water, samples will be taken from the well 4 times each year. This will replace the sampling at the springs. If groundwater contamination is detected at the well, pumping will be initiated, along with sampling at the springs. (See Section 2.5.11 for details.)

^{3/} Estimated at \$8,520 for construction of a new tank, including fencing.

^{4/} This is an "equivalent-acre" cultural treatment required to mitigate the loss of habitat at the mine site and new road construction.

^{5/} Alternatives 2, 4 & 5 include Company costs of pooled worker transportation; Alt.3 includes cost of 35-car parking lot.

^{6/} Includes all listed project costs, discounted at 10% over a projected 7-year planning horizon.

TABLE 2.7 IMPACTS ON WILDLIFE



Preferred Alternative

ISSUE OR CONCERN	UNITS OF MEASURE	ALTERNATIVE 1 NO ACTION (BASELINE DATA)	ALTERNATIVE 2 PROPOSED PLAN OF OPERATION (P.P.O.) USING HULL CABIN HAUL ROUTE TO CAMERON (ROUTE #1)	ALTERNATIVE 3 P.P.O.; WILDLIFE MITIGA- TION; MONITOR WATER, AIR AND SOIL; USING HAUL RTS 1 OR 2; SHORTEST DIST- ANCE OVERHEAD POWERLINE; 35-CAR PARKING LOT		ALTERNATIVE 4 P.P.O.; WILDLIFE MITI- GATION; MONITORING AIR, SOIL & WATER; COC. RIM ROUTE #5; OVERHEAD POWERLINE ALONG ACCESS ROAD	ALTERNATIVE 5 P.P.O.; MONITORING AIR, S&W; WILDLIFE MITIGATION USING HAUL ROUTE #6 (ALL HIGHWAY) OR ROUTE #7 (SP CRATER) TO MINIMIZE ROAD CONSTRUCTION	
				Route #1	Route #2		Route #6	Route #7
Elk Calving Habitat ^{1/}	Acres Potentially Impacted (within 0.5 ml. of road)	-0-	228	228	55	-0-	-0-	-0-
	Percent of Habitat Impacted (%)	-0-	11	11	3	-0-	-0-	-0-
Deer/Antelope/Turkey Fawning & Nesting Habitat ^{2/}	Acres Potentially Impacted	-0-	No Quantifiable Impacts					
Elk Migration Routes	Percent of Population Affected	-0-	-0-	-0-	-0-	-0-	-0-	11 ^{8/}
Area Lost From New Road Construction ^{3/}	Acres Taken Out of Production by Roads	-0-	9	9	10	7	-0-	-0-
Big Game Foraging Habitat ^{4/}	Area Directly Impacted by Mine Site (acres)	-0-	32	32	32	32	32	32
Total Acres of Habitat Replacement ^{5/}	Acres of Vegetative Treat- ment Required (ac.)	-0-	-0-	41	42	39	32	32
Key Waters ^{6/}	Number of Waters Impacted	-0-	3	3	2	3	1	1
	% of All Key Waters in Area	-0-	13	13	9	13	4	4
Replacement Waters ^{7/}	Total Needed as Mitigation Measure (no.)	-0-	-0-	4	3	3	1	1

^{1/} Estimated total acres of elk calving habitat within Tusayan Ranger District is 2,000 acres. Impacted elk calving habitat will be mitigated by constructing 1 water.

^{2/} To date there are no studies that show a definite relationship between increased traffic and impacts on these habitats.

^{3/} Habitat lost from new road construction will be mitigated by vegetative treatments at alternate sites.

^{4/} Includes acreage of natural opening at mine site; mitigated by vegetative treatments at alternate sites (reflected in total acres of habitat replacement).

^{5/} Based on total acres impacted: acreage within the natural opening at the mine site, and acres of habitat taken out of production by new road construction.

^{6/} Important waters that are adjacent to the haul road.

^{7/} Number of new wildlife waters needed to offset the impacts of elk calving habitat impacted and key waters along the haul routes.

^{8/} Impacts to elk migration are speculative and unquantifiable. If additional information indicates that significant impacts occur, the haul road would be temporarily closed during the migration period.

TABLE 2.8 EFFECT ON VEGETATION

**Preferred Alternative**

ISSUE OR CONCERN	UNITS OF MEASURE	ALTERNATIVE 1 NO ACTION (BASELINE DATA)	ALTERNATIVE 2 PROPOSED PLAN OF OPERATION (P.P.O.) USING HULL CABIN HAUL ROUTE TO CAMERON (ROUTE #1)	ALTERNATIVE 3 P.P.O.; WILDLIFE MITIGA- TION; MONITOR WATER, AIR AND SOIL; USING HAUL RTS 1 OR 2; SHORTEST DIST- ANCE OVERHEAD POWERLINE; 35-CAR PARKING LOT		ALTERNATIVE 4 P.P.O.; WILDLIFE MITI- GATION; MONITORING AIR, SOIL & WATER; COC. RIM ROUTE #5; OVERHEAD POWERLINE ALONG ACCESS ROAD	ALTERNATIVE 5 P.P.O.; MONITORING AIR, S&W; WILDLIFE MITIGATION USING HAUL ROUTE #6(ALL HIGHWAY) OR ROUTE #7 (SP CRATER) TO MINIMIZE ROAD CONSTRUCTION (same for both haul route options)
				Route #1	Route #2		
Loss of Grazing Capacity and Timber Production ^{1/}							
1) Grazing Capacity	District Total (AUM's) Amount Lost (AUM's) Amount Lost (%)	16,424.0 -0- -0-	7.9 0.05	7.9 0.05	8.0 0.05	6.6 0.04	5.2 0.03
2) Timber Annual Allowable Cut	District Total (MBF) ^{2/} Amount Lost (MBF/yr.) Amount Lost (%)	1809.0 -0- -0-	1.52 0.08	1.52 0.08	2.89 0.16	0.62 0.03	0.06 0.003
Loss of Vegetation							
1) Ponderosa Pine	District Total (acres) Amount Lost (acres) Amount Lost (%)	96,182.0 -0- -0-	7.9 0.008	7.9 0.008	8.0 0.016	3.2 0.003	0.3 0.00
2) Pinyon-Juniper	District Total (acres) Amount Lost (acres) Amount Lost (%)	175,770.0 -0- -0-	2.4 0.001	2.4 0.001	2.4 0.001	6.9 0.004	6.9 0.00
3) Forest Vegeta- tions Similar to Mine Site	District Total (acres) Amount Lost (acres) Amount Lost (%)	13,551.0 -0- -0-	15 0.11	15 0.11	15 0.11	15 0.11	15 0.11
Threatened, Endangered and Sensitive Plant Species	Species Present Amount of Impact (narrative)	Disturbed rabbit- brush	No T&E species are present on the Ranger District. The only known sensitive species "disturbed rabbitbrush" (<i>Chrysothamnus molestus</i>) can safely be avoided in both haul route and power corridor location. It does not exist in the mine-yard area.				

^{1/} As a result of mine yard construction and road improvements.^{2/} The timber removed is associated with road clearings, and represents a permanent loss of annual allowable cut.

TABLE 2.9 EFFECT ON VISUAL QUALITY OF GRAND CANYON AND KAIBAB FOREST ^{1/}**Preferred Alternative**

ISSUE OR CONCERN	UNITS OF MEASURE	ALTERNATIVE 1 NO ACTION (BASELINE DATA)	ALTERNATIVE 2 PROPOSED PLAN OF OPERATION (P.P.O.) USING HULL CABIN HAUL ROUTE TO CAMERON (ROUTE #1)	ALTERNATIVE 3 P.P.O.; MIT. WILDLIFE; MONITOR SOIL, WATER & AIR; USE HAUL RTS. 1 OR 2; SHORTEST DIST. OVERHEAD POWERLINE; 35-CAR PARKING LOT	ALTERNATIVE 4 P.P.O.; WILDLIFE MIT- IGATION; MONITORING AIR, SOIL & WATER; COC. RIM ROUTE #5; OVERHEAD POWERLINE ALONG ACCESS ROAD	ALTERNATIVE 5 P.P.O.; MONITORING AIR, S&W; WILDLIFE MITIGATION USING HAUL ROUTE #6 (ALL HIGHWAY) OR ROUTE #7 (SP CRATER) TO MINIMIZE ROAD CONSTRUCTION
Impacts on Viewed Landscape	Forest Service Visual Quality Objectives (VQO) ^{2/} 1) Preservation: Management activities except for very low visual impact recreation facilities are prohibited. 2) Retention: No change in landscape qual- ities related to size, inten- sity, amount, direction, pat- tern, etc., should be evident. 3) Partial Retention: Man's activities remain visually subordinate to the characteristic landscape. 4) Modification: Man's activities dominate but will borrow from existing visual characteristics. 5) Maximum Modification: Man's activities will dominate the view.	Current Objectives: Retention, partial retention, modifi- cation and maximum modification for various locations on the Tusayan Ranger District (See Fig. 3.6)	Current Objectives: Modification and maximum modifica- tion--Meets object- ives and will not appreciably alter visual characteris- tics adjacent to haul routes	Current Objectives: Modification an maximum modifica- tion--Meets object- ives and will not appreciably alter visual characteris- tics adjacent to haul routes	Current Objective: Maximum modifica- tion--Within Forest guidelines but will result in road scar on Coconino Rim	Current Objective: Maximum modifica- tion--Changes in visual appearance of Forest will remain unaltered along existing forest roads
Impacts on Grand Canyon Park and State Highway 64	Changes in Visual Experience at Park and State Route 64	No Change	No Change ^{3/}	No Change ^{3/}	No Change	No Change

^{1/} The Canyon Mine is located 13 miles south of the south rim of the Grand Canyon. Terrain and vegetative cover restricts visibility of the mine in the surrounding area to less than 1/2 mile. Therefore the Canyon Mine will not be seen from either SH. 64 or the Grand Canyon. Visual quality impacts on Forests lands will largely be dependent on haul route selection.

^{2/} Visual quality objectives are determined by: (1) variety class [i.e., attraction of the area's physical features (landforms, vegetation and waterform)]. and (2) sensitivity level (i.e., people's concerns about the scenic quality of an area. See Sec. 3.2.4.)

^{3/} The only potential effect mining activity might have on the Grand Canyon National Park, is a slight reduction in visibility in the extreme SE corner of the Park. This would result from road dust from ore trucks traversing the sharp turn near Hull Cabin on haul route #1, under extreme meteorological conditions. Visibility into the Grand Canyon would be unaffected since this small affected area is south of the rim road.



TABLE 2.10 EFFECTS ON AIR QUALITY AT GRAND CANYON, TUSAYAN AND MINE SITE

Preferred Alternative

ISSUE OR CONCERN	UNITS OF MEASURE	ALTERNATIVE 1 NO ACTION (BASELINE DATA)	ALTERNATIVE 2 PROPOSED PLAN OF OPERATION (P.P.O.) USING HULL CABIN HAUL ROUTE TO CAMERON (ROUTE #1)	ALTERNATIVE 3 P.P.O.; MIT.WILDLIFE; MONITOR SOIL, WATER & AIR; USE HAUL RTS. 1 OR 2; SHORTEST DIST. OVERHEAD POWERLINE; 35-CAR PARKING LOT	ALTERNATIVE 4 P.P.O; WILDLIFE MIT- IGATION; MONITORING AIR, SOIL & WATER; COC. RIM ROUTE #5; OVERHEAD POWERLINE ALONG ACCESS ROAD	ALTERNATIVE 5 P.P.O.; MONITORING AIR, S&W;WILDLIFE MITIGATION USING HAUL ROUTE #6(ALL HIGHWAY) OR ROUTE #7 (SP CRATER) TO MINIMIZE ROAD CONSTRUCTION
Predicted Impacts on Air Quality	<p>Predicted Impacts of Particulates and Radon Gas Emissions on Air Quality at Grand Canyon National Park (narrative)</p> <p>Predicted Impacts of Suspended Particulates and Radon Gas Emissions on Air Quality at Mine, Tusayan and Along Haul Routes</p> <p>Radon: (pCi/L) Average for Western U.S. Projected Increase in Levels (Due To Mine) at: 1) Owl Tank 2) Tusayan</p> <p>Particulates: (ug/m³) NAAQS Standards Current Levels Projected Levels 1) Mine Site 2) Haul Routes</p> <p>Radioactive Dust: (ug/m³)^{3/} Current Levels Projected Levels</p>	<p>The GCNP is a mandatory class 1 area.</p> <p>0.2</p> <p>260 (24-hr. max.) 47-58(24-hr. max.)</p> <p>background</p>	<p>No significant impact of radon gas or suspended particulates will occur in the park from the proposed mining project, even under the most extreme "worst-case" conditions.</p> <p>0.019 0.005</p> <p>26 (24-hr. max.)^{2/} 22 (24-hr. max.)</p> <p>0.01 increase^{4/}</p>	<p>-----Same for all alternatives.-----</p> <p>-----Same for all alternatives.-----</p> <p>-----Same for all alternatives.-----</p>		
Monitoring	Requirements (narrative)	N/A	Required during the life of the mining operation, to detect changes in background readings for radon and radioactive dust.			

^{1/} Total suspended particulates.

^{2/} These predicted values are in addition to existing (background) levels.

^{3/} These calculations assume that all potentially radioactive dust is 1% uranium.

^{4/} This is 300 times less than limits set for facilities which require a radioactive materials license.

TABLE 2.11 EFFECTS OF TRANSPORTATION ROUTE SELECTION ^{1/}**Preferred Alternative**

ISSUE OR CONCERN	UNITS OF MEASURE	ALTERNATIVE 1 NO ACTION (BASELINE DATA)	ALTERNATIVE 2 PROPOSED PLAN OF OPERATION (P.P.O.) USING HULL CABIN HAUL ROUTE TO CAMERON (ROUTE #1)	ALTERNATIVE 3 P.P.O.; MIT. WILDLIFE; MONITOR SOIL, WATER & AIR; USE HAUL RTS. 1 OR 2; SHORTEST DIST. OVERHEAD POWERLINE; 35-CAR PARKING LOT		ALTERNATIVE 4 P.P.O.; WILDLIFE MIT- IGATION; MONITORING AIR, SOIL & WATER; COC. RIM ROUTE #5; OVERHEAD POWERLINE ALONG ACCESS ROAD	ALTERNATIVE 5 P.P.O.; MONITORING AIR, S&W; WILDLIFE MITIGATION USING HAUL ROUTE #6(ALL HIGHWAY) OR ROUTE #7 (SP CRATER) TO MINIMIZE ROAD CONSTRUCTION	
				Route #1	Route #2		Route #6	Route #7
Road Construction	New Construction (miles)	-0-	3.6	3.6	4.1	2.9	-0-	-0-
	Reconstruction (miles)	-0-	23.9	23.9	21.3	30.6	4.8	29.8
Hauling ^{2/}	To Cameron (tons/mile)	-0-	48.5	48.5	46.4	54.5	128.8	85.0
Integration With Po- tential Future Forest Resource Management Needs	Degree of Integration (Narrative)	No commitment, future options open	Compatible (up- grades existing roads)	Compatible (up- grades existing roads)(both routes)		Compatible (access to southwest side) with possible future needs	No commitment on Forest, utilizes State and private land	
Surfacing Material Pits ^{3/}	Total Required (volume cu. yd.)	-0-	54,000	54,000	54,000	63,500	53,500	53,500
	(surface acres disturbed)	-0-	2.8	2.8	2.8	3.4	3.2	3.2
Traffic Use on Haul Route	Seasonal Average Daily Traffic Before Project Construction (no.) ^{4/}	Not Applicable	17	17	17	21-23	2,900 to 10,150	not available
	Projected Average Daily Traffic After Construction (no.)	Not Applicable	40	40	40	46	2,900 to 10,150	not available
	Percent Increase in Traffic	Not Applicable	135	135	135	109	0.6	not available
Monitoring	Radiometric Surveys Along Haul Routes ^{5/}	Not Applicable	Data gathered from other uranium mining operations, show no increase in detectable radiation along ore haul routes.					
Wildlife ^{6/}	Potential Increase in Impacted Area of Key Wildlife Habitat(ac.)	-0-	237	237	65	7	-0-	-0-

^{1/} Transportation hauling costs, construction costs and costs associated with mitigation requirements are shown on Tables 2.6 (Project Mitigation) & 2.7 (Wildlife).

^{2/} May require traffic control at intersection of Forest Road 305 and State 64 if Alternative 5 is selected.

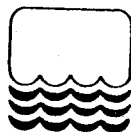
^{3/} Based on truncated cone 15' deep, 3:1 sideslopes. Calculated area x 2 for clearing, equipment, etc.

^{4/} Average Daily Traffic (ADT) along haul routes (Seasonal averages on Forest roads). Traffic on Route #6 includes 2,900 ADT on SR 64, 10,150 ADT on I-40, 7,600 ADT on US 89, and 3100 ADT on US 160 to the US 191 turn-off to Blanding.

^{5/} Based on surveys along haul roads in northern Arizona, any increase in radiation caused by passing ore trucks, will be indistinguishable from background radiation. Individuals standing along the highway shoulder would receive a radiation dose too small to measure. The truck driver will receive slightly more radiation than an airline pilot. (See Appendix E.)

^{6/} Includes direct and indirect impacts from haul routes (acres of elk calving habitat within .5 mi. of haul road and are taken out of production by new road construction).

TABLE 2.12 IMPACTS ON WATER AND SOIL RESOURCES

**Preferred Alternative**

ISSUE OR CONCERN	UNITS OF MEASURE	ALTERNATIVE 1 NO ACTION (BASELINE DATA)	ALTERNATIVE 2 PROPOSED PLAN OF OPERATION (P.P.O.) USING HULL CABIN HAUL ROUTE TO CAMERON (ROUTE #1)	ALTERNATIVE 3 P.P.O.; MIT. WILDLIFE; MONITOR SOIL, WATER & AIR; USE HAUL RTS. 1 OR 2; SHORTEST DIST. OVERHEAD POWERLINE; 35-CAR PARKING LOT	ALTERNATIVE 4 P.P.O.; WILDLIFE MIT- IGATION; MONITORING AIR, SOIL & WATER; COC. RIM ROUTE #5; OVERHEAD POWERLINE ALONG ACCESS ROAD	ALTERNATIVE 5 P.P.O.; MONITORING AIR, S&W; WILDLIFE MITIGATION USING HAUL ROUTE #6 (ALL HIGHWAY) OR ROUTE #7 (SP CRATER) TO MINIMIZE ROAD CONSTRUCTION
Radionuclide Contami- nation of Down Stream Lands and Waters thru Flooding of Ore Stock- piles at Mine Site	Diversion Channel Capacity (cfs)	NA	1,827	2,120	2,120	2,120
	Expected 500-yr. Flood (cfs) ^{1/}	NA	2,085	2,085	2,085	2,085
	Potential of Flood Waters Reaching Uranium Ore Stockpiles (narrative)	NA	Uranium ore stockpiles will be above the dike height in the southern part of the mine yard and will therefore be above the 500-year flood level.			
	Potential of 100-yr. Flood Reach- ing Lower Portion of Cataract Cr.	NA	Maximum flow during August 1984 event (100 yrs.+ recurrence interval) was was 2447 cfs. This flow dissipated at a large flat area about 14 miles below the mine site--about 12 miles upstream from Cataract Creek.			
	Sampling for Change from Baseline Surface Water Quality (pCi/L):					
	1) Arizona statewide average:					
	Gross alpha	4.9				
	Gross beta	6.4				
	Ra-226	0.2				
	2) Current levels at Owl Tank:					
	Gross alpha	<2				
	Gross beta	5.6 (25) ^{2/}	For the life of the mine and until all post mining cleanup operations are completed, surface water and soil sampling will be required annually between Aug.15 and Sept.15 and after any release of water from mine site.			
	Ra-226	0.76 (17)				
	Uranium					
	Sampling for Change from Base- line Soil Radionuclide Level	NA				
	Current levels: (pCi/L) ^{3/}					
	1) At Owl Tank					
	Gross alpha	35 (9)	"	"	"	"
	Gross beta	28	"	"	"	"
	Ra-226	1.6 (14)	"	"	"	"
	Uranium		"	"	"	"
	2) Wash SSW		"	"	"	"
	Gross alpha (pCi/L)	23 (10)	"	"	"	"
	Gross beta (pCi/L)	32	"	"	"	"
	Ra-226 (pCi/L)	1.8 (14)	"	"	"	"
	Uranium		"	"	"	"

^{1/} This flood-flow prediction in cubic feet per second (cfs) is based on a general storm with antecedent soil moisture at saturation.

^{2/} Values in parenthesis are the percent error at one standard deviation.

^{3/} See text in Section 3.2.7.4, Chapter 3, for complete assays.

TABLE 2.12 (continued) IMPACTS ON WATER AND SOIL RESOURCES

Preferred Alternative						
ISSUE OR CONCERN	UNITS OF MEASURE	ALTERNATIVE 1 NO ACTION (BASELINE DATA)	ALTERNATIVE 2 PROPOSED PLAN OF OPERATION (P.P.O.) USING HULL CABIN HAUL ROUTE TO CAMERON (ROUTE #1)	ALTERNATIVE 3 P.P.O.; MIT. WILDLIFE; MONITOR SOIL, WATER & AIR; USE HAUL RTS. 1 OR 2; SHORTEST DIST. OVERHEAD POWERLINE; 35-CAR PARKING LOT	ALTERNATIVE 4 P.P.O.; WILDLIFE MIT- IGATION; MONITORING AIR, SOIL & WATER; COC. RIM ROUTE #5; OVERHEAD POWERLINE ALONG ACCESS ROAD	ALTERNATIVE 5 P.P.O.; MONITORING AIR, S&W; WILDLIFE MITIGATION USING HAUL ROUTE #6 (ALL HIGHWAY) OR ROUTE #7 (SP CRATER) TO MINIMIZE ROAD CONSTRUCTION
Possible Groundwater Contamination by Radionuclides	Sampling for Change from Base- line Quality at Redwall Springs in Grand Canyon & Havasu Canyon Current levels: <u>1/</u> 1) Havasu <u>2/</u> Gross alpha (pCi/L) Gross beta (pCi/L) Ra-226 (pCi/L) 2) Indian Gardens <u>2/</u> Gross alpha (pCi/L) Gross beta (pCi/L) Ra-226 (pCi/L) 3) Mine-Site Well Gross alpha (pCi/L) Gross beta (pCi/L) Ra-226 (pCi/L)	NA NA 6.4 (30) <u>3/</u> 0.45 (38) NA 3.2 (56) 0.25 (40) NA	Sampling is not a requirement or part of EFN's Plan of Operation. " " " Sampling will be required if water is found in the Redwall-Muav aquifer. (See Section 2.5.11 for details.)	Assuming permission is granted by landowner, sampling will be done during the life of the mine and until all post mining cleanup operations are completed. " " " " " " " " " " " "		

1/ See Table 3.6, Chapter 3, for complete assays.

2/ Before mining operations start, samples will be taken every 6 mos. for 18 mos. After the groundwater well has been drilled, and if it produces water, samples taken 4 times a year from the well, will replace the sampling at the springs, unless groundwater contamination is detected at the well. Then pumping will be initiated, along with renewed sampling at the springs.

3/ Values in parenthesis are the percent error at one standard deviation.

TABLE 2.13 IMPACTS ON AMERICAN INDIAN RELIGIOUS CONCERNS

**Preferred Alternative**

ISSUE OR CONCERN	UNITS OF MEASURE	ALTERNATIVE 1 NO ACTION (BASELINE DATA)	ALTERNATIVE 2 PROPOSED PLAN OF OPERATION (P.P.O.) USING HULL CABIN HAUL ROUTE TO CAMERON (ROUTE #1)	ALTERNATIVE 3 P.P.O.; MIT. WILDLIFE; MONITOR SOIL, WATER & AIR; USE HAUL RTS. 1 OR 2; SHORTEST DIST. OVERHEAD POWERLINE; 35-CAR PARKING LOT Route #1 Route #2	ALTERNATIVE 4 P.P.O.; WILDLIFE MIT- IGATION; MONITORING AIR, SOIL & WATER; COC. RIM ROUTE #5; OVERHEAD POWERLINE ALONG ACCESS ROAD	ALTERNATIVE 5 P.P.O.; MONITORING AIR, S&W; WILDLIFE MITIGATION USING HAUL ROUTE #6 (ALL HIGHWAY) OR ROUTE #7 (SP CRATER) TO MINIMIZE HAUL ROUTE IMPACTS
Direct Impact on Religious Sites	Sites Affected (no.)	0	No specific sites have been identified which would be impacted by the development of the mine site or the proposed haul routes.			
Interference With Access to Religious Sites (eg. burial grounds or shrines)	Sites Affected (no.)	0				
	Trails Intersected by Mine Site or Haul Routes (no.) ^a	0	Access to religious sites would not be curtailed by operational activities.			
Interference With Gathering of Religious Articles (eg. feathers & herbs)	Land Temporarily Lost to Hunting & Gathering (ac.) ^b	0	39	39 36	37	32
	Potential Gathering Areas Impacted by Ore Hauling (mi.) ^c	0	3.6	3.6 2.3	2.9	0
Compatibility with Traditional Religious Beliefs	Narrative	Consistent with traditional beliefs	Development of lands of Hopi ancestral occupancy for commercial purposes conflicts with stated Hopi traditional religious beliefs.			

^a Trails leading to sites with religious significances.^b The Hopi and Havasupai Tribes indicate that the area near the mine site is used for hunting and gathering, but there is no evidence that the Canyon Mine site has been used for religious practices. (Areas shown here represent the sum of the mine site plus any new road corridors.)^c Number of miles of new road construction.

2.6.1 Comparison of Alternatives for Resolution of Issues and Concerns

None of the project alternatives fully resolves all nine identified issues and concerns, however by implementing the identified mitigation measures in Section 2.5, Alternatives 3, 4 and 5 are environmentally acceptable to the Forest Service. Alternative 5, with the substitution of an overhead powerline, has been selected as the Preferred Alternative.



IC #1 -Social and economic impacts on the community of Williams and Coconino County as a whole are considered by the Forest Service to be generally beneficial and virtually the same for Alternatives 2-5.

If the No Action Alternative were implemented, there would be no change in current levels of employment, income, tax revenue or output as a result of the Canyon Mine. Demand for public services would remain at current levels. No cultural resource sites would be identified or disturbed by mine development or road improvement or construction.



IC #2 -Reclamation measures required at the mine site are considered by Forest Service to be satisfactory in Alternatives 2-5, although measures called for in Alternatives 3-5 are more comprehensive and oriented toward improving wildlife habitat at the mine site upon its closing. Under the no action alternative, of course, no reclamation would be required at the Canyon Mine site.



IC #3 -The least cost alternative is Alternative 2. Alternatives 3-5 indicate increased expenditures of \$360,000 to \$1,300,000 can be expected depending on the haul route used and mitigation measures required. Increased expenditures are generally associated with mitigation requirements. The No Action Alternative would result in no construction or development costs, however, the costs of exploration and environmental review could not be recovered by EFN.



IC #4 -Wildlife habitat will be affected to varying degrees in all alternatives depending on the ore haulage route used. Alternative 5 has the least impact on wildlife. Alternative 2 would have the greatest impact because of a lack of mitigation requirements. Mitigation measures in Alternatives 3 and 4 should be effective in reducing the adverse impacts on wildlife resulting from increased road traffic.

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Alternatives 3-5 all call for "equivalent habitat replacement" to mitigate the impact of decreased habitat utilization caused by the mine and expanded transportation system. Alternative 3 also includes a proponent choice of road closure during May and June in lieu of habitat replacement to offset the impacts to elk calving habitat.

The No Action Alternative would have no impact from mining or ore transportation on wildlife or wildlife habitat and would require no mitigation. Any benefits associated with construction of alternative wildlife waters would not be realized.



IC #5 -Implementation of Alternatives 2-5 will have a negligible and insignificant effect on the makeup of vegetative types now present on the Tusayan Ranger District. The No Action Alternative would have no impact on vegetation at the Canyon Mine site.



IC #6 -Visual quality associated with the Grand Canyon will not be affected with the development of the Canyon Mine regardless of the alternative selected for implementation. Alternatives 2-5 will alter the short term visual quality at the mine site. Reclamation measures should effectively restore the area to its present visual landscape characteristics.

Implementation of mitigation measures in Alternatives 2-5 will minimize the likelihood of any adverse environmental impacts on the Grand Canyon National Park. To date the only apparent environmental impacts of the Orphan uranium mine, located on the south rim of the Grand Canyon at Maricopa Point, have been the conflicts of the mine with the National Park management objectives and some degradation of the scenic qualities of the Grand Canyon rim. Radionuclide contamination of air, soil or water has not been identified. For comparative purposes, the proposed Canyon Mine is some 13 airline miles from the rim of the Grand Canyon.

Haulage route selection will have a limited effect on the scenic qualities on the Tusayan Ranger District. Implementation of Alternative 5 would have the greatest effect by constructing a road off the Coconino Rim in a location that would be visible to travelers going to and from the Grand Canyon using the east Highway 64 entrance. The No Action Alternative would have no impact on the visual quality of the area near the mine site.



IC #7 -Implementation of Alternatives 2-5 will have no appreciable effect on the air quality, which includes particulates, radon gas, or radioactive dust, at either the Grand Canyon or the community of Tusayan. Increases in

particulate matter will be site specific along haul routes and at the mine site itself and are expected to be well within air quality standards. Current levels of air quality in the vicinity of the Canyon Mine site and haul routes would be unchanged by the No Action Alternative.



IC #8 -Implementation of Alternative 5 using the Highway or SP Crater haul routes (#6 or #7) would minimize impacts on the National Forest environment and resources by limiting road improvements to existing roadways. It would, however, transfer the use, and resulting impacts, to private and State lands, and at a greater cost to EFN (Table 2.2).

The haul route identified in Alternative 4 would be most cost effective in providing a road that would meet long term management needs in the event other mines are developed in the eastern quadrant of the Tusayan Ranger District.

Haul routes included in Alternatives 2 and 3 are the most cost effective routes for hauling ore from the Canyon Mine to the mill in Blanding, Utah.

No ore would be transported under the No Action Alternative.



IC #9 -Mitigation measures and operational procedures included in Alternatives 3-5 will reduce the possibility of radionuclide contamination to surface or subsurface water sources, and identify any contamination at the earliest possible time. Alternative 2 does not include air, soil and water monitoring requirements to ensure the operational designs of the mine are functioning properly. Under the No Action Alternative, current parameters for water quantity and water quality would remain unchanged at the mine site. Soil resources at the mine site would not be affected.

Neither the water quality on the Havasupai Indian Reservation nor the Grand Canyon National Park should be affected by the development of the mine under Alternatives 2-5. The Havasupai Reservation is located about 35 miles downstream from the mine site. A documented 100 year flood dissipated because of topographic features, about 14 miles downstream and 20 miles above the Reservation. Mitigation measures taken at the mine site would prevent any significant downstream radionuclide contamination in the event of an extreme flood occurrence.



IC #10 -Implementation of Alternatives 2-5 will have no appreciable effect on Indian religious sites and practices and will not burden traditional Tribal religious beliefs. Consultation with the Hopi and Havasupai Tribes has not identified any specific sacred site or the presence of any sacred plants used for ceremonial purposes which would be

disturbed by the development of the mine or any of the haul route options. Similarly, a detailed archeological review of the site has disclosed no sites of religious significance.

Development of the mine site (Alternatives 2-5) and haul route options requiring new construction (Alternatives 2-4) could slightly reduce the land area available for Indian religious practices. However, the current level of religious activity is not expected to be curtailed by any alternative nor will access to any religious sites or areas be restricted. Furthermore, there is no evidence of Indian religious activity at the mine site itself or along any of the proposed haul routes.

In comments regarding other proposed actions on the Kaibab National Forest, the Hopi Tribe has expressed a belief that the earth is sacred and that it should not be subjected to digging, tearing or commercial exploitation. While this conflict has not been raised directly in relation to the Canyon Mine, it is acknowledged that commercial use of the Forest within the area of Hopi ancestral occupancy is inconsistent with these stated religious beliefs.

The Preferred Alternative will include only the limited impacts associated with development of the mine site, as the haul route options included in the preferred alternative do not include any new road construction or significant reconstruction.

The No Action Alternative would have no impact on Indian religious beliefs, sites or practices. The Hopi and Havasupai Tribes have expressed a preference for the No Action Alternative.

CHAPTER 3

AFFECTED ENVIRONMENT

This chapter describes the physical and biological environment at the Canyon Mine site and surrounding area. All the individual environmental components are described as they exist without mining operations. Those components of the environment that will be directly or indirectly impacted by uranium mining are discussed in detail in Chapter 4.

3.1 ENVIRONMENTAL SETTING

The following paragraphs describe the factors of the environment that warrant some discussion in order to set the stage for evaluating impacts resulting from each alternative.

3.1.1 Location

The proposed Canyon Mine project area is located on the Tusayan Ranger District, Kaibab National Forest approximately 45 miles north of Williams, Arizona, 6 1/2 miles southeast of Tusayan, Arizona, and 10 miles south of Grand Canyon Village in the National Park. The mine site is located in the the western portion of Section 20, Township 29 North, Range 3 East, Gila and Salt River Meridian, Coconino County, Arizona.

3.1.2 Climate

Spring and fall seasons in the area are relatively dry. Summer and winter receive about equal amounts of precipitation. Summer rain usually comes as thunderstorms with locally heavy downpours of short duration. These convective events are mainly formed over the heated walls of the Grand Canyon almost every afternoon from early July until the end of August. In some years, continuous precipitation may result for one or two days during the summer when weak tropical storms move inland from the Pacific Ocean. Practically all winter precipitation occurs as snow associated with middle latitude storms moving eastward from the Pacific Ocean.

Annual precipitation is approximately 15 inches at Grand Canyon Airport (about 6 miles northwest of the mine site), and average monthly temperatures range from 20.1 F. to 75.6 F. Prevailing wind direction at the mine site is from the south.

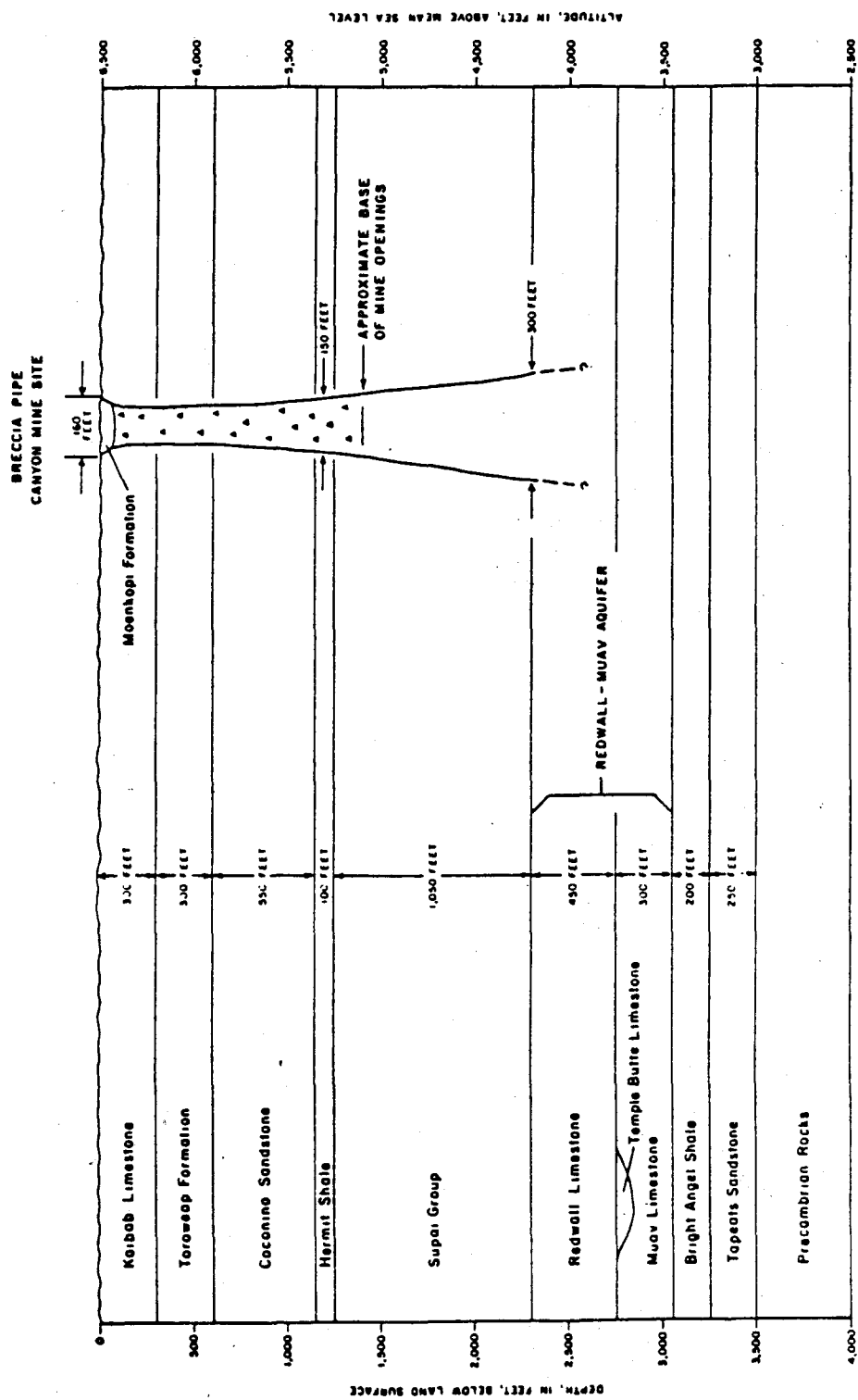
3.1.3 Topography

Major land forms in the general area of the Canyon Mine include nearly level drainage bottoms of recent alluvium, gently sloping plateau ridgetops and moderately sloping canyon sideslopes. Soils have developed from residual or colluvial parent materials, and outcrops of bedrock are typically exposed along shoulder slopes and ridgetops. The Coconino Rim, a north-facing escarpment east and north of the mine, is the major land form obstructing access between the mine and highways to the east.

3.1.4 Geology and Mineralization

The entire Project Area is covered by Mid-Permian Kaibab and Toroweap limestones that dip a few degrees to the south. These formations extend to approximately the 600 foot depth. Below this depth is the Coconino sandstone which is approximately 300 feet thick. This is the formation exposed at the Canyon rim just north of the visitor center at the Grand Canyon National Park. Minor mineralization is noted in the Coconino at the Canyon deposit. The next formation, from depths of 900 to 1,200 feet, is the Hermit Shale. This formation is the bright red rock viewed from Hermit's Rest, eight miles west of the headquarters of the Grand Canyon National Park. Because the Hermit Shale is a dense, clay-cemented siltstone under the much coarser Coconino sandstone, some water, springs or seeps are noted at outcrop contacts between these units. The formation below the Hermit Shale is the Supai formation which extends from 1,200 to 2,300 feet below the surface. The upper few hundred feet of the Supai formation is the resistant sandstone that caused the formation of the inner gorge of the Grand Canyon. It is the main host to the ore deposits that are the object of this mining project. The lower depths of the Supai formation change from a sandstone to a limestone, resting on the older limestones of the Redwall formation.

Uranium mineralization in the Project Area occurs in a breccia pipe structure that cuts vertically through the flat-lying sedimentary rocks (Fig. 3.1). Cavities formed millions of



**SCHEMATIC
GEOLOGIC SECTION
FOR CANYON
MINE SITE**

**FIGURE
3.1**

years ago by water dissolving the deeper Redwall limestone created space into which the overlying rock collapsed. The collapsed zone worked its way up hundreds of feet in the form of a cylinder or narrow cone. This broken rock, or pipe, created a favorable environment for mineral deposition. Based upon data from exploration test holes, EFN does not expect that minerals other than uranium will be found in economic quantities in the Canyon Mine.

3.1.5 Seismicity

The following was extracted from "Phase I Investigation and Evaluation Report, I.D. No. AZ00039" by Sergeant, Hauskins and Beckwith, consulting Geotechnical Engineers, 1981:

"The Big Chino, Bright Angel, Mesa Butte and Oak Creek Canyon Fault Zones in the general area of the site are believed to be an extension of a north-south trending zone of moderate seismic activity in western Utah. This zone is classified as the Intermountain Seismic Belt (ISB) by Smith and Sbar (1974). This moderately active section of the ISB is in the transition zone between the Colorado Plateau and Basin and Range Physiographic Provinces.

These faults have not been carefully studied and the relative importance, time of last displacement and probable earthquake magnitudes are inadequately known for positive classification.

However, generalized fault maps (Eguchi and others, 1979, Howard and others, 1978), studies of the regional seismotectonics (Smith and Sbar, 1974; Sbar and DuBois, 1979), specific studies of the Flagstaff area (Giardina, 1977) and the Mesa Butte Fault System (Shoemaker and others, 1978, Brumbaugh, 1980), and the moderate historical seismic record, suggest that several faults in the area influencing the site may be active in the engineering sense. Relative to evaluation of dams, nuclear power plants and other important structures, a fault is generally classified as active when it displays offsets which have occurred in the last 10,000 to 35,000 years (Slemmons and McKinney, 1977).

The earthquakes of January 25, 1906, September 10, 1910, and September 18, 1912, centered in the area around the north side of the San Francisco Peaks. All produced maximum Modified Mercalli intensities of about VII, to VIII, indicating that the magnitudes were on the order of 5 to 6. It appears these earthquakes could have been associated with either the Mesa Butte or Oak Creek Canyon Fault Systems.

On November 4, 1971, a small earthquake of 3.7 on the Richter Scale occurred in the Williams area.

The mine area is believed to be stable for buildings and most other construction activities.

3.1.6 Soils

Soil types within the area have undergone various degrees of development. Climate, vegetation, parent material, elevation, slope, exposure and landscape position all contribute to the developmental processes which are reflected in a range of physical, chemical and biological properties.

The dominant soil type within the operations area belongs to the fine-loamy, mixed family of Cumulic Haploborolls. Soil profiles are moderately deep to deep (20 to 60 inches), well-drained and have a moderate permeability rating. Surface horizons range from 5 to 30 inches thick and have fine sandy loam textures with dark brown and dark grayish brown colors. Subsoil textures are sandy clay loam or clay loam with brown and grayish brown colors. The internal volume of rock fragments is variable (10 to 40 percent by volume). The depth to limestone bedrock is generally greater than 40 inches. The revegetation suitability and inherent productive potential of this unit ranges from moderate to high. There is approximately 2,600 acres of this soil unit inventoried within the Tusayan Ranger District.

Soils within the contributing watershed to the north and northeast of the project area belong to the loamy skeletal, mixed, mesic and frigid families of Lithic Ustochrept. The mesic component is associated with the woodland species pinyon pine and Utah juniper whereas the frigid soils are associated with the ponderosa pine. Soil profiles are shallow (less than 20 inches) well-drained and have moderately slow to moderate permeability ratings. Surface horizons range from 1 to 3 inches thick and have fine, sandy loam textures with yellowishbrown and brown colors. Subsoil textures are sandy loam or loam, with light brown and brown colors. The internal volume of rock fragments ranges from 35 to 75 percent by volume. The depth to limestone bedrock generally ranges from 10 to 19 inches. The revegetation suitability and inherent productive potential for these units is low. This rating is the result of the soil taxonomic components being shallow over bedrock and high internal coarse fragment content. There are approximately 136,000 acres of these soil units on the Tusayan Ranger District.

Erosional processes in the form of sheet and rill are the result of high intensity summer thunderstorms and resulting overland flow. Saturated soil conditions are generally confined to a 2 or 3 week period during spring when snowmelt occurs.

3.1.7 Land Status and Land Uses

The Canyon Mine site is located on ground which was part of the original Grand Canyon Forest Reserve established in 1893. In 1908, it was incorporated into the National Forest System as part of the Coconino National Forest. Through the years, there have been numerous administrative name changes for this particular area. However, it officially became part of the Kaibab National Forest in 1934. There are no outstanding rights, reservations, executive orders, public land orders or withdrawals which preclude either mineral exploration or development in the immediate area of the Canyon Mine site.

National Forest system land affected by the proposed action are presently managed for multiple use purposes including timber harvesting, cattle grazing, wildlife management, mineral exploration and recreational uses such as Christmas tree cutting, firewood gathering and hunting.

Active copper mining took place on the western edge of the Tusayan Ranger District around the turn of the century. There are some patented mining claims on the Tusayan District which date back to the late 1800's as a result of this activity. These claims have been occasionally worked in the past for oxidized copper ores exposed in surface veins.

Most recent uranium mining activity and development in the immediate vicinity occurred from 1956 to 1969 at the Orphan Mine. This particular mine was patented in 1906 and is located on the rim of Maricopa Point in the Grand Canyon National Park. The Orphan mine produced significant quantities of uranium, copper, silver and gold. Nearly 4.4 million pounds of uranium oxide (U_3O_8) were produced from the Orphan Mine ore during this period. The Grand Canyon National Park is now closed to all forms of mineral exploration and development. The head frame and surface buildings at the Orphan Mine are still present at the site.

3.1.8 Recreation Activities

Recreation use on the Tusayan Ranger District is predominantly associated with Grand Canyon National Park visitation in the form of highway use on State 64 (2,100 average daily traffic)

and providing overnight camping at the Forest Service operated Ten-X Campground.

Recreational activities away from the highway corridors and developed campgrounds is light and fairly seasonal. Most dispersed use is associated with hunting, woodcutting and Christmas tree harvesting. Russell Tank is a small water impoundment which provides a local fishery for Tusayan and Grand Canyon Village residents. Annual recreational use for the Tusayan District in these categories is estimated at 21,000 recreation visitor days (RVD's).

There are no specific recreational activities or unique recreational attributes associated with the Canyon Mine site.

3.1.9 Noise

Background ambient sound levels within the project area and along haulage routes vary depending upon the level of human activity, including traffic, recreation and aircraft flight paths. Major sources of noise unrelated to human activities include insects, birds, wildlife and foliage rustling due to wind.

The Day-Night Average Sound Level (Ldn), for open unpopulated areas away from highways and paved roads can be expected to vary from 30 to 45 decibels (dB).

3.1.10 Cultural Resources

The Canyon Mine site and the associated ore haulage roads are located within an area that has been occupied over thousands of years by various prehistoric and historic American Indian groups. The Canyon Mine site was surveyed in November of 1984 to determine if any cultural resource sites were located in the area. A survey performed by Abajo Archeology disclosed the existence of two prehistoric sites. These sites were archeologically tested in June of 1985 to determine if they met the eligibility criteria for nomination to the National Register of Historic Places pursuant to the National Historic Preservation Act of 1966, 16 U.S.C. § 470 et. seq. and 36 CFR 800.

One site, AZ-H-4-3, 4 and 5 (inclusive), located in an alluvial catchment basin just north of the proposed area of operations, was indicated by sparse, surface artifact scatters containing

evidence of prehistoric Kayenta Anasazi, Cohonina and Cerbat (Pai) groups. Testing of this site revealed no subsurface archeological material, and it was found not to be eligible for the National Register.

A second site, AZ-H-4-6 and 7, located on a ridge sideslope east of the proposed catchment basin, was tested and produced evidence of a subsurface pit structure, as indicated by burned adobe, a wooden post and trash midden. The pit house was tentatively identified as a domestic structure, which may have been constructed and occupied by the prehistoric Kayenta Anasazi (750-950 A.D.). The general site area may have been sporadically occupied as an encampment in later years by the Cerbat (Pai) (about 1300 A.D.) groups. The historical role of sites of this type in the settlement/subsistence patterns and adaptive strategies of such groups is not well understood due to the paucity of the detailed excavation data. For this reason, this site was determined to be eligible for inclusion on the National Register.

In consultation between the Forest Service, the Arizona State Historic Preservation Officer, and the Advisory Council on Historic Preservation, it was determined that there would be no adverse effect to this site if an acceptable data recovery program was carried out. A data recovery program was proposed by Abajo Archeology and approved by these three agencies. Data recovery field work was carried out in November of 1985. Following data analysis, a final report will be submitted to the Forest Service for review and approval. All recovered data, including artifacts, photographs, maps and analyses will be submitted to the Arizona State Museum at the University of Arizona for curation and storage.

Proposed alternative haul roads have not yet been surveyed for cultural resources. However, based upon a one percent sample survey of the entire Tusayan Ranger District and tens of thousands of acres of project surveys on this same district, probable cultural resource site densities were projected for each of the alternatives as shown in Table 2.4. Probable cultural resource site density is one of the factors that will be considered in final haul route selection. In any case, a complete cultural resource survey will be carried out along the preferred haul route before a commitment is made to use that route. A similar survey will be undertaken for the powerline corridor prior to construction. Any sites located will be evaluated for National Register eligibility and dealt with through consultation between the Forest Service, the Arizona State Historic Preservation Officer and the Advisory Council.

3.1.11 American Indians

Three Indian Reservations can be found within the general vicinity of the Canyon Mine site. The Havasupai Indian Reservation is located approximately 35 miles northwest of the mine site, the Hualapai Indian Reservation is approximately 42 miles west of the mine site and the Navajo Indian Reservation is approximately 25 miles east of the mine site. Arizona State Highway 64 and U.S. Highway 89 intersect within the Navajo Reservation. The Hopi Reservation is approximately 80 miles east of the mine site and 40 miles north of Winslow, Arizona.

3.2 ISSUES AND CONCERNS

This section provides descriptions of specific components of the environment which will be directly or indirectly affected by mining activities and which have been identified as major issues and concerns from the scoping process.

Two of the ten identified issues and concerns do not lend themselves to a discussion of their specific affected environment: "Reclamation Measures" and "Cost". The affected environment for reclamation includes general climatic conditions, soils, vegetation, hydrology and geology. These elements are described under the general environmental setting (Section 3.1) and issues and concerns #5 and #9 (Sections 3.2.3 and 3.2.7).

Project costs have zero as an existing baseline, or present environment, and therefore will be discussed only in Chapter 4 when there are projected differences from this zero base.



3.2.1 IC #1 Socio - Economic Impacts on Coconino County

(a) Affected Community Descriptions

Social Environment

Development of the Canyon Mine has the potential of affecting three local communities, Tusayan, Williams and Flagstaff to varying degrees.

Tusayan

Tusayan is located closest to the proposed mine site. It is a

rural unincorporated village with an estimated seasonal population of 500-1,000 people. There is no formal local governing body to manage Tusayan's community affairs. Because of its proximity to the Grand Canyon, the vast majority of employment in Tusayan is oriented towards providing goods and services needed by Grand Canyon visitors.

Williams

Williams is a rural community located some 42 - 45 miles south of the proposed mine site. Major sources of employment are oriented toward providing services and retail goods for Interstate 40 travelers. A substantial number of residents are employed in agriculture and forestry activities.

The economic base of Williams has been declining for many years. Williams has often relied on only one industry at any given time to support the community. In the past, the railroad and sawmill industries were major parts of Williams, however, their influence on the economy has greatly diminished. Williams is now relying on tourism, most of which is summer use from people on I-40.

Williams has a variety of shopping facilities, an available labor force and available housing.

Flagstaff

Flagstaff is a full service city with a population of 38,000 to 40,000. It serves as a regional trade center and has a very stable economic base because of its size, location, and diversity in industry. Flagstaff has a high percentage of professional and government workers, partly because of the University, county seat and growing technical and industrial base.

(b) Infrastructure for Williams and Tusayan

Medical Facilities

Williams

The City of Williams is serviced by a 24-hour-a-day Emergency Center which is affiliated with the Flagstaff Hospital. It is equipped to stabilize patients, and perform minor surgery. The City also has a 24 hour-a-day ambulance service, two physicians and one dentist.

Tusayan

A clinic, operated by the Presbyterian Hospital in Phoenix, is located in the Grand Canyon National Park and is staffed with two doctors. It is equipped to handle emergency services and provides other routine health services.

Police and Fire Protection

Williams

Williams has an 8 man police department that provides 24 hour-a-day protection. The County Sheriff maintains a substation in Williams staffed by 4 full time deputies. In addition, there are several Department of Public Safety Officers stationed in Williams. All the police agencies have common radio frequencies and will provide assistance to each other when requested.

The City of Williams has a fire department which is staffed by 23 volunteers. The Fire Department operates out of 2 fire stations with a total of 8 pieces of apparatus including a light rescue unit. While their primary responsibility is within the city limits, they will respond outside the City when requested under various "Mutual Aid" agreements.

Tusayan

A Coconino County Deputy resides in Tusayan and provides the primary law enforcement needs. Back up help or assistance is available from U.S. Park Service personnel if necessary.

Organized fire protection services in Tusayan are somewhat limited. A fire engine is located at the Grand Canyon Airport and available to the community, provided personnel are available to operate it. Other sources of fire suppression equipment and personnel are the U.S. Park Service and U.S. Forest Service.

Schools

Williams

The Williams school district operates a public elementary and middle school as well as a high school. The school district employs approximately 55 people including 45 faculty members. Current student enrollment is 617, but existing school facilities can accommodate 800 students.

0561

Tusayan

School facilities for Tusayan are located in the Grand Canyon National Park for kindergarten through twelfth grade. Enrollment is between 225-250 students and is nearly always operated near its physical capacity. Growth of the school system is limited by severe housing shortages in both Tusayan and the Park.

Housing

Williams

Williams has a variety of housing types available including single family, mobile home parks and rental apartments. The high costs of constructing domestic water systems has slowed development of subdivisions outside the city limits. Residents of several subdivisions located immediately adjacent to Williams have to haul their potable water from the City. Williams has an annual water supply of approximately 2,750 acre feet of which about 350 acre feet or 13 percent is consumed domestically.

Tusayan

Surplus housing in Tusayan and the Grand Canyon Village is non-existent. This housing shortage and the lack of a domestic water supply have effectively limited the growth of Tusayan and are largely responsible for limiting opportunities for additional employment in the community. At the present time only four privately owned residential dwellings exist. House trailers provide limited housing for the balance of the work force population which varies between an estimated 275 and 700 people on a seasonal basis. A lack of privately owned lands has restricted the construction of additional residential areas. Domestic water for residential and commercial establishments is hauled from Williams or Bellemont on a daily basis. Approximately 80 acre feet is used annually.

Social Services

The following social services are available to residents of Tusayan and Williams:

- Job Training
- County Nurse
- Access Health Care Program
- Energy Assistance
- Emergency Assistance
- Weatherization Program

- Surplus Commodity Distribution
- Coconino Community Guidance Center
- Food Stamp Program
- County Legal Aid
- Senior Citizen Program

(c) Population and Land Base Uses of Coconino County

The State of Arizona and Coconino County in particular, are among the fastest growing areas in the United States. One of the reasons for this growth is the quality of life in the State. This quality of life is a result of the climate, landscape diversity and economic opportunities, as well as the opportunity for many different types of recreation on the vast amount of public lands in the state.

<u>Population¹</u>					<u>Increase</u>
	<u>1980</u>	<u>1984</u>	<u>1990</u>	<u>2000</u>	<u>1980-2000</u>
	-----in thousands-----				
Arizona	2718.4	3053.8	3710.2	4751.9	75%
Coconino County	75.0	82.4	99.1	130.5	74%

Coconino County (18,608 square miles)
Status of Land Ownership²

US Forest Service.....	27%
US Bureau of Land Management.....	5%
Indian Reservation.....	45%
State of Arizona.....	10%
Individual or Corporate.....	6%
Other.....	7%

¹Arizona Department of Commerce, May 1985.

²Arizona Statistical Review, 40th Ed., Sept. 1984, Valley National Bank of Arizona.

(d) Employment structure of Williams, Tusayan and Coconino County

Labor Force Data

	<u>Williams¹</u>	<u>Tusayan</u>	<u>Coconino County²</u>
Civilian Labor Force.....	1,155	NOT	35,294
Employed.....	1,055	AVAIL-	32,450
Unemployed.....	100	ABLE	3,100
Unemployment Rate.....	8.7%		8.2%
Total Population.....	2,325*		est. 84,500

*Local sources estimate the Williams and surrounding area 1984 population to be 4,000.

Employment

Estimated Present Employment by Sectors

	<u>Williams¹</u>	<u>Tusayan³</u>	<u>Coconino County²</u>
Agriculture and Mining.....	134	22	1,825
Construction.....	76	17	1,125
Manufacturing.....	71	10	2,625
Transportation, Communication and Utilities	104	50	2,225
Wholesale Trade.....	16	10	982
Retail Trade.....	273	108	6,168
Finance, Insurance and Real Estate.....	13	16	600
Services	265	101	7,975
Public Administration.....	<u>103</u>	<u>47</u>	<u>8,925</u>
	1,055	381	32,450

¹Arizona Department of Commerce, 5/85.

²Arizona Statistical Review, 40th Ed., Sept. 1984, Valley National Bank.

³Employment information for Tusayan is virtually non-existent.

Figures shown for Tusayan on the above tabulations are estimates based on interpretations of data provided by Tusayan Chamber of Commerce and NACOG.

Contribution of Existing Mining Activity to Tusayan, Williams, and Coconino county

Employment estimates shown for agriculture and mining in the Coconino County regional area are primarily associated with ranching and forestry related activities. Mining operations for sandstone, cinder and rock material pits in the Williams,

Tusayan and Flagstaff areas do provide small amounts of employment. Estimates of total direct income for this sector of employment for the Williams and Tusayan area have not been developed.



3.2.2 IC #4 Wildlife

Mining activities have the potential to affect wildlife populations primarily in the north-central portion of the Tusayan Ranger District.

(A) Habitat

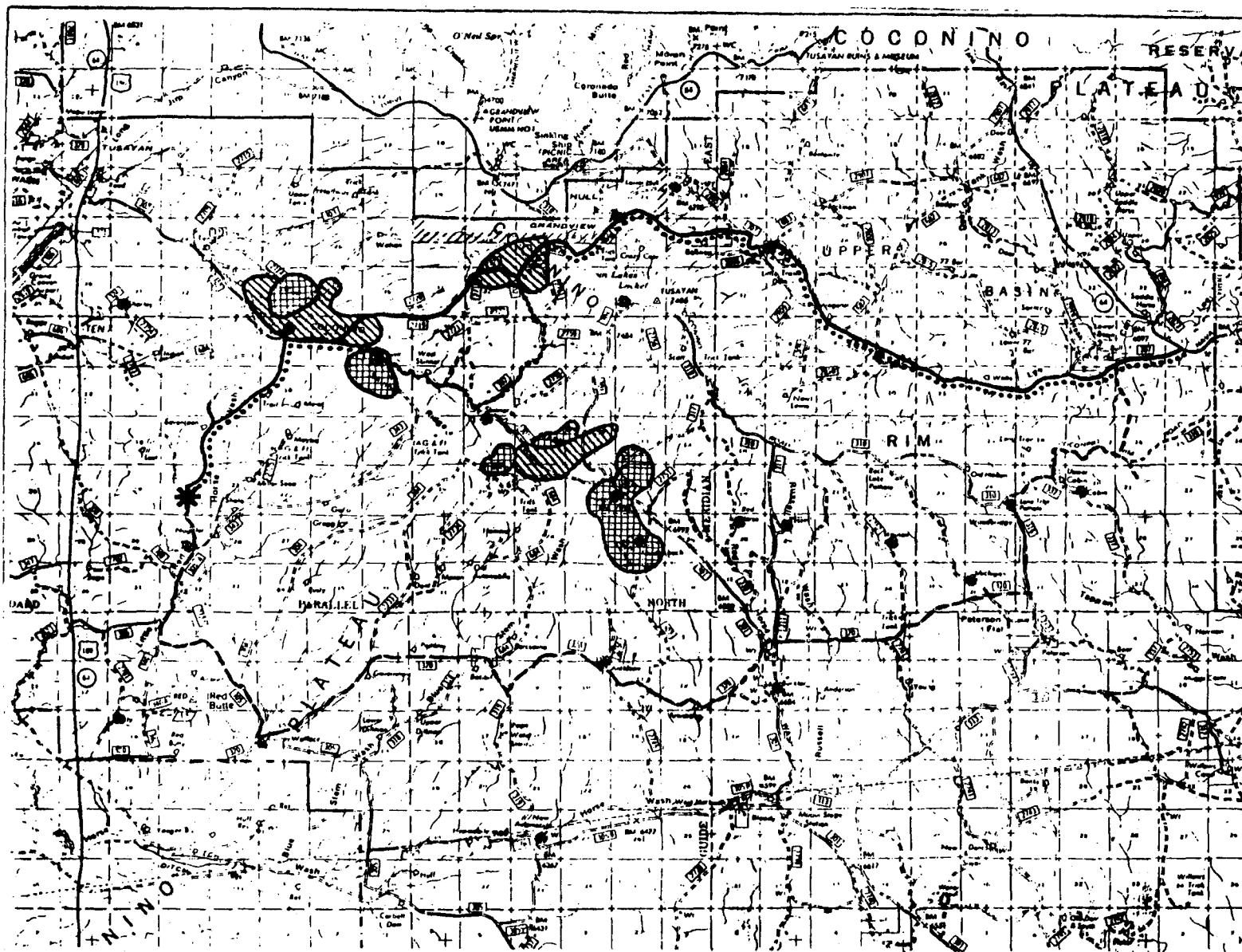
The Tusayan District is located in the northern half of Arizona Game and Fish Department, Game Management Unit 9. The overall carrying capacity (Glossary in Appendix C) of the habitat in Unit 9 is low relative to other units in northern Arizona. This is partly due to the lack of water in the area. Scarcity of reliable water sources in the unit affects the distribution, size and behavior of resident wildlife populations.





Wildlife habitat on the Tusayan Ranger District can be categorized into five vegetation types: Conifer, Pinyon-Juniper, Sagebrush, Browse, and Grassland. (Acreage figures represent the total acres of each vegetation type on the Tusayan Ranger District).

(1) Conifer (96,182 acres)

Ponderosa pine forest covers approximately 96,182 acres on the Tusayan Ranger District. Understory species are typically gambel oak, pinyon pine and juniper. This vegetation type serves as summer habitat for antelope, mule deer, elk, and turkey. The northern goshawk, Cooper's hawk, red-tailed hawk, acorn woodpecker and pygmy nuthatch are among the more than twenty five bird species that nest in the area. The Abert squirrel, golden-mantled squirrel and valley pocket gopher are yearlong residents in this vegetation type.

Five elk calving areas totaling approximately 2,000 acres, have the potential to be impacted by the mine proposal (Fig. 3.2). Water is an important component in elk calving habitat. Calving occurs during the dry months of May and June when water becomes limited. This makes the habitat adjacent to reliable waters particularly critical. Each of the known calving areas is within the proximity of a reliable water source.



-  ELK CALVING AREA
-  ANTELOPE FAWNING AREA
-  IMPORTANT WILDLIFE WATER SOURCE
-  CANYON MINE SITE

HAUL ROUTE OPTION BY PROJECT ALTERNATIVE	
PROJECT	HAUL ROUTE
ALTERNATIVE 2&3	OPTION 1 (dotted line)
ALTERNATIVE 3	OPTION 2 ——— (solid line)
ALTERNATIVE 4	OPTION 5 - - - (dashed line)

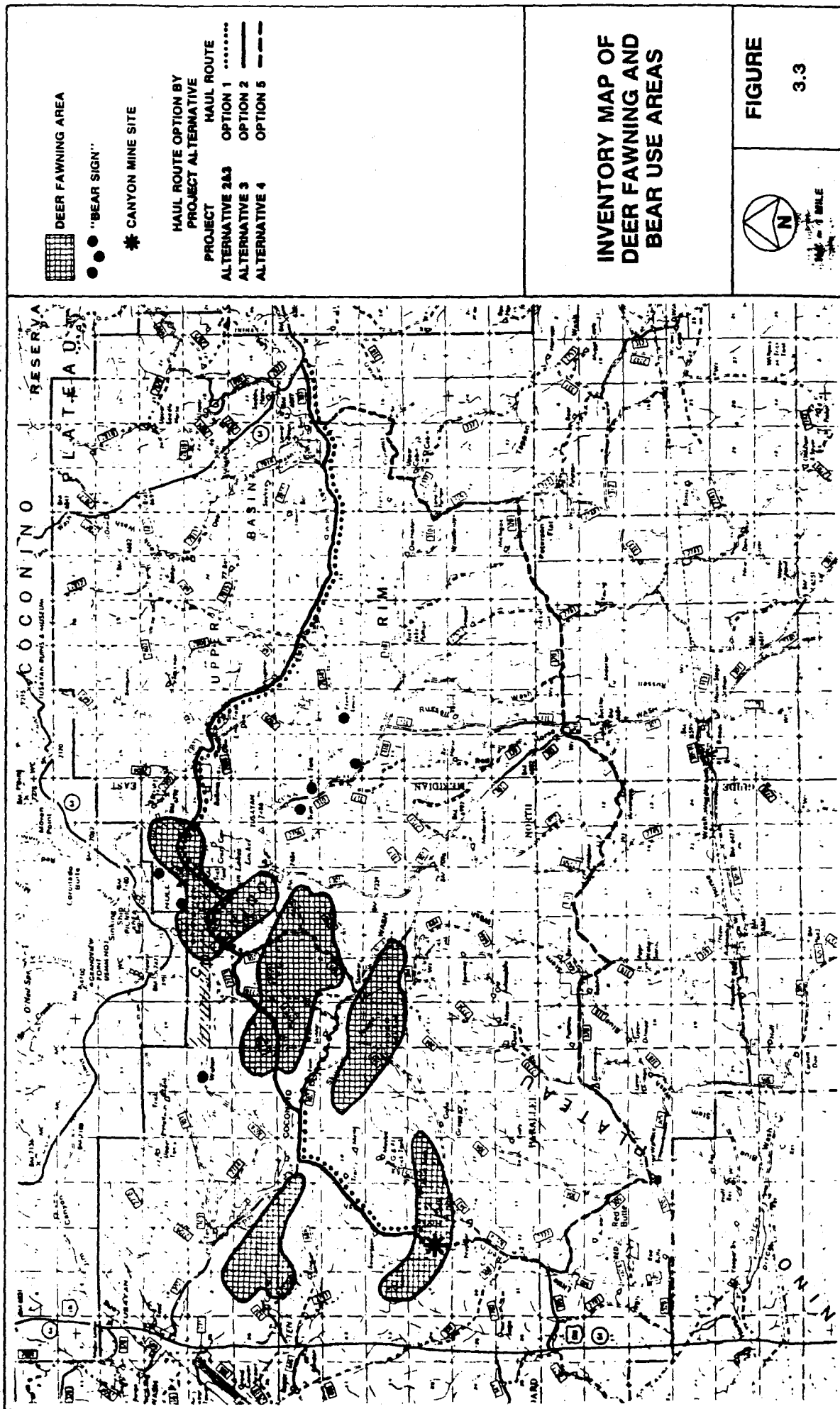
INVENTORY MAP OF ELK CALVING AND ANTELOPE FAWNING AREAS



1" = 1 MILE

FIGURE

3.2



Approximately 9,900 acres of deer fawning habitat have been identified in the vicinity of the mine and ore haul routes (Fig. 3.3). Quality forage and available water are essential components in optimum fawning habitat. "Optimum fawning habitat for deer includes low shrubs or small trees from 0.6 to 1.8 meters (2 to 6 ft.) tall under a tree overstory of approximately 50 percent crown closure" (Thomas 1979).

Antelope fawning occurs primarily in open grassland habitats which provide high visibility as well as adequate grass cover for concealing young fawns. Three fawning areas, totaling roughly 2,300 acres have been identified in the vicinity of the mine and ore haul routes (Fig. 3.2).

Turkey typically select nest sites on slopes in or adjacent to ground cover. Nesting cover is often provided by dense oak thickets, logging slash, logs, or shrubs (Phillips 1982, Jones 1981). Approximately 1,600 acres of turkey nesting habitat have the potential to be impacted by the mine (Fig. 3.4).

(2) Pinyon-Juniper (175,770 acres)

Pinyon pine-juniper woodland is the most extensive vegetation type on the District, covering 175,770 acres. Sagebrush and rabbitbrush are the most common understory species. This vegetation type serves as winter habitat for antelope, mule deer and elk. Other mammals in the area include the grey fox, bobcat, rock squirrel and blacktailed jackrabbit. Pinyon pine and juniper trees provide nest sites for the plain titmouse, pinyon jay and great horned owl.

(3) Sagebrush (27,759 acres)

This vegetation type is dominated by sagebrush, rabbitbrush or a mixture of both. Grasses and forbs are generally very sparse in the understory. Blue grama is typically the most abundant forage species found in this type. The black-throated sparrow and Brewer's sparrow inhabit the area.

(4) Browse (1,731 acres)

Winterfat, cliffrose, and four-wing saltbush are the primary species in the browse vegetation type. The understory forb and grass composition varies depending upon browse stand density and location. Elk, deer, and antelope depend more heavily on browse plants for forage during the

winter months when palatable grasses and forbs are unavailable. The relatively large seeds from the four-wing saltbush provide a food source for small birds and mammals.

(5) Grassland (23,591 acres)

Grassland openings are dominated by perennial grasses with low densities of forbs and sedges. Primary forage species within these openings are mutton bluegrass, western wheatgrass, squirreltail and blue grama. Crested wheatgrass, an introduced species, is abundant in areas that have been disturbed and reseeded.

The 17-acre mine site is located within a grassland opening. The area is dominated by blue grama and western wheatgrass with low-moderate densities of rabbitbrush and sagebrush. Recent vegetation surveys in the opening indicate that both soil and forage are in fair condition.

The opening is used as a foraging area by elk, antelope, and deer. This is also a quality hunting habitat for raptors due to the availability of surrounding pine trees for perches, high visibility within the opening and abundance of small mammals such as the desert cottontail and pocket gopher. The western meadowlark and lark sparrow nest in this vegetation type.

(6) Water

Lack of dependable water is the primary factor affecting wildlife distribution in the area. Twenty-three stock tanks have been identified as important water sources due to their reliability and historic use by wildlife (Fig. 3.2).

Russell and Bucklar Tanks are the only tanks that are stocked with fish. The Arizona Game and Fish Department stocks Russell Tank with trout on a seasonal basis. Bucklar Tank, on private land, is also occasionally stocked with fish by the landowners. The Arizona tiger salamander is also known to inhabit several stock tanks on the District. Breeding typically occurs in July and August during the summer rains. Adults spend much of the non-breeding season in the underground burrows of small mammals.

(B) Wildlife Populations

(1) Nongame

Nongame animals include all wildlife species except for game mammals, game birds, fur-bearing animals, predators and aquatic species.

A minimum of 141 nongame wildlife species occur in the affected area including 36 mammal species, 82 bird species, 20 reptile species and 3 amphibian species. There is little detailed information available concerning the habitat requirements of most of these species. No known studies of nongame species have been conducted on the Tusayan District to date.

A listing of all game and nongame species that potentially occur in the affected area can be found in Appendix C.

(2) Game

Game animals include all wildlife species that can be legally taken under Arizona State law (Arizona Hunting Regulations 1985).

The following discussion will focus on game species that may be impacted by mining activities. These game species include antelope, elk, mule deer, turkey and black bear.

Big game population estimates for the Tusayan Ranger District are displayed in the following table (Kaibab National Forest Annual Wildlife and Fisheries Report 1983):

<u>Species</u>	<u>Population Estimate</u>
Black Bear	15
Antelope	100
Elk*	325
Turkey	365
Mule Deer	1,200

*Revised 1985 estimate

Bear and antelope population levels are currently static. Deer and turkey populations are on a slight upward trend while the elk population is increasing rapidly at a rate of roughly 20 percent per year.

The elk herd deserves special note due to its unique history, rapid expansion, and developing importance to elk hunters statewide.

Elk were not present on the Tusayan District until the 1950's. The first documented elk sighting was made in 1959, though several unverified sightings were made prior to that date. The animals apparently originated from the elk population in the Williams and Flagstaff area (Game Management Unit 7). The immigration can be partly attributed to increasing competition for resources within the growing Unit 7 herd combined with human encroachment into traditional elk habitat.

The Tusayan elk population is expanding at a rapid rate. At its present population level of 325 animals, the herd is at approximately 60 percent of the area's potential carrying capacity. An unusually high percentage of bulls in this herd are in the older age classes. This is due to the fact that, until recently, it was a virtually unhunted population. Consequently, the herd is gaining popularity statewide among trophy elk hunters.

(C) Threatened, Endangered and Sensitive Species

There are no known threatened, proposed, or sensitive fish or wildlife species that inhabit the area on a permanent basis. The Bald Eagle and Peregrine Falcon are two endangered species that may use the area on a seasonal basis.

The Bald Eagle may be found at low densities on the District as a winter migrant. Eagles forage primarily on winter or road killed deer, elk, livestock and small mammals. Habitat use is sporadic and largely depends on the abundance and location of carrion during the winter months. No roost sites have been identified in the area.

Peregrine Falcons may be found on the Tusayan District on a seasonal basis. Ellis (1978) reported that "[Peregrine] Falcons nesting in the Grand Canyon have been observed hunting over the forests on the rim."

No falcon nest sites have been located in the vicinity of the proposed mine or its haul routes.

Peregrines are known to migrate through the area during the winter and spring months. Like the Bald Eagle, habitat use on the Tusayan Ranger District is at a low intensity and very sporadic.



3.2.3 IC#5 Vegetation

The native vegetation of the project area and the surrounding watersheds represents five plant community types indigenous to the Kaibab Plateau. Their presence is a result of climatic and edaphic interactions along with topographic and geomorphic influences. The proposed mine site is in a valley plain with a predominant sagebrush and grassland vegetation type. Common plant species include sagebrush (Artemesia tridentata), rabbit brush (Chrysothamnus nauseosus), squirreltail (Sitanion hystrix), blue grama (Bouteloua gracilis), blue grass (Poa fendleriana), and crested wheatgrass (Agropyron smithii) with only scattered trees of ponderosa pine (Pinus ponderosa), pinyon pine (Pinus edulis) and Utah juniper (Juniperus osteosperma). The upland plains of the watersheds are typically comprised of coniferous woodland vegetation. Common plant species include ponderosa pine (Pinus ponderosa), pinyon (Pinus edulis), gambel oak, (Quercus gambelii), big sage (Artemesia tridentata), cliffrose (Cowania stansburiana), broom snakeweed (Gutierrezia sarothrae), blue grass (Poa fendleriana), blue grama (Bouteloua gracilis) and squirreltail (Sitanion hystrix). Some exposed points and southerly aspects have the presence of droughtier woodland species and these areas generally have an absence of ponderosa pine.

A breakdown and brief description of the five plant communities found on the Tusayan Ranger District are as follows:

- 1) Conifer type; 96,182 acres - This type is the typical ponderosa pine forest. Understory species are gambel oak, pinyon pine and juniper.
- 2) Pinyon-Juniper type; 175,700 acres - Pinyon pine and juniper woodland is the most extensive vegetation type on the Tusayan District. Sagebrush and rabbitbrush are the most common understory species.
- 3) Sagebrush type, 27,759 acres - This vegetation type is dominated by sagebrush and rabbitbrush. Grasses and forbs are generally very sparse in the understory.
- 4) Browse type; 1,731 acres - Winterfat, cliffrose and four-wing saltbush are the primary species in the browse vegetation type.

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5) Grassland; 23,591 acres - Grassland openings are dominated by perennial grasses with low densities of forbs and sedges. Primary grasses are mutton bluegrass, western wheatgrass, squirreltail and blue gramma.

(a) Threatened, Endangered and Sensitive Species

There are no threatened and endangered plants or plants proposed for listing on the District. The following sensitive plants may exist on the Tusayan District (Region 3 Sensitive Plant List 1984):

On Notice of Review

Astragalus cremnophylax
Chrysothamnus molestus
Clematis hirsutissima var. arizonica
Rosa stellata
Silene rectiramea
Talinum validulum

Not On Notice of Review

Aquilegia desertorum
Potentilla multiflorata

To date, C. molestus is the only plant which has been found in the affected area. The population, located approximately five miles to the southwest of the mine site, will not be impacted by mining activities. Additional plant surveys will be conducted within the mine site, along new road alignments and in any other areas where surface disturbance will occur.



3.2.4 IC#6 Visual Impacts

Visual quality objectives (VQO's) are determined by: 1) variety class [i.e., attraction of an area based on its physical features (landforms, vegetation and waterforms)], and 2) sensitivity level (i.e., people's concerns about the scenic quality of an area).

Secondary roads and areas with only occasional use are classified in sensitivity level 3, which is the classification for all the considered haul route options on the Forest. This sensitivity level means that viewer (or user) interest in the scenic quality of the landscape as viewed from these roads, is low (Table 2.9).

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Ponderosa Pine Type

Except for the corridor along State Highway 64, in the ponderosa pine type the visual quality objective is "Modification." This objective allows man's activities to dominate the landscape. Along main highways, such as State Route 64, the visual quality objective is Partial Retention or Retention. This means that man's activities must remain subordinate, or changes in the landscape should not be evident.

Pinyon-Juniper Type

In the pinyon-juniper type, "Maximum Modification" is the visual quality objective. This objective allows man's activities to dominate the landscape and may only appear natural when viewed as background. Both of these vegetative types show evidence of having been "modified" by past activities through timber cutting, road construction and numerous range improvement projects.

Present visual quality objectives are shown in Figure 3.5.



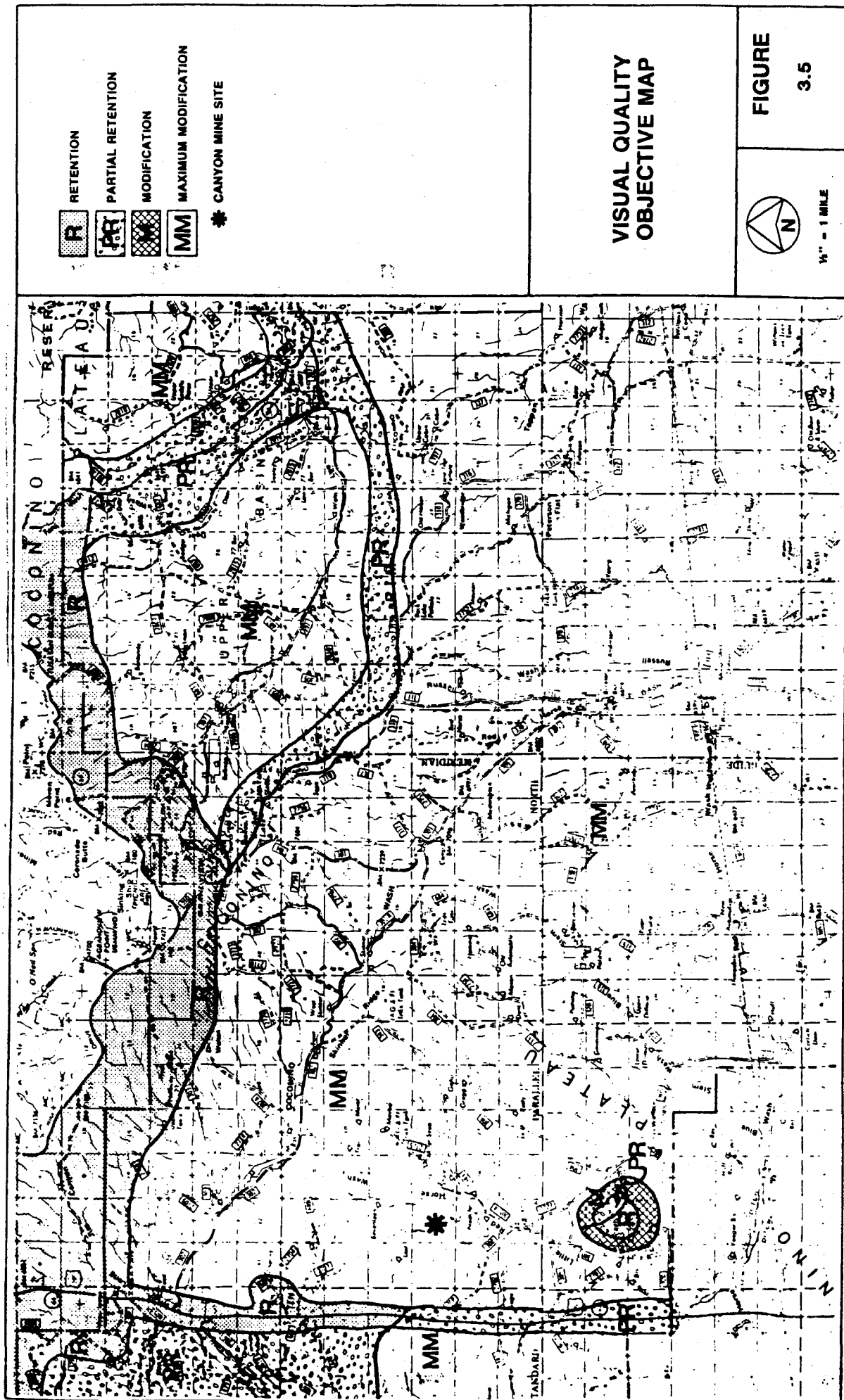
3.2.5 IC #7 Air Quality -

Dust and Background Radiation

3.2.5.1 Particulates

Only particulates will be emitted by the mine or related operations in any measurable quantity. Particulate data have been collected by the Park Service at Hopi Point in Grand Canyon National Park for a number of years. The Hopi Point Total Suspended Particulates (TSP) station is located approximately 16 miles north-northwest of the proposed mine site. Summaries of the 1981 through 1983 TSP data collected at Hopi Point are presented in Table 3.1 showing background particulate concentrations near the proposed mine site. These data show that the annual geometric mean dropped from 16 to 12 $\mu\text{g}/\text{m}^3$ from 1981 to 1982, and dropped substantially in 1983 to 5 $\mu\text{g}/\text{m}^3$. The highest 24-hour concentration measured in the 3 data sets was 58 $\mu\text{g}/\text{m}^3$.

These data are representative of the general area of the proposed Canyon Mine. Proximity, similarity in climatology and the lack of nearby major sources of emissions combine to make the Hopi Point data representative of the particulate



concentration that would be expected at the project site. The expected TSP baseline of the Project Area should be about 5 to 16 $\mu\text{g}/\text{m}^3$ on an annual basis with maximum 24-hour concentrations in the range of 47 to 58 $\mu\text{g}/\text{m}^3$. No other pollutants have been monitored or are expected in any significant concentrations.

TABLE 3.1 TSP Summary from the Grand Canyon, Collected at Hopi Point by the National Park Service

	<u>Concentration ($\mu\text{g}/\text{m}^3$)</u>		
	<u>1981</u>	<u>1982</u>	<u>1983</u>
Annual Geometric Mean	16	12	5
First 24-hr. Max.	48	47	58
Second 24-hr. Max.	36	33	38
Number of Samples	53	56	55

3.2.5.2 Background Radiation & Radon Gas

The area around the Canyon Mine Site has been surveyed to determine background levels of radiation in air and water. Monitoring stations which measure background radiation were established in April 1985. The twelve monitoring sites are identified in Fig. 2.4.

Background gamma radiation (whole body) ranges between 90 and 130 mrem/yr. The lowest radiation measurements were observed at the stations which are to the south and west of the mine site. Owl Tank registers one of the higher background areas. There is a small, localized anomaly in the wash just south of the mine site where radiation is elevated to approximately 300 mrem/yr. Perhaps this is caused by uranium mineralization which is closer to the surface than the main ore body. Measurements of background radon concentrations in the vicinity of the mine site have ranged from 0.2 to 0.8 pCi/L, providing a lung dose of 125 to 500 mrem/yr.

For purposes of comparison, exposure to the average western U.S. outside air leads to a lung dose of about 125 mrem/yr and indoor radiation levels are usually much higher (Table 3.2). The EPA occupational limit for underground uranium miners is 4 WLM/yr, based on a 0.3 WL atmosphere (maximum).

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TABLE 3.2 Radon Doses to Lung Compared to Radon Gas Concentrations and Radon Progeny Exposure

Source of Radon/Progeny	Concentration or Working Level	Lung Dose (mrem/year)
Occupational limit, underground mining	4 WLM/yr	20,000
U.S. uranium miners, current average	2 WLM/yr or less	10,000
Hack Canyon Miners (average)	2.2 WLM/yr	11,000
Avg. exp. to public (natural)	0.2 WLM/yr (3mWL)	375
Average radon levels atop high-grade uranium ore pile	150 pCi/L	93,750
Average radon levels atop mill tailings pile	10 pCi/L	6,250
Energy efficient homes (varies by ventilation, etc.)	5 pCi/L	3,125
Concrete buildings in Arizona	1.7 pCi/L	1,062
Canyon Squire conf. room, Tusayan, Arizona	1.2 pCi/L	750
New Mexico, average outside air	0.5 pCi/L	312
Western U.S. Average outside air	0.2 pCi/L	125
Owl Tank & Mine Site	0.2 to 0.8 pCi/L	125 to 500
Bright Angel Lodge	0.2 pCi/L	125

Note: EPA discourages conversion of WLM to mrem. EPA suggests that use of mrem may be confusing to the public.



3.2.6 IC #8 Transportation

The Tusayan Ranger District is reasonably well-roaded from past activities. The roads that exist are narrow, unsurfaced, generally have poor alignment and are considered low standard. This is due to the lack of the development of an early

transportation plan, established design standards and an inexpensive surfacing material source in the area. The needs for routes to the east have been met by the single road off the Coconino Rim at Hull Cabin (Forest Road 307). Because it is steep and rocky, the rim has been a natural barrier for travel routes in the past.

The major uses of the transportation system on the Tusayan District are for general administrative needs, dispersed recreation (including hunting), timber hauling, range use and mineral exploration.

Winter access to the Forest is nearly non-existent due to snow and adverse weather. No forest roads are maintained for all weather use.

The major routes east of State Route 64 in the area being considered are the east-west Forest Roads 302, on the north side of the District, and 320 in the south-central part of the District. The majority of use originates from SR 64 with these two roads serving as feeders.

Existing roads other than State and Federal Highways proposed as haul routes are described below and shown on Figures 2.1, 2.1A, 2.2 and 2.3.

Haul Route Option #1 This route connects with the major east-west corridor across the north end of the District (Roads 302-307). This road is the Forest arterial which serves both through traffic and connecting roads along the route. The connecting road from the mine to 302 (Road 305A) is a narrow trail which was severely impacted by the 1984 floods. Currently this road is nearly impassable. Portions of Roads 305A, 302 and 307 which are located in higher elevations are subject to seasonal closures due to winter snow accumulations and wet ground conditions during spring thaws.

A portion of Road 307 near Hull Cabin on the Coconino Rim is steep with poor alignment.

Traffic along this route varies from 12 to 30 seasonal average daily traffic (SADT).

Summary of Haul Route Option #1

<u>Road #</u>	<u>Length(mi)</u>	<u>Width(ft)</u>	<u>Alignment</u>	<u>Surfacing</u>
305A	1.7	8	Very Poor	None
305A	2.3	N/A		New

Summary of Haul Route Option #1 (cont'd)

<u>Road #</u>	<u>Length(mi)</u>	<u>Width(ft)</u>	<u>Alignment</u>	<u>Surfacing</u>
302 (1)	4.0	12	Good	Gravel
302 (2)	5.2	12	Fair	None
New	1.3	N/A		New
307 (2)	<u>13.0</u> 27.5	12	Good	None

Haul Route Option #2 This route is a modification of Route #1, to improve hauling by shortening the total distance and improving the route off the Coconino Rim. The mill at Blanding is 213 miles over State and Federal Highways after leaving Forest Road 307. This route is also subject to the seasonal closures identified for Route #1.

Summary of Haul Route Option #2

<u>Road #</u>	<u>Length(mi)</u>	<u>Width(ft)</u>	<u>Alignment</u>	<u>Surfacing</u>
305A	4.0	8	Very Poor	None
302, 2719 2720	1.2	12	Good	Gravel
2723	4.4	8	Poor	None
302	1.5	12	Fair	None
307	<u>13.0</u> 25.4	12	Good	None

Haul Route Option #5 This route utilizes the southern east-west corridor on the District which is comprised of arterial roads 305 and 320. The connecting roads to this lower route primarily serve ranching needs. At the present time, there is only a primitive road off the Coconino Rim on the eastern part of the Tusayan Ranger District.

Traffic on this route is 6 to 25 SADT. Winter use on the route is low since the roads are not maintained during the winter.

Summary of Haul Route Option #5

<u>Road #</u>	<u>Length(mi)</u>	<u>Width(ft)</u>	<u>Alignment</u>	<u>Surfacing</u>
305A	2.8	8	Very Poor	None

Summary of Haul Route Option #5 (cont.)

<u>Road #</u>	<u>Length(mi)</u>	<u>Width(ft)</u>	<u>Alignment</u>	<u>Surfacing</u>
305	3.8	12	Good	None
320	18.3	12	Good	None
316	2.0	12	Good	None
310	2.3	10	Fair	None
New	2.9	N/A		
307	<u>1.4</u> 33.5	12	Good	None

The mill at Blanding is 213 miles over State and Federal Highways after leaving Forest Road 307.

Haul Route Option #6

Route #6 is designed to minimize haul-route impacts on the Forest environmental setting and resources as well as reducing initial development and maintenance costs. It utilizes paved highway almost exclusively. The route would virtually eliminate haul route maintenance. Its drawback is the increased haul distance to the Blanding, Utah mill by a factor of 35 percent over the shortest haul route (#2).

Summary of Haul Route Option #6

<u>Road #</u>	<u>Length(mi)</u>	<u>Width(ft)</u>	<u>Alignment</u>	<u>Surfacing</u>
305A	2.8	8	Very Poor	None
305	<u>2.0</u> 4.8	12	Good	None

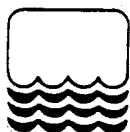
The mill at Blanding is 316 miles on State and Federal Highways after leaving Forest Road 305. (See Fig. 2.1A.)

Haul Route Option #7 This route utilizes a combination of Forest Road 305, State Routes, county and other roads. The county and private roads are used primarily for ranch access. Maintenance schedules are not known but appear to be quite sporadic. Access on this low elevation route is partially restricted in the winter, but to a lesser degree than the northern routes.

Summary of Haul Route Option #7

Road #	Length(mi)	Width(ft)	Alignment	Surfacing
305A	2.8	8	Very poor	None
305	2.0	12	Good	None
County 417	4.0	24	Very Good	Cinders
State/Private	<u>21.0</u> 29.8	12	Good	None

The Blanding mill is an additional 242 miles over State and Federal Highways.



3.2.7 IC #9 Impacts on Water and Soil Resources

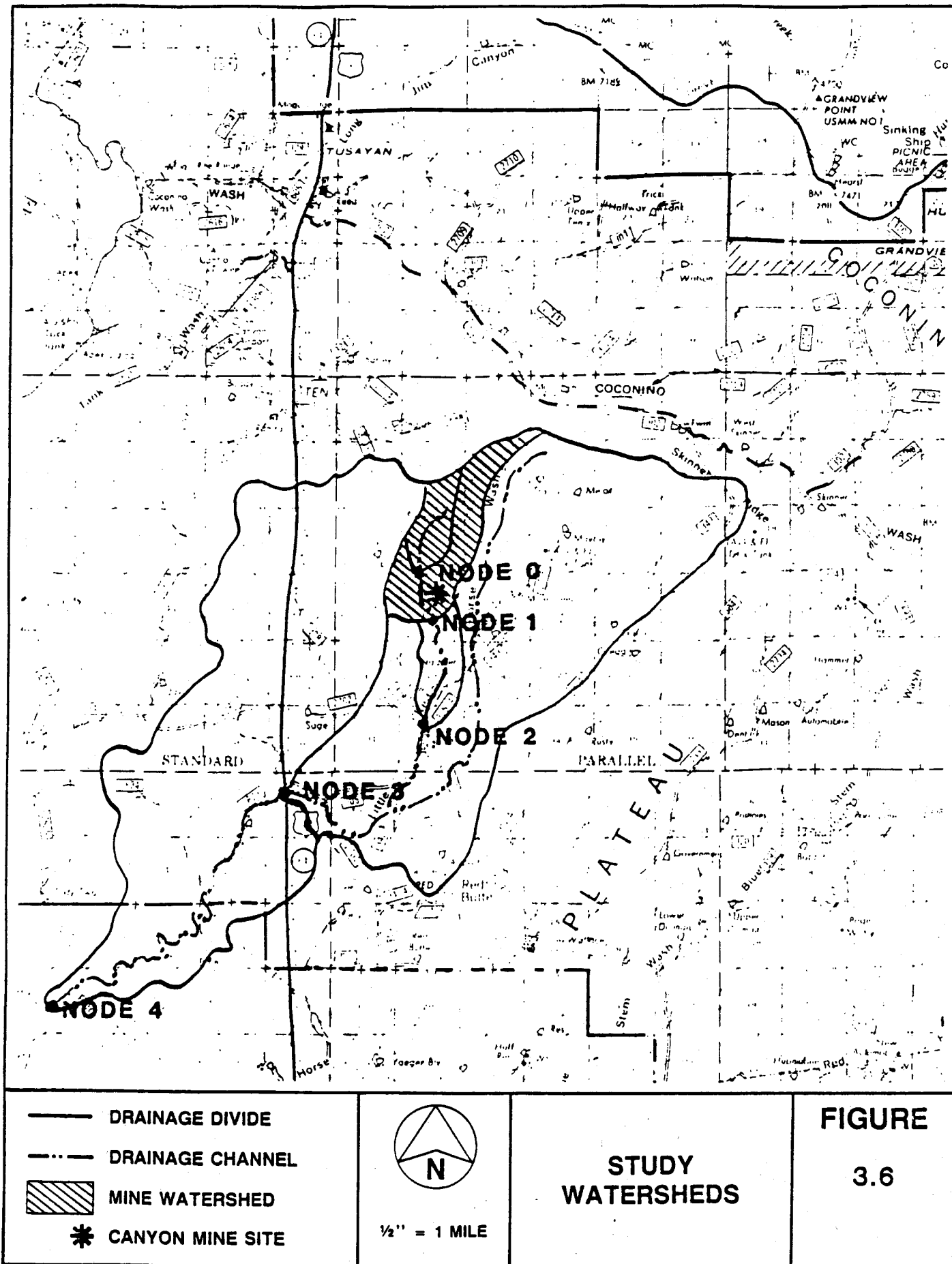
3.2.7.1 Surface water

Surface water drainages near the proposed Canyon Mine are usually dry, but flow intermittently during periods of rainfall or rapid snowmelt. The area is subject to high intensity rainfall and is frequent, but sometimes significant flooding. Heavy rains confined to small areas and of short duration are responsible for most storm runoff.

Figure 3.6 shows watersheds analyzed in the area. The shaded area in Figure 3.6 identifies the watershed that would directly impact the proposed development. Five reference locations, or nodes, define the outlet of the primary drainage areas. Each Node represents the point past which storm runoff from the watershed must pass.

Node 0 is located just upstream from the proposed mine site. This watershed drains approximately 1.0 square mile. Node 1 located just below the site, has a drainage area of 2.3 square miles. Node 2 is just below Owl Tank, and has a drainage area of 3.5 square miles. Node 3, just upstream from Highway 64, receives runoff from 22.7 square miles in Little Red Horse Wash. Node 4 is at the confluence of Little Red Horse Wash in Red Horse Wash some 13.5 miles downstream from the mine site. The drainage area of Node 4 is 43.4 square miles (Appendix D).

The Canyon Mine site will occupy approximately 17 acres. The area is part of a natural clearing approximately 0.2 mile (0.3 km) in diameter. The area generally slopes downward to the



south, and surface water from small storm events is diverted around the clearing by natural drainageways. The area is surrounded by pinyon, juniper, ponderosa pine and scrub oak.

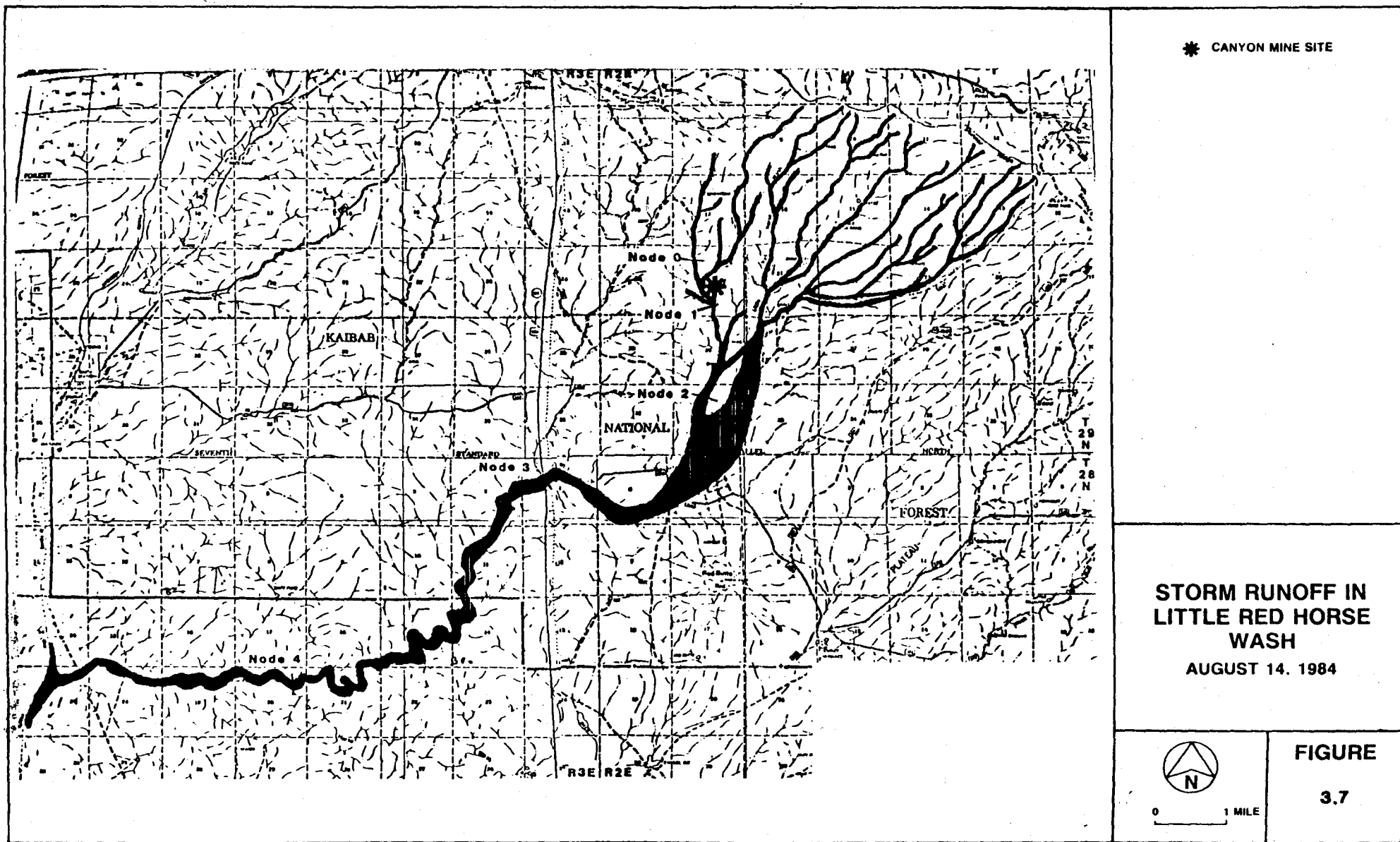
The Canyon Mine site lies in the ephemeral watershed of Little Red Horse Wash, which is tributary to Red Horse Wash, which is tributary to Cataract Canyon and Havasu Creek. In the principal stream channel between the mine site and Cataract Canyon, outcrops of Kaibab Limestone separate sections of channel alluvium. Water flow does not occur across these outcrops except during, and for a short time after, flood flow in the channel. After flood events, water stored in the discontinuous sections of channel alluvium percolates readily downward via fractures and solution openings in the Kaibab Limestone, which comprises an important recharge medium in northern Arizona. Downward percolation of groundwater from temporary groundwater storage in the channel alluvium reduces water content in the alluvium until another flood event occurs. Therefore, groundwater underflow in the channel alluvium in this reach of the drainage does not occur except during, and for a short time after, flood flow in the channel.

Historical data, as well as projections of storm intensity and runoff are important to the design of diversion channels which will protect the mine site and prevent any release from the ore or waste stockpiles to the surface drainages during a storm or heavy runoff. An extreme (100-year recurrence interval) storm event in Little Red Horse Wash in August of 1984 provides useful data to evaluate flooding potential at the mine site.

Peak flows for this storm (at Nodes 0-3) were computed from high water marks and surveys of channel cross-sections and slope.

<u>Node #</u>	<u>Estimated Peak Discharge from August 14, 1984 Storm (c.f.s.)</u>
0	106
1	908
2	1350
3	2447

According to an observer who monitored the flood, the crest overtopped Highway 64, flowed downstream in Little Red Horse Wash, merged with main Red Horse Wash (Node 4) and dissipated in the large flat area some 4 miles downstream (see Fig. 3.7). Apparently, no significant runoff from this event was observed beyond the large open area.



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3.2.7.2 Groundwater

An analysis of the hydrogeologic structure of the proposed Canyon Mine site and the results of other wells and boreholes drilled in the area indicate that it is unlikely that any significant groundwater resources or aquifers will be encountered by mine construction and operation.

Figure 3.1 illustrates the formations present at the Canyon Mine site. Any groundwater present will likely be stored in small perched reservoirs. The perched aquifers do not occur at all locations. Most wells drilled to the perched aquifer units in the region do not encounter groundwater and are immediately abandoned. Most wells which encounter perched groundwater fail after a pumping period of several days to several years. Groundwater may be perched above confining layers in areas where fractures are sparse. These conditions occur most commonly in the Toroweap Formation and in the base of the Coconino Sandstone where groundwater may be perched on the mudstone strata of the Hermit Shale. At these places, the perched aquifers may yield small quantities of groundwater for domestic and stock use. Because the perched water leaks slowly downward through the confining layers and moves downward along fractures, the perched reservoirs are commonly small, thin and discontinuous. If the groundwater stored in these perched reservoirs is not replenished annually by rainfall and snowmelt, wells and springs which yield from the perched aquifers may fail. A comparison of the quantity of groundwater yielded to seeps and springs from the perched aquifers to the quantity yielded from the Redwall-Muav aquifer indicates that the principal direction of groundwater movement is downward in the rocks overlying the Redwall-Muav aquifer.

An exploration borehole drilled at the proposed mine site encountered perched groundwater in the Kaibab Limestone at a depth of 140 feet. Initial yield from this aquifer was approximately eight gallons per minute (gpm), later declining until groundwater production ceased. No wells in the area show significant, consistent production.

Groundwater recharge in the Canyon Mine site area occurs via infiltration of rainfall and snowmelt through the rocks which underlie the plateau south of the Grand Canyon. Metzger, in his report on groundwater conditions along the South Rim of the Grand Canyon (U.S. Geological Survey Water-Supply Paper 1475-C, 1961), estimated that average groundwater recharge in the drainage area of Cataract Canyon, in which the mine site lies,

is approximately 0.3 inch of water per year. Under natural conditions, a fraction of the groundwater recharge to the area passes through the Canyon Mine uranium deposit and other similar mineralized breccia pipes. Small quantities of native minerals, including radioactive minerals, are continuously leached from the breccia pipes and other mineralized zones, and travel in solution in the water.

Several springs issue from fractures or sandstone strata in the Toroweap Formation, Coconino Sandstone, and the Supai Group along the south wall of the Grand Canyon and its southern tributary canyons from Havasu Spring to Blue Spring. Records available for three of these springs indicate that average discharge is less than one gpm. The most important springs that discharge from these strata are Sinyella Spring in the western wall of Havasu Canyon, Great Thumb Spring in 140 Mile Canyon, Fossil Spring in Fossil Canyon, and Dripping Springs and Santa Maria Spring in Hermit Creek Canyon. Discharge from the Redwall-Muav aquifer is comparatively large, over 100,000 gm at Blue Spring, Havasu Spring and Indian Gardens Spring. Small springs and seeps discharge from volcanic rocks south of the Canyon Mine site. These springs and seeps are exit points for groundwater which has become perched on generally impermeable unfractured lavaflow rocks. These perched aquifers are discontinuous and lie above the strata in which the mine openings will occur in the volcanic rocks.

Sinyella Spring, a major spring on the Havasupai Reservation, is located about 25 miles west of the mine site and occurs in a tributary canyon along the west wall of Cataract Canyon, about 640 feet above the floor of the canyon. Sinyella Spring was inspected during the initial water sampling round for the groundwater monitoring program for the Canyon Mine project. Sinyella Spring appears to discharge from a perched aquifer at the base of the Coconino Sandstone, where the underlying Hermit Shale retards the downward seepage of infiltrated rainfall and snowmelt.

The Grand Canyon and its tributary canyons provide a regional groundwater drain for the rock units which are cut by the canyons. The existing data do not allow for an exact determination of the direction of groundwater flow in the Redwall-Muav aquifer at the mine site. However, groundwater movement in this aquifer is chiefly lateral from areas of principal recharge located generally south of the mine site toward large springs along the south wall of the Grand Canyon.

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3.2.7.3 Groundwater quality

Existing data for chemical quality of groundwater from wells which penetrate perched aquifers are summarized in Table 3, Appendix F. Existing data for chemical quality of groundwater which discharges from the Redwall-Muav aquifer at Havasu, Indian Gardens and Blue Springs have been compiled and summarized in Tables 4 and 5 of Appendix F.

In cooperation with the National Park Service, and the Havasupai, Hopi and Navajo Indian Tribes, a water quality monitoring program has been established by EFN for the Canyon Mine site area. The monitoring program is comprised of three program elements: first, an inventory of existing data for chemical quality of groundwater in the area; second, periodic collection and chemical analysis of water samples from Havasu, Indian Gardens and Blue Springs, which are the largest springs along the south wall of the Grand Canyon; and third, construction by EFN of a groundwater supply and monitoring well at the mine site. The initial results from the second element -- water quality sampling from selected springs -- were reported in Appendix F of the DEIS and discussed in Section 3.2.7.3 of the DEIS.

In accordance with the monitoring program, water samples for laboratory chemical analyses are presently collected from Havasu, Indian Gardens, and Blue Springs at six-month intervals. These springs discharge from the Redwall-Muav aquifer. The initial sampling round was conducted on May 16 - 17, 1985 and the results included in the DEIS. The second sampling round was conducted on December 18, 1985. Results for the sampling rounds are summarized in Tables 3.3, 3.5 and 3.6. The results of the December 1985 sampling round are discussed below. A third sampling round was conducted in June 1986, but laboratory results were not available for inclusion in the FEIS.

The parameters analyzed include routine constituents, trace elements, gross alpha/beta radiation, uranium (isotopic and fluorometric), thorium, radium 226 and radium 228. These parameters were selected to provide comprehensive documentation of water quality at the springs prior to mining operations, and to provide a basis for monitoring water quality during mining operations. In addition, a check sample was obtained from bottled deionized drinking water and was analyzed for radiological parameters. All samples were collected and transmitted to qualified chemical laboratories in accordance with U.S. Environmental Protection Agency (EPA) protocol and

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instructions from the laboratories. The samples were collected by Errol L. Montgomery and Associates personnel at the headwaters point where discharge at each spring begins. The water samples were analyzed using laboratory methods recommended by EPA.

At the request of the Havasupai Indian Tribe, duplicate water samples were collected from Havasu Spring for submittal to an independent chemical laboratory selected by the Tribe.

The CFEP (Controls for Environmental Pollution, Inc.) chemical laboratory was selected by the Havasupai Tribe. CFEP analyzed only the water samples submitted by the Havasupai Tribe for Havasu Spring. BC Laboratories, Inc., EAL (EAL Corp.) and ASU (Arizona State University) were selected by Errol L. Montgomery and Associates, Inc., and analyzed water samples from each of the springs. The laboratories and analyses requested include:

<u>Laboratory</u>	<u>Analyses Requested</u>
BC Laboratories, Bakersfield, California	Routine constituents and trace elements
EAL Corp., Richmond, California	Radiological parameters
Arizona State University, Tempe, Arizona	Radiological parameters
Controls for Environmental Pol- lution, Inc., Santa Fe, New Mexico	Routine constituents, trace elements and radiological parameters

(A) Routine Constituents

Results of laboratory analyses for routine constituents are given in Tables 3.3, 3.5 and 3.6. Federal drinking water standards for parameters analyzed are given in Table 3.4. Results for the December 1985 sampling round corroborate results for the May 1985 sampling round.

(1) Havasu Springs

Results of the December 1985 sampling round for Havasu Spring (Table 3.3A) indicate a calcium bicarbonate water type, with average total dissolved solids content of 584 mg/l (milligrams per liter). With the exception of total dissolved solids content, routine constituents analyzed do not exceed Federal and Arizona drinking water limits. Total dissolved solids content in the water samples from Havasu Spring exceeds the

suggested Federal drinking water limit of 500 mg/l (U.S. Public Health Service, 1962) but is less than the maximum Federal drinking water limit of 1,000 mg/l (Table 3.4). The water samples from Havasu Spring would be classified as fresh by the USGS (U.S. Geological Survey) water classification system based on dissolved solids content (Heath, 1984). The water samples from Havasu Spring would be classified as very hard by the USGS water classification system based on hardness as calcium carbonate; average hardness as calcium carbonate was 476 mg/l.

Normal data processing procedures for chemical analyses of routine constituents in water samples include computations of analytical error using methods described in Standard Methods (American Public Health Association et. al., 1981) and in Anderson (1979). Chemical analyses are normally rejected if the analytical error is more than the maximum allowable. Analytical error for routine constituent results reported by CFEP for the May and December 1985 samples from Havasu Spring exceeds the maximum allowable for error. The groundwater consultant, Errol L. Montgomery and Associates, Inc., recommended that those results be rejected. Analytical error for results reported by BC Laboratories, Inc., EAL, and ASU do not exceed the maximum allowable error.

(2) Indian Gardens Springs

Results of the December 1985 sampling round for Indian Gardens Spring (Table 3.3B) indicate a magnesium-calcium bicarbonate water type, with total dissolved solids content of 310 mg/l. Routine constituents analyzed do not exceed Federal and Arizona drinking water limits. The water samples from Indian Gardens Spring would be classified as fresh by the USGS water classification system based on dissolved solids content. The water samples from Indian Gardens Spring would be classified as very hard by the USGS system based on hardness as calcium carbonate.

(3) Blue Spring

Results of the December 1985 sampling for Blue Spring (Table 3.3C) indicate a sodium chloride water type, with total dissolved solids content of 2,455 mg/l. With the exception of chloride concentrations, total dissolved solids content, and specific electrical conductance, routine constituents analyzed do not exceed Federal and Arizona drinking water limits. Concentration of chloride and total dissolved solids content in the water samples from Blue Spring both exceed the maximum Federal drinking water limits. The water samples from Blue Spring would be classified as slightly saline by the USGS water classification system based on dissolved solids content.

Specific electrical conductance exceeds the maximum Federal drinking water limit of 1,600 umho/cm. Specific electrical conductance of water is defined as the electrical conductance of a cube of water with a volume of one cubic centimeter and is reported in micromhos per centimeter (umho/cm). The water samples from Blue Spring would be classified as very hard by the USGS water classification system based on hardness as calcium carbonate.

(B) Trace elements

Results of laboratory analyses for trace elements are given in Tables 3.5 A, B and C. Results for the December 1985 sampling round corroborate the results for the May 1985 sampling round.

(1) Havasu Spring

Results of the December 1985 sampling for Havasu Spring (Table 3.5A) indicate that low concentrations of arsenic, barium, boron, and zinc were detected. Concentration of trace elements analyzed were less than Federal and Arizona drinking water limits.

(2) Indian Gardens Spring

Results of the December 1985 sampling for Indian Gardens Spring (Table 3.5B) indicate a low concentration of zinc was detected. Concentration of trace elements analyzed were less than Federal and Arizona drinking water limits.

(3) Blue Spring

Results of the December 1985 sampling for Blue Spring (Table 3.5C) indicate that low concentrations of boron and zinc were detected. Concentration of the trace elements analyzed were less than Federal and Arizona drinking water limits.

(C) Radiological Parameters

Results of laboratory analyses for radiological parameters are given in Tables 3.6 A, B and C. Field measurements of relative ambient radiation were obtained at each sampling site using scintillometers and results are also provided. The analyses of radiological parameters performed by ASU are not yet complete and therefore are not included. In addition to the Federal drinking water limits given in Table 3.4, the Arizona Department of Health Services (ADHS) has adopted a maximum limit of 35 ug/l (micrograms per liter) for total uranium in drinking water.

Considering the low concentrations reported, there is generally good agreement between results of chemical analyses for radiological parameters by the different laboratories and between results of analyses for the May and December 1985 sampling rounds. Small differences between laboratory results may appear to be significant, however, these differences are not unusual because assay of such small amounts of radioactivity approaches the minimum detection limits of laboratory methods.

Because emissions of atomic particles from radioactive elements in a water sample are counted statistically, results of laboratory analyses for radiological parameters are commonly reported as a concentration \pm the statistical error of measurement. For example, a result of 7 ± 2 pCi/l (picocuries per liter) indicates that there is a 95 percent confidence that the true concentration is within a range from five to nine pCi/l. For problematic analyses, the statistical error of measurement may be large.

(1) Havasu Spring

Results of the December 1985 sampling round indicate that low concentrations of uranium and radium, as well as low levels of gross alpha and gross beta radiation, occur naturally in the groundwater discharged from Havasu Spring (Table 3.6A). Concentrations of other radiological parameters analyzed were zero or slightly greater than zero. None of the radiological parameters analyzed for the December 1985 samples exceed Federal or Arizona limits for drinking water. In general, there is good agreement of results between laboratories and between sampling rounds.

Notable differences between concentrations reported by EAL for the May and December water samples from Havasu Spring occur for gross alpha, gross beta and thorium 228. Concentrations of gross alpha and gross beta reported by EAL for the May 1985 water samples were problematic and were not corroborated by results reported by CFEP and ASU. Analyses for gross alpha radiation for water samples may be affected by impurities in water such as calcium, which increases the detection thresholds and self-absorption corrections and which reduces detection efficiencies. Analyses for gross beta radiation may also be affected by impurities, but to a lesser extent. Concentrations of gross alpha and gross beta reported by EAL for the December samples are more similar to results reported by CFEP and ASU.

(2) Indian Gardens Spring

Results of the December 1985 sampling indicate that low concentrations of uranium and radium, as well as low levels of gross alpha and gross beta radiation, occur naturally in the groundwater discharged from Indian Gardens Spring (Table 3.6B). Concentrations of other radiological parameters analyzed were zero or slightly greater than zero. None of the radiological parameters analyzed exceed Federal or Arizona limits for drinking water. In general, there is good agreement of results between laboratories and sampling rounds.

A notable difference between concentrations reported by EAL for the May and December samples occurs for thorium 228. EAL reported a concentration of thorium 228 in the May 1985 sample which was definitely greater than zero. However, EAL detected a concentration of thorium 228 in the December 1985 sample which is in the range from zero to 0.5 pCi/l. (Table 3.6B).

(3) Blue Spring

Results of the December 1985 sampling indicate that low concentrations of uranium and radium, as well as low levels of gross alpha and gross beta radiation, occur naturally in the groundwater discharged from Blue Spring (Table 3.6C). Concentrations of other radiological parameters were zero or slightly greater than zero. None of the radiological parameters analyzed exceed Federal or Arizona limits for drinking water. In general, there is good agreement of results between laboratories and sampling rounds.

Due to statistical error of measurement, gross alpha radiation reported by EAL for the May 1985 samples from Blue Spring is within the range from zero to 19.4 pCi/l. Therefore, this level of gross alpha radiation might have exceeded the Federal and Arizona limit of 15 pCi/l for drinking water. The limit of detection reported by ASU for gross alpha radiation in the May 1985 samples was above the Federal and Arizona limit for drinking water. Gross alpha radiation reported by EAL for the December 1985 samples from Blue Spring does not exceed the Federal and Arizona limit. The significant error of measurement for analyses of gross alpha and gross beta in the Blue Spring samples are believed to result from impurities such as calcium.

A notable difference between concentrations reported by EAL for the May 1985 and December 1985 samples from Blue Spring occurs for thorium 228. EAL reported a concentration of thorium 228 in the May 1985 samples which was definitely greater than zero. However, EAL detected a concentration of thorium 228 in

the December 1985 samples which is in the range from zero to 0.5 pCi/l (Table 3.6C).

(D) Check Samples

As a check for quality control for each sampling round, a water sample was obtained from bottled deionized drinking water and was submitted to one of the three laboratories for analyses of radiological parameters. The same brand of bottled water was used for each sampling round.

Results of the May 1985 and December 1985 sampling rounds indicate that low levels of gross alpha and gross beta radiation were detected in the bottled water (Table 3.6D). Concentrations of all other radiological parameters analyzed were zero or, due to statistical error of measurement, slightly greater than zero. None of the radiological parameters analyzed exceed Federal or Arizona standards and there is good agreement of results between sampling rounds.

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TABLE 3.3A. SUMMARY OF RESULTS FOR ROUTINE CONSTITUENTS
IN WATER SAMPLES COLLECTED FROM HAVASU SPRING

DATE SAMPLED:	05/16/85		12/18/85	
LABORATORY ^a :	BC	CFEP	BC	CFEP
<u>CONSTITUENTS (mg/l)</u>				
CALCIUM	130	127	97	134
MAGNESIUM	44	51	42	47
SODIUM	32	30	34	26
POTASSIUM	4.9	5.2	4.8	4
CARBONATE	0	0	0	0
BICARBONATE	580	534	482	551
SULFATE	37	35	40	21
CHLORIDE	44.6	44	37.2	46
FLUORIDE	0.25	0.25	0.24	0.23
NITRATE	1.8	1.3	1.8	1.4
PHOSPHATE	<0.1	<0.1	<0.1	<0.1
SILICA	16	16.2	18	18.1
ALKALINITY (as CaCO ₃)	476	438	396	452
HARDNESS (as CaCO ₃)	506	505	416	518
TOTAL DISSOLVED SOLIDS (residue @ 180°)	605	614	615	552
<u>PARAMETERS</u>				
SPECIFIC ELECTRICAL				
CONDUCTANCE (umho/cm):				
field	1,200	1,200	970	970
laboratory	1,040	1,060	1,000	940
pH: field	6.7	6.7	6.9	6.9
laboratory	7.5	7.27	7.6	7.46
FIELD TEMPERATURE (°C)	21.5	21.5	21	21

^a BC - BC Laboratories, Inc., Bakersfield, California
CFEP - Controls for Environmental Pollution, Inc., Santa Fe,
New Mexico

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TABLE 3.3B. SUMMARY OF RESULTS FOR ROUTINE CONSTITUENTS
IN WATER SAMPLES COLLECTED FROM INDIAN GARDENS SPRING

DATE SAMPLED:	<u>05/17/85</u>	<u>12/18/85</u>
LABORATORY ^a :	BC	BC
<u>CONSTITUENTS (mg/l)</u>		
CALCIUM	45	44
MAGNESIUM	32	29
SODIUM	7	6
POTASSIUM	2	2.3
CARBONATE	0	0
BICARBONATE	275	262
SULFATE	17	16
CHLORIDE	9.9	9.9
FLUORIDE	0.16	0.17
NITRATE	2.2	2.2
PHOSPHATE	<0.1	<0.1
SILICA	10	16
ALKALINITY (as CaCO ₃)	225	215
HARDNESS (as CaCO ₃)	244	229
TOTAL DISSOLVED SOLIDS (residue @ 180°)	330	310
<u>PARAMETERS</u>		
SPECIFIC ELECTRICAL CONDUCTANCE (umho/cm):		
field	520	430
laboratory	470	460
pH: field	6-7	7.5
laboratory	8.1	8.0
FIELD TEMPERATURE (°C)	18	17.5

^a BC - BC Laboratories, Inc., Bakersfield, California

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TABLE 3.3C. SUMMARY OF RESULTS FOR ROUTINE CONSTITUENTS
IN WATER SAMPLES COLLECTED FROM BLUE SPRING

DATE SAMPLED:	<u>05/16/85</u>	<u>12/18/85</u>
LABORATORY ^a :	BC	BC
<u>CONSTITUENTS (mg/l)</u>		
CALCIUM	243	243
MAGNESIUM	74	74
SODIUM	540	550
POTASSIUM	6.4	5.9
CARBONATE	0	0
BICARBONATE	889	903
SULFATE	156	141
CHLORIDE	846	839
FLUORIDE	0.36	0.28
NITRATE	1.8	1.3
PHOSPHATE	<0.1	<0.1
SILICA	16	12
ALKALINITY (as CaCO ₃)	728	741
HARDNESS (as CaCO ₃)	912	913
TOTAL DISSOLVED SOLIDS (residue @ 180°)	2,315	2,455

PARAMETERS

SPECIFIC ELECTRICAL		
CONDUCTANCE (umho/cm):		
field	5,500	5,000
laboratory	4,100	4,100
pH: field	6.3	6.4
laboratory	7.3	7.3
FIELD TEMPERATURE(°C)	20.5	19.5

^a BC - BC Laboratories, Inc., Bakersfield, California

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TABLE 3.4 FEDERAL DRINKING WATER STANDARDS
FOR PARAMETERS ANALYZED

<u>PARAMETERS</u>	<u>MAXIMUM^b LIMIT</u>	
PRIMARY:		
ARSENIC:	0.05	mg/l
BARIUM	1.0	mg/l
CADMIUM	0.01	mg/l
CHROMIUM (TOTAL)	0.05	mg/l
LEAD	0.05	mg/l
MERCURY	0.002	mg/l
NITRATE (as NO ₃)	45	mg/l
SELENIUM	0.01	mg/l
SILVER	0.05	mg/l
FLUORIDE ^a	1.4 - 2.4	mg/l
RADIUM 226	3	pCi/l
COMBINED RADIUM 226 AND RADIUM 228	5	pCi/l
GROSS ALPHA PARTICLE ACTIVITY (EXCLUDING RADON AND URANIUM)	15	pCi/l
GROSS BETA PARTICLE ACTIVITY	50	pCi/l
SECONDARY:		
CHLORIDE	500	mg/l
COPPER	1.0	mg/l
IRON	0.3	mg/l
MANGANESE	0.05	mg/l
SULFATE	500	mg/l
ZINC	5.0	mg/l
TOTAL DISSOLVED SOLIDS	1,000	mg/l
SPECIFIC ELECTRICAL CONDUCTANCE	1,600	umho/cm.

^a Temperature dependent

^b mg/l - milligrams per liter

pCi/l - picocuries per liter

umho/cm - micromhos per centimeter

TABLE 3.5A. SUMMARY OF RESULTS FOR TRACE ELEMENTS IN WATER SAMPLES
COLLECTED FROM HAVASU SPRING

DATE SAMPLED:	<u>05/16/85</u>		<u>12/18/85</u>	
LABORATORY ^a :	BC	CFEP	BC	CFEP
<u>CONSTITUENTS (mg/l)</u>				
ALUMINUM	<0.1	<0.1	<0.5	<0.1
ANTIMONY	<1.0	<0.003	<1.0	<0.01
ARSENIC	0.01	0.01	0.01	<0.01
BARIUM	<0.5	0.2	<0.5	0.2
BERYLLIUM	<0.05	<0.0001	<0.01	<0.001
BORON	0.27	0.3	0.26	0.3
CADMIUM	<0.005	<0.001	<0.005	<0.001
CHROMIUM (total)	<0.01	<0.01	<0.01	<0.01
COPPER	<0.01	<0.01	<0.01	<0.01
IRON	<0.05	<0.01	<0.05	<0.01
LEAD	<0.01	<0.01	<0.01	<0.01
MANGANESE	<0.01	<0.01	<0.01	<0.01
MERCURY	<0.0002	<0.0004	<0.0002	<0.0004
MOLYBDENUM	<0.1	<0.01	<0.1	<0.01
NICKEL	<0.05	<0.01	<0.05	<0.1
SELENIUM	<0.005	<0.01	<0.005	<0.01
SILVER	<0.01	<0.01	<0.01	<0.01
THALLIUM	<0.5	<0.01	<0.5	<0.01
VANADIUM	<0.5	<0.01	<0.5	<0.01
ZINC	<0.01	<0.005	0.01	<0.1

^a BC - BC Laboratories, Inc., Bakersfield, California
 CFEP - Controls for Environmental Pollution, Inc., Santa Fe,
 New Mexico
 (<) Less than

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TABLE 3.5B. SUMMARY OF RESULTS FOR TRACE ELEMENTS IN WATER SAMPLES
COLLECTED FROM INDIAN GARDENS SPRING

DATE SAMPLED:	<u>05/17/85</u>	<u>12/18/85</u>
LABORATORY ^a :	BC	BC
<u>CONSTITUENTS (mg/l)</u>		
ALUMINUM	<0.1	<0.5
ANTIMONY	<1.0	<1.0
ARSENIC	<0.01	<0.01
BARIUM	<0.5	<0.5
BERYLLIUM	<0.05	<0.01
BORON	<0.1	<0.1
CADMIUM	<0.005	<0.005
CHROMIUM (total)	<0.01	<0.01
COPPER	<0.01	<0.01
IRON	<0.05	<0.05
LEAD	<0.01	<0.01
MANGANESE	<0.01	<0.01
MERCURY	<0.0002	<0.0002
MOLYBDENUM	<0.1	<0.1
NICKEL	<0.05	<0.05
SELENIUM	<0.005	<0.005
SILVER	<0.01	<0.01
THALLIUM	<0.5	<0.5
VANADIUM	<0.5	<0.5
ZINC	<0.01	0.01

^a BC - BC Laboratories, Inc., Bakersfield, California
(<) Less than

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TABLE 3.5C. SUMMARY OF RESULTS FOR TRACE ELEMENTS IN WATER SAMPLES
COLLECTED FROM BLUE SPRING

DATE SAMPLED:	<u>05/16/85</u>	<u>12/18/85</u>
LABORATORY ^a :	BC	BC
<u>CONSTITUENTS (mg/l)</u>		
ALUMINUM	<0.1	<0.5
ANTIMONY	<1.0	<1.0
ARSENIC	<0.01	<0.01
BARIUM	<0.5	<0.5
BERYLLIUM	<0.05	<0.01
BORON	0.39	0.42
CADMIUM	<0.005	<0.005
CHROMIUM (total)	<0.01	<0.01
COPPER	<0.01	<0.01
IRON	<0.05	<0.05
LEAD	<0.01	<0.01
MANGANESE	<0.01	<0.01
MERCURY	<0.0002	<0.0002
MOLYBDENUM	<0.1	<0.1
NICKEL	<0.05	<0.05
SELENIUM	<0.005	<0.005
SILVER	<0.01	<0.01
THALLIUM	<0.5	<0.5
VANADIUM	<0.5	<0.5
ZINC	<0.01	0.04

^a BC - BC Laboratories, Inc., Bakersfield, California
(<) Less than

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TABLE 3.6A. SUMMARY OF RESULTS FOR RADIOLOGICAL PARAMETERS
IN WATER SAMPLES COLLECTED FROM HAVASU SPRING

DATE SAMPLED:	05/16/85			12/18/85		
LABORATORY ^a :	EAL	CFEP	ASU	EAL	CFEP	ASU
<u>PARAMETER (in picocuries</u> <u>per liter +/- two standard</u> <u>deviations)</u>						
GROSS ALPHA	41.6±34.7	<2	<8	<0.7±5.0	<2	<8.5
GROSS BETA	44.8±40.4	<3	6.4±3.8	<5.4±7.9	5±2	5.4±1.5
TOTAL URANIUM						
picocuries per liter	7±2	3±1	---	3±2	7	---
micrograms per liter	10±3	4±1	---	4±3	10	---
URANIUM 234	3.6±0.2	<0.6	3.1±1.2	3.8±0.2	<0.6	3.0±0.2
URANIUM 235	0±0.2	<0.6	0.3±0.4	0±0.2	<0.6	0.13±0.04
URANIUM 238	1.3±0.1	<0.6	1.6±0.8	1.3±0.1	<0.6	1.2±0.1
THORIUM 228	2.1±0.5	<0.6	---	0±0.5	<0.6	---
THORIUM 230	0±0.2	<0.6	---	0±0.2	<0.6	---
THORIUM 232	0±0.2	<0.6	---	0±0.2	<0.6	---
RADIUM 226	0±0.05	<0.6	0.45±0.34	0.8±0.1	<0.6	0.26±0.05
RADIUM 228	0±0.5	<1	---	0±0.5	<1	---
POTASSIUM 40	---	---	4.1	---	---	---

^a EAL - EAL Corporation, Richmond, California

CFEP - Controls for Environmental Pollution, Inc., Santa Fe, New Mexico

ASU - Arizona State University, Tempe, Arizona

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TABLE 3.6B. SUMMARY OF RESULTS FOR RADIOLOGICAL PARAMETERS
IN WATER SAMPLES COLLECTED FROM INDIAN GARDENS SPRING

DATE SAMPLED:	<u>05/17/85</u>		<u>12/18/85</u>	
LABORATORY ^a :	EAL	ASU	EAL	ASU
<u>PARAMETER (in picocuries</u> <u>per liter +/- two standard</u> <u>deviations)</u>				
GROSS ALPHA	1.5±2.5	<4	1.0±3.0	11.7±8.2
GROSS BETA	2.2±2.0	3.2±3.6	1.9±3.3	<2.0
TOTAL URANIUM				
picocuries per liter	3±2	---	4±2	---
micrograms per liter	4±3	---	6±3	---
URANIUM 234	2.5±0.1	3.1±0.8	2.7±0.1	2.2±0.2
URANIUM 235	0±0.1	0.1±0.1	0±0.2	0.08±0.03
URANIUM 238	0.6±0.1	0.8±0.4	0.8±0.1	0.52±0.07
THORIUM 228	1.4±0.4	---	0±0.5	---
THORIUM 230	0±0.2	---	0±0.2	---
THORIUM 232	0±0.2	---	0±0.2	---
RADIUM 226	0.14±0.05	0.25±0.20	1.4±0.2	0.18±0.03
RADIUM 228	0±0.5	---	0±0.8	---
POTASSIUM 40	---	1.4	---	---

^a EAL - EAL Corporation, Richmond, California
ASU - Arizona State University, Tempe, Arizona
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TABLE 3.6C. SUMMARY OF RESULTS FOR RADIOLOGICAL PARAMETERS
IN WATER SAMPLES COLLECTED FROM BLUE SPRING

DATE SAMPLED:	05/16/85		12/18/85	
LABORATORY ^a :	EAL	ASU	EAL	ASU ^b
<u>PARAMETER (in picocuries per liter +/- two standard deviations)</u>				
GROSS ALPHA	1.5±17.9	<21	1.2±9.5	<24
GROSS BETA	8.4± 8.1	9.4±-4.9	3.9±16.0	5.0±2.4
TOTAL URANIUM				
picocuries per liter	5±2	---	3±2	---
micrograms per liter	7±3	---	4±3	---
URANIUM 234	4.4±0.2	4.4±0.9	3.9±0.2	4.2±0.4
URANIUM 235	0±0.2	0.4±0.2	0±0.2	0.18±0.07
URANIUM 238	1.8±0.1	1.4±0.4	1.7±0.1	1.3±0.2
THORIUM 228	1.7±0.3	---	0±0.5	---
THORIUM 230	0±0.2	---	0±0.2	---
THORIUM 232	0±0.2	---	0±0.2	---
RADIUM 226	0.12±0.05	0.31±0.24	1.0±0.2	<0.5
RADIUM 228	0±0.5	---	0±0.5	---
POTASSIUM 40	---	6.6	---	---

^a EAL - EAL Corporation, Richmond, California
ASU - Arizona State University, Tempe, Arizona
(<) Less than

TABLE 3.6D. SUMMARY OF RESULTS FOR RADIOLOGICAL PARAMETERS
IN CHECK WATER SAMPLES COLLECTED FROM
BOTTLED DEIONIZED DRINKING WATER

DATE SAMPLED:	<u>05/17/85</u>	<u>12/18/85</u>
LABORATORY ^a :	EAL	EAL
<u>PARAMETER (in picocuries</u> <u>per liter +/- two standard</u> <u>deviations)</u>		
GROSS ALPHA	0.2±0.6	<0.4±1.5
GROSS BETA	<0.2±1.7	<0.9±2.4
TOTAL URANIUM		
picocuries per liter	0±2	0±2
micrograms per liter	0±3	0±3
URANIUM 234	0±0.1	0±0.1
URANIUM 235	0±0.1	0±0.1
URANIUM 238	0±0.1	0±0.1
THORIUM 228	0±0.5	0±0.5
THORIUM 230	0±0.2	0±0.2
THORIUM 232	0±0.2	0±0.2
RADIUM 226	0±0.05	0±0.1
RADIUM 228	0±0.5	0±0.5
POTASSIUM 40	---	---

^a EAL - EAL Corporation, Richmond, California
(<) Less than

As part of the sampling procedure, field measurements of relative ambient radiation were made at each sampling site using a scintillometer. At each site, one measurement was made directly above the water surface where samples were collected. A second measurement was made over dry ground approximately 50 feet from the sampling site. Results of the scintillometer measurements are as follows:

SCINTILLOMETER READING
(microrems per hour)

Havasu Spring

<u>Date Measured</u>	<u>At Water Sampling Site^a</u>	<u>50 Feet From Sampling Site^b</u>
05-16-85	5 - 7	5 - 7
12-18-85	7 - 7.5	7.5 - 8

Indian Gardens Spring

<u>Date Measured</u>	<u>At Water Sampling Site^a</u>	<u>50 Feet From Sampling Site^b</u>
05-17-85	4 - 6	4 - 6
12-18-85	6 - 7	6 - 7

Blue Spring

<u>Date Measured</u>	<u>At Water Sampling Site^a</u>	<u>50 Feet From Sampling Site^b</u>
05-16-85	2	5
12-18-85	4	8

^aMeasured at the water sampling site, about six inches above water surface.

^bMeasured about 50 feet from the sampling site, about six inches above ground surface.

Radon commonly occurs as a gaseous emission from springs fed by groundwater containing elevated levels of radionuclides. Radon emissions from springs commonly result in ambient radiation near the springs which is higher than background levels. Results of the scintillometer measurements indicate that radiation detected near the springs was not higher than background radiation detected 50 feet from the springs.

Results of scintillometer measurements made during the December 1985 sampling round are slightly higher than results for the May 1985 sampling round.

3.2.7.4 Soils

Soil samples were collected and assayed for background radionuclides. These sample sites are shown in Figure 2.4, Chapter 2. Results of the assays are as follows:

<u>Radionuclide Assays in Soil (pCi/qm)</u>							
<u>Sample</u>	<u>Ra-226</u>	<u>Gross Alpha</u>	<u>Gross Beta</u>	<u>Th-232</u>	<u>Ti-208</u>	<u>K-40</u>	<u>Cs-137</u>
Wash NNW	1.3(9)*	20(10)	21	0.7(6)	0.24(4)	13(3)	0.42
Wash NNE	1.3(9)	35(11)	25	1.0(5)	0.36(3)	17(2)	0.32
Wash SSW	1.8(14)	23(10)	32	1.3(8)	0.42(7)	21(4)	1.10
Owl Tank	1.6(11)	35(9)	28	1.0(6)	0.35(4)	18(2)	0.83

*Values in parenthesis are the percent error at one standard deviation

The results for soil collected from Red Horse Wash at U.S. Highway 180 and at Willaha are not yet available. All soil is also being analyzed for uranium content but results are not yet available. The Ra-226 reported is normal for Arizona soil. The gross alpha and gross beta results are not sufficiently accurate to provide useful information. Improvement in assay technique is not possible due to the magnitude of the self absorption corrections which need to be made. Th-232 and Ti-208 radionuclides are members of the Thorium decay chain and are normal. The naturally occurring K-40 concentrations are the same as other soils measured in Arizona. Fallout Cs-137 concentrations are approximately a factor of two higher than those measured in the Phoenix area.

In summary, the radionuclide concentrations in the soil around the Canyon Mine site are normal and do not indicate the presence of surface deposits of natural radioactivity. It appears that the two prime indicators for changes in the natural radiation environment will be Ra-226 and uranium. Therefore further soil sampling analysis will be limited to these radionuclides.

3.2.8 IC #10 Indian Religious Concerns

Lands historically occupied by Native Americans and their ancestors are common in Northern Arizona. The American Indian Religious Freedom Act, 42 U.S.C. §1996, requires that federal agencies, have an awareness of tribal beliefs and practices and consider these when formulating government policy by: (1) consulting with Tribes with respect to actions which may affect traditional Indian religious practices; and (2) evaluating policies with an aim toward protecting Tribal religious practices. The statute does not require that Federal officials protect Tribal religious practices to the exclusion of all other Federal courses of action nor is it intended to provide Indian religions with a more favorable status than other religions.

In completing this environmental impact statement, the Forest has attempted to identify Indian concerns, both religious and environmental, through the formal scoping process and through informal consultation with tribal leaders.

The primary concern expressed by Indian tribes relates to possible water quality impacts that might result from contamination of the Redwall-Muav aquifer by mine operation. Blue Spring, located in the Little Colorado River Gorge, approximately 30 miles northeast of the mine site, and Havasu Springs, located on the Havasupai Indian Reservation approximately 35 miles northwest of the mine site, both discharge from the Redwall aquifer. Havasu Springs is an important water source and economic asset to the Havasupai Tribe. Blue Spring is an extremely important sacred site for the Hopi Tribe. For a discussion of existing water quality at these springs, see Section 3.2.7.3. Potential impacts are discussed in Section 4.2.7.2.

The Hopi and Havasupai Tribes have suggested that sacred religious sites, including ruins, graves and hunting areas, exist at or near the mine site and haul routes. However, consultation with the Tribes and experts on Indian religious sites and practices as well as archeological inventories have failed to identify any specific Hopi or Havasupai sites of sacred or religious significance near the proposed mine site.

There is evidence that Hopi gather turkeys, pinion nuts and sacred herbs in the area near Tusayan. Turkeys are gathered around Twin Lakes, Skinner Ridge and Red Butte. These practices have religious significance. Hopi also hunt deer

for both food and ceremonial purposes in the Tusayan area and visit ruins of Hopi ancestors.

The Havasupai traditionally cremated their dead until sometime in the 1880's. Since this times they have buried their dead in Supai Canyon with the exception of medicine men, who are buried at locations away from the Grand Canyon.

Hopi also gather golden eagles along U.S. Highway 89 near the Little Colorado River bridge and near the Echo Cliffs. The feathers of golden eagles are used in making "pahos" or prayer feather sticks which convey the prayers of Hopi to the Creator.

The Sipapu and Salt Trails are also of religious importance to the Hopi. Both trails are in the floor of the Little Colorado River near the confluence with the Colorado River.

Other areas sacred to the Hopi are located on the San Francisco Peaks and Bill Williams Mountain, 48 miles south of the mine site. Those areas are discussed in the Environmental Impact Statement for the Bill Williams Mountain Ski Area Proposal. No areas of sacred or religious significance have been identified near the mine site or proposed ore haul routes.

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CHAPTER 4

ENVIRONMENTAL CONSEQUENCES

This chapter of the EIS describes the consequences to the environment that may result from the proposed action and each alternative. Anticipated consequences have been quantified wherever possible. For those consequences that are difficult to quantify, qualitative statements are made to describe relative differences of the various alternatives, emphasizing those impacts that relate to the issues and concerns (IC's) identified in the scoping process.

This chapter discusses the alternatives, including the No Action Alternative, and the projected impacts of each alternative, emphasizing those impacts that relate to the issues and concerns (IC's) identified in the scoping process. IC's #2 (reclamation) and #5 (vegetation) are not treated separately but are addressed wherever appropriate under other factors such as air quality, water quality, wildlife impacts or transportation routes. The effects of the proposed mine on the air quality of the Grand Canyon and water quality of the Havasupai Reservation, and the possibility of radionuclide contamination to the surrounding environment are discussed under related IC's and are not evaluated as separate concerns. A discussion and evaluation and comparison of all the alternatives is presented in Chapter 2.

For many factors, the impacts of the No Action Alternative is to preserve the existing environment as described in Chapter 3. The No Action Alternative serves as a baseline against which the project alternatives can be compared. The impacts of the Proposed Action and Alternatives 3-5 are identical for many factors. For these factors, one discussion and analysis of the impacts is provided for all alternatives for purposes of efficiency and clarity.

Cumulative Impacts

Council on Environmental Quality (CEQ) regulations implementing NEPA, require an analysis of the cumulative impacts of the proposed action where the proposed action and related actions may result in cumulatively significant impacts. Cumulative impacts are those which result from the incremental impact of the proposed action "when added to other past, present and reasonably foreseeable future action." 40 C.F.R. § 1508.7.

Potential cumulative impacts have not been separately identified as a major issue and concern for this document, but

concern about the future impacts of uranium mining was expressed by the public in scoping meetings, and there is the potential for future mining proposals in the Tusayan area. The detailed data and analysis in this document will provide an accurate basis for assessing the impacts of similar proposals in the future. At this time, there are no other proposed mining operations in Coconino County south of the Grand Canyon. However, there is considerable exploration for uranium in the area by several companies. Thus, even though the construction and operation period for the Canyon Mine is relatively brief, it may be reasonably foreseeable that one or more additional mines will be located in the general area during that period.

The specific timing and location of additional mines will be determined by unforeseeable geographic and economic factors, so potential cumulative impacts cannot be specifically quantified. Where cumulative impacts are possible, this analysis projects potential impacts of the proposed mine.

Many of the issues considered in this statement are affected only at or near the mine site. Reclamation, vegetation, visual quality and water quality will not generate cumulative impacts unless another mine is located very close to the Canyon Mine site. Other issues, especially those associated with transportation, will generate greater cumulative impacts if separate ore transportation routes are developed to serve additional mines. That possibility is noted as well.

Cumulative impacts are analyzed, as appropriate throughout chapter 4, based on two hypothetical scenarios: first, one additional mine in the Tusayan area near the Canyon Mine and second, three additional mines in Coconino County south of the Grand Canyon. To assess maximum potential impacts, it is assumed that all mines will be producing at a maximum production rate of 200 tons per day at the same time.

4.1 ENVIRONMENTAL CONSEQUENCES OF FACTORS NOT IDENTIFIED AS MAJOR ISSUES OR CONCERNS AND HAVE COMMON IMPACTS FROM IMPLEMENTATION OF ALTERNATIVES 2-5

4.1.1 Wetlands, Floodplains, Prime Farmlands, Rangeland and Forest Land

None of the alternatives will affect wetlands, floodplains, or prime farmlands. A loss of 5 to 8 AUM's grazing capacity is

anticipated with the implementation of the project alternatives 2, 3, 4 and 5. These alternatives will cut between 0.9 and 76.5 thousand board feet of timber in road construction and reconstruction. These effects are considered to be insignificant.

Land displaced for additional mines and haul routes would affect existing uses of the land. Based on projected impacts of the Canyon Mine, one additional mine near Tusayan would result in the loss of an additional 5 to 8 AUM's grazing capacity and an extremely small amount of timber. Precise impacts would of course depend on the exact location and the existing uses of the land. Significant cumulative impacts would not be expected from three additional mines in the County south of the Grand Canyon as the total loss of grazing capacity, timber or forest vegetation would still be small.

Impacts on vegetation will be limited to the land disturbed by each mine site or new road construction. (Each additional mine would be required to fully reclaim the site at the end of mining). However, the total acres disturbed would be additive, that is, each additional mine would add 15 to 20 acres to the total disturbed acreage in the county. After reclamation there would be no impacts on the vegetation.

4.1.2 Civil Rights, Minority Groups and Women

None of the alternatives will have an effect on minority groups and women, other than the Havasupai interests as expressed under the surface and groundwater concern. EFN will be required to be an equal opportunity employer.

4.1.3 Short Term Use and the Maintenance and Enhancement of Long Term Productivity

Short term use is usually considered to be one to nine years. Long term is from 10 to 50 years or more. A large capital investment such as a mine, is normally amortized over the life of the mine. The Canyon Mine is projected to operate for 5-10 years, therefore, there will be no long term commitment of the Forest resources at the mine yard. Acres improved through various cultural treatments to offset the loss of important wildlife habitats and new road construction for ore transport, are considered to be long term commitments.

4.1.4 Irreversible and Irretrievable Commitment of Resources

Irreversible commitment applies to nonrenewable resources such as mineral and cultural resources. All mining alternatives will have an irreversible commitment on the underground ore deposit. There will be an irretrievable loss of timber growth when the trees are cleared for road construction under Alternatives 2, 3, and 4. Cultural resources will be avoided or recovered according to the appropriate laws and regulations.

4.1.5 Agency Financial Burdens

The proposed uranium mine will not create increased financial needs for police or fire protection. Existing off highway roads are inadequate to handle the ore haulage. Road construction and reconstruction will be the responsibility of EFN. Emergency medical facilities in Tusayan, approximately 6-1/2 miles from the site, are adequate to meet perceived needs. No substantial increased financial burdens are expected to accrue to either the local communities or Coconino County. However, if a significant number of the mine employees hired are from areas other than Flagstaff, Williams or Tusayan, the immigration of workers and their families may create some limited burdens. In the event that one or more additional mines are located in the County south of the Grand Canyon during the period of operation for the Canyon Mine, the excess capacity of many services provided by local government will disappear and expansion of some services may be required. If the City of Williams provides water for the project, it will be sold as a commodity, thus providing income.

The Forest Service and those agencies listed in Section 1.3 (Permitting Process) will administer the regulatory requirements of their respective agencies. These responsibilities are not expected to impose any significant additional financial burdens on the regulating agencies.

4.1.6 Possible Conflicts With Other Agency Plans or Policies

There are no known conflicts with other Federal, State or local government plans, policies or regulations.

4.1.7 Energy Requirements

The energy requirements of the alternatives are a function of automobile and truck use and operation of the mine itself. Alternative 1 will keep energy requirements at current levels. All other alternatives will require considerable amounts of electrical and internal combustion energy. Alternative 5 will require slightly more energy and is the least energy efficient alternative because of the increase in ore hauling distance. The mining of a fuel source such as uranium will, however, yield a net gain in terms of energy expenditures.

4.1.8 Noise

Under the operational alternatives (Alternatives 2 - 5), only the occasional passersby on Forest Roads 305A or 308 will be able to hear the mine noises, and then at an acceptable level because of the distance to the mine site. With a mile and a half of tall, fairly dense forest between the mine and the highway, the mine generated noises should be filtered to an insignificant level, particularly since the buffer effects of vegetation and distance are acting in unison. Travelers on State Highway 64 will not be able to hear the mine noises because of the effect of vegetation as a noise screen.

Mine workers will be exposed only intermittently to unacceptable noise levels when they pass within 50 feet of the air compressor room and the vent shaft. Neither location, however, is near a work site that requires extended worker presence. (Dames and Moore consulting Report on file at Kaibab National Forest.)

Haul route truck noise is expected to be well within the acceptable level (<65 decibels) based on measurements of existing traffic noise along State Highway 389. However, intermittent noise created by ore trucks can have a disturbing effect on wildlife during certain critical periods (wildlife impacts are further discussed in 4.2.3). Ore trucks on U.S. 89, I-40, state highway 64 and U.S. 160 would add insignificantly to the already heavy traffic of 2,870 - 10,155 vehicles per day.

The No Action Alternative would leave current noise levels unaffected by mine operations near the Canyon Mine site or ore truck traffic along the proposed haul routes.

Additional mines would not add to the noise created by the Canyon Mine. If common haul routes are used, the frequency of noise impacts from ore truck traffic would increase in proportion to the number of additional trucks.

4.1.9 Recreation

Recreation that is dependent upon solitude will be adversely impacted as a result of the noise, truck traffic, and increased activity at the mine site and along the haulage route. Improving the road system to transport the ore to the mill will increase accessibility and recreational opportunities for the general public. For some people who fear radiation or covet solitude, the existence of a uranium mine may change their attitude and beliefs regarding the project area.

Those alternatives which involve new road construction or major road improvements (Alternatives 2, 3 and 4) within the Forest will allow increased accessibility and traffic into previously remote areas. The impacts of increased access and use are both positive and negative. The improved transportation routes would allow greater recreational use of the area for hiking, hunting, sightseeing and camping. However, those currently attracted to the area by the opportunities for solitude will be disrupted by more traffic and use. If several mines utilize haul routes across the Forest, opportunities for solitude or primitive recreation near each route will be diminished.

Cumulative impacts are not expected from the use of the Preferred Alternative since it utilizes existing roads and highways largely outside the forest. Implementation of the Preferred Alternative is not expected to appreciably alter the general Forest environment on the Tusayan Ranger District.

4.1.10 Impacts on Mine Workers

Workers in the Canyon Mine can expect direct radiation levels to be on the order of 0.8 mrem/hr. The direct radiation limits, dosimetry and record keeping requirements are mandated by federal regulation (30 CFR 57). Theoretically, a miner can remain at or near the high grade ore body during an entire work period and not exceed the weekly guidelines (100 mrem) or the annual whole body limit (5,000 mrem).

Radon gas and progeny will be flushed from the mine with a 150,000 cubic foot per minute vent fan. Based on measurements atop the Hack Canyon Mine vent, radon gas concentrations will be on the order of 2,400 pico Curie Levels and 1,600

milliworking levels m(WL). Radon progeny will be present at approximately 10 percent of their potential equilibrium values. This means that much of the radon gas will be removed from the mine before it is able to decay to its hazardous decay products. The occupational radon progeny limit is 4 Working Level Months (WLM) per year. Miners at Hack Canyon are currently experiencing an average of about 2.2 WLM/yr. (See Appendix E and Glossary.)

Currently, uranium miners work an average of 10 years underground. The cumulative 10 to 25 WLM they may receive is well below the 100 WLM value where studies indicate possible increases in lung cancer might appear. Current data and standards support the conclusion that increases in lung cancer among mine workers are not expected at levels lower than 100 WLM. However, EPA has suggested that the risk of lung cancer may increase at exposure levels in the range of 20-100 WLM.

4.1.11 Cultural Resources

No impacts upon cultural resources are expected under the No Action Alternative. The construction and operation of the mine would have essentially similar impacts on cultural resources under Alternative 2-5. Site AZ-H-4-3, 4 and 5 (inclusive) would not be directly impacted by construction or operation as it is out of the area of operations. However, indirect impacts from construction activities or greater use of the mine area could result in the disturbance to this area. During the process of evaluating this site, virtually all surface artifacts were collected and analyzed. Archeological testing revealed no subsurface material. The site was determined to contain no significant information and was thus found to be ineligible for the National Register. Any disturbance to the site area will not result in loss of important data.

Site AZ-H-4-6 and 7 (inclusive) is also outside the area of direct mining impact but is close enough that it could be impacted indirectly by activity around the mine. The site was excavated through an approved data recovery program, which was designed to recover information important to the prehistory of the region. Since it was the information potential of the site that made it eligible for the National Register, and the information has been recovered through an approved program, the spot where the site was located no longer has archeological value. Thus future disturbance of this location will not result in loss of important data.

Impacts on cultural resources associated with road construction, improvement or maintenance, powerline construction or wildlife mitigation activities can only be

estimated qualitatively based on cursory field surveys (see Table 2.4). No detailed site specific inspection of the potentially impacted areas has occurred. However, prior to any construction or improvement of any road or line, or construction associated with wildlife mitigation, a site specific investigation of any affected area will be conducted for evidence of cultural resources. Any resources found will be avoided by realignment of the road. If avoidance is not practical, sites will be evaluated for National Register eligibility. If any are found eligible, a program of mitigation will be developed through consultation between the Forest Service, the Arizona State Historic Preservation Officer and the Advisory Council in accordance with the National Historic Preservation Act of 1966 and 36 CFR 800.

4.2 ISSUES AND CONCERNS

This section is primarily directed to those issues and concerns which were considered of major importance, or which surfaced as significant issues during the scoping process. Impacts of the four alternatives have been displayed in Chapter 2, as well as here, so the relative resolution of each issue and concern can be distinguished.

The No Action Alternative represents the existing environment with no mining activities on the Tusayan Ranger District and provides a baseline against which all other alternatives can be measured.



4.2.1 IC #1 What Social and Economic Impacts Will the Uranium Mine Have on the Local Communities and Coconino County

A computer impact model called IMPLAN was used to estimate the number of jobs created or lost by implementing each alternative. The model takes a regional area, in this case Coconino County, and estimates the dollars generated in the area, the amount of money brought into the County and the ripple effect of new money through the region. The model assigns jobs in each of several hundred industry sectors. These industry sectors were grouped into nine general categories to coincide with available employment data. The IMPLAN Model is not suitable for use on a small subsection of a regional area, so it was not used to predict the number of jobs generated specifically in Williams or Tusayan. Changes in job numbers for these two areas were estimated by looking at the change in the total number of jobs in an industry sector on a county-wide basis.

The various project alternatives evaluated in this EIS will not have any different effect on employment levels at the mine or development costs associated with the mine. Consequently, the estimated economic changes will apply to all project alternatives.

The following projected 10-year estimates of wages, capital investments, taxes, etc., derived from the mine, were used to drive the IMPLAN economic model and to predict the secondary changes in the employment, salaries and Total Gross Outputs for Coconino County.

1. Wages and Fringe Benefits	\$10,000,000
2. Plant and Equipment	\$ 3,000,000
3. Mining Supplies	\$15,000,000
4. Haulage to Blanding, Utah	\$ 4,000,000
5. Transaction Privilege (sales and use taxes)	\$ 600,000
6. Mineral Severance Taxes	\$ 1,700,000
7. Property Taxes	\$ 1,275,000
8. Energy Usage	
Electricity	\$ 2,000,000
Diesel Fuel	\$ 450,000

In addition to the above estimated expenditures, there will be income taxes generated at both the state and federal levels throughout the life of the mine. Additional tax revenues generated from mining activities will include license fees, motor vehicle taxes, motor carrier taxes, fuel taxes and local retail transaction privilege taxes incurred by mine workers, mine suppliers and other contractors.

Some assumptions have been made in developing Table 4.1, "Estimated Employment Change by Sector for Alternatives 2-5," which warrant explanation.

The Community of Williams may initially receive the most direct economic impacts from the development of the mine for several reasons. The lack of available water, housing and a labor pool in Tusayan, sufficient to meet employment needs of the mine, may limit the economic effects in the Tusayan area. The Williams area has both a labor pool and housing sufficient to meet the immediate employment needs of the additional 10-35 personnel required at the mine. However, it is not clear that

a sufficient pool of qualified miners will be available in the Coconino County area, and accordingly, this assumption may not prove to be completely accurate.

Over time, the secondary economic impacts of the mine will be dispersed over Coconino County.

- (1) Alternative 1 - No Action, disapproval of the operating plan.

This alternative represents the current economic and social situation in Coconino County. Alternative 1 will have little effect on the lifestyle, attitude, beliefs and economy of Williams and Coconino County. Coconino County would be expected to continue to grow at its present rate while Williams would be expected to continue to experience a general economic and population downward trend.

- (2) Alternatives 2-5 - All of these project alternatives include development of the mine.

Social and economic impacts will likely be felt most in the community of Williams and are considered to be beneficial because of increased employment. Population increases or other development in Tusayan should be discouraged by lack of housing, a limited water supply and a small existing work force. However, because the resources of the town are limited, even small increases in population will result in noticeable impacts.

TABLE 4.1 -- Estimated Employment Change By Sector
For Alternatives 2-5

<u>Employment Sectors</u>	<u>WILLIAMS</u> <u>Number of Jobs</u>		<u>Percent Change</u>
	<u>Current¹</u>	<u>Predicted</u>	
Ag & Mining	134	164	+22
Construction	76	79	4
Manufacturing	71	71	0
Trans, Comm & Util	104	111	7
Wholesale Trade	16	17	6
Retail Trade	273	294	8
Finance, Insurance & Real Estate	13	13	0
Services	265	270	2
Public Admin	103	103	0
TOTAL	1,055	1,113	5

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COCONINO COUNTY
(includes Flagstaff & Tusayan)

Employment Sectors	Number of Jobs		Percent Change
	Current ²	Predicted	
Ag & Mining	1,825	1,860	<1
Construction	1,125	1,128	<1
Manufacturing	2,625	2,628	<1
Trans, Comm & Util	2,225	2,235	<1
Wholesale Trade	982	985	<1
Retail Trade	6,168	6,196	<1
Finance, Insurance & Real Estate	600	602	<1
Services	7,975	7,992	<1
Public Admin	8,925	8,925	0
TOTAL	32,450	32,552	<1

¹Williams Chamber of Commerce and Arizona Department of Commerce, May, 1985.

²Arizona Statistical Review, 40th Ed., Sept., 1984, Valley National Bank of Arizona.

If there is no population increase, development of the Canyon Mine should not appreciably affect the existing economic and social structure of Tusayan. Nor should it significantly impact any employment sector for Coconino County as a whole, given the 33,000 job base which already exists.

On a County-wide basis, it is estimated that a total of approximately 100 jobs may be created. The net effect of these additional jobs plus the expenditures associated with the operation of the mine could increase the total annual income in Coconino County by three million dollars or one-half percent.

The Williams area may receive a larger proportionate share of the project employment and subsequent income given its relatively small base of 1,000 jobs compared to the nearly 33,000 jobs in Coconino County. It is possible that upwards of 58 jobs may be created in the Williams area, or a 5 percent increase in the present work force, when the proposed mine reaches its full production capacity.

Most of the jobs would be attributed to direct employment of 10-25 people at the mine. Additional employment might also occur in the transportation, wholesale and retail sectors.

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It is not expected that there will be any significant population changes in Williams because the available labor pool is now present. Small population increases could be readily accommodated by existing City facilities such as schools and other support facilities. These facilities have not operated at capacity for many years.

Given the relatively small potential for a significant population increase there should be little, if any, change in the social structure and lifestyle now present in Williams. Overall, any changes which might occur would have to be considered as being positive given the increased levels of employment and the associated improvement in the relative standards of living.

4.2.1.1 Cumulative Impacts

Additional mines located in Coconino County south of the Grand Canyon will create impacts roughly equivalent to those projected for the Canyon Mine, though the ultimate distribution of impacts within the area will depend on the location of any mine site.

One additional mine located in the Tusayan area will add approximately 58 jobs in the Williams area and 102 jobs in Coconino County. Total income in the County should increase by about \$3 million, or 0.5 percent of the current level. One additional mine would have no significant effect on the services needed in Williams. However, as the number of mines increases, new government and private services may be required.

Three additional mines in the County south of the Grand Canyon would increase employment by approximately 306 new jobs and total income by about \$9.2 million. Total County population would not increase significantly.



4.2.2 IC #3 Proponent-Incurred Project Costs

Project implementation, rehabilitation and mitigation costs were considered for comparison, if they could potentially vary by alternative. The cost of mining would be the same for all project alternatives, and were not used as part of the comparison (e.g. shaft sinking, building construction, energy requirements, etc.). Cost estimates were based on data from contractors, trade journals, etc., and are for comparison only. Actual costs could vary significantly from these estimates.

(1) Alternative 1 - No Action

The No Action Alternative would impose no additional construction or development costs on EFN. However, the costs of exploration and environmental review would be lost and could not be recovered.

(2) Alternative 2 - Proposed Plan of Operation, using Hull Cabin Haul Route #1.

Implementation of this alternative would have a 7-year Net Discounted Cost (NDC) of \$3,398,000 and based solely on economics is the most cost effective alternative to EFN. Project costs are almost 15 percent lower for this alternative than for the next lowest cost alternative. The lower cost results from the absence of monitoring and wildlife mitigation costs, along with decreased powerline costs. Worker transportation costs are high under this alternative because of the expense of company-owned vans.

(3) Alternative 3 - Proposed Plan of Operation with monitoring of air, soil and water; equivalent wildlife habitat replacement; cross country overhead powerlines; parking lot; and using either Hull Cabin haul route #1 or #2.

With an NDC of \$3,761,000 (when using haul route #2), this alternative is the most cost effective to EFN of the three modified alternatives that provide for additional mitigation measures. Wildlife habitat replacement expenditures are highest under this alternative. Worker transportation costs are lower in this alternative because company transportation is not included. A parking lot for private vehicles, in lieu of Company vans, is provided.

(4) Alternative 4 - Proposed Plan of Operation with monitoring of air, soil and water; equivalent wildlife habitat replacement; overhead powerline along access road; coordinated worker transportation; and use of haul route #5.

This alternative has the highest NDC (\$4,786,000) of the four project alternatives because of the high cost of constructing the haul road off the Coconino Rim escarpment. The overhead powerline along the access road also adds appreciably to the project cost.

This alternative has the potential of being the most cost effective route to EFN in the event another mine should be developed in the eastern quadrant of the Tusayan District, and if construction and maintenance costs are spread over both projects. Some wildlife mitigation costs are incurred, but are

considerably less than wildlife costs in Alternative 3, because transportation route #5 avoids most of the important wildlife habitat on the Tusayan District.

(5) Alternative 5 - Preferred Alternative - Proposed Plan of Operation with monitoring of air, soil and water; equivalent wildlife habitat replacement, overhead powerline along access road; pooled worker transportation; and use of either haul route #6 or #7, to minimize haul road impacts. Implementation of this alternative would result in the least amount of new road construction. The alternative is designed to utilize existing road systems.

Because of increased haul distances and associated costs, this alternative is more costly than Alternatives 2 and 3 but less costly than Alternative 4. Initial capital investment is less than half that required in the other project alternatives. The net discounted cost of this alternative is \$4,242,000 with haul route #6, and \$4,103,000 using haul route #7.

Terms, conditions and purchase price for the acquisition of a right-of-way across State and private lands for haul route #7 would have to be negotiated by EFN.

Wildlife habitat replacement costs are the least of the three modified project alternatives.



4.2.3 IC #4 Wildlife

4.2.3.1 Threatened and endangered species

A biological evaluation documenting the impacts of the proposed Canyon Mine on threatened, endangered and sensitive species is included in Appendix C. No adverse effects to threatened, endangered or sensitive wildlife species have been identified.

4.2.3.2 Other wildlife impacts

(1) Alternative 1 - No Action

The No Action Alternative would have no impact on the existing wildlife population or wildlife habitat. The mine site would remain available as a big game foraging area and there would be no ore transport, road construction or improvement associated with mine development. Any beneficial impacts associated with the mitigation measures in the Preferred Alternative --

replacement of habitat and water sources -- would be lost. Wildlife populations would be expected to grow at current rates until limited by habitat availability or other factors.

(2) Alternative 2 - Proposed Plan of Operations using Hull Cabin Haul route #1.

Removal of the topsoil layer within the mine site will eliminate approximately 17 acres of grassland habitat. This will have the greatest adverse effect on small mammals and reptiles whose home ranges are mostly or entirely within the mine site. It is expected that the majority of these animals will be eliminated as their habitat is destroyed. This reduction in local nongame species will not threaten population viability on a region-wide basis, and is considered to be of little consequence in light of total populations and available habitat of non-game species.

Mining activities are expected to disrupt elk use of the grassland opening encompassing the mine site. Elk will avoid foraging in the opening during active mining operations. Approximately 32 acres will be reduced in effectiveness. This represents a loss of about 0.14 percent of the available grassland type on the Tusayan District.

Haul route 1 will require 3.6 miles of new road construction. This equates to approximately 9 acres of vegetation clearing within a 20-foot wide road corridor. This habitat loss will reduce local nongame species that reside within the corridor but will not adversely affect population viability on the Tusayan Ranger District.

Noise and disturbance from ore trucks and increased recreational traffic on haul route 1 are expected to disrupt elk use within one half mile of the road. Use of the habitat will not be denied, but it will not be as effective as it was prior to road upgrading. This loss in habitat utilization will impact an estimated 228 acres of important elk calving habitat. The resultant reduction in habitat carrying capacity is expected to reduce the currently rapid growth rate of the elk population.

Haul route traffic is likely to disrupt the use of adjacent wildlife water sources. Trash Dam, Twin Tanks and Sand Tank are three important water sources that will be affected. These waters represent 13 percent of all reliable waters in the affected area which are historically used by wildlife. The predicted loss in utilization of these tanks will reduce the overall habitat carrying capacity.

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Haul Route 1 travels in close proximity to antelope and deer fawning areas, and turkey nesting areas. Available research and literature concerning the impacts of traffic on the use of these habitats is inconclusive. With no monitoring program, the extent of possible impacts to these wildlife populations will not be known until changes in population size and viability have already occurred. Even with a monitoring program it will be difficult to establish a cause and effect relationship for population changes.

Assuming a 20-foot right-of-way would be completely cleared of vegetation for the powerline, 4.1 acres of habitat would be eliminated. This would have minimal effects on resident wildlife populations due to the narrow configuration of the disturbed area. The powerline poles would provide additional hunting and roosting perches for raptors.

(3) Alternative 3 - Proposed Plan of Operation with monitoring of air, soil and water; equivalent wildlife habitat replacement; cross country overhead powerline; parking lot; and using either Hull Cabin haul route #1 or #2.

Mine site impacts are the same for this alternative as those for Alternative 2. Impacts to wildlife associated with the use of haul route 1 are discussed under Alternative 2 as well.

Environmental consequences resulting from the upgrading and use of haul route 2 are very similar to haul route 1. Route 2 will affect the use of two important wildlife waters, Trash Dam and Sand Tank. Increased traffic flows will discourage the use of these water sources by wildlife. An estimated 55 acres of elk calving habitat will be disrupted by haul route traffic. Ten acres of habitat will be eliminated through new road construction. The ultimate effect of these habitat losses is an overall reduction in habitat carrying capacity.

With a specified 60-inch separation of phase wires, the risk of raptor electrocution would be minimized, and the poles would provide additional hunting and roosting perches.

Under haul route option #2, the total loss in utilization of the various habitat types should be partially offset through the construction of 3 water sources.

(4) Alternative 4 - Proposed Plan of Operation with monitoring of air, soil and water; equivalent wildlife habitat replacement; overhead powerline along access road; coordinated worker transportation; and use of haul route #5.

This alternative will have the same mine site impacts on wildlife as Alternatives 2 and 3. Haul route #5 differs markedly from routes 1 and 2 in its effect on big game habitat.

Assuming that the powerline would be erected within the existing road clearing, no additional loss of vegetation or habitat would occur.

Route 5 bypasses all known deer and antelope fawning areas, elk calving areas and turkey nesting areas. It travels primarily through big game winter range which is not considered to be in limited supply.

Haul route #5 will, however, have some impacts on several important wildlife water sources. Owl Tank, Antelope Tank and Woodbridge Tank are expected to decline in effectiveness due to traffic disturbance. The loss of these tanks represents a 13 percent reduction in reliable waters within the affected area. It also results in an overall reduction in habitat carrying capacity. The loss in utilization of the three affected water sources should be entirely offset through the construction of three new water sources, in areas having suitable habitat characteristics except for a lack of reliable water.

(5) Alternative 5 - Preferred Alternative - Proposed Plan of Operation with monitoring of air, soil and water; equivalent wildlife habitat replacement; overhead powerline along access road; coordinated worker transportation; and use of haul routes #6 or #7.

Mine site impacts are the same for this alternative as for Alternatives 2, 3 and 4. The buried cable powerline that parallels the access road, should have little or no effect on vegetation and wildlife. Note that the Preferred Alternative adopts Alternative 5, but substitutes an overhead powerline. The impacts of an above ground line are discussed under Alternative 2.

Using haul route #7, the most greatest impact could result from unrestricted haul-route use during the winter months. An estimated 11 percent of the Game Management Unit 7 elk population crosses within two miles of Cedar Ranch during seasonal migrations (Appendix C). The increased recreational and ore traffic use during the winter months could disrupt traditional elk migration patterns.

Maximizing the use of existing State and Federal highways in haul route #6 will result in minimal impacts to wildlife and wildlife habitat. No new road construction will be required and development of a new water source to replace the loss of Owl Tank will further reduce potential impacts to wildlife.

4.2.3.3 Cumulative Impacts

Impacts on wildlife resources will generally be localized to the mine site and haul routes. The level of impacts will depend on the location of mines and roads relative to important habitat. Each additional mine and any new road construction will displace some additional habitat in the area and impact nearby habitat. For example, each mine site, if comparable to the Canyon Mine, would displace 15-20 acres of habitat near the mine site.

Similarly, wildlife habitat will be impacted by construction of new ore haul routes. The impact will be reduced if common haul routes are used or if road-use is restricted during the elk calving period.

Wildlife impacts will also depend on the mitigation measures required at each mine. With proper mitigation, the impacts of one additional mine in the Tusayan area or three additional mines in Coconino County south of the Grand Canyon would not be expected to be significant unless mining operations and haul routes are concentrated in critical habitat.



4.2.4 IC #6 Visual Impacts

For evaluation purposes, visual impacts are broken into two categories, impacts at the mine site and impacts along haul routes. Alternative 1, the No Action Alternative, would have no impact on visual quality near the mine site as no structures would be constructed. No impacts from road construction or improvement associated with the mine would be expected.

Impacts at the mine site are identical for Alternatives 2-5. Visual impacts would consist primarily of short-term reversible alterations of the natural character and overall scenic quality of the viewed landscape. These impacts are related to changes in vegetation, topography, intrusion of project related equipment and machinery at the mine site, and vehicle traffic along the respective haul routes.

4.2.4.1 Mine site visual impacts

Visual quality associated with the Grand Canyon will not be affected with the development of the Canyon Mine regardless of the alternative selected for implementation. Alternatives 2-5

will alter the short term visual quality at the mine site. Reclamation measures should effectively restore the area to its present characteristic landscape.

The mine site will be visible from the road adjacent to the mine and from aircraft. The headframe of the mine will not be visible from State Highway 64, Forest roads 688, 305, 302 or the Grand Canyon National Park.

The most visible intrusion will be the mine headframe which will be approximately 100 feet in height. It will be visible only from Forest roads 305A and 308, but then only within one-half mile of the mine site. The minor visual impact of the headframe and surrounding structures will be mitigated to some extent by selecting an appropriate paint color that blends with the characteristic landscape.

Changes in vegetation and topography at the mine site will result from clearing grass, bushes, and a few small trees from the project area and will be generally limited to the duration of the mine. Reclamation of the disturbed area following mining will return the visual characteristics of the mine site to something approaching its present nature.

Impacts on visual quality will be site specific and no cumulative impacts are expected from the potential development of additional mines.

4.2.4.2 Haul route visual impacts

Haul route selection will have a limited effect on the scenic qualities on the Tusayan Ranger District. Implementation of Alternative 4 would have the greatest effect by constructing a road off the Coconino Rim in a location that would be visible to travelers going to and from the Grand Canyon by the east Highway 64 entrance.

Along the haul corridors, an average of 10 to 20 ore trucks each day will intrude upon the relatively untraveled natural landscape. Road improvement necessary to ore haulage may indirectly result in some increased local or tourist traffic along the same route, creating a proportionately greater visual intrusion.

(1) Alternatives 2, 3, and 5

Under these alternatives, the Forest visual quality objectives will be met. Visual characteristics adjacent to haul routes will not be appreciably altered. Utilization of haul route #6

(existing State Highways) in Alternative 5 will have the least visual impacts on scenic qualities by avoiding the need for additional road construction.

(2) Alternative 4

This alternative achieves Forest guidelines for the assigned visual quality objective but will result in a road scar on the Coconino Rim escarpment which will be visible from State Highway 64 near the east entrance to Grand Canyon National Park.



4.2.5 IC #7 Air Quality Impacts - Dust and Radon Gas

Changes in air quality may result from the mine construction, operation and transportation of ore. Dispersion models were used to calculate the maximum TSP concentrations possible from the Canyon Mine site and the proposed haul routes. The Industrial Source Code (ISC) was used to calculate the annual average and highest 24-hour Total Suspended Particulates (TSP) concentration that could result from operations at the mine. CALINE-3 was used to calculate maximum short-term particulate concentrations from ore truck traffic on the haul roads. Extreme meteorological data were specified to provide an estimate of potential ground level TSP concentrations.

No significant air quality impacts will occur in the Grand Canyon National Park as a result of the proposed Canyon Mine, even under the most extreme conditions.

No Action

Under Alternative 1, the No Action Alternative, levels of particulates and radon gas in the area would remain at current levels. Naturally occurring radiation would still be present in varying levels and traffic along forest roads would generate temporary increases in particulate levels. The air quality impacts associated with development of the Canyon Mine and transportation of ore would not occur.

4.2.5.1 Particulates

The National Ambient Air Quality Standards (NAAQS...) for particulates are 260 ug/m^3 for the 24-hour average and 75 ug/m^3 for the annual geometric mean. The State of Arizona

has adopted the same standards. The Federal Prevention of Significant Deterioration (PSD) regulations will not apply to the Canyon Mine because emissions will be fugitive dust which is not subject to PSD requirements under either Federal or State of Arizona regulations. However, the allowable particulate increments for PSD Class I areas (National Parks and Wilderness Areas) are referenced for the purpose of analyzing potential impacts on the Grand Canyon National Park. The PSD increments established for Class I areas are 5 ug/m³ for the 24-hour average and 1 ug/m³ for the annual average.

(1) Mine Site Impacts - Alternatives 2-5

The only nonradiological pollutant to be released in any measurable amount from the construction and operation of the Canyon Mine will be particulate matter, emitted as fugitive dust and measured as Total Suspended Particulates (TSP). Particulate matter emissions can be expected from land clearing, earth moving, and shaft and haul road construction. Operational fugitive dust will result from ore and waste rock removal, transport, storage activities and wind erosion of exposed surfaces.

Particulate data have been collected by the Park Service at Hopi Point in Grand Canyon National Park for a number of years. The Hopi Point TSP station is located approximately 16 miles northwest of the Project Area. Because of the close proximity of this monitoring station to the Project area, the similarities in climatology and the absence of nearby major industrial sources, these data are representative of the Project Area. The expected TSP baseline of the Project Area are estimated to range from 5 to 16 micrograms per cubic meter (ug/m³) on an annual basis, with maximum 24-hour concentrations in the range of 47 to 58 ug/m³.

An emissions inventory for the mining project at maximum production was developed to assess potential air quality impacts. The inventory quantified all operations and activities associated with the Canyon Mine that could potentially result in the atmospheric release of pollutants. In order to establish an upper limit on potential air quality impacts, no emission controls or mitigation techniques were assumed to be in effect on any potential source.

During a full production year, absent emission controls, a total of 34.4 tons per year of TSP emissions could potentially be released by operation of the Canyon Mine. The primary source of TSP emissions within the project area will be wind erosion of disturbed areas and ore stockpiles. These emissions account for approximately one-half of all TSP emissions. Since haul trucks will be tightly covered with tarpaulins, haul road

emissions will result exclusively from natural dust from the road surface. TSP emissions from haul roads are dependent upon the number of haul trucks, their speed, the silt content of the road surface and precipitation. Based on the factors expected for the proposed activity, the resultant dust emissions from each mile of unpaved road is calculated to be 9.68 tons per year. Total emissions will depend on the length of the haul road selected.

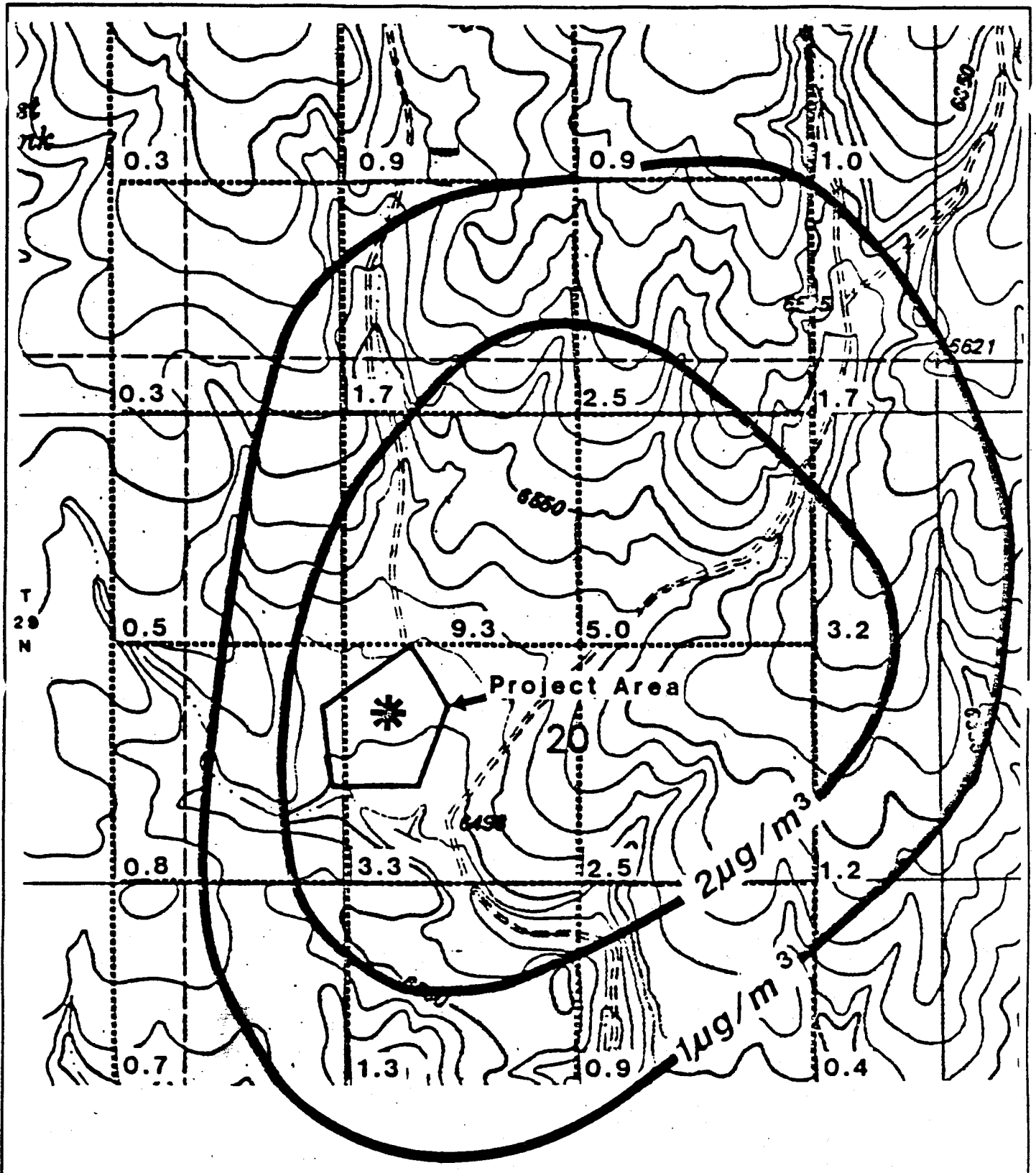
The results of the annual Industrial Source Code (ISC) modeling are shown in Figure 4.1. Predicted particulate concentrations resulting from mine operations are shown as lines of constant concentration or isopleths. All concentrations are well below both National Ambient Air Quality Standards (NAAQS) and Federal Prevention of Significant Deterioration (PSD) standards. The maximum off-site 24-hour particulate concentration reflecting extreme meteorological conditions, was 26 ug/m^3 . The annual particulate background in the vicinity of the mine site is, at a maximum, 16 ug/m^3 . Even adding this background concentration to the modeled impact, the resulting concentrations are predicted to be quite low, with a average maximum impact of 42 ug/m^3 . Figure 4.1 also shows that the 1 ug/m^3 significance level isopleth, at its furthest distance, extends only 1,200 to 1,500 meters from the Project Area. Thus, there should be no impact from the proposed Canyon Mine on Grand Canyon National Park.

(2) Haul Route Impacts - Alternatives 2-5

To assess the maximum potential impact from haul road routes, the CALINE-3 model was used assuming a perpendicular wind direction for most haul road segments and a parallel wind direction for any road segment which subsequently makes a sharp, near 90 degree turn. Extreme meteorological conditions were also assumed where associated risks would be the greatest. All projected concentrations are well below the NAAQS.

The Federal Clean Air Act establishes goals for the protection of visibility within Federal Class I areas, including the Grand Canyon National Park. Release of light-scattering particulates may affect visual range, thus the projected emissions of particulate from ore haulage activities were analyzed to determine potential impacts on visibility in the Park.

Results of the CALINE-3 modeling of the road segment closest to the Park boundary and under extreme meteorological conditions show that the projected 24-hour particulate concentration at the boundary would be 3.0 ug/m^3 , well below the Class I PSD standard of 5 ug/m^3 level of significance.



* CANYON MINE SITE



1" = 2000 FT.

ANNUAL AVERAGE
TOTAL SUSPENDED
PARTICULATE
(TSP)
CONCENTRATION

FIGURE
4.1

Ore haulage near the Park may result in particulates being transported into a small section of the Park. Under worst-case meteorological conditions, a small reduction in visibility could occur if an observer were looking through this area when haul route traffic was present. Any visibility reduction should be short-lived as traffic would pass the area in less than 5 minutes. Haul routes #5, #6 and #7 are so far removed from the Grand Canyon as to preclude the possibility of any visibility impairment to the Grand Canyon because of increased particulate concentrations derived from unpaved road surfaces.

The use of haul route #6 (existing State Highways) virtually eliminates any potential increase of additional particulates to the atmosphere because of the paved road surfaces.

4.2.5.2 Airborne radiation

(1) Radon Gas Emissions - Alternative 2 - 5

Radon gas will diffuse from the ore piles and be exhausted from the mine vent. Once airborne, the gas will be transported away from the area by prevailing winds and will decay. Radon progeny also will be exhausted from the mine vent. Radon progeny, however, have rapid decay rates and quickly become of no concern.

Uranium and all progeny will be present in dust blown off the ore piles and in dust released from the mine vent. The potential impact from these radionuclides may be determined based on the magnitude of each release and the prevailing meteorological conditions. Dispersion models were used to project the concentrations of released radionuclides.

The annual radon gas release from the high-grade ore stockpile and lowgrade material storage pile was calculated to be 764 Ci. An end release of 4,300 Ci was determined by measuring the actual radon emission from the vent at the Hack Canyon Mine. The MILDOS Code modeled the dispersion of these radon sources using the generic wind rose for normal conditions. In addition, the code modeled radon concentrations for extreme meteorological conditions. For this case hypothetical meteorology and wind conditions were established to provide maximum radon at the locations of interest. Basically, the wind rose was rotated so that the prevailing winds carried the radon directly to each location of interest. Results for the normal and extreme situations are presented in the following tabulation:

Projected Increases in Radon Concentrations
at Specific Locations

<u>Location</u>	<u>Distance from Site (km)</u>	<u>Radon (pCi/L) Normal Conditions</u>	<u>Radon (pCi/L) Worst Case</u>
Owl Tank	2.2 SSE	0.019	0.120
House (Old Grand Canyon Airport)	3.4 SSE	0.011	0.061
U.S. Highway	3.2 W	0.028	0.068
Tusayan	9.9 NW	0.005	0.020

For the residents of Tusayan, the most extreme potential increase in radon concentration of 0.02 pCi/L results in an increased lung dose of only 12.5 mrem/yr. This may be compared against the normal background outdoor Rn-222 concentrations for this area which have been measured in the range of 0.2 to 0.8 pCi/L, providing a lung dose of about 125 to 500 mrem/yr. However, since individuals spend time indoors where radon levels are higher, or may even reside in energy-efficient dwellings which typically have higher radon concentrations, lung doses from sources unrelated to the proposed mining activities may increase measurably. If the winds behave as predicted by the generic wind rose, then the mine radon which reaches Tusayan will be on the order of 0.005 pCi/L and would contribute an additional dose of only 3 mrem/yr. Therefore, when compared to normal outdoor concentrations, radon doses to residents of Tusayan might increase about 10 percent assuming an extreme risk scenario and realistically will increase about 2 percent or less. None of these potential increases could be distinguished from normal fluctuations of the natural radon environment.

(2) Radioactive Dust - Alternatives 2 - 5

Radioactivity in dust emissions from the ore piles and mine vent was analyzed using the Industrial Source Code (ISC) dispersion model. Thus, dispersion of radioactive materials is equal to the dispersion of particulate matter analyzed in Section 4.2.5.1. If all of the potentially radioactive particulate matter includes 1 percent uranium, the 1 ug/m³ particulate isopleth of Figure 4.1 represents a natural uranium concentration of 0.01 ug/m³. For purposes of comparison, the Nuclear Regulatory Commission limits natural airborne uranium releases from federally licensed uranium processing facilities

to 3.0 ug/m³. The Canyon Mine is not subject to these regulations, but they provide a useful comparison as releases from mine operations are approximately 300 times less than permissible releases from licensed milling facilities. The radiological impacts of Alternatives 2-5 are considered to be indistinguishable.

4.2.5.3 Cumulative Impacts

Each additional mine can be expected to contribute 25 to 30 tons of TSP per year and each additional mile of haul road would add 35 to 40 tons of TSP per year. Cumulative impacts will be limited however, as particulates settle quickly near the site and haul roads.

There would be no cumulative impact from one additional mine in the Tusayan area unless it and the Canyon Mine were within a few miles of each other. No violation of air quality standards would be expected. If both mines used the same haul route, transportation related emissions would increase. If the Hull Cabin route were selected, the frequency of potential visibility impacts on the Grand Canyon National Park would also increase.

Three additional mines in the County should produce no cumulative impacts with the Canyon Mine unless common haul routes are used. If several mines use the same haul route, additional mitigation measures including paving or watering might be required to limit TSP emissions.

The radiation impacts from the mine operations are largely site specific. Airborne radioactivity will disperse within a short distance of the mine site and specific impacts will depend on meteorological conditions in the site area. One additional mine near Tusayan might add an additional 3 mrem/yr to the annual lung dose at Tusayan if it were located such that meteorological conditions would add its radiation contribution to that of the Canyon Mine. That increase would be insignificant when compared with existing background levels. Three additional mines in Coconino County south of the Grand Canyon would not make a significant contribution to cumulative levels of radiation in the county. Impacts would be localized near the mine sites.



4.2.6 IC #8 Transportaion Routes

Traffic counts have been taken on several roads on the Tusayan Ranger District. Traffic varies considerably along any

specific road segment (Fig. 3 in Appendix B), but is generally considered low over most of the District. Fluctuations are due to various resource activities in a specific area, such as timber and range projects. With the exception of certain private lands with residences, there are no major attractions within the Tusayan Ranger District to create a continuous or high level of travel.

Past studies have shown that when roads similar in nature to the proposed haul routes are improved, the volume of casual traffic will increase approximately 20 percent. This increased use is a combination of traffic from other roads and new users taking advantage of the improved access.

The selected uranium ore haul route across the Forest will be upgraded to a single-lane (14 ft. wide) route with good grade and alignment, ditched and culverted for drainage and surfaced with 6 inches of aggregate. This same standard applies to haul route #7 across State and private land. All road grades are based on a maximum of 8 percent. Clearing would be restricted to a minimum width necessary to safely accommodate the traffic while allowing for snow removal and snow storage.

In the Proposed Plan of Operations, ore haulage rates are given as 200 tons of ore per day (10 loaded vehicles). The described 14-foot standard will provide for this use except during spring snowmelt or other short periods of adverse weather (heavy snow, prolonged rainy spells, etc.) during which time the haul route subgrade would not support the loads.

Ore Truck Accidents

The possibility of an ore truck accident resulting in a spill of uranium ore exists along all haul route alternatives. Data from EFN indicates that ore transport for their mines in northern Arizona has resulted in five ore spills in approximately 6,600,000 miles of ore transportation. Only in one case was more than 2 tons of ore spilled and in all five cases, all spilled ore was recovered. Mitigation measures require that appropriate federal and state authorities be notified and that any spilled ore be cleaned up immediately. Tribal authorities will be notified of any spills on Indian lands. (See Section 2.5.5.) Existing response plans and mitigation measures appear to be effective -- every ore spill has been cleaned up with no residual contamination. Thus, should an accident occur, the potential for exposure to low level radiation from uranium ore is limited in duration.

In the event of a spill, traffic and wildlife passing the immediate vicinity of the spill would be temporarily exposed to extremely low levels of radiation until the spill is removed.

Normal spill removal techniques may not be effective for an accident which spills ore into flowing surface water. Ore which cannot be removed from the stream will create a temporary increase in stream particulates and extremely low-level radioactivity. (See Appendix E, pp. 27 and 28.)

Wildlife impacts resulting from a specific haul route alternative are described in 4.2.3.

(1) Alternative 1 - No Action

If the Plan of Operations were not approved, traffic along all of the haul route options utilizing existing roads or highways would remain at current levels, subject to increases associated with other uses including mineral exploration, timber harvesting or recreation. Use of Forest roads on the Kaibab National Forest is discussed in the DEIS on the Kaibab Forest Management Plan, July, 1986.

(2) Alternative 2 - Proposed Plan of Operation using Hull Cabin Haul Route #1.

Short sections of new construction would be required on this haul route to connect the mine to Road 302 and for an improved access off the Coconino Rim escarpment near Hull Cabin. Reconstruction will be minor, consisting mainly of gravel or cinder surfacing, with some widening of the travelway and corridor clearing. This route uses existing Forest arterial roads except for some minor realignment south of Hull Cabin, which would improve the road grade and move the road further south and away from the stock tank. Upgrading this road system would improve access to lands on the Tusayan District that are classified as suitable for commercial timber production.

A total of 3.6 miles of new road construction and 23.9 miles of reconstruction will be required using haul route #1. Approximately 40.3 thousand board feet (MBF) of timber will be removed as a result of the road work. Cattle grazing capacity would be reduced by about 8 animal-unit-months (AUM's). This represents only 0.05 percent of the District's total grazing capacity.

Since haul route #1 traverses the portion of the Tusayan Ranger District where archeological site density is low, the potential for inadvertent site damage is minimal. Only minor realignment would be needed or very few site excavations required to mitigate impacts to cultural resource sites.

This haul route would be subject to seasonal closures due to snow accumulations in the winter and wet road conditions during spring thaws.

- (3) Alternative 3 - Proposed Plan of Operation with modifications, and use of either transportation route #1 or #2 along the northern boundary of the Tusayan Ranger District.

This alternative uses either haul route #1 (discussed above) or haul route #2. Haul route #2 is a modification of route #1, designed to shorten the haul distance and improve the road grade and alignment off the Coconino Rim escarpment. These modifications would increase initial costs, but shorten the haul distance by 2.1 miles. There would be 4.1 miles of new construction, and 21.3 miles of reconstruction consisting primarily of road widening and resurfacing with cinders or gravel. Although haul route #2 requires the largest amount of timber removal (76.5 MBF), this represents only 0.016 percent of the District's total commercial timber.

The potential impacts to cultural resources from haul route #2 are very similar to haul route #1. Under haul route #2, grazing capacity would be reduced by 8 AUM's.

- (4) Alternative 4 - Proposed Plan of Operations with modifications, and construction of haul route #5 off the Coconino Rim escarpment.

Haul route #5 was designed to reduce the impacts of ore hauling on wildlife. It uses Road 320 and requires new construction off the east end of the Coconino Rim near Upper Cabin Tank. Haul route #5 would be the most cost effective of the routes considered if future mines are developed in the southeast quadrant of the Tusayan Ranger District. However the construction costs of this haul route are the highest of the haul options because of the steep topography of the Coconino Rim. Haul route #5 would require 2.9 miles of new construction and 30.6 miles of reconstruction. Very little timber would be removed (10.1 MBF), but cultural resource site densities are high (>25 sites/mi²), which could require costly site excavation if roads could not be relocated to avoid the sites. About 7 AUM's would be lost which equates to 0.04 percent of the District's total grazing capacity.

- (5) Alternative 5 - Preferred Alternative - Proposed Plan of Operation with modifications, and use of haul route #6 (all highway) or route #7 near SP Crater (pending right-of-way acquisition across 20 miles of State and private land).

Haul route #6 uses State Highway 64 south to I-40, east to U.S. 89, north to U.S. 160 and north again on U.S. 191 to Blanding. Total haul distance is increased by 35 percent, but no investment in new road construction is required. Only 4.8 miles of Forest road would require reconstruction and maintenance.

This route has the least environmental impacts of any of the routes considered. Accidental spills of uranium ore from haul trucks may occur on routes having 100-250 times the volume of traffic as on the other described routes, thereby briefly exposing passing traffic to low levels of radiation emitted from the uranium ore until such time the spill was cleaned up.

Haul route #7 incorporates State Highway 64 to Valle, US 180 to the Coconino Forest Road 417, and 417 and an unnamed extension across State and private property to intersect US 89.

Potential impacts to wildlife along this route are minimal since no key habitat is intersected. It does however cross an elk migration route which is used during the period from late December through mid February. No new road construction would be required, but 29.8 miles of minor reconstruction is needed.

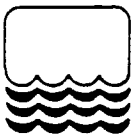
Route #7 passes within a few hundred yards of the Cedar Ranch Headquarters. Other than one seasonal occupied dwelling this is the only residence on this route.

Only 900 board feet of timber would be removed for the widened road corridor along Roads 305 and 305A.

Cultural resource site densities vary from low to moderate along this haul route option.

Five AUM's of grazing capacity would be lost, or about 0.03 percent of the District's total grazing capacity.

Route #7 greatly increases haul costs while significantly reducing initial investment. Failure to negotiate acquisition of a right-of-way across State and private land would preclude this alternative from being implemented.



4.2.7 IC #9 Impacts on Soil and Water Resources

The proposed mine site is subject to shallow flooding during extreme runoff events. Alternative methods have been proposed to divert storm runoff away from the mine site.

The mine may require 8 acre-feet of potable water from the Williams water supply if a water source is not developed at the mine. This additional use is considered insignificant, given the available supply of 2,750 acre feet and the annual consumption of 350 acre feet in Williams.

4.2.7.1 Surface water

(1) Alternative 1 - No Action

If the Canyon Mine is not developed, the mine site will remain subject to surface flooding. Uranium occurring at or near the surface may be eroded and washed into drainages in the area. However, there will be no ore or waste piles. The naturally occurring uranium in the Canyon Mine breccia pipe will remain subject to leaching into subsurface waters. Perched aquifers at the mine site, if any, would be affected only by natural processes. Impacts on seeps and springs are considered indistinguishable from the operational alternatives.

(2) Alternative 2 - Proposed Plan of Operation using Hull Cabin Haul Route #1.

The proposed diversion channels will be of sufficient size to carry runoff from a 100-year, 1-hour storm event. During runoff from larger events, channel capacity might be exceeded and flood control would depend on the effectiveness of the dikes along the water course. It is estimated that the channels would be only partially effective in controlling storms larger than the 100-year event. If the diversion structure is not fully effective, contaminants from the ore or low grade stockpiles could be released into surface water drainages near the site.

Construction of the diversion channels would require considerable site disturbance, including earth moving and removal of natural vegetation. The steep gradients of the artificial channels and the concentration of the flow might cause increased erosion and channel instability unless the bed and banks of the channel are heavily enforced.

(3) Alternatives 3-5

An altered storm control plan is proposed as a part of all modified project alternatives. From stockpiled top soil and borrow material within the mine yard, a dike will be constructed around the perimeter of the mine site. The borrow area will be later filled with waste rock generated during shaft sinking. This would confine flows to existing natural channels, cause the least amount of site and channel disturbance, and should have the capacity to handle the volume of water expected in flood events on the order of at least a 500-year recurrence interval (Table 4.2). A concept plan for surface-water control system is shown in Figure 4.2.

As seen in this Figure, perimeter geometry would be modified slightly from the original mine plan to take maximum advantage of high ground and existing channel capacity. Another important feature of this concept plan is the reduction in perimeter width at the south end of the site, which provides additional flow capacity for the channels that merge together in this area. The ford crossing and approach ramps into the site, would efficiently control overland flow near the southwest corner of the mine site.

Diking of the mine site perimeter would involve less surface disturbance and create less potential for erosion or soil instability than the construction of diversion channels as proposed in Alternative 2. In the unlikely event that the storm control measures fail or runoff exceeds design capacity, the potential downstream effect of a release from the mine site was analyzed. Any release would be quickly diluted by storm runoff (Fig. 4.3).

The potential downstream impacts were analyzed for two watershed antecedent moisture conditions (AMC). The first, designated AMC I, assumes the storm occurs when the watershed is initially dry. A second condition, designated AMC III, assumes the watershed is wet before the rainfall begins.

Figure 4.3 summarizes percent of initial impact (concentration or load) as a function of distance downstream for the AMC I thunderstorm and AMC III general storm. Both scenarios show considerable reduction of initial impact (either concentration or load) in the first 2 miles. Just below Owl Tank at Node 2, the reduction of initial impact would be 70 percent for the AMC III general storm and 90 percent for the AMC I thunderstorm.

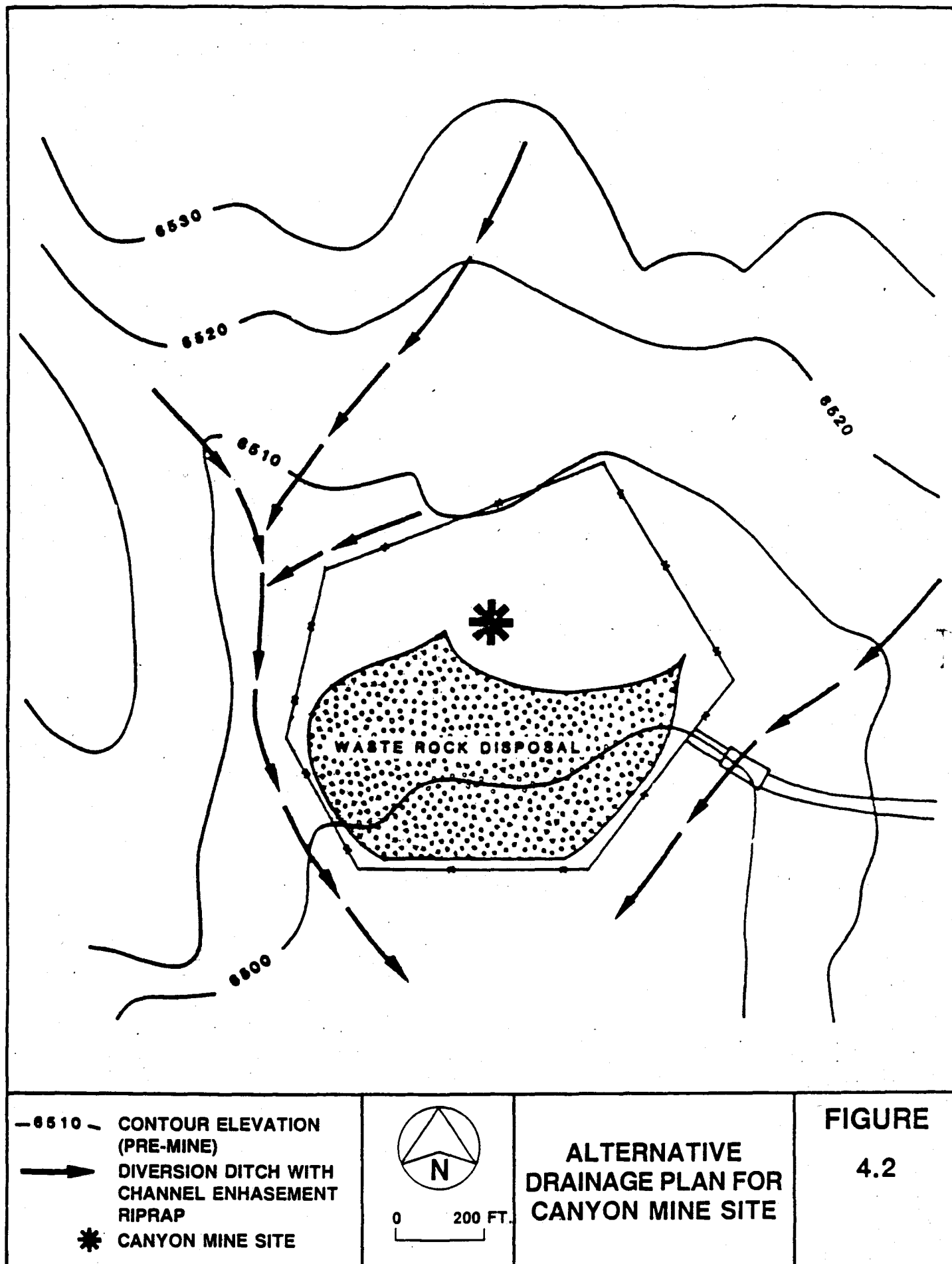
Impacts from any sediment or leachate introduced at the mine rapidly diminish with distance downstream. At the confluence of Little Red Horse Wash with Red Horse Wash some 13.5 miles downstream, it is estimated that initial impact would be diminished by approximately 98 percent for both general and local thunderstorm flood occurrences that exceed diversion channel capacities.

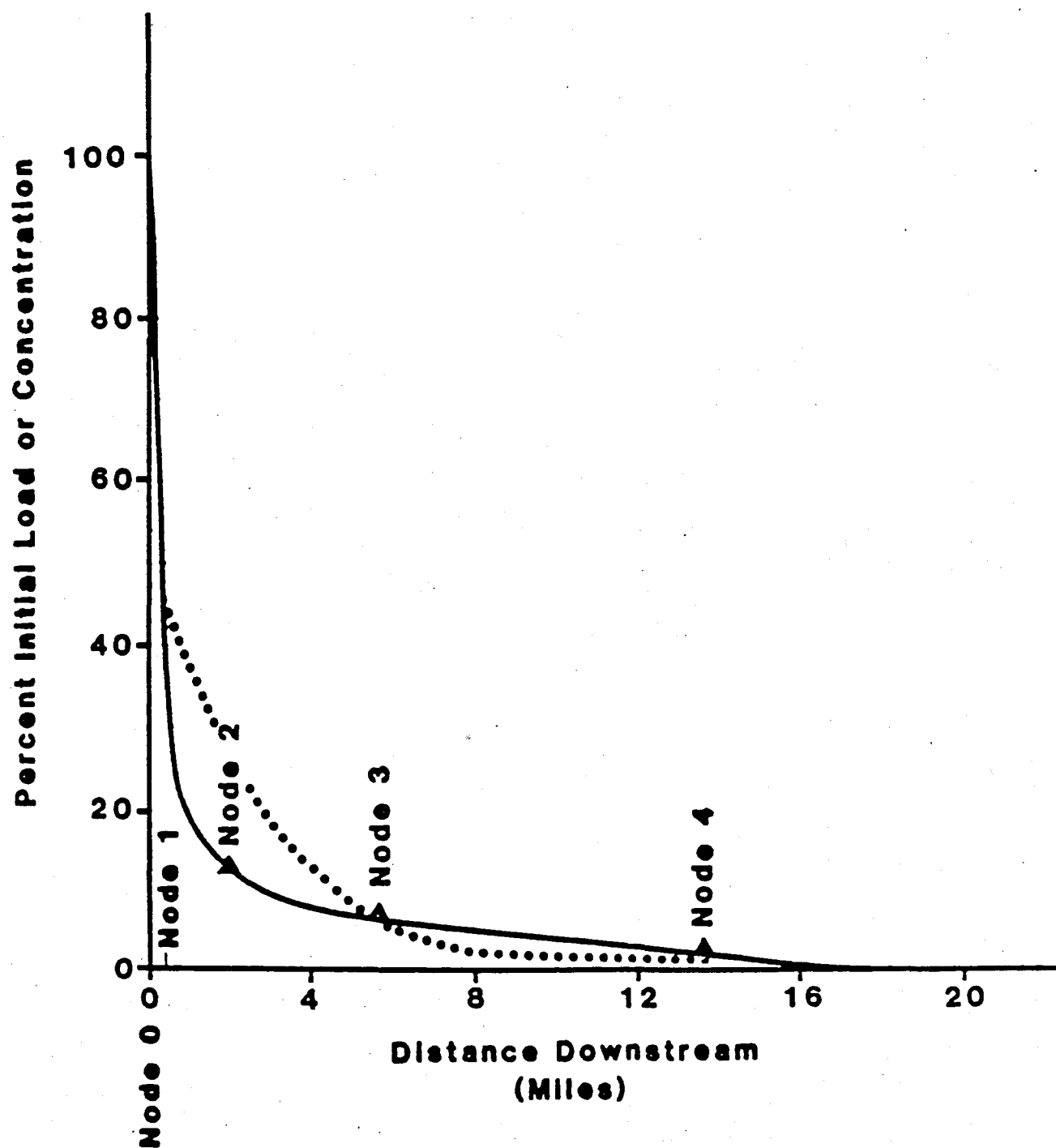
Groundwater underflow in the channel alluvium in this reach of the drainage does not occur except during, and for a short time after, flood flow in the channel. If contaminants are released and enter the Kaibab Limestone, the water containing the contaminants will percolate downward until it meets a confining rock layer with sufficiently small permeability to detain the flow. Where the water is detained, a saturated zone forms above the confining layer, and lateral groundwater movement begins. This saturated zone may comprise a perched groundwater

TABLE 4.2 - Summary of Peak Discharge
and Runoff Volume for Various Recurrence Interval Storms.

Storm Analyzed	NODE									
	0		1		2		3		4	
	Peak (cfs)	Vol. (a-f)	Peak (cfs)	Vol. (a-f)	Peak (cfs)	Vol. (a-f)	Peak (cfs)	Vol. (a-f)	Peak (cfs)	Vol. (a-f)
AMC* I Thunderstorm										
2-yr.	41	5.6	67	12.3	77	18.7	340	121.1		
10	124	16.8	200	36.8	232	56.2	1021	363.2		
25	187	25.2	300	55.2	309	74.9	1362	484.3		
50	207	28.0	333	61.3	386	93.6	1702	605.3		
100	249	33.6	400	73.6	502	121.7	2213	786.9		
500	352	47.6	567	104.3	695	168.5	3064	1089.6		
AMC* III General Storm										
2-yr.	228		367	67.5	425	103.0	1873	665.9	2014	926
10	664		1067	196.3	1235	299.5	5448	1937.1	8055	3704
25	767		1234	226.9	1429	346.3	6299	2239.7	9062	4166
50	829		1334	245.3	1544	374.4	6810	2421.3	10572	4861
100	954		1534	282.1	1776	430.6	7831	2784.5	11076	5092
500	1120		1801	331.2	2085	505.4	9193	3268.8	13593	6250
Roeske (1978)										
2-yr.	20		33		44		124		229	
10	131		203		258		743		1073	
25	259		392		491		1327		1873	
50	403		601		746		1932		2688	
100	598		878		1080		2697		3705	
500	1329		1893		2290		5315		7119	
Est. Flood of Aug. 14, 1984	106		908		1350		2447			

* Antecedent Moisture Condition (Class I = dry; Class III = wet)





— ANTECEDENT MOISTURE
CONDITION I
(THUNDERSTORM)

..... ANTECEDENT MOISTURE
CONDITION II
(GENERAL STORM)

ESTIMATED DOWNSTREAM
EFFECTS OF INTRODUCED
SEDIMENT OR LEACHEATE
FROM PROPOSED CANYON
MINE FOR FLOOD
OCCURRENCES

FIGURE
4.3

reservoir. Because the confining layers are not completely impermeable, part of the perched water eventually leaks downward through the confining layer. The remaining groundwater will move laterally until it encounters fractures which permit the water to move downward and bypass and the confining layer, or until the water discharges along canyon walls at seeps and springs.

The report on potential surface water impacts, (Appendix D), indicates that the preferred drainage plan at the mine site would be effective for diverting floods from storms with a 500-year recurrence interval. The report indicates that the largest floods observed in the Canyon Mine watershed have not flowed beyond 18 miles from the mine site. (Appendix D) The analysis of surface water impacts investigated potential impacts of transport of ore-bearing sediments downstream from the mine site after failure of the proposed drainage controls during extreme floods. Much of the runoff would be lost through evaporation and most of the remaining diluted fraction would infiltrate. Suspended sediment would be removed from the runoff by natural filtration. Surface water runoff at the proposed mining operations would have little or no impact on chemical quality of groundwater because of the following:

- o Due to dilution, concentrations of dissolved radioactive minerals in the runoff would be small in floods sufficiently large to cause failure of the proposed drainage controls;
- o The initial low concentrations of radioactive minerals would be decreased significantly via chemical precipitation and hydrodynamic dispersion in the subsurface;
- o The probability is small that a flood sufficiently large to cause failure of the proposed drainage controls would occur during the approximate 10-year period from the first intersection of ore by mine openings to the end of reclamation operations; and
- o According to the Plan of Operations, retention ponds for localized on-site storm runoff and for captured mine shaft drainage will be lined to prevent seepage.

4.2.7.2 Subsurface water

All project alternatives employ the same mining methods, therefore the possible effects on ground water would be the same for all operational alternatives (Appendix F).

(1) Perched Aquifers - Alternatives 2 - 5

If perched aquifers are not encountered at the site, mining operations will have no effect on circulation and storage of groundwater. If perched groundwater is encountered, the water will drain into the various mine openings. This drainage may remove small amounts of water from storage in the local system, but since the perched groundwater zones are commonly thin and discontinuous, the drainage would not be expected to affect adjacent groundwater resources.

Because data do not exist to specifically define groundwater flow in perched fractured rock aquifers near the mine, and because pumping from a discontinuous perched groundwater reservoir would not typically be expected to influence pumping conditions from a nearby discontinuous perched reservoir, drawdown effects on springs and wells of draining a perched aquifer were predicted utilizing the following extremely conservative assumptions (Appendix F, pages 34-35):

- o The perched aquifer is continuous rather than discontinuous;
- o Saturated thickness is 100 feet rather than a few feet;
- o Aquifer permeability and coefficient of storage would be about 50 gallons per day per square foot and 0.05, respectively, as at the municipal wells at Flagstaff;
- o Time of continuous pumping is 50 years rather than 10 years;
- o Pumping rate is 20 gallons per minute rather than five gallons per minute; and
- o The aquifer conditions can be analyzed using the Theis equation.

The effect of using these conservative assumptions is to overestimate drawdown impact. Under these extremely conservative assumptions, theoretical drawdown impact at the nearest well of record outside the mine site would be 0.6 feet. This well is an abandoned mineral exploration borehole located about 2-1/2 miles southwest from the mine site. Records indicate that the nearest water supply wells completed in perched aquifers occur near Tusayan, located six miles northwest from the mine site. Theoretical drawdown at these wells would be about 0.1 foot. Inspection of the Tusayan wells in June 1977 and interviews with well owners in June 1986 indicate that the wells are abandoned. Pumping rates of less than one gallon per minute for short periods resulted in excessive water level drawdown in most of these wells. All water supply for Tusayan is trucked from reliable water sources at Williams, Grand Canyon, or Flagstaff, Arizona. Because the perched aquifers are thin, discontinuous, and ephemeral, the drawdown effect of drainage of perched groundwater into the

mine would be negligible or nonexistent at seeps and springs in the vicinity of Cataract Canyon, located more than 20 miles west from the mine site, or along the south wall of the Grand Canyon, located more than 10 miles north from the mine site.

In view of the data on groundwater conditions and the analysis discussed above, it appears that the proposed mining operations at the Canyon Mine site will have little or no impact on groundwater circulation and storage in perched aquifers (other than any perched aquifer drained by the mine), and will have negligible or no impact on springs and wells that yield groundwater from perched aquifers.

Sinyella Spring, a major spring on the Havasupai Reservation, is located about 25 miles west from the mine site. Cataract Canyon separates Sinyella Spring from the mine site and the distance between the spring and the mine site is large. The source of water for Sinyella Spring is a perched aquifer on the west side of Cataract Canyon. Perched aquifers in the area, particularly aquifers on opposite sides of large canyons, are discontinuous. Adverse impacts on Sinyella Spring do not appear to be possible.

(2) Redwall-Muav Aquifer - Alternatives 2 - 5

Impacts on the Redwall-Muav aquifer are considered separately since the discharge from the aquifer exceeds 100,000 gpm at Blue Springs, Havasu Spring and Indian Garden Springs, and groundwater storage is relatively large.

Construction and operation of the Canyon mine will not impact the Redwall-Muav aquifer which is well below the shaft depth. EFN will construct a test well at the mine site. If groundwater yield is sufficient, the well will be completed as a water supply and ground water monitoring well. Total requirements for water use at the mine are projected to be approximately five gpm. No water wells currently produce from the Redwall-Muav aquifer within 20 miles of the mine site, therefore, withdrawal of five gpm at the mine site, will have no impact on existing wells or springs.

Recharge to the Redwall-Muav aquifer in the Canyon Mine site area occurs via infiltration of rainfall and snowmelt through the rocks which underlie the plateau south of the Grand Canyon. Under natural conditions, a fraction of this recharge water passes through mineralized breccia pipes. Small quantities of native minerals, including radioactive minerals, are continuously leached from the breccia pipes and travel in solution in the water. During mining operations, the mine workings will be ventilated and much of the water that

percolates into the mine will evaporate. Excess water will be collected and used for industrial purposes.

Since the quantity of recharge water passing through the breccia pipe during mining operations will be reduced, the potential for movement of dissolved minerals will also be reduced. After mining operations are complete and the natural recharge system at the mine site is reestablished, native material, including radioactive minerals, will continue to be leached and move to points of discharge with the groundwater. Because groundwater discharge is small, no measurable impacts are expected.

If a perched groundwater reservoir is intercepted by the mine shaft, the shaft will function as a drain for the reservoir. The rate of water discharge to the shaft will decrease as the perched reservoir is depleted, until it is approximately equal to the recharge for that individual perched reservoir. If drainage of perched groundwater into the mine shaft occurs during mining operations, much of the groundwater will evaporate via mine ventilation. If drainage to the mine shaft continues after mining operations stop, a fraction of the groundwater will collect and be stored in some of the underground mine openings in the firmly cemented rocks of the breccia pipe, a fraction of the groundwater will evaporate, and the remainder of the groundwater may percolate slowly downward from the mine openings. If perched groundwater reservoirs occur at or below the level of water stored in the mine openings, seepage from the mine openings may mix and be diluted with water in the local perched reservoirs and continue to percolate slowly downward, where it may eventually mix and be diluted further with groundwater in the Redwall-Muav aquifer.

Studies of groundwater contamination in shallow aquifers near uranium mill tailings in Colorado and New Mexico indicate that concentration of total uranium is commonly about one milligram per liter in groundwater at the mill tailings, and is in the magnitude of 0.1 milligram per liter approximately one mile down-gradient from the tailings. If perched groundwater drains into the Canyon Mine shaft after reclamation operations, concentrations of radioactive minerals in the mine drainage are anticipated to be small.

The following extremely conservative conditions were assumed to provide a estimate for maximum impacts from water drainage to the mine shaft, if perched groundwater is encountered at the mine site:

- o All of the groundwater recharge to the Redwall-Muav aquifer over 160 acres of land surrounding the area of mine operations (17.4 acres), drains to the mine shaft;

- o Average groundwater recharge in the mine site area is 0.3 inch per year (Metzger, 1961);
- o Concentration of total uranium in water seeping downward from the mine is 3.5 milligrams per liter, which is 100 times the Arizona Department of Health Services recommended drinking water standard of 0.035 milligrams per liter, and more than three times the concentration detected in groundwater at uranium mine tailings studies in Colorado and New Mexico;
- o Decrease in concentrations of radioactive minerals in groundwater with distance from the shaft, via chemical precipitation and hydrodynamic dispersion, is neglected.

The effect of these conservative assumptions is to overestimate the quantity of drainage of perched groundwater to the mine shaft, to overestimate concentrations of radioactive minerals in groundwater seepage in the mine shaft, and to overestimate concentrations of radioactive minerals in mine shaft seepage at large distances from the mine shaft.

Under these assumptions, calculated long-term drainage to the mine shaft would occur at the rate of 2.5 gallons per minute. This hypothetical estimate of maximum drainage is equivalent to about 0.008 percent of the discharge from Havasu Spring, 0.8 percent of the discharge from Indian Gardens Spring, and 0.003 percent of the discharge from Blue Spring. Using the conservative assumptions noted above, the resulting concentration of total uranium at each of these springs, including background concentrations measured for each spring, would be less than the recommended drinking water limit of 0.035 milligrams per liter. The hypothetical maximum increase in concentration of total uranium in groundwater discharge at Havasu and Blue Springs would be less than 10 percent of the standard deviation reported for laboratory measurements for the May and December 1985 sampling rounds and, therefore, would not be discernible.

If perched groundwater drains into the mine shaft after reclamation operations, it may leach some of the residual native radioactive minerals and seep downward. If downward seepage occurs, the path of the mineralized water would roughly resemble the shape of an inverted cone distorted by lateral flow at perching layers and by concentration of flow along fractures. The mine shaft would be at the apex of the cone. Therefore, the area over which the mineralized water would encounter groundwater in the Redwall-Muav aquifer would be larger than the area near the bottom of the mine shaft. Because the proposed monitor well will also serve as a water supply well, a radially inward groundwater gradient will be created around the well by pumping operations, if groundwater

is present. Therefore, the monitor well will continually capture groundwater at the site during mining operations and will serve as a down or inward gradient monitoring system.

With implementation of planned mitigation measures to seal the mine after mining operations are completed, the possibility for significant deterioration of water quality at any discharge is very small. Any deterioration in the water quality of the Redwall-Muav aquifer will be detected by the monitoring program.

4.2.7.3 Soils

No radiological impacts are expected on the soil resource near the mine or along haul routes. A monitoring plan will be active throughout the life of the mine to detect dispersal of radioactive materials. These materials could be easily cleaned up and pose no health threat.

Implementation of any of the project alternatives will result in disturbance of the surface soil at the 17-acre mine site. This area will be rehabilitated after mining operations cease, and should be near premining productivity levels within 3-5 years after reclamation.

4.2.7.4 Cumulative impacts

As noted in Section 4.2.7.1, surface water control features at each mine site would be designed to prevent ore and waste stockpiles from contaminating surface waters, even in extreme storm events. Additional mines should create no cumulative impacts on surface water or groundwater quality. Impacts would be limited to the mine site. One additional mine in the Tusayan area would create the potential for impact on surface waters only if both mines were located in the same drainage system. If the surface water control features at both mines were simultaneously breached by a probable maximum flood, approximately 100 Ci of uranium and decay products (progeny) might be released. Such a release would result in a gross alpha concentration and an Ra-226 concentration much greater than EPA drinking water standards. However, the concentrations would dissipate rapidly and any remaining radioactivity in the soil would be cleaned up by the mine operators immediately following the discharge.

Three additional mines in Coconino County south of the Grand Canyon would not increase the impact which may result from a release of radioactivity into the surface waters, but may increase the risk that such an accident could occur.

Potential radiological impacts on groundwater would be localized near the mine site. Mitigation measures, including wells or pumping from the mine shaft, would be taken to insure no increase in groundwater radioactivity at any site.



4.2.8 IC #10 Impacts on Indian Religious Concerns

(1) Alternative 1

Implementation of the No Action Alternative would create no additional impacts on the religious sites or practices of American Indians. Indian concerns about potential impacts on unidentified sacred sites, sacred springs and hunting and gathering, and conflicts with traditional beliefs would be alleviated for the Canyon Mine proposal, but not for other activities in the region.

(2) Alternatives 2-5

Construction and operation of the Canyon Mine will have no impact on Indian lands in northern Arizona. Traffic on U.S. Highway 89 across the Navajo Reservation will increase by approximately 20 ore truck trips per day, but given existing traffic levels, that increase is insignificant. (See Table 2.11.)

The Hopi and Havasupai Tribes have expressed concern about possible water quality impacts at Blue Spring and Havasu Springs. (See Section 4.2.7.) Both springs discharge from the Redwall-Muav aquifer which is located below the mine site. The aquifer is well below mine shaft depth and no impacts are expected. In addition, movement of subsurface water to and in the Redwall-Muav aquifer and toward the springs is extremely slow and significant dilution over time and distance is anticipated. Finally, Alternatives 3-5 include a groundwater quality monitoring well which is expected to identify any contamination and allow mitigation, thus preventing any threat to either Blue Spring or Havasu Spring. (See Section 4.2.7.)

After communications and consultation with Hopi and Havasupai Tribal leaders and experts on Indian religious sites and practices as well as an archeological investigation of the mine

site, no specific Indian sacred or religious sites have been identified near the mine site. The Tribes maintain that Indian religious interests will be adversely affected but have not identified specific sites which are threatened. In addition, a review by an expert in Indian religious sites and practices has failed to identify sites that would be affected by the proposed action. Consultation with tribal leaders will continue.

Certain sites and areas with religious significance have been identified and evaluated. (See Section 3.1.11.) The area near Tusayan has been historically used by the Hopi to gather turkey feathers and sacred herbs for religious and ceremonial purposes. The loss of the mine site and the additional traffic and activity in the area will reduce the area available for these practices but should not impose a significant burden on these occasional uses and will not prevent the Hopi from continuing these practices on National Forest lands. Mine development will not affect Indian access to the area nor materially restrict the present level of religious activities. The mine site is only one small part of a large area available for Indian religious activities, and development of the mine will not burden traditional Indian religious beliefs.

Some areas near the haul routes are also used for gathering purposes, including the Little Colorado River near the bridge on U.S. Highway 89. These areas are used for gathering golden eagles and feathers to be used in religious ceremonies. The additional truck traffic along these well-traveled highways would not impair Indian access to the area or affect the current level of religious activity. Arizona Highway Department figures show an average daily traffic count of 7600 and 3100 vehicles along U.S. 89 and U.S. 160, respectively. An additional 20 trucks/day would be virtually unnoticed.

Other sites have been identified in the area including Blue Springs and the Sipapu and Salt Trails. (See Section 3.1.11.) These areas will not be affected by mine operations or ore transport.

Finally, in comments regarding other proposed actions on the Kaibab National Forest, the Hopi Tribe has expressed a belief that the earth is sacred and that it should not be subjected to digging, tearing or commercial exploitation. While this conflict has not been raised directly in relation to the Canyon Mine, it is acknowledged that commercial use of the Forest within the area of Hopi ancestral occupancy is inconsistent with these stated religious beliefs.

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Cumulative Impacts

Indian religious sites and practices are sensitive to increased mineral and industrial activity and thus may be adversely affected by additional mines or other activities that intrude upon land utilized by the Indians. The precise impacts of additional mines, if any, can only be determined on a site specific basis following consultation with the affected Tribes. Tribal leaders must be consulted and included in the decision making process for any proposed mine. Sites of religious significance to the Indians must be identified and avoided or mitigated. However, the Forest Service is not required to protect Tribal religious practices to the exclusion of all other land uses.

Because of the nature of Indian beliefs and the religious importance of all lands of Hopi ancestral occupancy in northern Arizona any mining activity or ore transport is expected to conflict with stated traditional beliefs that the earth is sacred and not to be developed and is believed by the Hopi to diminish the availability of the land for sacred and religious purposes. This is true of the hunting and gathering activities of the Hopi in the Tusayan area. While each additional mine will only marginally affect these occasional religious uses, the loss of any land is considered significant by the Hopi and each new activity impacts the general environmental setting of such areas and detracts from their religious significance.

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CHAPTER 5

LIST OF PREPARERS

CONSULTANTS

The following individuals had a major direct role during the past year in the collecting of background data and evaluations which formed a basis for the preparation of the Environmental Impact Statement on the Canyon Uranium Mining Proposal.

Charles F. Leaf - Consulting Hydrologist. Dr. Leaf is a registered Professional Engineer in Colorado, Montana and New Mexico. He is a private consultant with 20 years of experience that includes working for USGS, USFS, and as a consulting meteorologist in private practice. His expertise includes such fields as: streamflow forecasting, avalanche hazard evaluation, design and construction of surface water management and control systems, and snowpack management. Dr. Leaf has authored more than 40 technical publications and hydrologic impact analyses. He was awarded a PhD in 1969 from Colorado State University.

John W. McKlveen - Consulting Radiological Engineer. Dr. McKlveen is Professor of Engineering and Radiation Protection Officer at Arizona State University. He is in charge of the Radiation Research Laboratory, which he created. He teaches nuclear engineering and health physics. He has 15 years of research and teaching experience. Dr. McKlveen has authored more than 55 technical publications and one book. He was awarded a PhD from the University of Virginia in 1973.

Errol L. Montgomery - Consulting Hydrogeologist. Dr. Montgomery heads his own consulting firm, Errol L. Montgomery and Associates, Inc. He has 20 years experience in groundwater geology including the design and construction of water wells. As Assistant Professor of Geology at NAU for seven years, he taught classes in hydrogeology, applied geophysics and engineering geology. Dr. Montgomery has authored more than 16 technical publications. He was awarded a PhD in 1971 from the University of Arizona.

Barry L. Stewart - Consulting Atmospheric Scientist. Mr. Stewart is senior atmospheric scientist with the consulting firm of EnecoTech. He has 13 years of experience in air quality and meteorological monitoring, modeling and permitting studies, and EA and EIS support. Mr. Stewart has managed

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and/or participated in more than 50 air quality and meteorological studies for industry and government. He holds an MS in meteorology from Texas A&M University.

INTERDISCIPLINARY TEAM MEMBERS

The following people shared the responsibility for bringing the data together and writing the EIS:

Daniel W. Baertlein - Civil Engineer. Mr. Baertlein has been employed by the Forest Service for 25 years. He has 16 years experience on the Kaibab NF in staff work related to operations in the engineering section. He holds a Bachelor of Science Degree in Civil Engineering. Mr. Baertlein's major responsibility was in the engineering costs and feasibility aspects, but he also worked on the outline and overall content of the document.

Thomas R. Cartledge - Archeologist. Dr. Cartledge has been employed by the Forest Service for 10 years. He has 9 years experience on the Kaibab NF in staff work related to archaeology. He holds a Doctor of Philosophy Degree in Archeology. Dr. Cartledge's major responsibility was related to surveys to determine historic occupation of the site.

Thomas F. Gillett - Assistant Recreation and Lands Staff. Mr. Gillett has been employed by the Forest Service for 11 years. He has 7 years experience on the Kaibab NF in staff work related to recreation planning and development. He holds a Bachelor of Science Degree in Forest Management from Northern Arizona University. Mr. Gillett worked on the outline and overall content of the document.

R. Dennis Lund - Recreation, Lands and Minerals Staff. Mr. Lund has been employed by the Forest Service for 23 years. He has 9 years experience on the Kaibab NF in staff work related to recreation, land ownership and minerals planning and development. He holds a Bachelor of Science Degree in Forestry from the University of California at Berkeley. Mr. Lund had major responsibility for the overall preparation of the EIS. He served as leader of the Interdisciplinary Team.

Katherine A. Peckham - Wildlife Biologist. Ms. Peckham has been employed by the Forest Service for 6 years. She has 5-1/2 years experience on the Kaibab NF, Williams and Tusayan Ranger Districts, in staff work relating to wildlife management. She holds a Bachelor of Science Degree in Wildlife Management. Ms. Peckham was responsible for coordinating all wildlife input to the EIS.

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Jesse R. Thompson - Consulting Hydrologist. Mr. Thompson had been employed by the Forest Service for 25 years when he retired in 1982. He has 21 years experience in research and one year of experience on the Kaibab NF in staff work related to Hydrology. He holds a Bachelor of Science in Watershed Management from CSU. Mr. Thompson's major responsibility was in assembling and editing the overall document starting with input from Interdisciplinary Team members and consultants. He has authored 20 technical publications.

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Charles C. Avery - Professor, Northern Arizona University.

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Chris A. Ortega - Civil Engineer, Kaibab National Forest.

CHAPTER 6

CIRCULATION OF THE EIS

The following lists include the agencies, organizations and individuals who responded to the "Notice of Intent to Publish an EIS," the Scoping Letter, or have otherwise expressed an interest in receiving the document.

Copies of the Appendices were sent to all Forest offices, libraries, organizations, State Agencies, Native American groups, news media and elected officials on the following lists.

1. Federal Agencies

- 1) U.S. Forest Service, Washington Office
- 2) Kaibab National Forest
- 3) Chalender RD
- 4) Williams RD
- 5) Tusayan RD
- 6) North Kaibab RD
- 7) Coconino National Forest
- 8) Beaver Creek RD
- 9) Long Valley RD
- 10) Sedona RD
- 11) Blue Ridge RD
- 12) Mormon Lake RD
- 13) Elden RD
- 14) Flagstaff RD
- 15) Tonto National Forest
- 16) Mesa RD
- 17) Cave Creek RD
- 18) Globe RD
- 19) Payson RD
- 20) Pleasant Valley RD
- 21) Tonto Basin RD
- 22) Coronado National Forest
- 23) Santa Catalina RD
- 24) Douglas RD
- 25) Nogales Rd
- 26) Sierra Vista RD
- 27) Safford RD
- 28) Apache-Sitgreaves National Forest
- 29) Alpine RD
- 30) Springerville RD
- 31) Heber RD
- 32) Clifton
- 33) Chevelon RD
- 34) Lakeside RD
- 35) Prescott National Forest
- 36) Chino Valley RD
- 37) Bradshaw RD
- 38) Verde RD

- 39) U.S. Bureau of Land Management
- 40) Arizona Strip District Office
- 41) U.S. Bureau of Indian Affairs
- 42) U.S. Department of Interior
- 43) U.S. Department of Commerce
- 45) U.S. Environmental Protection Agency
- 46) U.S. Fish and Wildlife Service
- 47) U.S. Mine Safety and Health Admin
- 48) USPHS Indian Health Center
- 49) U.S. Park Service, Grand Canyon National Park
- 50) U. of A. College of Business
- 51) Colo. State University

2. State and Local Agencies

- 1) Arizona Game and Fish Department
- 2) Arizona State Clearinghouse
- 3) Arizona Outdoor Recreation Coordinating Commission
- 4) Arizona Department of Transportation
- 5) Arizona State Land Department
- 6) Arizona Dept. of Revenue
- 7) Arizona Public Service, EA
- 8) Arizona State Environmental Planning
- 9) Arizona State Parks
- 10) Arizona Dept. of Water Resources
- 11) Arizona State Mine Inspector
- 12) Arizona Dept. of Health Services
- 13) City of Williams
- 14) Northern Arizona Council of Governments
- 15) Salt River Project
- 16) Coconino County Building Inspector
- 17) Coconino County Board of Supervisors
- 18) Coconino County Health Inspector

3. Native Americans

- 1) Hopi Tribal Council
- 2) Hualapai Tribal Council
- 3) Navajo Tribal Council
- 4) Havasupai Tribal Council
- 5) Havasupai Tribal Planners Office
- 6) Hopi Office Natural Resources
- 7) Navajo Tribe Div. of Resources

4. News Media

- 1) Arizona Daily Star
- 2) Arizona Daily Sun
- 3) Arizona Republic
- 4) Williams News
- 5) Holbrook Tribune-News
- 6) Indian Arizona News
- 7) Lake Havasu City Herald
- 8) Lake Powell Chronicle
- 9) Prescott Courier
- 10) Phoenix Gazzett

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- 11) KTVK - TV 3
- 12) Red Rock News
- 13) Mesa Tribune
- 14) Southern Utah News
- 15) Paydirt

5. Elected Officials

- 1) Governor Bruce Babbitt
- 2) U.S. Senator Dennis DeConcini
- 3) U.S. Senator Barry Goldwater
- 4) Congressman John McCain
- 5) Congressman Eldon Rudd
- 6) Congressman Bob Stump
- 7) Congressman Morris K. Udall
- 8) Congressman Jim Kolbe
- 9) State Senator Tony Gabaldon
- 10) State Representative John Wettaw
- 11) State Representative Sam McConnell
- 12) County Supervisor Dennis Wells
- 13) County Manager Kathy Eden

6. Mining Companies

- 1) Energy Fuels Nuclear, Inc.
- 2) Pathfinders Mine Corp.
- 3) Rocky Mountain Energy
- 4) Uranerz USA, Inc.
- 5) Western Nuclear, Inc.
- 6) Santa Fe Mining Co.

7. Organizations

- 1) Arizona Wildlife Federation
- 2) National Parks and Conservation Association
- 3) Sierra Club Plateau Group
- 4) Audubon Society
- 5) Williams Chamber of Commerce
- 6) Circle of Friends
- 7) Friends of the River
- 8) Coconino Sportsmen
- 9) Four Corners Wilderness Workshop
- 10) Nat. Parks & Consc. Assoc.
- 11) Southwest Resource Council
- 12) Arizona Wildlife Federation
- 13) The Wilderness Society
- 14) Nature Conservancy
- 15) Animal Defense Council
- 16) Garkane Power Assoc.

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CHAPTER 8

GLOSSARY

ALPHA PARTICLE - Alpha particles are the nuclei of helium atoms (two protons and two neutrons). They possess large amounts of kinetic energy, but may be stopped by nothing more than a sheet of paper. Because of the large amount of localized biological damage to the absorbing tissue, alpha particles are considered to be the greatest hazard when ingested or inhaled.

ANNUAL GEOMETRIC MEAN - The mean value of data points (n) collected over a year obtained by taking the nth root of the product of the data points.

ANTECEDENT MOISTURE CONDITIONS (AMC) - An index of the amount of soil moisture on a watershed just prior to a given rainfall event. Antecedent soil moisture has a significant effect on runoff volume. Three AMC conditions are defined as follows:

Condition I: soils are relatively dry with little or no rainfall during the previous 5 days.

Condition II: average soil moisture conditions.

Condition III: soils are saturated due to significant rainfall during the previous 5 days.

BETA PARTICLES - High speed electrons which have been ejected from the nucleus of a radioactive atom.

BRECCIA PIPE - Cylindrical or conical collapse features in sedimentary rocks believed to be the result of the collapse of roof rocks over solution cavities in the Redwall limestone, creating a favorable environment for mineral deposition.

CALINE 3 - A computerized steady state Gaussian dispersion model which is used to assess concentrations of pollutants from roadway traffic sources.

CFS - Cubic feet per second. Example: 1 cfs of streamflow equals one cubic foot of water flowing past a given reference point every second.

COSMIC RADIATION - Radiation from space which interacts with the atmosphere to produce ionizing radiation. Cosmic radiation and the earth's natural radioactivity are the components of the natural background radiation environment.

CURIE - Unit of radio-activity which is equivalent to 37 billion decays (disintegrations) each second.

DRAINAGEWAY - Any route or course along which water flows or may flow.

FLOOD - Any relatively high water flow that overtops the natural artificial banks in any reach of a stream or drainageway.

FUGITIVE DUST - Particulates, usually soil, suspended in the air, that were not released through a stack, vent or chimney. Examples include wind erosion of exposed ground and particulates generated from traffic on unpaved roads.

GAMMA RADIATION - Waves or photons of energy emitted from the nucleus of an atom. X-rays are of lower energy and are emitted as atomic electrons transition from one orbit to another.

IONIZING RADIATION - Radiation with sufficient kinetic energy to release electrons which are normally bound to an atom or molecule. Examples of ionizing radiation include alpha, beta and gamma radiation.

ISC - Industrial Source Complex model. A steady state Gaussian dispersion computer model which can be used to assess pollutant concentrations from a wide variety of sources associated with an industrial facility and/or operation.

MANDATORY CLASS I AREA - Under PSD requirements, all National Parks over 6000 acres in size and all National Wilderness areas over 5000 acres existing as of August 1977, were mandatorily designated Class I areas - which have the most restrictive pollution increments for sulfur dioxide and particulates.

MeV - Million Electron Volts. A unit which describes the amount of kinetic energy possessed by ionizing radiation.

MICRO-ROENTGEN - One millionth of a Roentgen (uR).

MILLI-ROENTGEN - One thousandth of a Roentgen (mR).

NODE - A reference point along the stream channel referenced by distance upstream or downstream from the proposed Canyon Mine and by drainage area (see map, Figure 1). With respect to each Node, all upstream runoff from the respective watershed must pass the identified Node.

NON-IONIZING RADIATION - Waves or photons of energy which do not have sufficient energy to cause ionization of matter. Examples of non-ionizing radiation include ultrasound, radio-frequencies, microwaves, infrared and visible light.

PARTICULATE INCREMENT - Under PSD, the allowable increase of particulate concentrations in a designated area. For class I areas this increment is 5 ug/m³ expressed as a 24-hour average, and 1 ug/m³ as an annual average.

PARTICULATES - Any material, except water in uncombined form, that is or has been airborne, and exists as a liquid or solid at standard conditions.

PSD - Prevention of Significant Deterioration. A part of the Clean Air Act Amendments of 1977 (PL95-95) which established limits to the increases of particulate and sulfur dioxide concentrations which would be allowed into areas where the air quality was cleaner than the national ambient air quality standards. The intent was to prevent further air quality degradation of these clean areas.

RADIATION - Radiation is energy traveling in the form of waves, particles or bundles of energy called photons. Radiation may be classified as ionizing or non-ionizing.

RADIOACTIVITY - The natural and spontaneous process by which the unstable atoms of an element emit or radiate the excess energy of their nuclei as particles or photons and change (or decay) to atoms of a different element or to a lower energy form of the original element.

RADON PROGENY - Daughter products from the decay of radon gas which are also radioactive.

RECURRENCE INTERVAL - The average length of time in years between events of a given magnitude. This is not to say that having experienced a 100-year flood, another flood of an equal magnitude will not occur again for 100 years.

ROENTGEN - A unit of radiation exposure. Other units of exposure and dose are rad and rem. Each has a specific application and use. For simplification the terms are often considered synonymous.

TSP - Total Suspended Particulates or all particles suspended in the air.

ug/m³ - Micrograms (10⁻⁶ grams) per cubic meter.

WORKING LEVEL - A standard measure of radon daughter concentration in air. It is an expression of potential alpha energy. One "working level" (WL) is any combination of radon daughters per liter of air that will result in the emission of 130,000 MeV of alpha energy in their decay through Po-214 (a radon progeny).

WORKING LEVEL MONTH - A standard measurement of cumulative exposure. A "working level month" (WLM) is an exposure equivalent to working in an atmosphere containing one WL of radon progeny for 173 hours (sometimes rounded to 170 hours).

CHAPTER 9

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