Chapter 4

ENVIRONMENTAL CONSEQUENCES

4.1 INTRODUCTION

Implementation of any one of the alternatives described in Chapter 2, Proposed Action and Alternatives, may result in direct or indirect changes to the human and physical/natural environment in and around the proposed withdrawal area. Actions associated with any of the alternatives may also contribute to impacts associated with other past, present, or reasonably foreseeable future actions in and around the area. This EIS assesses and analyzes these potential changes and discloses the impacts, as well as the significance of these impacts, to the decision-maker and the public. This process of full disclosure is one of the fundamental aims of NEPA.

This chapter is organized by resource as described in Chapter 3, Affected Environment, and is divided into assessments, by alternative, of the following resources: air quality and climate; geology and mineral resources; water resources; soil resources; biological resources, including vegetation, wildlife, and special status species; visual resources; soundscapes; cultural resources; American Indian resources; wilderness resources; recreation resources; and social and economic conditions, including environmental justice and public health and safety. Impacts specific to a given alternative are described as changes in resource condition with respect to the resource indicators identified in Chapter 3.

Impacts to these resources were determined using both quantitative and qualitative approaches. Impacts were considered within specific temporal and spatial boundaries established for each resource, as described in Chapter 3, and the analysis included consideration of the crossing of administrative boundaries. The potential for simultaneous or related impacts to more than one resource was also considered in the analysis, as was the potential under any alternative for impacts to be beneficial as well as adverse.

4.1.1 Foreseeable Activity Assumptions

In order to complete a meaningful impacts assessment, it was necessary to generate RFD scenarios of anticipated mining-related exploration and development within the proposed withdrawal area. This analysis is included in Appendix B. The purpose of the RFD scenarios is to provide a prediction of the level and type of reasonably foreseeable future locatable mineral exploration and development and thereby provide a common set of assumptions across all resources and alternatives.

In developing the RFD, the life cycle of a mine was assumed to be 7 years. This was determined from a review of existing and recent locatable mining activity and includes initial permitting, development, production, and reclamation. This time period does not include uncertainty factors, such as delays in permitting, size of the ore body, or periods of temporary closure where operations are being conducted pursuant to the interim management plan in the mine's approved plan of operations. In the context of the RFD, "reclamation" refers to backfilling waste rock into the mine, sealing the mine to re-establish hydraulic gradients and prevent mine drainage, dismantling and removing infrastructure or equipment, and initially revegetating the mine site and haul roads.

The following assumptions were made in developing the RFD scenarios:

- While other precious metals could be recovered from breccia pipe deposits concurrent with uranium mining, including gold, silver, copper, and vanadium, in accordance with the BLM mineral potential report for the proposed withdrawal (BLM 2010a), the values from recovery of these metals are assumed to not be sufficient to drive mine development.
- There are 45 confirmed breccia pipes within the proposed withdrawal area; potential future mining activity would be associated with these pipes as well as undiscovered uranium reserves. Based on the findings of the 2010 USGS estimate of undiscovered uranium resources, the RFD estimates that 16 mines would be required to extract that reserve (see Appendix B, page B-22 of the RFD).
- Four of these confirmed breccia pipes are associated with approved mining plans of operation (Arizona 1, Kanab North, Pinenut, and Canyon). These breccia pipes are assumed to be mined under all alternatives. An additional seven breccia pipes have adequate information to estimate uranium reserves, and these breccia pipes are also assumed to be mined under all alternatives. Development of all other breccia pipes, discovered or undiscovered, varies depending on the alternative.
- The active life of a typical uranium mining operation is assumed to be 7 years and includes four phases: initial permitting and planning (2 years), physical development of the mine (1 year), production (3 years), and reclamation (1 year). A maximum of six mines would be in production at any given time.
- Based on historic data, approximately 28 exploration projects are expected to take place for every mine expected to be developed, with each exploration project requiring five drill holes and temporarily disturbing 1.1 acres.
- Mining a typical breccia pipe would result in the removal of 278,000 tons of ore and yield 3 million pounds of the uranium compound U_3O_8 (1,500 tons U_3O_8) at an ore grade of 0.54%. Removal of this quantity of ore would require 11,120 haul trips of 25 tons each.
- Each mine expected to be developed has a surface disturbance of approximately 20 acres, with each mile of access/haul road disturbing 2.42 acres/mile and each mile of power line disturbing 0.17 acre/mile.
- Each mine would drill a production well into the R-aquifer and would use an average of 5 gpm during development and production, or approximately 10.5 mgal over the life of the mine.

4.1.2 Impact Assessment Methodology and Definitions

This chapter analyzes both beneficial and adverse impacts that would result from implementing any of the alternatives considered in this EIS. This chapter also includes definitions of impact thresholds for each resource, methods used to analyze impacts, and the analysis methods used for determining cumulative impacts. Table 4.1-1 provides standard definitions of degree and duration of impact that are broadly applicable to all resources; certain analyses in the sections that follow have further refined these definitions to be more specific to that particular resource. A summary of the environmental consequences for each alternative is provided in Table 2.8-1, which can be found in Chapter 2.

Table 4.1-1. Standard Resources Impact Description

	Description Relative to Resource
Magnitude	
No Impact	Would not produce obvious changes in baseline condition of the resources.
Minor	Project-related impacts would occur, but resources would retain existing character and overall baseline conditions.
Moderate	Project-related impacts would occur, and resources would partially retain existing character. Some baseline conditions would remain unchanged.
Major	Project-related impacts would occur that would create a high degree of change within the existing resource character and overall condition of resources.
Duration	
Temporary	Up to 1 year (periods of development and reclamation)
Short-term	1 to 5 years
Long-term	Greater than 5 years

The following section defines and clarifies the concepts and terms used in this EIS when discussing the impacts assessment. The terms “impact” and “effect” are used synonymously.

Impacts

Impacts may refer to ecological, economic, aesthetic, historical, cultural, social, or health-related phenomena that may be caused by implementation of the Proposed Action or any of the other alternatives. Impacts, both beneficial and detrimental, may be direct, indirect, or cumulative.

Direct Impacts

A direct impact is an effect on a resource that is caused by the action and occurs at the same time and place.

Indirect Impacts

An indirect impact is a reasonably foreseeable effect that would occur later in time or be separated by some distance from the action while remaining consistent with the temporal and spatial boundaries of analysis established for the resource.

Cumulative Impacts

A cumulative impact is a project-induced impact that, when added to the effects of other past, present, and reasonably foreseeable future actions, results in an incremental effect on the resource. Individually minor actions can become collectively more significant taking place over a period of time.
Note that the temporal and spatial bounds for cumulative impacts assessment may be substantially larger than those for a direct impacts assessment.

Residual Impacts

Impacts are considered residual when the effect from the proposed project cannot be completely avoided or minimized and remains after or despite mitigation.

Significance

Significance has a very particular meaning when used in a NEPA document. Significance is defined by CEQ [40 CFR 1508.27] as a measure of the *context* and *intensity* of the impacts of a major federal action on, or the importance of that action to, the human environment.

Intensity refers to the severity or level of magnitude of impact. Proximity to sensitive areas or protected resources, public health and safety, level of controversy, unique risks, or potentially precedent-setting results are all factors considered in determining the intensity of the effect.

Context means that the effect(s) of an action must be analyzed within a framework or within physical or conceptual limits. Resource disciplines, location, type, or size of area affected (e.g., local, regional, national), and affected interests are all elements of context that ultimately determine significance. Both short- and long-term impacts are relevant.

Impact Indicators

Use of the term *significant* when referring to resource impacts indicates that some threshold was exceeded for a particular impact indicator. Impact indicators are the consistent parameters used to determine quality, intensity, and duration of change in a resource. Working from an established existing condition (i.e., the baseline conditions described in Chapter 3), one or more condition indicators are used to predict or detect change in a resource related to causal impacts of proposed actions. These thresholds are consistent with CEQ's guidance on the criteria for a significant impact. Table 3.1-1 in Chapter 3 lists the key issues for analysis in this EIS, as derived from public scoping and agency input, and the corresponding resource condition indicators that were used in the impact analyses described in this chapter.

4.2 AIR QUALITY AND CLIMATE

4.2.1 Introduction

This section analyzes the potential changes in air pollutant emissions created by each alternative being evaluated for this EIS. The air resources analysis addresses potential changes on attainment of the NAAQS, HAP emissions, and AQRVs or the triggering of conformity analysis with respect to an individual or combined uranium mines (i.e., PSD/New Source Review [NSR]).

It is important to note that the comparison of the air quality impacts to the NAAQS and AQRVs was made using screening level modeling. Air pollutant dispersion concentrations for the comparison of the NAAQS were derived from existing mine operations (i.e., the Arizona 1 Mine). Visibility was determined using a screening model and the emissions associated with air pollutant emissions under each alternative. Refined dispersion or visibility modeling was not conducted. Individual mines or development of such mines were considered point sources for the purpose of determining an exceedance of the significance thresholds for PSD/NSR. It should be noted that when considering significance thresholds for PSD/NSR fugitive particulates and tailpipe emissions (i.e., mobile sources) are not quantified. Only those particulates or other criteria pollutants associated with point sources are quantified when evaluating significance. However, these emissions have been quantified for the purposes of NEPA only for informational purposes as the NEPA air quality analysis is not a PSD increment consumption analysis.

The majority of the impacts discussed in the following sections pertain to the following four underground mine life cycle stages: 1) exploration, 2) mine site development, 3) actual production operations, and

4) reclamation. Within each of these stages, the following construction, although temporary in nature, and operational emission sources, are considered:

- Exploration Activities
  - Criteria air pollutant and GHG tailpipe emissions from vehicles and equipment;
  - Fugitive dust emissions (PM_{10} and $PM_{2.5}$) from vehicles and equipment traveling on paved and unpaved roads, and;
  - Fugitive dust emissions (PM_{10} and $PM_{2.5}$) from earth-moving activities and exploratory drill holes.
- Mine Development
  - Criteria air pollutant and GHG tailpipe emissions from construction vehicles, equipment, and worker commuting associated with the development of the mine site and construction of new access roads and power lines;
  - Fugitive dust emissions (PM_{10} and $PM_{2.5}$) from construction and worker commuting vehicles traveling on paved and unpaved roads, and;
  - Fugitive dust emissions (PM_{10} and $PM_{2.5}$) from earth-moving activities.
- Mining Operations
  - Criteria air pollutant and GHG tailpipe emissions from vehicles, equipment, and worker commuting associated with the operation of the mine;
  - Fugitive dust emissions (PM_{10} and $PM_{2.5}$) from equipment and worker commuting vehicles traveling on paved and unpaved roads;
  - Point and fugitive emissions associated with the mining equipment, material handling sources, storage piles, and fuel storage tanks, and;
  - Radon gas emissions associated with the operation of the mine.
- Mine Closure and Reclamation
  - Criteria air pollutant and GHG tailpipe emissions from reclamation vehicles and equipment;
  - Fugitive dust emissions (PM_{10} and $PM_{2.5}$) from reclamation vehicles and equipment traveling on paved and unpaved roads, and;
  - Fugitive dust emissions (PM_{10} and $PM_{2.5}$) from earth-moving activities associated with reclamation.

For purposes of this air quality impact analysis, a “typical” 300 ton per day (tpd) breccia pipe mine from exploration to reclamation was evaluated. Based on Appendix B, Locatable Mineral Resources—Reasonably Foreseeable Development Scenarios, it is anticipated that a maximum of six mines would be operated at any one time in the North, East, and South parcels. It was also assumed that each mine would be in production (i.e., “mine operations” stage) for no more than 3 years with a 7-year life cycle (i.e., exploration through reclamation). It is also important to note the possibility exists of the mines’ being idle for 20 years. In most instances, impacts are categorized and described in general terms without reference to a particular mining facility type or any site-specific resources. This “typical” mine’s predicted emissions are then multiplied by the number of proposed exploration sites, mine sites, and number of miles of new access roads and power lines as presented in Table 2.7-3, Reasonably Foreseeable Future Mineral Activity by Alternative. Analysis of the number of existing and proposed exploration sites, mine site, miles of new access roads, miles of new power lines, and number of ore haul trips required for each of the alternatives presented in Chapter 2 was conducted.

Proposals for mining operations continue to be processed by the BLM and the federal land managers in the proposed withdrawal area. Mining operations would be required to obtain an air quality permit from the ADEQ. For the purposes of the impacts analysis, the Arizona 1 Mine was assumed to be representative of a "typical" mining operation in the proposed withdrawal area.
This assessment assumes there would be no processing (physical or chemical) of the uranium ore at the actual mine site or within the proposed withdrawal area. All ore mined within the proposed withdrawal area is assumed to be hauled from the mine site to the White Mesa Mill, located in Blanding, Utah.

4.2.2 Incomplete or Unavailable Information

Refined dispersion or visibility modeling was not conducted for this EIS. $PM_{2.5}$ modeling results were not available and were not included in the Arizona 1 Mine Air Permit Application, dated April 2008. The type of analysis required to determine the impact from all potential sources is beyond the scope of this analysis. Such modeling is required to estimate potential impacts to the air quality study area. Furthermore, there is currently no standard methodology or model to determine how an individual source's or project's GHG emissions would translate into physical impacts to the local or global environment.

A valid analysis of potential air quality impacts associated with any of the alternatives cannot be made without descriptions of each of the individual proposed exploration and mine sites, including precise location (topography), atmospheric conditions, roster of equipment, number of mine shafts, ore production rates, etc. Without knowledge of the specific location of each air pollutant source, these variables cannot be considered.

This EIS is framed as an overarching review for a very large area included in the three proposed withdrawal parcels encompassing numerous proposed exploration and mine sites. If a future mine is proposed, an independent EIS for that specific mine would be performed at a level of detail appropriate for that site.

4.2.3 Impact Assessment Methodology and Assumptions Pertaining to all Alternatives

For the purposes of air quality impact analysis, the following terms were used to describe the potential impact and duration of impact on air quality (Tables 4.2-1 and 4.2-2).

Table 4.2-1. Magnitude and Degrees of Effects on Air Quality

Attribute of Effect	Description Relative to Air Quality
Magnitude	
No Impact	Would not produce obvious changes in baseline condition of the resources.
Minor	Project-related impacts would occur, but resources would retain existing character and overall baseline conditions.
Moderate	Project-related impacts would occur, and resources would partially retain existing character. Some baseline conditions would remain unchanged.
Major	Project-related impacts that would create a high degree of change within the existing resource character and overall condition of resources.

Table 4.2-2. Duration Definition of Effects on Air Quality

Duration	
Temporary	Up to 1 year (periods of development and reclamation)
Short-term	1 to 5 years
Long-term	Greater than 5 years

Source: UDEQ (2005).

The Proposed Action deals specifically with the withdrawal of federal lands from future location and entry under the Mining Law. The withdrawal of these lands from future mining would likely have little effect on the worldwide generation of power but could have a negative effect on America's ability to generate clean power. Uranium mining activities in the proposed withdrawal will likely cause localized increases in air pollutant emissions, with the exception of GHG emissions, which are considered by scientists to contribute to global climate change and which could have global impacts.

To assess the current value of the air quality resource condition indicators, measurement of existing background air pollutant concentrations, topography, and meteorological data in the specific area of any potential mine sites would be needed. Once the proposed mine site background air pollutant concentrations, site-specific topographic and meteorological data, and sufficient details regarding the exploration, mine development, operations, and closure/reclamation are accurately established, air modeling could be carried out. The results of the modeling would allow for a quantitative estimate of possible air pollution effects of each proposed mining operation. Without specific knowledge of the location of potential mine sites or how the mine operations will be carried out (e.g., number of shafts, ore production rate, specific types of equipment, etc.), no realistic conclusions can be drawn with regard to the possible air quality effects of their operation on Grand Canyon National Park.

Potential impacts of the proposed withdrawal alternative and the other alternatives on ambient air quality were assessed by first quantifying emissions for a "typical" 300-tpd breccia pipe uranium mine, including exploration through mine closure and reclamation activities (Denison 2010a). Emissions were calculated using ADEQ and EPA agency-accepted emission factors (EFs) and conservative engineering assumptions, as needed. Tables 4.2-2 and 4.2-3 provide definitions of impact magnitude and duration, respectively, as they relate to Air Quality and Climate.

These emission rates were then input to EPA's VISCREEN model (Version 1.01), following guidance in the EPA Workbook for Plume Visual Impact Screening and Analysis (Revised), October 1992, EPA-454/R-92-02 (EPA 1992). Sources of air pollution can cause visible plumes if emissions of particulates and NO_x are sufficiently large. The plume will be visible if the pollutant constituents scatter or absorb sufficient light to make the plume brighter or darker than its viewing background (e.g., the sky or terrain feature). PSD Class I areas such as national parks and wilderness areas are afforded special visibility protection designed to prevent such plume visual impacts to observers within a Class I area (EPA 1992).

VISCREEN was used to ascertain whether the emissions from the facility have the potential to be perceptible to untrained observers under "reasonable worst case" conditions. These VISCREEN results were compared with the criteria established in EPA (1992) for maximum visual impacts inside Grand Canyon National Park.

First, the methods used to estimate emissions are described, including exploration, mine site development, ore mining operations, and finally mine closure and reclamation. Next, the modeling analyses used for the impact assessment related to the visible plume are described.

Exploration Activities

The initial exploration activities would include mobilization of a drill rig and support vehicles to a potential mine site for the drilling of exploratory drill holes. Sources of air pollutant emissions during the exploration activities include both particulate matter emissions and fuel-combustion emissions. For the purposes of estimating emissions, each exploration site was estimated to disturb approximately 1.1 acres and would involve boring five exploratory drill holes (BLM 1990). Based on Goldenseal Construction Estimating Software, the anticipated duration for the exploratory activities was assumed to require 30 working days (1.5 months) per exploration site.

Exploration activities generally would be scheduled during daylight hours (8:00 a.m.–5:00 p.m.), Monday through Friday. In actuality, the project duration may last longer than the number of days estimated above because of unfavorable weather conditions and holidays. However, these non-working days do not affect the emission estimates calculated here.

Mine Development

Activities included in development of the mine are the construction of access roads, installation of power lines, site preparation for the fixed facilities (e.g., office complex, shop/warehouse hoist house, fuel storage tanks, standby generator, screener, and mine shaft exhaust fans), delivery of materials and equipment to the mine, and other construction vehicle activity. Sources of air pollutant emissions during the mine development activities include both particulate matter emissions and fuel-combustion emissions. As described in Chapter 2, each development site was estimated to disturb approximately 20 acres, and varied lengths of new access roads and power lines would be installed for each withdrawal parcel, depending on the alternative. It was assumed the power lines would be constructed using 40-foot-long wooden poles, spaced 300 feet apart, requiring approximately 18 poles per mile.

The anticipated duration for the development of the mine site was assumed to require 40 working days (2 months), and it was assumed that 5 working days would be required per mile of new access road or power line to be installed. Mine development activities generally would be scheduled during daylight hours (8:00 a.m.–5:00 p.m.), Monday through Friday. In actuality, the project duration may last longer than the number of days estimated above because of unfavorable weather conditions and holidays. However, these non-working days would not affect the emission estimates calculated here. The individual mine development schedules are based on typical construction activities in rural locations.

Mine Operations

Sources of pollutant emissions during the operation of the mines include particulate matter emissions and fuel-combustion emissions. Both on- and off-site mining activities were considered. Based on Chapter 2, each mine would have a uranium production life of 3 years. The following particulate matter emissions associated with the mining activities (fugitive dust) were evaluated:

- Vehicle and equipment traffic on improved and unimproved dirt roads as well as paved roads (worker vehicles, water trucks, heavy-duty diesel trucks, and ore haul trucks).
- Topsoil and waste rock handling and storage (front-end loaders and trucks).
- Uranium ore loading, unloading, hauling, and storage (front-end loaders and trucks).
- Wind erosion of storage piles, and
- Underground mining operations.

Dust suppression procedures such as routine watering were considered in the emission inventory calculations.

The following fuel-combustion emissions associated with the mining activities (tailpipe exhaust) were evaluated:

- Mobilization of vehicle and equipment to the mine site (worker vehicles, water trucks, heavy-duty diesel trucks, and ore haul trucks).
- On-site equipment operation (standby generator, front-end loaders, and haul trucks).

Mine Closure and Reclamation

Once the mining activities have ceased, the impacted land is required to be reclaimed. Reclamation activities include backfilling the waste rock into the mine, sealing the mine, removing the infrastructure and equipment, and revegetating the mine site. Emissions were quantified for the closure/reclamation of the mine, which include fugitive dust generated during earth-moving activities (e.g., waste rock backfilling, site grading, and revegetation) and fuel-combustion (vehicle and equipment tailpipe emissions). As described in Chapter 2, each development site was estimated to disturb approximately 20 acres. The anticipated duration for the closure and reclamation of the mine site was assumed to require 20 working days (1 month) of surface disturbance related activities (Goldenseal 2010).

Mine closure/reclamation activities generally would be scheduled during daylight hours (8:00 a.m.–5:00 p.m.), Monday through Friday. In actuality, the project duration may last longer than the number of days estimated above because of unfavorable weather conditions and holidays. However, these non-working days do not affect the emission estimates calculated here.

Surface Disturbance Emissions

During exploration, development, and operation of the mine fugitive dust emissions associated with surface disturbances (e.g., exploratory drilling, site development, and other earth-moving activities) would be generated. Fugitive dust emissions were quantified for each category using the specified timeline, number of acres disturbed, and reasonable assumptions. It was assumed that the entire surface of the 1.1-acre exploration site and 20-acre mine site would be disturbed and that the access roads would be 14 feet wide. Power lines were assumed to parallel the access roads and to not require construction of a separate access road. In reality, power lines deviate to take the most direct route; therefore, the actual miles of power lines to be installed would likely be less.

There are numerous ways to estimate fugitive dust emissions from construction activities. However, the level of precision depends on the availability and accuracy of project-specific data such as silt content of excavated soil, soil moisture content, depth of excavation, wind speed, annual precipitation, type of construction equipment used, distance traveled, and the frequency and magnitude of water or surfactants application to control dust on unpaved roads and in the excavation areas.

Because of the lack of data, fugitive dust emissions associated with exploration operations were quantified using fugitive dust emission factors available on the California Air Resources Board (CARB) webpage[5] (CARB 2003). The emission factor, 0.11 ton of PM_{10} per acre-month, was developed to analyze PM_{10} emissions generated from average construction operations that do not involve substantial earth-moving activities. This emission factor assumes that water is applied during operations to minimize fugitive dust, resulting in an emission reduction efficiency of 50%. Substantial earth-moving operations are defined as any earth-moving operation with a daily volume of 5,000 cubic yards or more that occurs

[5] Available at: <http://www.arb.ca.gov/ei/areasrc/ONEHTM/ONE7-7.HTM>.

three times during a 365-day period (CARB 2003). Since only the surface would be disturbed as a result of vehicle and equipment traveling from each of the drill hole sites and the limited number of exploratory borings, the exploration activities are considered to be an average, typical construction operation, as defined by CARB.

To estimate $PM_{2.5}$ emissions from combustion and fugitive sources, South Coast Air Quality Management District (SCAQMD) created a method to estimate $PM_{2.5}$ emissions from combustion and mechanical/fugitive emission sources. Mechanical sources are any type of sources other than combustion (in this case, fugitive dust generated from motor vehicles traveling on unpaved roads). The method assumes a direct correlation between PM_{10} and $PM_{2.5}$ data in the 2003 air quality management plan (AQMP) annual inventories for combustion and mechanical/fugitive sources, SCAQMD-derived default ratios for mechanical/fugitive process, combustion sources, and off-highway combustion sources. The default ratios assume that a specified portion (expressed as a percentage) of PM_{10} emissions are $PM_{2.5}$ emissions. For mechanical/fugitive dust, the method assumes that 21% of PM_{10} emissions are $PM_{2.5}$. For combustion sources, 99% of PM_{10} emissions are $PM_{2.5}$, and for off-highway combustion sources 89% of PM_{10} emissions are $PM_{2.5}$ (SCAQMD 2006). $PM_{2.5}$ emissions for fugitive dust and off-highway combustion sources were estimated using the default ratios.

Fugitive dust emissions from the actual drilling of the exploratory boring were estimated using a total suspended particulate (TSP) emission factor of 1.3 lb per hole, which was obtained from EPA AP-42 Table 11.9-4, Uncontrolled Particulate Emission Factors for Open Dust Sources at Western Surface Coal Mines, dated July 1998. The resulting maximum potential emission estimates on a per site basis for fugitive dust as a result of surface disturbances are summarized in Table 4.2-3.

Table 4.2-3. Particulate Matter Emissions Associated with Surface Disturbances

Activity (per site or mile)	Disturbed Area (acres)*	PM_{10} Emission Factor (tons/acre-month)†	PM_{10} Emissions, Total (tons/month)	Duration of Project (months)‡	PM_{10} Emissions, Total (tons)	$PM_{2.5}$ Emissions, Total (tons)§
Exploration	1.10	0.11	0.12	1.5	0.18	0.04
Mine Development	20.00	0.11	2.20	2.0	4.40	0.92
Road Construction (per mile)	1.70	0.11	0.19	0.3	0.05	<0.01
Power Line Construction (per mile)	0.17	0.11	0.02	0.3	<0.01	<0.01
Mine Closure and Reclamation	20.00	0.11	2.20	1.0	2.20	0.46

* The average area of soil disturbance was obtained from Appendix B, Locatable Mineral Resources—Reasonably Foreseeable Development Scenarios, draft dated April 15, 2010.

† The CARB document states that the emission factor is for site preparation work, which may include scraping, grading, loading, digging, compacting, light-duty vehicle travel, and other operations. Available at: <http://www.arb.ca.gov/ei/areasrc/ONEHTM/ONE7-7.HTM>.

‡ It has been estimated that 30 days would be required for each exploratory drilling, 40 days would be required to develop the mine site, 5 days per mile of new access road constructed, 5 days per mile of new power line constructed, and 20 days for mine closure and reclamation. At 20 days/month, the project duration for exploration, mine development, and mine closure and reclamation would be 1.5 months, 2.0 months, and 1.0 months, respectively.

§ The SCAQMD-derived default ratio for estimating $PM_{2.5}$ is that for mechanical/fugitive dust 21% of PM_{10} is $PM_{2.5}$.

Vehicles/Equipment Tailpipe Emissions

During exploration, development, and mining operations, both on- and off-highway vehicles/equipment would generate gaseous exhaust emissions. Use of ultra-low-sulfur diesel fuel for vehicles and generators was also applied in the inventory. Table 4.2-4 summarizes the on-road equipment and vehicle roster for each of the various mine stages.

Table 4.2-4. Vehicle/Equipment Roster for "Typical or Hypothetical" Mine*

Primary Equipment Description	hp	Fuel Type	Primary Equipment Quantity	Estimated Activity Schedule (days)	Estimated Equipment Usage Time (hr/day)
Exploratory Activity (per site)				(1 Crew)	(1 Crew)
Truck, Pick-Up	180	Gas	4	30	8.00
Water Truck	350	Diesel	1	30	8.00
Drill Rig (Travel)	350	Diesel	1	2	8.00
Drill Rig (Drilling)	400	Diesel	1	30	8.00
Mine Development (per mine site)				(1 Crew)	(1 Crew)
Truck, Pick-Up	180	Gas	10	60	8.00
Back Hoe, w/Bucket	85	Diesel	1	60	8.00
Crane, Hydraulic, Rough Terrain, 25−35 Ton	125	Diesel	1	60	8.00
Loader, Front End, w/Bucket	165	Diesel	1	60	8.00
Road Grader	350	Diesel	1	60	8.00
Truck, Dump, 10 Ton	235	Diesel	1	60	8.00
Truck, Flatbed, 2 Ton	210	Diesel	2	60	8.00
Water Truck	350	Diesel	1	60	8.00
Generator	1,100	Diesel	1	60	8.00
Truck, Semi, Tractor	310	Diesel	2	60	8.00
Mine Development (per mile of new access road)				(1 Crew)	(1 Crew)
Backhoe/Front Loader	350	Diesel	1	5	8.00
Road Grader	350	Diesel	1	5	8.00
Scraper	600	Diesel	1	5	8.00
Dozer	600	Diesel	1	5	8.00
Truck, Pick-Up	180	Gas	5	5	8.00
Truck, Semi, Tractor	310	Diesel	2	5	8.00
Water Truck	350	Diesel	1	5	8.00
Mine Development (per mile of new power line)				(1 Crew)	(1 Crew)
Truck, Pick-Up	180	Gas	5	5	8.00
Back Hoe, w/Bucket	85	Diesel	1	5	8.00
Digger, Distribution Type, Truck Mount	190	Diesel	1	5	8.00
Crane, Hydraulic, Rough Terrain, 25−35 Ton	125	Diesel	2	5	8.00
Backhoe/Front Loader	350	Diesel	1	5	8.00
Forklift, 5 Ton	200	Diesel	1	5	8.00
Truck, Flatbed, w/Bucket, 5 Ton	235	Diesel	2	5	8.00
Truck, Dump, 10 Ton	235	Diesel	1	5	8.00
Truck, Wire Puller, 3-Drum	310	Diesel	1	5	8.00
Roller/Compactor	200	Diesel	1	5	8.00
Water Truck	350	Diesel	1	5	8.00
Truck, Semi, Tractor	310	Diesel	2	5	8.00
Mine Operation (per site)				(1 Crew)	(1 Crew)
Truck, Pick-Up	180	Gas	5	927	8.00
Backhoe/Front Loader	350	Diesel	2	927	8.00
Water Truck	350	Diesel	1	927	8.00
Ore Haul Trucks	400	Diesel	12	927	NA

Table 4.2-4. Vehicle/Equipment Roster for "Typical or Hypothetical" Mine* (Continued)

Primary Equipment Description	hp	Fuel Type	Primary Equipment Quantity	Estimated Activity Schedule (days)	Estimated Equipment Usage Time (hr/day)
Mine Closure and Reclamation (per site)				(1 Crew)	(1 Crew)
Road Grader	350	Diesel	1	20	8.00
Truck, Pick-Up	180	Gas	5	20	8.00
Water Truck	350	Diesel	1	20	8.00
Truck, Semi, Tractor	310	Diesel	2	20	8.00

* Equipment roster assumed by Ninyo and Moore based on previous experience with similar types of projects.

On-road motor vehicle emissions for employee vehicles and haul trucks were calculated using EFs for on-road gasoline and diesel vehicles obtained from UDEQ, Division of Air Quality 2005 mobile source (Mobile 6) emission factors for Kane County. These data are the most recent available and are representative of the project area. However, the Mobile 6 SO_2 emission factors were adjusted to account for a more restrictive gasoline and diesel sulfur standard than was assumed in the State's analysis. In 2005, the sulfur content of the fuels did not take into account current federal regulations. In April 2006, EPA published new rule Non-road and Highway Fuel Regulations. Therefore, an adjustment to the Mobile 6 SO_2 emission factors was made as follows: the sulfur content of gasoline in the Mobile 6 runs was 160 ppm versus a current standard of 30 ppm, and the sulfur content of diesel in the Mobile 6 runs was 191.5 ppm versus a standard of 15 ppm. CO_2 emissions were also calculated as part of this analysis. Emission factors in lb/mile for on-road gasoline combustion were based on a CO_2 EF of 19.4 lb/gallon and assuming an average fuel economy of 25.5 miles per gallon (mpg). The 25.5 mpg fuel economy assumes a 50/50 mix of passenger vehicles with an average fuel economy of 27.5 mpg and light duty trucks with an average fuel economy of 23.5 mpg based on the proposed Corporate Average Fuel Economy (CAFÉ) Rule for 2010. Emission factors in lb/mile for on-road diesel combustion were based on a CO_2 EF of 22.2 lb/gallon and assuming an average fuel economy of 6.6 mpg. Off-highway CO_2 EF was calculated using CO_2 (g/hp–hr) = (BSFC × 453.6 – HC) × 0.87 × (44/12), where brake specific fuel consumption (BSFC) is 0.367 (g/hp–hr), hp is horsepower, hr is hour, HC is hydrocarbon EF, and 44 molecular weight (MW) of CO_2 and 12 is the MW carbon. Off-highway motor vehicle emissions for construction and mining equipment were calculated using EFs from *Exhaust and Crankcase Emission Factors for Non-Road Engines Modeling Compressive Ignition* (EPA 2004).

Daily and annual exploratory emissions were quantified using the anticipated timeline, type of equipment, quantity of equipment, hours of operation, and reasonable assumptions. Assumptions were made for missing data, including distance traveled by on-road vehicles (i.e., drill rig and support vehicle commute distance). Vehicles and equipment were assumed to travel from Fredonia, Arizona, for exploration projects located in the North Parcel; Page, Arizona, for exploration projects located in the East Parcel; and Flagstaff, Arizona, for exploration projects located in the South Parcel. Drill rig and the support vehicles (i.e., gasoline pick-up trucks) were assumed to travel a round-trip distance of 73 miles for exploration activities located in the North Parcel, 121 miles for exploration activities located in the East Parcel, and 145 miles for exploration activities located in the South Parcel. Ore haul trucks were assumed to travel an average round-trip distance of 595 miles from the North Parcel, 507 miles from the East Parcel, and 523 miles from the South Parcel to the ore processing facility in Blanding, Utah. All of the ore haul truck travel routes selected were the shortest distances that avoid truck travel through Grand Canyon National Park.

OHVs and equipment were assumed to operate on average 8 hours per workday. The resulting maximum potential emission estimates for criteria and GHG pollutants are summarized in Table 4.2-5.

Table 4.2-5. Hypothetical/Typical Mine Vehicle/Equipment Exhaust Emissions in Tons*†

Segregation Area	NO_X	SO_2	CO	PM_{10}‡	$PM_{2.5}$§	VOCs	CO_2¶
North Parcel							
Exploration	0.70	< 0.01	0.48	0.02	< 0.01	0.05	61.15
Mine Site	6.10	0.01	3.57	0.35	0.32	0.53	561.36
Access Roads	0.52	< 0.01	0.27	0.03	0.03	0.04	46.44
Power Lines	0.39	< 0.01	0.39	0.05	0.04	0.06	34.22
Mine Operations	113.58	0.10	76.47	7.47	6.93	11.22	11,262.96
Reclamation	0.44	< 0.01	0.43	0.02	0.02	0.04	41.04
Total	**121.73**	**0.11**	**81.62**	**7.95**	**7.34**	**11.95**	**12,007.17**
East Parcel							
Exploration	0.74	< 0.01	0.70	0.02	< 0.01	0.06	64.42
Mine Site	6.44	0.01	4.74	0.36	0.33	0.62	593.88
Access Roads	0.53	< 0.01	0.32	0.03	0.03	0.05	47.80
Power Lines	0.42	< 0.01	0.44	0.05	0.05	0.07	37.19
Mine Operations	102.11	0.10	77.53	7.09	6.55	10.97	10,050.08
Reclamation	0.50	< 0.01	0.62	0.02	0.02	0.05	46.46
Total	**110.74**	**0.10**	**84.37**	**7.58**	**6.97**	**11.82**	**10,839.83**
South Parcel							
Exploration	0.76	< 0.01	0.81	0.02	< 0.01	0.07	66.01
Mine Site	6.60	0.01	5.31	0.37	0.33	0.67	609.57
Access Roads	0.54	< 0.01	0.34	0.03	0.03	0.05	48.45
Power Lines	0.44	< 0.01	0.47	0.05	0.05	0.07	38.62
Mine Operations	104.77	0.10	81.71	7.17	6.63	11.33	10,319.09
Reclamation	0.53	< 0.01	0.72	0.02	0.02	0.06	49.08
Total	**113.63**	**0.11**	**89.35**	**7.67**	**7.06**	**12.25**	**11,130.82**

* Vehicles and equipment were assumed to travel from Fredonia, Arizona, for exploration projects located in the North Parcel, Page, Arizona, for exploration projects located in the East Parcel, and Flagstaff, Arizona, for exploration projects located in the South Parcel. Ore haul trucks were assumed to travel to uranium ore processing plant located in Blanding, Utah. Distances were estimated using Google Earth.

† Emission factors for on-road gasoline and diesel vehicles obtained from UDEQ Kane County Mobile 6.2 and for off-highway diesel vehicles/equipment from EPA (2004)

‡ For on-road equipment, PM emission factor was used to calculate PM_{10} emissions.

§ The SCAQMD-derived default ratio for estimating $PM_{2.5}$ is that for off-highway combustion sources 89% of PM_{10} is $PM_{2.5}$ and for on-road combustion sources 99% of PM_{10} is $PM_{2.5}$.

¶ EFs in lb/mile for on-road gasoline combustion were based on a CO_2 EF of 19.4 lb/gallon and assuming an average fuel economy of 25.5 mpg. EFs in lb/mile for on-road diesel combustion were based on a CO_2 EF of 22.2 lb/gallon and assuming an average fuel economy of 6.6 mpg. Off-highway CO_2 EF was calculated using CO_2 (g/hp–hr) = (BSFC × 453.6 – HC) × 0.87 × (44/12) where BSFC is 0.367 (g/hp–hr), HC is hydrocarbon EF, and 44 MW of CO_2 and 12 is the MW of CO.

Vehicles/Equipment Travel over Paved and Unpaved Surfaces

During the exploration activities, fugitive dust emissions would be generated from vehicles and equipment traveling over the paved and unpaved surfaces. Emissions from vehicle/equipment travel on paved roads were calculated based on EFs developed from Equation 2 in AP-42, Chapter 13.2.1, Paved Roads (EPA 2006a). Emissions from vehicle/equipment travel on unpaved roads were calculated based on EFs developed from Equation 2 in AP-42, Chapter 13.2.2, Unpaved Roads (EPA 2006b). Daily and annual exploratory emissions were quantified using the anticipated timeline, type of equipment, quantity of equipment, hours of operation, and reasonable assumptions. Assumptions were made for missing data,

including where the vehicles and equipment were mobilizing from and the distance traveled by on-road vehicles.

Each proposed withdrawal parcel was broken into four quadrants. The linear distance to the nearest paved highway from the center point of each quadrant was determined using Google Earth. An additional factor of 50% was added to the dirt road values to account for the sinuosity of the roads.

Vehicles and equipment were assumed to travel from Fredonia, Arizona, for exploration projects located in the North Parcel; Page, Arizona, for exploration projects located in the East Parcel; and Flagstaff, Arizona, for exploration projects located in the South Parcel. However, depending on the withdrawal parcel, the following was assumed for the average miles per day traveled by the drill rig and other vehicles:

- North Parcel – 27 miles per day on paved and 46 miles per day on unpaved surfaces
- East Parcel – 106 miles per day on paved and 15 miles per day on unpaved surfaces
- South Parcel – 135 miles per day on paved and 10 miles per day on unpaved surfaces

Ore haul trucks were assumed to travel the following average miles per day on paved and unpaved surfaces:

- North Parcel – 549 miles per day on paved and 46 miles per day on unpaved surfaces
- East Parcel – 492 miles per day on paved and 15 miles per day on unpaved surfaces
- South Parcel – 513 miles per day on paved and 10 miles per day on unpaved surfaces

The resulting maximum potential emission estimates for fugitive dust from on-road vehicle/equipment travel of paved and unpaved surfaces are summarized in Table 4.2-6.

Table 4.2-6. Hypothetical/Typical Mine Vehicle/Equipment Fugitive Dust Emissions Over 20 Years*†

Segregation Area	PM_{10} (lb/day)	Total PM_{10} (in tons)	$PM_{2.5}$ (lb/day)	Total $PM_{2.5}$ (in tons)
North Parcel				
Exploration	247.26	2.44	24.78	0.24
Mine Site	622.33	18.67	62.35	1.87
Access Roads	362.36	0.91	36.35	0.09
Power Lines	572.77	1.43	57.50	0.14
Mine Operations	1,639.08	598.26	181.36	66.20
Reclamation	362.36	3.62	36.35	0.36
Total	**3,806**	**625**	**399**	**69**
East Parcel				
Exploration	90.51	0.85	9.34	0.09
Mine Site	227.82	6.83	23.50	0.70
Access Roads	134.65	0.34	14.02	0.04
Power Lines	214.33	0.54	22.43	0.06
Mine Operations	765.83	279.53	92.25	33.67
Reclamation	134.65	1.35	14.02	0.14
Total	**1,568**	**289**	**176**	**35**

Table 4.2-6. Hypothetical/Typical Mine Vehicle/Equipment Fugitive Dust Emissions Over 20 Years*† (Continued)

Segregation Area	PM_{10} (lb/day)	Total PM_{10} (in tons)	$PM_{2.5}$ (lb/day)	Total $PM_{2.5}$ (in tons)
South Parcel				
Exploration	63.58	0.58	6.73	0.06
Mine Site	160.03	4.80	16.93	0.51
Access Roads	95.84	0.24	10.30	0.03
Power Lines	153.47	0.38	16.62	0.04
Mine Operations	631.43	230.47	90.43	33.01
Reclamation	95.84	0.96	10.30	0.10
Total	**1,200**	**237**	**140**	**30**

* Vehicles and equipment were assumed to travel from Fredonia, Arizona, for exploration projects located in the North Parcel, Page, Arizona, for exploration projects located in the East Parcel, and Flagstaff, Arizona, for exploration projects located in the South Parcel. Ore haul trucks were assumed to travel to uranium ore processing plant located in Blanding, Utah. Distances were estimated using Google Earth.

† EF was calculated using Equation 1 and 2 in §13.2.1 Paved Roads. Note: There may be situations where low silt loading and/or low average weight would yield calculated negative emissions from equation 1. If this occurs, the emissions calculated from equation 1 should be set to zero.

Mine Operation Emissions

Emissions from construction activities and uranium mining activities were considered as project emissions. Primary sources within each of these activities are related to fuel (gasoline and diesel) use in internal combustion engines and to fugitive dust emitted into the ambient air from various sources. The methodology used to calculate these emission sources is described in detail below, and emission summary tables are provided. For uranium mining activity emissions, a “typical” 300-tpd mine production rate was assumed, as described in Chapter 2.

The only currently active mine within the proposed withdrawal area is the Arizona 1 Mine, located approximately 35 miles south of Fredonia, Arizona, within the North Parcel. Estimated emissions of criteria and HAPs from continued uranium mining activities were extracted from the Class II Permit Application for the proposed 500-tpd Arizona 1 Mine Project prepared for Denison and submitted to the ADEQ in January 2008. Therefore, mine emissions associated with a “typical” 300-tpd mine were assumed to be 60% (300/500) of the Arizona 1 Mine projected emissions. Ninyo and Moore calculated construction and vehicle emissions not covered by the air permit application. The resulting maximum potential emission estimates for mine operations are summarized in Table 4.2-7.

Table 4.2-7. Typical Mine Projected Facility-Wide Annual Emissions (tons/year)*

Emissions	Standby Generator (Cummins 700 hp)	Material Handling Sources	Storage Pile Fugitive Sources	Road Fugitive Sources	Storage Tank Emissions	Total (tons/year)
CO	0.21	–	–	–	–	0.21
NO_X	1	–	–	–	–	1
PM_{10}	0.071	0.414	0.096	3.738	–	4.319
VOC	0.08	–	–	–	0.297	0.377
SO_2	0.07	–	–	–	–	0.07
Lead	–	3.01E-14	1.37E-13	5.44E-12	–	5.609E-12
CO_2	48.3	–	–	–	–	48.3

Source: Denison (2008:Table 3-1).

Note: 3.01E-14 tons/year is equal to 0.0000000000000301 tons/year.

* Typical mine emissions assumed to be 60% (300/500) of the Arizona 1 Mine Emissions.

Climate and Greenhouse Gas Emissions

There is currently no standard methodology or model to determine how an individual source or project's (i.e., multiple sources) GHG emissions may translate into physical impacts to the local or global environment. The project's GHG emissions would increase the concentration of the GHG in the atmosphere in combination with GHG emissions from other sources. However, the project's cumulative GHG emissions would be insignificant, compared with the amount of GHG emissions generated worldwide.

GREENHOUSE GAS EMISSIONS ASSOCIATED WITH ALTERNATIVES

GHG emissions would occur as result of the mining activities described in the Air Quality Introduction above (e.g., exploration activities, mine development, mining operations, and mine closure and reclamation). When considering GHG emissions from the combustion of gasoline or #2 fuel oil (diesel), more than 99.99% of those emissions are in the form of CO_2; therefore, for this analysis, only CO_2 emissions are considered. However, not all GHGs have uniform global warming potentials (GWPs). Nitrous oxide (N_2O) has a GWP of 200 times the potential of CO_2. If the remaining 0.1% of emissions were nitrous oxide, it would only account for approximately 2% of the GWP, a figure that is insignificant in relation to other uncertainties in this analysis.

CO_2 emissions associated with those mobile and stationary combustion sources are provided in the summary of maximum total emission table for each alternative, below.

4.2.4 Impacts Common to All Alternatives

The main pollutant to be released from the construction and operation of the mines would be particulate matter, emitted as fugitive dust. Particulate matter emissions can be expected from land clearing, earth-moving, mine development, access road and power line construction, and mine closure and reclamation activities. Operational fugitive dust would result from ore and waste rock removal, transport, storage activities, and wind erosion of exposed surfaces.

Ore haulage near Grand Canyon National Park may result in particulates' being transported into the borders of the Park. Under worst-case meteorological conditions, a small reduction in visibility could occur if an observer were looking through the potential fugitive dust plume when haul road traffic was present. However, any visibility reduction should be temporary, as traffic would pass along the haul road in less than a minute.

Exploration Impacts on Air Quality

Air quality impacts from exploration activities would result primarily from vehicle/equipment and fugitive dust emissions. The operation of drill rigs and other mobile sources would result in the combustion of diesel and gasoline fuels, which would have intermittent and short-term emissions of CO, SO_2, NO_X, PM_{10}, $PM_{2.5}$, VOCs, and CO_2. The diesel and gasoline engines would be built in accordance with EPA mobile source regulations [40 CFR 85] and would only be operated on an as-needed basis, further minimizing vehicle exhaust emissions.

The potential impacts resulting from exploration activities would occur over a limited geographic area, as each exploration site is relatively small in area (1.1 acres), and would be intermittent and temporary in duration. Under normal atmospheric conditions, fugitive dust tends to settle out within a few kilometers. Emissions from exploration-related activities would be reduced with the implementation of routine, commonly accepted operating procedures to curb dust (e.g., limiting vehicle speeds, maintaining

stabilized soil surfaces, active watering during drilling activities). However, exceptional wind events have the potential for fugitive dust to be transported beyond several kilometers. To assess the current value of the air quality resource condition indicators, measurement of existing background air pollutant concentrations, topography, and meteorological data in the specific area of any potential mine sites would be needed.

Mine Development Impacts on Air Quality

Air quality impacts from the development phases of the project (e.g., construction of access roads and power lines) would result primarily from vehicle/equipment and fugitive dust emissions. The operation of construction equipment and other mobile sources would result in the combustion of diesel and gasoline fuels, which in turn would result in emissions of CO, SO_2, NO_X, PM_{10}, $PM_{2.5}$, VOCs, and CO_2. The diesel and gasoline engines would be built in accordance with EPA mobile source regulations [40 CFR 85] and would only be operated on an as-needed basis, further minimizing vehicle exhaust emissions.

Operation of vehicles/equipment has the potential to generate nuisance fugitive dust during mine development activities. The generation of fugitive dust emissions during mine development activities would be reduced using appropriate compliance measures identified in the Compliance with Environmental Regulations and Permitting section.

The potential impacts resulting from development activities would occur over a limited geographic area, as each mine site is relatively small in area (20 acres). Under normal atmospheric conditions, fugitive dust tends to settle out within a few kilometers. However, exceptional wind events have the potential for fugitive dust to be transported beyond several kilometers.

Mine Operation Impacts on Air Quality

Air quality impacts from mining operations would result primarily in fugitive dust emissions generated during the hauling of the uranium ore to the processing facility located in Blanding, Utah. Additionally, fugitive dust (e.g., material handling, storage piles, and road fugitive emission) and vehicle/equipment exhaust emissions would be generated during the mining of the uranium ore. Emissions from the mining activities would mainly consist of CO, SO_2, NO_X, PM_{10}, $PM_{2.5}$, VOCs, and CO_2. CO_2, a GHG, would also be produced from the fuel combustion sources used to carry out mining operations. GHGs include CO_2, methane (CH_4), and N_2O; however, CO_2 is the main GHG of concern when dealing with fuel combustion sources.

However, not all GHGs have uniform GWPs. Nitrous oxide has a GWP of 200 times the potential of carbon dioxide. If the remaining 0.1% of emissions were nitrous oxide, it would only account for approximately 2% of the GWP, a figure that is insignificant in relation to other uncertainties in this analysis.

None of the proposed mines would have potential emissions in quantities large enough to trigger a PSD review, as defined in Section 3.2.2. Therefore, each mine would be considered a minor source relative to the PSD permitting process and would only require a State of Arizona Class II Non-Title V air quality permit. Compliance with the permit and the applicable state regulations would minimize the air quality impacts of mine operation.

For information purposes only, these emissions are considered less than significant with respect to those regulations governing PSD/NSR. Those regulations define significance to be emissions of criteria pollutants to be greater than 250 tons per year. However, this analysis is not meant or intended to be an increment consumption analysis.

Mining operations related to all of the alternatives would be expected to result in increases in ambient air pollutant concentrations. Use of the unpaved and paved roads by the ore haul trucks would result in potential increases in fugitive dust and vehicle exhaust emissions. However, these impacts would be localized and temporary when they did occur and would be minimized by speed limit restrictions on unpaved roads. However, exceptional wind events have the potential for fugitive dust to be transported beyond several kilometers. The extent of the impact is dependent on the proximity of the mining activity to the Grand Canyon National Park boundary. Areas of the Park that are closer to mining operations could be impacted greater than areas that are farther away.

Air quality impacts would be mitigated through use of a compliance plan following the control measures as discussed in the Arizona 1 Mine Compliance Plan provided below. This reference was provided for informational purposes only. It should be noted that each individual mine would be required to submit a compliance plan specific to its operations. These plans will provide specific compliance measures for the individual project.

Mine Closure and Reclamation Impacts on Air Quality

Air quality impacts from the mine closure and reclamation would result primarily from vehicle/equipment and fugitive dust emissions. The operation of heavy-equipment and other mobile sources would result in the combustion of diesel and gasoline fuels, which would have localized increases in emissions of CO, SO_2, NO_X, PM_{10}/$PM_{2.5}$, VOCs, and CO_2. The diesel and gasoline engines would be built in accordance with EPA mobile source regulations [40 CFR 85] and would only be operated on an as-needed basis, further minimizing vehicle exhaust emissions.

The potential impacts resulting from mine closure and reclamation activities would occur over a limited geographic area, as each mine site is relatively small in area (20 acres), and would be intermittent and temporary in duration. Under normal atmospheric conditions, fugitive dust tends to settle out within a few kilometers and with the incorporation of sufficient dust control measures, emissions from mine closure and reclamation activities would not significantly affect local or regional air quality, although exceptional wind events have the potential for fugitive dust to be transported beyond several kilometers. Reclamation activities would include revegetation of the mine site, which would result in a reduction of bare ground, stabilizing the previously disturbed soil surfaces and decreasing the potential for generation of wind-blown fugitive dust. Moreover, because the mines would be reclaimed following closure it would be expected that a decrease in fugitive emissions would occur as a result of the stabilization of soils and the re-establishment of vegetation.

The operation of the vehicles/equipment has the potential to generate fugitive dust during mine closure and reclamation activities. The generation of fugitive dust emissions during mine closure and reclamation activities would be reduced using appropriate compliance measures.

Compliance with Environmental Regulations and Permitting

Compliance measures for exploration activities, mine development, mine operations, and mine closure/reclamation would be required and applied in a manner consistent with federal, state, and local air quality regulations. These compliance measures would be based on the individual activity and for the air pollutant to be controlled.

A compliance plan for the Arizona 1 Mine was created by Denison and submitted to ADEQ within the Class II Permit Application for the Proposed Arizona 1 Mine Project (Tetra Tech 2008). This compliance plan identifies applicable requirements of AAC Article 6 of R18-2 pertaining to roadways/streets, emission requirements for material handling and storage piles, opacity requirements for point and non-

point sources, and standards of performance for storage vessels for petroleum liquids. This plan identifies specific control measure options to be used as needed to control project-related fugitive dust emissions.

The magnitude of the particulate matter emissions expressed herein was calculated based on the diligent use of the control measures, as follows:

- Keep dust and other particulate emissions to a minimum by reducing travel speeds on unpaved surfaces.
- Apply gravel to silty pockets and/or use magnesium chloride or a similar soil stabilizer on dust problem areas along the haul road.
- Install a track-out device (i.e., grizzly, gravel pad, and/or wash down pad) adjacent to the entrance of an area accessible to the public to control carryout and track-out.
- On the last day of active operations prior to a weekend or holiday, apply water or chemical stabilizer to maintain a stabilized surface.
- Water excavated soil piles hourly or cover them with temporary coverings.
- Moisten excavated soil prior to loading haul trucks.
- Cover all loads of dirt leaving the site. Apply water to ground surfaces prior and during earth-moving activity.
- Apply chemical stabilizers, per manufacturer's directions, and/or water as necessary prior to expected high wind events. During periods of high winds, work activities would cease temporarily.

These compliance measures would be compared with those measures required to comply with state regulation at the time the compliance plan was approved and adopted as a permit requirement for the Arizona 1 Mine. These measures would be applicable to all the alternatives described in this EIS.

Hazardous Air Pollutant Impact Assessment

HAPs can cause various adverse health effects. They are not regulated under the NAAQS, but high concentrations at the mine site boundary could indicate the need for further analysis and/or mitigation strategies.

Uranium mining operations have the potential to emit ionizing radiation. The negative health effects attributed to ionizing radiation depend on many parameters, including the dose (i.e., amount of radiation received), the dose rate (i.e., rate at which radiation is delivered), and the type of ionizing radiation (i.e., alpha, beta, x-ray, or gamma). The types of radiation emitted from typical underground uranium mines will include alpha and beta particles and x-rays and gamma rays. These types of radiation are emitted from the radioactive materials found in and around the uranium ore body.

The natural environment consists of cosmic radiation and many other radioactive elements (e.g., hydrogen-3, carbon-14, potassium-40, radium-226, rubidium-87, uranium 235 [^{235}U], uranium 238 [^{238}U], and thorium-232). Both ^{238}U and Thorium-232 are ubiquitous in soil, with average concentrations on the order of a few parts per million. ^{238}U is considered a parent element of a radioactive decay series, which means the "parents" decay to "daughters" that are also radioactive. Natural occurring uranium is typically about 99.3% ^{238}U (DUF_6 Guide 2010).

Radioactive materials are present in air, water, and soil. Concentrations of radioactive materials are expressed in units of radioactivity per volume or mass. Typical concentrations of naturally occurring uranium and radium-226 in normal soil are on the order of one pico-Curie per gram (pCi/g) (ADEQ 2008). One pCi is equivalent to 2.22 atoms of the radionuclide decaying each minute.

When ionizing radiation deposits energy in living matter, it produces a physical and biological effect, which is quantified in terms of dose. The dose is expressed in radiological units, known as roentgen equivalent man, or rem. However, because a rem is so large it is often divided by 1,000 and called an mrem.

A progeny of ^{238}U is radon-222, which is a colorless, odorless, and inert gas. Radon-222 diffuses into the atmosphere from rocks, soil, and building materials. When radon-222 decays, it releases alpha particles, which have been linked to negative human health effects.

The following text is excerpted from ADEQ's (2008) Technical Review and Evaluation of Application for Air Quality Permit No. 46700 for Denison's Arizona 1 Mine:

> Radon gas emanates from the earthen materials containing uranium such as natural soil and the ore stockpiles. Once airborne, the gas will be transported by prevailing winds and will decay to its progeny. Uranium and its progeny will be present in dust from the mining operations.
>
> The natural background radon gas concentration in the vicinity of the Arizona 1 Mine is on the order of 0.2 picocuries per liter (pCi/l) or 125 mrem/yr. Based upon previous evaluations of the project (McKleveen 1988) the highest potential exposure projected from radon would be on the order of 106 mrem/year. The mineshaft vent emissions are subject to limitations set forth of 40 Code of Federal Regulations (CFR) part 61 subpart B at 10 mrem/year. Radiation exposure from dust associated with the mining operation is dependent on the concentrations of dust in the air and the activity of the compounds in the dust. Since these values are variable, it is not feasible to estimate the radiation impact from the dust.
>
> Direct radiation from haul trucks will be about 2 mrem/hr at the truck bed, about 0.3 mrem/hr on the shoulder of the roadbed, and normal background at about 96 feet from the trailer. As a truck passes, individuals standing on the shoulder of the road would receive a dose of radiation too small to quantify. These radiation concentrations can be put in perspective by comparing them to what naturally occurs in various locations. For example, naturally occurring radiation levels for a person living in the Colorado Plateau will receive 400-500 mrem/year based on EPA estimates. Thus, the estimated radiation exposure at the Arizona 1 Mine site [or from hauling ore] does not present a significant risk to human health.

VISCREEN Modeling Results

Plume visibility impacts were analyzed at the Grand Canyon using EPA's VISCREEN model (Version 1.01) following the guidance in *Workbook for Plume Visual Impact Screening and Analysis* (Revised), October 1992, EPA-454/R-92-02 (EPA 1992). VISCREEN uses two successive levels of screening (Levels 1 and 2). Level 1 screening is the most simplified approach and is designed to provide a very conservative estimate of a plume's visual impact using worst-case meteorological conditions. The Level 1 analysis is designed to simulate the most conservative (highest) plume visual impact that an observer may possibly experience. These worst-case meteorological conditions includes extremely stable atmospheric conditions, a wind speed of 1 meter per second persisting for 12 hours, and assumes the wind would transport the plume directly adjacent to the hypothetical observer. Furthermore, the Level-1 analysis assumes the plume is uniformly distributed vertically and normally (Gaussian) distributed horizontally over a 22.5-degree sector in the direction of transport towards the Class I area. The following technical options for the VISCREEN modeling analysis were selected:

- Hypothetical 1 gram per second emission rate;
- Default particle characteristics assumed;
- Default (zero) emission rates for primary NO_2, soot, and sulfate;

- Default background visual range for the region (275 km);
- Default Level 1 parameters (background O_3 equal to 0.06 ppm, wind speed equal to 1 meter per second, stability index of 6, and a plume source observer angle of 11.25 degrees).

The Level 1 screening analysis was performed for a plume generated by a "typical" 300-tpd mine operation at the North, East, and South parcels. The operation of the "typical" mine would cause elevated emissions from numerous process points and ground-level emissions of fugitive dust. For the Level l screening, all the elevated and ground-based emissions were lumped together as if they originated from a single source. The maximum particulate matter emission rate input value was determined to be the total tons per year of PM_{10} from the standby generator, material handling operations, storage piles, and road fugitive sources, plus the tailpipe emissions generated from the on-site vehicles/equipment.

The maximum NO_x emission rate input value was determined to be the total tons per year of NO_X from the standby generator and tailpipe emissions generated from the on-site vehicles/equipment. The maximum NO_X and PM_{10} emission rate input values are summarized in Table 4.2-8.

VISCREEN also requires source-observer distances and maximum/minimum receptor distances, which have been summarized in Table 4.2-9.

Table 4.2-8. VISCREEN Maximum Tons per Year NO_X and PM_{10} Emission Rate Input Values

Area	PM_{10} (tpy)	NO_X (tpy)
North Parcel	6.7	15.8
East Parcel	6.7	16.2
South Parcel	6.7	16.4

Table 4.2-9. VISCREEN Source-Receptor Distances

Area	Source-Observer Distance (km)	Minimum Source-Observer Distance (km)	Maximum Source-Observer Distance (km)
North Parcel*	10.9	10.9	39.4
East Parcel†	6.6	6.6	10.3
South Parcel‡	12.4	12.4	54.1

* The Arizona 1 Mine location was used as the representative emission source within the North Parcel.
† A hypothetical mine located in the center of the East Parcel was used as the location of the representative emission source within the East Parcel.
‡ The Canyon Mine was used as the representative emission source within the South Parcel.

VISCREEN uses two screening criteria to ascertain whether a plume has the potential to be perceptible to untrained observers under "reasonable worst-case" conditions. The first screening criterion is a delta E (ΔE) of 2.0. ΔE is used to characterize the perceptibility of given plume based on the color difference between the plume and the viewing background (e.g., sky, cloud, or terrain feature). The second screening criterion is a contrast value of 0.05 (EPA 1992). VISCREEN calculates a ΔE and contrast both from inside and outside the study area. The resulting maximum visual impacts inside Grand Canyon National Park are summarized in Table 4.2-10.

Note that only results "inside" the receptor area (i.e., Grand Canyon National Park) were considered in this analysis, as the area "outside" the receptor area is not considered a Class I area. These results are based on emission data from the Arizona 1 Mine and one particular location within each of the proposed withdrawal parcels.

Table 4.2-10. Class I Visibility Modeling Results—Maximum Visual Impacts Inside Grand Canyon National Park

Background	Theta (degrees)	Azimuth (degrees)	Distance (km)	Alpha (degrees)	ΔE Screening Criteria	ΔE Plume	Absolute Contrast Screening Criteria	Absolute Contrast Plume
North Parcel								
Sky	10	165	39.4	4	2.00	1.691	0.05	0.034
Sky	140	165	39.4	4	2.00	0.340	0.05	−0.009
Terrain	10	165	39.4	4	2.00	3.681	0.05	0.032
Terrain	140	165	39.4	4	2.00	0.315	0.05	0.004
East Parcel								
Sky	10	150	10.3	19	2.00	0.843	0.05	0.019
Sky	140	150	10.3	19	2.00	0.340	0.05	−0.006
Terrain	10	84	6.6	84	2.00	3.893	0.05	0.010
Terrain	140	84	6.6	84	2.00	0.093	0.05	0.000
South Parcel								
Sky	10	165	54.1	3	2.00	1.32	0.05	0.021
Sky	140	165	54.1	3	2.00	0.184	0.05	−0.006
Terrain	10	84	12.4	84	2.00	2.178	0.05	0.008
Terrain	140	84	12.4	84	2.00	0.053	0.05	0.000

Notes:

Alpha = The horizontal angle between a line of sight and the plume centerline.

Azimuth = The horizontal angle between the line connecting the emission source and the observer and the line of sight.

Distance = The distance between the emission source and the most distant Class I area boundary.

Theta = Scattering angle, which is the angle between direct solar radiation and the line of sight.

Potential impacts on regional haze or visibility were evaluated. VISCREEN modeling efforts concluded the “typical” mining project would comply with the criteria established by the EPA for maximum visual impacts inside Grand Canyon National Park.

The modeling results provided in Table 4.2-10 show that plume impacts from a typical mining operation are below the absolute contrast value but exceed the ΔE. Therefore, a Level 2 analysis would be required to determine potential impacts to Grand Canyon National Park. A valid analysis of potential air quality impacts associated with any of the alternatives cannot be made without descriptions of each of the individual proposed exploration and mine sites, including precise location (topography), atmospheric conditions, roster of equipment, number of mine shafts, and ore production rates, etc. Without knowledge of the specific location of each air pollutant source, these variables cannot be considered.

In each study area, the maximum impacts occur outside the area looking in, in other words, views outside Grand Canyon National Park. Note that only results “inside” the receptor area were considered in this analysis, as the area “outside” the receptor area is generally not protected.

Arizona 1 Mine Modeling Results Summary

Arizona 1 Mine facility-wide annual emission limits were obtained from the Arizona 1 Mine Air Permit Application (Tetra Tech 2008). Criteria pollutant emissions from the operation of the Arizona 1 Mine are relatively low, as shown in Table 4.2-11.

Table 4.2-11. Arizona 1 Mine Projected Facility-Wide Annual Emissions

	CO (tpy)	CO (lb/hr)	NO_X (tpy)	NO_X (lb/hr)	PM_{10} (tpy)	PM_{10} (lb/hr)	VOC (tpy)	VOC (lb/hr)	SO_2 (tpy)	SO_2 (lb/hr)	Pb (tpy)	Pb (lb/hr)
Standby Generator (Cummins 700 hp)	0.21	3.58	1.0	16.63	0.071	1.18	0.08	1.35	0.07	1.10	–	–
Material Handling Sources	–	–	–	–	0.69	0.16	–	–	–	–	5.02E-14	4.58E-08
Storage Pile Fugitive Sources	–	–	–	–	0.16	0.04	–	–	–	–	2.28E-13	2.08E-07
Road Fugitive Sources	–	–	–	–	6.23	1.07	–	–	–	–	9.07E-12	6.20E-06
Storage Tank Emissions	–	–	–	–	–	–	0.297	0.07	–	–	–	–
Total	**0.2**	**3.58**	**1.0**	**16.63**	**7.2**	**2.44**	**0.38**	**1.42**	**0.07**	**1.10**	**9.35E-12**	**6.46E-06**

Source: Denison (2008:Tables 3-1 and 3-2).

Note: 5.02-14 tpy is equal to 0.0000000000000502 tpy.

Maximum SO_2, NO_2, and CO concentrations for the operation of the standby generator were analyzed using the EPA SCREEN3 model (version 96043). SCREEN3 is a very conservative Gaussian plume modeling analysis that predicts maximum ground-level concentrations using worst-case meteorological conditions from point, area, and volume emission sources. A Gaussian plume model assumes that a pollutant plume is carried downwind from its emission source and that concentrations in the plume can be approximated by assuming that the highest concentrations occur on the horizontal and vertical midlines of the plume, with the distribution about these midlines characterized by bell-shaped (i.e., Gaussian) concentration profiles.

Maximum PM_{10} concentrations from Arizona 1 Mine emissions (e.g., standby generator, material handling, and fugitive dust) were analyzed using the American Meteorological Society and EPA Regulatory Model Improvement Committee Dispersion Model (AERMOD version 07026). AERMOD is the EPA preferred model for near-field applications to access impacts to NAAQS and both Class I and Class II increments. Recently issued (or in the process of being reviewed) air quality permits by the ADEQ for the Denison mines (Arizona 1, Pinenut, Canyon, and EZ mine) have all performed air quality impact analyses using AERMOD to calculate impacts to the NAAQS and Class I increments inside and on the boundary of Grand Canyon National Park. Tables 4.2-12 through 4.2-14 were obtained from the ADEQ (2008) Technical Review and Evaluation of Application for Air Quality Permit No. 46700 for Denison's Arizona 1 Mine.

Table 4.2-12. Arizona 1 Mine Modeling Results

Pollutant	Averaging Period	Year	Highest Modeled Concentration* ($\mu g/m^3$)	Background Concentration ($\mu g/m^3$)	Total Concentration ($\mu g/m^3$)	NAAQS ($\mu g/m^3$)	% Ambient Standard
SO_2	3-Hour	N/A	17.3	73	90.3	1,300	6.9%
	24-Hour	N/A	7.7	16	23.7	365	6.5%
	Annual	N/A	1.5	3	4.5	80	5.6%
NO_2	Annual	N/A	23.2	4	27.2	100	27.2%
CO	1-Hour	N/A	62.6	582	644.6	40,000	1.6%
	8-Hour	N/A	43.8	582	625.8	10,000	6.3%
PM_{10}	24-Hour	2002	43.1	47	90.1	150	60.1%
	Annual	2001	9.64	18	27.6	Revoked	-

Sources: ADEQ (2008:Table 4); Denison (2008).

Note: N/A = Not applicable.

* Highest: first-high modeled concentrations are presented for both short-term and annual averaging periods, per ADEQ request.

Regional haze modeling was conducted using CALPUFF for Grand Canyon National Park. CALPUFF is an advanced integrated atmospheric pollution dispersion model. Table 4.2-13 presents the regional haze modeling results from the Arizona 1 Mine and haul road traffic, compared with the 5% change in light extinction (ΔB_{ext}) screening level. A change in ΔB_{ext} that is less than 5% is considered acceptable by the EPA.

Modeling results indicate that predicted visibility impairment is below the 5% screening criteria for all days in the 3-year meteorological period (2001–2003), except for one day in the year 2002. This one isolated event in the 3-year data set occurred on March 19, 2002, approximately 7.5 miles from the Arizona 1 Mine Site at the northern edge of Grand Canyon National Park. The specific cause of the isolated event on March 19, 2002, is unknown.

Table 4.2-13. Grand Canyon Visibility Impact Modeling Results*

Visibility Parameter	Averaging Period	Denison Mines Arizona 1 Mine and Haul Road Traffic – 2001	Denison Mines Arizona 1 Mine and Haul Road Traffic – 2002	Denison Mines Arizona 1 Mine and Haul Road Traffic – 2003	Screening Threshold
Max ΔB_{ext} (%)	24-Hour	3.29	5.76	3.56	5%
# days > 5%	N/A	0	1	0	N/A
# days > 10%	N/A	0	0	0	N/A

Source: ADEQ (2008:Table 5).
Notes:
= Number.
N/A = Not Applicable.
* Visibility Impacts (% degradation).

Table 4.2-14 presents the regional haze modeling results, showing that at the ninety-eighth percentile, the regional haze impacts are below the threshold 5% ΔB_{ext}. The proposed draft FLAG approach uses a modified algorithm and monthly relative humidity values and takes the ninety-eighth percentile to screen out seven days of haze-type visibility impairment per year. These results are further evidence that the Arizona 1 Mine will not have an adverse impact on regional haze.

Table 4.2-14. Grand Canyon Visibility Impact Modeling Results New FLAG Approach*

Visibility Parameter	Averaging Period	Denison Mines Arizona 1 Mine and Haul Road Traffic – 2001	Denison Mines Arizona 1 Mine and Haul Road Traffic – 2002	Denison Mines Arizona 1 Mine and Haul Road Traffic – 2003	Screening Threshold
Max ΔB_{ext} (%)	24-Hour	2.56	4.87	4.00	5%
# days > 5%	N/A	0	0	0	N/A
# days > 10%	N/A	0	0	0	N/A

Source: ADEQ (2008:Table 6).
Notes:
= Number.
N/A = Not applicable.
* Visibility impacts ninety-eighth percentile values (% degradation).

These model results indicate that operation of the Arizona 1 Mine will not adversely impact visibility within Grand Canyon National Park. Since the proposed withdrawal parcels border Grand Canyon National Park, it is possible that emissions from proposed mine operation activities could impact the Park. However, this is relative to the location of the actual proposed mine within the parcel and must be determined for each source location.

Table 4.2-15 compares the maximum total emissions in tons from exploration, mine site development, mine operations, and mine reclamation for each of the proposed alternatives. Alternative A (No Action) would result in the highest emissions. The majority of the NO_X, SO_2, CO, VOC, and CO_2 emissions are associated with the vehicle/equipment exhaust. The majority of the particulate matter emissions would result from surface disturbances associated with the ore haul trucks and other vehicle and equipment travel over paved and unpaved surfaces.

Table 4.2-15. Total Emission in Tons (20-year time frame)

Alternative	NO_X	SO_2	CO	PM_{10}	$PM_{2.5}$	VOCs	CO_2
A	4,156.13	10.09	2,922.25	17,645.08	2,532.31	430.84	399,100.21
B	1,359.69	3.53	909.26	6,785.60	956.23	143.67	132,418.99
C	2,334.15	5.90	1,633.34	10,160.17	1,472.11	247.08	225,614.37
D	3,475.84	8.62	2,411.21	15,514.21	2,213.97	362.69	335,210.44

4.2.5 Impacts of Alternative A: No Action (No Withdrawal)

Assumptions for Impact Analysis

Under Alternative A, reasonably foreseeable uranium mining exploration activities could occur at 728 exploration sites, leading to the potential development of 30 mine sites (including Pinenut, Kanab North, Arizona 1, and Canyon Mines, which are existing mines) and 22.4 miles of new access roads and power lines over the next 20 years. Additionally, a total of 945 acres within the North Parcel, 107 acres within the East Parcel, and 312 acres within the South Parcel would be disturbed. The number of areas disturbed includes both areas of new disturbance and areas already disturbed at the existing mines. Table 4.2-16 summarizes the activities associated with Alternative A, including the number of sites and the total acreage of land disturbed during exploration, mine site development, access road and power line construction, and reclamation activities.

Table 4.2-16. Summary of Activity Associated with Alternative A over 20 Years

Activity	North Parcel	East Parcel	South Parcel
Total Number of Proposed Mines	21	2	7
Anticipated Number of Exploration Projects	504	56	168
Miles of New Road (miles)	16.4	2.4	3.6
Number of Haul Trips	208,385	22,240	69,540
Miles of New Power Lines (miles)	16.4	2.4	3.6
Acreage of New Mine Footprint (20 acres/mine)	360	40	120
Acreage of New Roads (1.7 acres/mile)	28	4	6
Acreage of New Power Lines (0.17 acre/mile)	3	1	1
Acreage of Exploration (1.1 acres/site)	554	62	185
Total Disturbed Acreage (acres)	945	107	312

Summary of Impacts

Table 4.2-17 compares the maximum total emissions in tons from all phases of mine operations associated with Alternative A. Under Alternative A, over a 20-year period approximately 3,413 tons NO_X, 9 tons SO_2, 2,352 tons CO, 15,346 tons PM_{10}, 2,254 tons $PM_{2.5}$, 371 tons VOCs, and 333,203 tons CO_2 would be emitted to the atmosphere during the mine operation activities.

Table 4.2-17. Summary of the Maximum Total Emission Associated with Alternative A (in Tons)

Exploration / Activity	NO_X	SO_2	CO	PM_{10}	$PM_{2.5}$	VOCs	CO_2
Surface Disturbance Emissions	–	–	–	132	28	–	–
Bore Hole Drilling Emissions	–	–	–	2	2	–	–
Vehicle and Equipment Tailpipe Emissions	521	< 1	418	14	< 1	39	45,515
Fugitive Emissions Vehicle and Equipment Travel over Paved and Unpaved Surfaces	–	–	–	1,372	137	–	–
Subtotal	*521*	*< 1*	*418*	*1,520*	*167*	*39*	*45,515*
Mine Development (mine site)							
Surface Disturbance Emissions from Development (Mine Site)	–	–	–	132	28	–	–
Vehicle and Equipment Tailpipe Emissions from Development (Mine Site)	187	< 1	122	11	10	17	17,243
Fugitive Emissions Vehicle and Equipment Travel over Paved and Unpaved Surfaces (Mine Site)	–	–	–	439	44	–	–
Subtotal	*187*	*< 1*	*122*	*582*	*82*	*17*	*17,243*
Mine Development (access roads)							
Surface Disturbance Emissions from Development (Road Construction)	–	–	–	< 1	< 1	–	–
Vehicle and Equipment Tailpipe Emissions from Development (Road Construction)	12	< 1	6	< 1	< 1	1	1,051
Fugitive Emissions Vehicle and Equipment Travel over Paved and Unpaved Surfaces (Road Construction)	–	–	–	16	2	–	–
Subtotal	*12*	*< 1*	*6*	*17*	*2*	*1*	*1,051*
Mine Development (power lines)							
Surface Disturbance Emissions from Development (Power Line Construction)	–	–	–	< 1	< 1	–	–
Vehicle and Equipment Tailpipe Emissions from Development (Power Line Construction)	9	< 1	9	1	1	1	789
Fugitive Emissions Vehicle and Equipment Travel over Paved and Unpaved Surfaces (Power Line Construction)	–	–	–	26	3	–	–
Subtotal	*9*	*< 1*	*9*	*27*	*4*	*1*	*789*
Mine Operation							
Arizona 1 Mine Emissions (Standby Generator, Material Handling Sources, Storage Pile Fugitive Emissions, Road Fugitive Sources, and Fuel Storage Tanks)	90	6	19	389	389	34	4,347
Vehicle and Equipment Tailpipe Emissions from Development	3,323	3	2,333	221	205	337	328,856
Fugitive Emissions Vehicle and Equipment Travel over Paved and Unpaved Surfaces	–	–	–	14,736	1,661	–	–
Subtotal	*3,413*	*9*	*2,352*	*15,346*	*2,254*	*371*	*333,203*
Mine Closure and Reclamation							
Surface Disturbance Emissions	–	–	–	66	14	–	–
Vehicle and Equipment Tailpipe Emissions from Reclamation	14	< 1	15	1	< 1	1	1,298
Fugitive Emissions Vehicle and Equipment Travel over Paved and Unpaved Surfaces	–	–	–	85	9	–	–
Subtotal	*14*	*< 1*	*15*	*152*	*23*	*1*	*1,298*
Total over 20 years for all activity*	**4,156**	**10**	**2,922**	**17,645**	**2,532**	**431**	**399,100**

* There are no existing federal or state regulations that provide significance criteria for a 20-year period.

Under Alternative A, exploration and development of a proposed mine site would be expected to result in temporary increases in ambient concentrations of air pollutants in the immediate vicinity of the site.

Use of the unpaved and paved roads by the ore haul trucks would result in possible impacts associated with fugitive dust and vehicle exhaust emissions. However, these impacts would be localized and temporary when they do occur.

The majority of the NO_X, SO_2, CO, VOC, and CO_2 emissions are associated with the vehicle/equipment exhaust. The majority of the particulate matter emissions would result from surface disturbances associated with the ore haul trucks and other vehicle and equipment travel over paved and unpaved surfaces. Since these emissions would occur at ground level and would likely cause temporary increases in air pollutant emissions in the immediate vicinity of the exploration and development sites, it is unlikely that these emissions would be transported more than a few kilometers, except on windy days and during significant wind events. The compliance measures, discussed in Section 4.2.4, would be expected to reduce these impacts. The extent of the minor impact is dependent on the proximity of the mining activity to a sensitive receptor (i.e., residential areas, schools, recreation areas, etc.). Under Alternative A, over a 20-year period, approximately 4,156 tons NO_X, 10 tons SO_2, 2,922 tons CO, 17,645 tons PM_{10}, 2,532 tons $PM_{2.5}$, 431 tons VOCs, and 399,100 tons CO_2 would be emitted to the atmosphere during the mine operation activities. Emissions would be the greatest under this alternative.

Impacts at the individual mine sites would be nearly identical for all alternatives.

Climate Impacts

The GHG emissions associated with the construction and operation of mining operations are identified in Table 4.2-17. There is currently no standard methodology or model to determine how an individual source's or project's GHG emissions would translate into physical impacts to the local or global environment. However, the project's GHG emissions would increase the concentration of the GHG in the atmosphere by a very small amount in combination with present and future GHG emissions from other sources and could contribute incrementally to the previously mentioned impacts.

4.2.6 Impacts of Alternative B: Proposed Action (~1 Million Acres, 20-Year Withdrawal)

The Alternative B withdrawal would occur for a period of 20 years. No new mining claims could be located within the withdrawal area, nor could further exploration or development occur on existing mining claims within the withdrawal area unless valid existing rights were established. Mineral exploration and development on any claims with valid existing rights would continue under the applicable BLM or Forest Service surface management regulations. After the expiration of the segregation period or signing of the ROD for this EIS, the proposed withdrawal under Alternative B would restrict the location of new mining claims and the exploration, development, and underground uranium mining activities.

Assumptions for Impact Analysis

Under Alternative B, reasonably foreseeable exploration activities would occur at 11 exploration sites, possibly leading to the development of 11 mine sites (including Pinenut, Kanab North, Arizona 1, and Canyon Mines), with 6.4 miles of new access roads and power lines. A total of 163 acres within the North Parcel, 0 acre within the East Parcel, and 1 acre within the South Parcel would be disturbed. The number of areas disturbed includes both new areas and areas already disturbed at the existing mines. Table 4.2-18 summarizes the activities associated with Alternative B, including the number of sites and the total

acreage of land disturbed during exploration, mine site development, access road and power line construction, and reclamation activities.

Table 4.2-18. Summary of Activity Associated with Alternative B

Activity	North Parcel	East Parcel	South Parcel
Total Number of Proposed Mines	10	0	1
Anticipated Number of Exploration Projects	10	0	1
Miles of New Road (miles)	6.4	0	0
Number of Haul Trips	86,065	0	2,820
Miles of New Power Line (miles)	6.4	0	0
Acreage of New Mine Footprint (20 acres/mine)	140	0	0
Acreage of New Roads (1.7 acres/mile)	11	0	0
Acreage of New Power Lines (0.17 acre/mile)	1	0	0
Acreage of Exploration (1.1 acres/site)	11	0	1
Total Disturbed Acreage (acres)	323	0	32

Summary of Impacts

Table 4.2-19 compares the maximum total emissions in tons from all phases of mine operations associated with Alternative B. Under Alternative B, over a 20-year period approximately 1,273 tons NO_X, 3 tons SO_2, 853 tons CO, 6,437 tons PM_{10}, 909 tons $PM_{2.5}$, 136 tons VOCs, and 124,543 tons CO_2 would be emitted to the atmosphere during the mine operation activities.

Table 4.2-19. Summary of the Maximum Total Emission Associated with Alternative B (in Tons)

Exploration / Activity	NO_x	SO_2	CO	PM_{10}	$PM_{2.5}$	VOCs	CO_2
Surface Disturbance Emissions	–	–	–	2	< 1	–	–
Bore Hole Drilling Emissions	–	–	–	< 1	< 1	–	–
Vehicle and Equipment Tailpipe Emissions	8	< 1	6	< 1	< 1	< 1	677
Fugitive Emissions Vehicle and Equipment Travel Over Paved and Unpaved Surfaces	–	–	–	25	2	–	–
Subtotal	*8*	*< 1*	*6*	*27*	*3*	*< 1*	*677*
Mine Development (Mine Site)							
Surface Disturbance Emissions From Development (Mine Site)	–	–	–	48	10	–	–
Vehicle and Equipment Tailpipe Emissions From Development (Mine Site)	68	< 1	41	4	3	6	6,223
Fugitive Emissions Vehicle and Equipment Travel Over Paved and Unpaved Surfaces (Mine Site)	–	–	–	191	19	–	–
Subtotal	*68*	*< 1*	*41*	*244*	*33*	*6*	*6,223*
Mine Development (Access Roads)							
Surface Disturbance Emissions From Development (Road Construction)	–	–	–	< 1	< 1	–	–
Vehicle and Equipment Tailpipe Emissions From Development (Road Construction)	3	< 1	2	< 1	< 1	< 1	297
Fugitive Emissions Vehicle and Equipment Travel Over Paved and Unpaved Surfaces (Road Construction)	–	–	–	6	1	–	–
Subtotal	*3*	*< 1*	*2*	*6*	*1*	*< 1*	*297*

Table 4.2-19. Summary of the Maximum Total Emission Associated with Alternative B (in Tons), Continued

Exploration / Activity	NO_x	SO_2	CO	PM_{10}	$PM_{2.5}$	VOCs	CO_2
Mine Development (Power Lines)							
Surface Disturbance Emissions From Development (Power Line Construction)	–	–	–	< 1	< 1	–	–
Vehicle and Equipment Tailpipe Emissions From Development (Power Line Construction)	2	< 1	2	< 1	< 1	< 1	219
Fugitive Emissions Vehicle and Equipment Travel Over Paved and Unpaved Surfaces (Power Line Construction)	–	–	–	9	1	–	–
Subtotal	*2*	*< 1*	*2*	*9*	*1*	*< 1*	*219*
Mine Operation							
Arizona 1 Mine Emissions (Standby Generator, Material Handling Sources, Storage Pile Fugitive Emissions, Road Fugitive Sources, and Fuel Storage Tanks)	33	2	7	142	142	12	1,594
Vehicle and Equipment Tailpipe Emissions From Development	1,240	1	846	82	76	124	122,949
Fugitive Emissions Vehicle and Equipment Travel Over Paved and Unpaved Surfaces	–	–	–	6,213	691	–	–
Subtotal	*1,273*	*3*	*853*	*6,437*	*909*	*136*	*124,543*
Mine Closure and Reclamation							
Surface Disturbance Emissions	–	–	–	24	5	–	–
Vehicle and Equipment Tailpipe Emissions From Reclamation	5	< 1	5	< 1	< 1	< 1	459
Fugitive Emissions Vehicle and Equipment Travel Over Paved and Unpaved Surfaces	–	–	–	37	4	–	–
Subtotal	*5*	*< 1*	*5*	*62*	*9*	*< 1*	*459*
Total	**1,360**	**3**	**909**	**6,786**	**956**	**144**	**132,419**

Direct Impacts

Under Alternative B, exploration and development of a proposed mine site would be expected to result in temporary increases in ambient concentrations of air pollutants in the immediate vicinity of the site.

Use of the unpaved and paved roads by the ore haul trucks would result in possible impacts associated with fugitive dust and vehicle exhaust emissions. However, these impacts would be localized and temporary when they did occur.

The majority of the NO_X, SO_2, CO, VOC, and CO_2 emissions are associated with the vehicle/equipment exhaust. The majority of the particulate matter emissions would result from surface disturbances associated with the ore haul trucks and other vehicle and equipment travel over paved and unpaved surfaces. Since these emissions would occur at ground level and would likely cause temporary increases in air pollutant emissions in the immediate vicinity of the exploration and development sites, it is unlikely that these emissions would be transported more than a few kilometers, except on windy days and during significant wind events. The compliance measures, discussed in Section 4.2.4, would be expected to reduce these impacts. The extent of the minor impact is dependent on the proximity of the mining activity to a sensitive receptor (i.e., residential areas, schools, recreation areas, etc.). Under Alternative B, over a 20-year period, approximately 1,360 tons NO_X, 3 tons SO_2, 909 tons CO, 6,786 tons PM_{10}, 956 tons

$PM_{2.5}$, 144 tons VOCs, and 132,419 tons CO_2 would be emitted to the atmosphere. Emissions would be least under this alternative, compared with the other alternatives.

Impacts at the individual mine sites would be nearly identical for all alternatives.

Arizona 1 Mine facility-wide annual emission limits were obtained from the Arizona 1 Mine Air Permit Application (Tetra Tech 2008). Maximum SO_2, NO_2, and CO concentrations for the operation of the stand-by generator were analyzed using the EPA SCREEN3 model (version 96043). Maximum PM_{10} concentrations from Arizona 1 Mine emissions (e.g., standby generator, material handling, and fugitive dust) were analyzed using the American Meteorological Society and EPA Regulatory Model Improvement Committee Dispersion Model (AERMOD version 07026).

These model results indicate the operation of the Arizona 1 Mine will not adversely impact visibility within Grand Canyon National Park. Since the proposed withdrawal parcels border Grand Canyon National Park, it is possible that emissions from future mining operations in those locations could possibly impact the Park. However, this is relative to the location of the actual proposed mine within the parcel and must be determined for each source location. Therefore, the use of Arizona 1 Mine as a surrogate represents only that operation. Other mining activities under Alternative B would require individual analyses. Data for future mining activities under Alternative B are inconclusive.

Climate Impacts

The GHG emissions associated with the construction and operation of mining operations are identified in Table 4.2-19. There is currently no standard methodology or model to determine how an individual source's or project's GHG emissions would translate into physical impacts to the local or global environment. However, the project's GHG emissions would increase the concentration of the GHG in the atmosphere in combination with present and future GHG emissions from other sources and could contribute incrementally to the previously mentioned impacts.

4.2.7 Impacts of Alternative C: Partial Withdrawal (~700,000 acres)

The potential withdrawal under Alternative C is similar to that described for Alternative B, except it would apply to a smaller area—695,774 acres of federal lands, compared with approximately 1 million acres under Alternative B.

The Alternative C withdrawal would occur for a period of 20 years (same as the Alternative B withdrawal). No new mining claims could be located within the withdrawal area, nor could further exploration or development occur on existing mining claims within the withdrawal area unless valid existing rights were established. Mineral exploration and development on any claims with valid existing rights would continue under the applicable BLM or Forest Service surface management regulations. After the expiration of the segregation period or signing of the ROD for this EIS, the proposed withdrawal under Alternative C would restrict the location of new mining claims and the exploration, development, and underground uranium mining activities similar to that for Alternative B but would apply to a smaller area.

Assumptions for Impact Analysis

Under Alternative C reasonably foreseeable uranium mining exploration activities would occur at 207 exploration sites, leading to the development of 14 mine sites (including Pinenut, Kanab North,

Arizona 1, and Canyon Mines), and 12.1 miles of new access roads and power lines. Additionally, a total of 320 acres within the North Parcel, 54 acres within the East Parcel, and 158 acres within the South Parcel would be disturbed. The number of areas disturbed includes both new areas and areas already disturbed at the existing mines. Table 4.2-20 summarizes the activities associated with Alternative C, including the number of sites and the total acreage of land disturbed during exploration, mine site development, access road and power line construction, and reclamation activities.

Table 4.2-20. Summary of Activity Associated with Alternative C

Activity	North Parcel	East Parcel	South Parcel
Total Number of Proposed Mines	13	1	4
Anticipated Number of Exploration Projects	94	28	85
Miles of New Road (miles)	9.1	1.2	1.8
Number of Haul Trips	119,425	11,120	36,180
Miles of New Power Line (miles)	9.1	1.2	1.8
Acreage of New Mine Footprint (20 acres/mine)	200	20	60
Acreage of New Roads (1.7 acres/mile)	15	2	3
Acreage of New Power Lines (0.17 acre/mile)	2	1	1
Acreage of Exploration (1.1 acres/site)	103	31	94
Total Disturbed Acreage (acres)	320	54	158

Summary of Impacts

Table 4.2-21 compares the maximum total emissions in tons from all phases of mine operations associated with Alternative C. Under Alternative C, over a 20-year period approximately 2,052 tons NO_X, 6 tons SO_2, 1,410 tons CO, 9,345 tons PM_{10}, 1,367 tons $PM_{2.5}$, 223 tons VOCs, and 200,353 tons CO_2 would be emitted to the atmosphere during the mine operation activities.

Table 4.2-21. Summary of the Maximum Total Emission Associated with Alternative C

Exploration / Activity	NO_X	SO_2	CO	PM_{10}	$PM_{2.5}$	VOCs	CO_2
Surface Disturbance Emissions	–	–	–	38	8	–	–
Bore Hole Drilling Emissions	–	–	–	1	1	–	–
Vehicle and Equipment Tailpipe Emissions	151	< 1	134	4	< 1	12	13,162
Fugitive Emissions Vehicle and Equipment Travel Over Paved and Unpaved Surfaces	–	–	–	302	30	–	–
Subtotal	*151*	*< 1*	*134*	*344*	*39*	*12*	*13,162*
Mine Development							
Surface Disturbance Emissions From Development (Mine Site)	–	–	–	79	17	–	–
Vehicle and Equipment Tailpipe Emissions From Development (Mine Site)	112	< 1	72	6	6	10	10,330
Fugitive Emissions Vehicle and Equipment Travel Over Paved and Unpaved Surfaces (Mine Site)	–	–	–	269	27	–	–
Subtotal	*112*	*< 1*	*72*	*354*	*49*	*10*	*10,330*

Table 4.2-21. Summary of the Maximum Total Emission Associated with Alternative C (Continued)

Exploration / Activity	NOX	SO2	CO	PM10	PM2.5	VOCs	CO2
Mine Development (Access Roads)							
Surface Disturbance Emissions From Development (Road Construction)	–	–	–	< 1	< 1	–	–
Vehicle and Equipment Tailpipe Emissions From Development (Road Construction)	6	< 1	3	< 1	< 1	1	567
Fugitive Emissions Vehicle and Equipment Travel Over Paved and Unpaved Surfaces (Road Construction)	–	–	–	9	1	–	–
Subtotal	*6*	*< 1*	*3*	*9*	*1*	*1*	*567*
Mine Development (Power Lines)							
Surface Disturbance Emissions From Development (Power Line Construction)	–	–	–	< 1	< 1	–	–
Vehicle and Equipment Tailpipe Emissions From Development (Power Line Construction)	5	< 1	5	1	1	1	425
Fugitive Emissions Vehicle and Equipment Travel Over Paved and Unpaved Surfaces (Power Line Construction)	–	–	–	14	1	–	–
Subtotal	*5*	*< 1*	*5*	*15*	*2*	*1*	*425*
Mine Operation							
Arizona 1 Mine Emissions (Standby Generator, Material Handling Sources, Storage Pile Fugitive Emissions, Road Fugitive Sources, and Fuel Storage Tanks)	54	4	11	233	233	20	2,608
Vehicle and Equipment Tailpipe Emissions From Development	1,998	2	1,398	133	123	202	197,745
Fugitive Emissions Vehicle and Equipment Travel Over Paved and Unpaved Surfaces	–	–	–	8,989	1,010	–	–
Subtotal	*2,052*	*6*	*1,410*	*9,345*	*1,367*	*223*	*200,353*
Mine Closure and Reclamation							
Surface Disturbance Emissions	–	–	–	40	8	–	–
Vehicle and Equipment Tailpipe Emissions From Reclamation	8	< 1	9	< 1	< 1	1	776
Fugitive Emissions Vehicle and Equipment Travel Over Paved and Unpaved Surfaces	–	–	–	52	5	–	–
Subtotal	*8*	*< 1*	*9*	*92*	*14*	*1*	*776*
Total	**2,334**	**6**	**1,633**	**10,160**	**1,472**	**247**	**225,614**

Direct Impacts

Under Alternative C, exploration and development of a proposed mine site would be expected to result in temporary increases in ambient concentrations of air pollutants in the immediate vicinity of the site.

Use of the unpaved and paved roads by the ore haul trucks would result in possible impacts associated with fugitive dust and vehicle exhaust emissions. However, these impacts would be localized and temporary when they did occur.

The majority of the NO_X, SO_2, CO, VOC, and CO_2 emissions are associated with the vehicle/equipment exhaust. The majority of the particulate matter emissions would result from surface disturbances associated with the ore haul trucks and other vehicle and equipment travel over paved and unpaved surfaces. Since these emissions would occur at ground level and would likely cause temporary increases in air pollutant emissions in the immediate vicinity of the exploration and development sites, it is unlikely

these emissions would be transported more than a few kilometers, except on windy days and during significant wind events. The compliance measures, discussed in Section 4.2.4, would be expected to reduce these impacts. The extent of the minor impact is dependent on the proximity of the mining activity to a sensitive receptor (i.e., residential areas, schools, recreation areas, etc.). Under Alternative C, over a 20-year period, approximately 2,334 tons NO_X, 6 tons SO_2, 1,633 tons CO, 10,160 tons PM_{10}, 1,472 tons $PM_{2.5}$, 247 tons VOCs, and 225,614 tons CO_2 would be emitted to the atmosphere.

Impacts at the individual mine sites would be nearly identical for all alternatives.

Climate Impacts

The GHG emissions associated with the construction and operation of mining operations are identified in Table 4.2-21. There is currently no standard methodology or model to determine how an individual source's or project's GHG emissions would translate into physical impacts to the local or global environment. However, the project's GHG emissions would increase the concentration of the GHG in the atmosphere in combination with present and future GHG emissions from other sources and could contribute incrementally to the previously mentioned impacts.

4.2.8 Impacts of Alternative D: Partial Withdrawal (~300,000 acres)

The withdrawal proposed in Alternative D would apply to approximately 306,015 acres of federal lands. As with Alternatives B and C, the Alternative D withdrawal would occur for a period of 20 years and no new mining claims could be located within the withdrawal area, nor could further exploration or development occur on existing mining claims within the withdrawal area unless valid rights were first established. Mineral exploration and development on mining claims with valid existing rights would continue under the respective BLM or Forest Service surface management regulations.

After the expiration of the segregation period or signing of the ROD for this EIS, the potential withdrawal under Alternative D would continue to restrict the location of new mining claims and exploration, development, and underground uranium mining activities similar to that for Alternative B but would apply to a smaller area (306,015 acres of federal land).

Assumptions for Impact Analysis

Under Alternative D reasonably foreseeable uranium mining exploration activities would occur at 431 exploration sites, leading to the potential development of 26 mine sites (including Pinenut, Kanab North, Arizona 1, and Canyon Mines) and 19.1 miles of new access roads and power lines. Additionally, a total of 688 acres within the North Parcel, 54 acres within the East Parcel, and 209 acres within the South Parcel would be disturbed. The number of areas disturbed includes both new areas and areas already disturbed at the existing mines. Table 4.2-22 summarizes the activities associated with Alternative D, including the number of sites and the total acreage of land disturbed during exploration, mine site development, access road and power line construction, and reclamation activities.

Summary of Impacts

Table 4.2-23 compares the maximum total emissions in tons from all phases of mine operations associated with Alternative D. Under Alternative D, over a 20-year period approximately 2,975 tons NO_X, 8 tons SO_2, 2,032 tons CO, 13,926 tons PM_{10}, 2,018 tons $PM_{2.5}$, 321 tons VOCs, and 290,672 tons CO_2 would be emitted to the atmosphere during the mine operation activities.

Table 4.2-22. Summary of Activity Associated with Alternative D

Activity	North Parcel	East Parcel	South Parcel
Total Number of Proposed Mines	20	1	5
Anticipated Number of Exploration Projects	290	28	113
Miles of New Road (miles)	15.5	1.2	2.4
Number of Haul Trips	197,265	11,120	47,300
Miles of New Power Line (miles)	15.5	1.2	2.4
Acreage of New Mine Footprint (20 acres/mine)	340	20	80
Acreage of New Roads (1.7 acres/mile)	26	2	4
Acreage of New Power Lines (0.17 acre/mile)	3	1	1
Acreage of Exploration (1.1 acres/site)	319	31	124
Total Disturbed Acreage (acres)	688	54	209

Table 4.2-23. Summary of the Maximum Total Emission Associated with Alternative D

Exploration / Activity	NO_X	SO_2	CO	PM_{10}	$PM_{2.5}$	VOCs	CO_2
Surface Disturbance Emissions	–	–	–	78	16	–	–
Bore Hole Drilling Emissions	–	–	–	1	1	–	–
Vehicle and Equipment Tailpipe Emissions	309	< 1	251	8	< 1	23	26,995
Fugitive Emissions Vehicle and Equipment Travel over Paved and Unpaved Surfaces	–	–	–	795	80	–	–
Subtotal	*309*	*< 1*	*251*	*883*	*97*	*23*	*26,995*
Mine Development							
Surface Disturbance Emissions from Development (Mine Site)	–	–	–	114	24	–	–
Vehicle and Equipment Tailpipe Emissions from Development (Mine Site)	161	< 1	103	9	8	15	14,869
Fugitive Emissions Vehicle and Equipment Travel over Paved and Unpaved Surfaces (Mine Site)	–	–	–	404	41	–	–
Subtotal	*161*	*< 1*	*103*	*528*	*73*	*15*	*14,869*
Mine Development (Access Roads)							
Surface Disturbance Emissions from Development (Road Construction)	–	–	–	< 1	< 1	–	–
Vehicle and Equipment Tailpipe Emissions from Development (Road Construction)	10	< 1	5	1	1	1	893
Fugitive Emissions Vehicle and Equipment Travel over Paved and Unpaved Surfaces (Road Construction)	–	–	–	15	1	–	–
Subtotal	*10*	*< 1*	*5*	*16*	*2*	*1*	*893*
Mine Development (Power Lines)							
Surface Disturbance Emissions from Development (Power Line Construction)	–	–	–	< 1	< 1	–	–
Vehicle and Equipment Tailpipe Emissions from Development (Power Line Construction)	8	< 1	8	1	1	1	668
Fugitive Emissions Vehicle and Equipment Travel over Paved and Unpaved Surfaces (Power Line Construction)	–	–	–	24	2	–	–
Subtotal	*8*	*< 1*	*8*	*25*	*3*	*1*	*668*

Table 4.2-23. Summary of the Maximum Total Emission Associated with Alternative D (Continued)

Exploration / Activity	NO_X	SO_2	CO	PM_{10}	$PM_{2.5}$	VOCs	CO_2
Mine Operation							
Arizona 1 Mine Emissions (Standby Generator, Material Handling Sources, Storage Pile Fugitive Emissions, Road Fugitive Sources, and Fuel Storage Tanks)	78	5	16	337	337	29	3,767
Vehicle and Equipment Tailpipe Emissions from Development	2,897	3	2,015	192	178	292	286,905
Fugitive Emissions Vehicle and Equipment Travel over Paved and Unpaved Surfaces	–	–	–	13,397	1,503	–	–
Subtotal	*2,975*	*8*	*2,032*	*13,926*	*2,018*	*321*	*290,672*
Mine Closure and Reclamation							
Surface Disturbance Emissions	–	–	–	57	12	–	–
Vehicle and Equipment Tailpipe Emissions from Reclamation	12	< 1	13	1	1	1	1,113
Fugitive Emissions Vehicle and Equipment Travel over Paved and Unpaved Surfaces	–	–	–	79	8	–	–
Subtotal	*12*	*< 1*	*13*	*136*	*20*	*1*	*1,113*
Total	**3,476**	**9**	**2,411**	**15,514**	**2,214**	**363**	**335,210**

Direct Impacts

Under Alternative D, exploration and development of a proposed mine site would be expected to result in temporary increases in ambient concentrations of air pollutants in the immediate vicinity of the site.

Use of the unpaved and paved roads by the ore haul trucks would result in possible impacts associated with fugitive dust and vehicle exhaust emissions. However, these impacts would be localized and temporary when they did occur.

The majority of the NO_X, SO_2, CO, VOC, and CO_2 emissions are associated with the vehicle/equipment exhaust. The majority of the particulate matter emissions would result from surface disturbances associated with the ore haul trucks and other vehicle and equipment travel over paved and unpaved surfaces. Since these emissions would occur at ground level and would likely cause temporary increases in air pollutant emissions in the immediate vicinity of the exploration and development sites, it is unlikely that these emissions would be transported more than a few kilometers, except on windy days and during significant wind events. The compliance measures, discussed in Section 4.2.4, would be expected to reduce these impacts. The extent of the minor impact is dependent on the proximity of the mining activity to a sensitive receptor (i.e., residential areas, schools, recreation areas, etc.). Under Alternative D, over a 20-year period, approximately 3,476 tons NO_X, 9 tons SO_2, 2,411 tons CO, 15,514 tons PM_{10}, 2,214 tons $PM_{2.5}$, 363 tons VOCs, and 335,210 tons CO_2 would be emitted to the atmosphere.
Impacts at the individual mine sites would be nearly identical for all alternatives.

Climate Impacts

The GHG emissions associated with the construction and operation of mining operations are identified in Table 4.2-23. There is currently no standard methodology or model to determine how an individual source's or project's GHG emissions would translate into physical impacts to the local or global environment. However, the project's GHG emissions would increase the concentration of the GHG in the atmosphere by a very small amount in combination with present and future GHG emissions from other sources and could contribute incrementally to the previously mentioned impacts.

Cumulative Impacts

There are other uses and activities for the lands within the proposed withdrawal area besides uranium mining (i.e., recreational activities, OHVs, livestock grazing, etc.). However, sufficient data are not currently available to quantify these other potential emission.

Each additional mine (including exploration, mine development, mine operations, and mine closure/reclamation) can be expected to contribute approximately 256 to 644 total tons PM_{10} over its 7-year duration. Cumulative impacts would be limited, as particulates settle quickly near the mine sites and haul roads.

The majority of the development effects of the proposed mining projects would be mitigated by the fact that these projects would be constructed over different periods. Both development- and operation-related air emissions are not expected to have a significant impact on air quality within the area since the mines would likely have varying development schedules and must adhere to federal, state, and local regulations for the protection of ambient air quality.

On a local scale, cumulative increases in air pollution emissions could occur where new exploration and mining operations are located near the existing mines (e.g., Arizona 1 Mine). Each of the new underground mines would be required to obtain an ADEQ-issued air permit. These air permits would require certain air quality protection measures, which would ensure that cumulative air emissions remain at or below the NAAQS. However, since portions of the proposed withdrawal area border Grand Canyon National Park, areas of the Park that are closer to mining operations would have the potential to be impacted more than areas that are farther away.

4.3 GEOLOGY AND MINERAL RESOURCES

4.3.1 Impact Assessment Methodology and Assumptions

There are seven resource condition indicators for analysis of mineral resources:

- Availability of high mineral potential lands;
- Number of ore deposits mined;
- Potential for subsidence and alteration of geology or topography;
- Amount of uranium mined as percentage of known domestic resources, domestic production, and domestic demand;
- Depletion of uranium resources within proposed withdrawal area;
- Amount of uranium mined as percentage of global production and demand; and
- Cumulative amount of high potential uranium resource lands withdrawn from exploration and development.

The availability of high mineral potential lands and the cumulative amount of high potential lands withdrawn from exploration and development are calculated solely from the acres of mineral estate withdrawn (mineral estate refers to the ownership of the minerals at or beneath the surface of the land, which may be separate from owning the land itself). The number of ore deposits mined is taken directly from the RFD scenarios (see Appendix B).

Historically, there has been no subsidence associated with existing breccia pipe mines, and with the exception of removal of ore from the subsurface, after reclamation there would be no permanent alteration

of the surface geology or topography. This resource condition indicator will not vary by alternative and is not further analyzed.

The amount of uranium mined consists of three components: uranium extracted from the four mines with approved plans of operation, uranium from discovered breccia pipes, and uranium extracted from yet-to-be-developed mines (see Table 3.3-1). The amount of uranium extracted from the four mines with approved plans of operation is based on published estimates of uranium reserves in these four pipes, minus reserves already mined (personal communication, Spiering 2010). The amount of uranium from mines that have not yet been developed is based either on available estimates of uranium reserves in specific pipes or on the assumption used in the RFD that the average mine produces 1,500 tons U_3O_8. The depletion of uranium resources within the withdrawal area is calculated based on an estimated uranium resource of 33,155 tons U_3O_8.

The domestic uranium reserve is estimated at 445,000 tons U_3O_8 (EIA 2010a). Domestic uranium production is estimated at 1,875 tons U_3O_8 (U.S. EIA 2010b). Current domestic uranium requirement for nuclear reactors is estimated at 23,040 tons U_3O_8 (World Nuclear Association 2010). Current global production of uranium is estimated at 57,000 tons U_3O_8 (TradeTech 2010). Total global uranium requirement is estimated at 84,000 tons U_3O_8 (TradeTech 2010).

Spatial boundaries for the above resource condition indicators are not restricted solely to the proposed withdrawal area, as the resource condition indicators encompass both the U.S. and global markets. Temporally, analysis has been restricted to a 20-year time frame, identical to the approach used in the RFD. Impacts are considered long term if they exceed 5 years in duration.

Historically, mining interests targeting breccia pipe deposits in Arizona have developed mines on public lands, as opposed to state or private lands. The proposed withdrawal of federal lands from mineral location and entry would limit the overall number of breccia-pipe mines that could develop on federal lands; however, there would be additional industrial capacity for the development of mines beyond the proposed withdrawal area. The proposed withdrawal of federal lands from mineral location and entry could spur development on private and state lands within the vicinity of the proposed withdrawal area unless reserved federal mineral estate is present; these lands are still considered to have high mineral potential for uranium (Finch et al. 1990), although historically little exploration has taken place there. The amount of mine development that could result on state and private lands in the vicinity of the proposed withdrawal area has not been quantified.

Table 4.3-1. Magnitude and Degrees of Effects on Geology and Mineral Resources

Attribute of Effect	Description Relative to Geology and Mineral Resources
Magnitude	
No Impact	Would not produce changes in the number of operating mines, amount of produced uranium, or the availability of high mineral potential lands.
Minor	Changes the number of operating mines or amount of produced uranium by less than 20%, or changes the availability of high mineral potential lands by less than 20%.
Moderate	Changes the number of operating mines or amount of produced uranium by 20% to 50%, or changes the availability of high mineral potential lands by 20% to 50%.
Major	Changes the number of operating mines or amount of produced uranium by more than 50%, or changes the availability of high mineral potential lands by more than 50%.

Table 4.3-2. Duration Definition of Effects on Geology and Mineral Resources

Duration	
Temporary	Up to 1 year (periods of development and reclamation)
Short-term	1 to 5 years
Long-term	Greater than 5 years

4.3.2 Incomplete or Unavailable Information

There was no incomplete or unavailable information necessary to form the impacts analysis for geology and mineral resources.

4.3.3 Compliance with Environmental Regulations and Permitting

Reclamation takes place concurrent with mining activities and after completion of mining. Reclamation includes the restoration of the surface topography, vegetation, and drainage. It may also include the restoration of the subsurface groundwater flow regime, prevention of surface or groundwater from entering the closed mine, and prevention of leachate from the mine to groundwater aquifers.

4.3.4 Impacts of Alternative A: No Action (No Withdrawal)

Direct and Indirect Impacts

Over the next 20 years, if no withdrawal occurs, the high mineral potential lands within the proposed withdrawal area would remain fully available for exploration and development of uranium deposits associated with breccia pipes. The number of ore bodies mined could increase from four to 30, yielding approximately 33,155 tons U_3O_8 over a 20-year time frame.

As described in the RFD scenario (see Appendix B), under Alternative A it is likely that the industrial capacity for mining uranium will exceed the amount of uranium resources estimated to be present and economically able to be mined in the proposed withdrawal area (33,155 tons U_3O_8). As described in Table 3.3-1, this estimate includes only 15% of the estimated 163,380 tons U_3O_8 of uranium endowment in the proposed withdrawal area. For the purposes of this impact assessment, mining occurring under Alternative A over the 20-year period would represent 100% depletion of the estimated uranium resource in the proposed withdrawal area that is currently economic to mine; however, it should be noted that a large portion of the estimated uranium endowment will remain unmined. Direct impacts associated with mineral resources are considered long term and permanent.

With no withdrawal, mine development would likely continue to occur primarily on federal lands, as it has occurred historically; therefore, there would be no indirect impact to the amount of mine development that might occur on nearby lands.

Conventional mining techniques do not remove all uranium from the deposit; uranium of grades considered too low to be economically mined is left in place and if previously removed and stockpiled would also be backfilled into the mine as waste rock (Denison 2010a). Indirect impacts also would include the subsurface disturbance and exposure of this low-grade remnant uranium ore, which could result in mobilization of dissolved uranium into groundwater. No estimates have been made of the magnitude of low-grade uranium ore that might remain in a reclaimed mine. The effects of mine leachate

are considered elsewhere in this document. The indirect impacts discussed above (mine development on private or state lands, mine leachate) associated with mineral resources are considered long term.

Cumulative Impacts

Of the approximately 9,100 square miles of lands designated as high mineral potential for uranium in northern Arizona and southern Utah, almost 50% have previously been withdrawn from mineral location and entry, reducing the overall amount of high mineral potential lands available for uranium mining. There would be no further cumulative loss of these high mineral potential lands to mining availability under Alternative A.

The proposed withdrawal will only affect locatable minerals. The proposed withdrawal area has additional potential for leasable and salable minerals, and development of these mineral resources would continue. With respect to leasable minerals, the proposed withdrawal area has no or low potential for coal, phosphate, potash, or sodium deposits. Oil and gas potential within the East and South parcels is generally considered low, although little exploration has been conducted within the area. Portions of the North Parcel have been rated as having moderate potential for oil and gas based on oil shows in several wells. The proposed withdrawal area has also been rated as moderately favorable for the occurrence of low-temperature geothermal resources, although extensive geothermal exploration has not occurred (BLM 2007).

With respect to salable minerals in the proposed withdrawal area, sand and gravel deposits exist but are relatively isolated within the North and South parcels and are mostly associated with the Moenkopi Formation and alluvial deposits. In the East Parcel, gravel deposits of relatively large quantity and good quality have formed at the bottom of the western slope of the Kaibab monocline. Building materials (primarily flagstone and limestone) are widespread throughout the proposed withdrawal area, primarily associated with the Moenkopi and Kaibab Limestone Formations. Cinder deposits are limited to the far southwest corner of the North Parcel in the vicinity of Mount Trumbull (BLM 2007).

Development of leasable and salable minerals is expected to occur incrementally and in diverse locations. Geologically, the occurrence of leasable and salable minerals in the same locations as breccia pipe uranium deposits is unlikely. Cumulative impacts from leasable and salable minerals would be expected to be minor.

Direct, indirect, and cumulative impacts for Alternative A and all other alternatives are summarized in Table 4.3-3.

Table 4.3-3. Summary of Direct, Indirect, and Cumulative Impacts for All Alternatives

Resource Category Issue	Alternative A No Action Area Remains Open under the Mining Law	Alternative B Proposed Action 20 Years ~1 Million Acres Withdrawn	Alternative C Partial Withdrawal 20 Years (~700,000 acres)	Alternative D Partial Withdrawal 20 Years (~300,000 acres)
Availability of High Mineral Potential Lands in the Proposed Withdrawal Area	All Available	None Available	30% Available	70% Available
Amount of Uranium Mined (tons U_3O_8)*	33,155	4,147	14,647	26,647
Number of Ore Deposits Mined	30	11	18	26
Potential for Subsidence or Alteration of Geology or Topography	None	None	None	None

Table 4.3-3. Summary of Direct, Indirect, and Cumulative Impacts for All Alternatives (Continued)

Resource Category Issue	Alternative A No Action Area Remains Open under the Mining Law	Alternative B Proposed Action 20 Years ~1 Million Acres Withdrawn	Alternative C Partial Withdrawal 20 Years (~700,000 acres)	Alternative D Partial Withdrawal 20 Years (~300,000 acres)
Amount Mined as Percentage of Domestic Reserves	8	1	3	6
Amount Mined as Percentage of Annual Domestic Production	88	11	39	71
Amount Mined as Percentage of Annual Domestic Reactor Requirement	7	1	3	6
Amount Mined as Percentage of Annual Global Production	3	<1	1	2
Amount Mined as Percentage of Annual Global Reactor Requirement	2	<1	<1	2
Percent Depletion of Uranium Resources within Withdrawal Area	100	13	44	80
Cumulative Percentage of High Uranium Potential Lands Withdrawn	50	70	60	55

* Amount of uranium mined based on the following criteria for each alternative:

Alternative A – Known reserves in existing mines and breccia pipes (4,147 tons U_3O_8), estimated resources in discovered breccia pipes (4,500 tons U_3O_8), and 15% of the estimated uranium endowment of 163,380 tons U_3O_8 (24,507 tons U_3O_8).

Alternative B – Known reserves in existing mines and breccia pipes (4,147 tons U_3O_8).

Alternative C – Known reserves in existing mines and breccia pipes (4,147 tons U_3O_8), and an additional estimated 7 mines (10,500 tons U_3O_8).

Alternative D – Known reserves in existing mines and breccia pipes (4,147 tons U_3O_8), and an additional estimated 15 mines (22,500 tons U_3O_8).

4.3.5 Impacts of Alternative B: Proposed Action (~1 Million Acres, 20-Year Withdrawal)

Direct and Indirect Impacts

The Proposed Action would close all of the high mineral potential lands within the proposed withdrawal area to location and entry for 20 years. Those areas under claims shown to have valid existing rights on the date of segregation could continue to full mine development. The number of ore bodies mined could increase from four to 11, yielding approximately 4,147 tons U_3O_8 over a 20-year time frame; this estimate is based on the estimated uranium reserves from known mineralized breccia pipes. Mining occurring under Alternative B over the next 20 years would deplete approximately 13% of the estimated uranium resource in the proposed withdrawal area. Direct impacts associated with removal of mineral resources by mining are considered long term and permanent.

Indirect impacts would include the possible relocation of uranium mines from federal to nearby state or private lands, and the potential for exposure of remnant low-grade uranium ore in the subsurface from backfill or rock displacement. Indirect impacts associated with mineral resources are considered long term.

Cumulative Impacts

The Proposed Action would withdraw an additional approximately 1,686 square miles; the Proposed Action would result in cumulatively almost 70% of the lands with high mineral potential for uranium being unavailable for mineral location and entry, subject to valid existing rights. Cumulative impacts

associated with the withdrawal of mineral resources are considered long term; however, these cumulative impacts may not be permanent, as the withdrawal may not be renewed after the withdrawal period expires.

Cumulative impacts from the development of leasable and salable minerals would continue as described under Alternative A.

4.3.6 Impacts of Alternative C: Partial Withdrawal (~700,000 acres)

Direct and Indirect Impacts

Over the next 20 years, the partial withdrawal under Alternative C would close 695,774 acres of high mineral potential lands within the proposed withdrawal area to exploration and development of uranium resources associated with breccia pipes, with the exception of those areas under claims shown to have valid existing rights. The number of ore bodies mined could increase from four to 18, yielding approximately 14,647 tons U_3O_8 over a 20-year time frame. Mining occurring under Alternative C would deplete approximately 44% of the estimated uranium resource in the proposed withdrawal area. Direct impacts associated with mineral resources are considered long term and permanent.

Indirect impacts would include the possible relocation of uranium mines from federal to nearby state or private lands and the potential for exposure of remnant low-grade uranium ore in the subsurface from backfill or rock displacement. Indirect impacts associated with mineral resources are considered long term.

Cumulative Impacts

The partial withdrawal under Alternative C would withdraw an additional approximately 1,087 square miles; the partial withdrawal under Alternative C would result cumulatively in approximately 60% of the lands with high mineral potential for uranium being unavailable for mineral location and entry. Cumulative impacts associated with the withdrawal of mineral resources are considered long term; however, these cumulative impacts may not be permanent, as the withdrawal may not be renewed after the withdrawal period expires.

Cumulative impacts from the development of leasable and salable minerals would continue as described under Alternative A.

4.3.7 Impacts of Alternative D: Partial Withdrawal (~300,000 acres)

Direct and Indirect Impacts

Over the next 20 years, the partial withdrawal under Alternative D would close 306,015 acres of high mineral potential lands within the proposed withdrawal area to exploration and development of uranium resources associated with breccia pipes, with the exception of those areas under claims shown to have valid existing rights. The number of ore bodies mined could increase from four to 26, yielding approximately 26,647 tons U_3O_8 over a 20-year time frame. Mining occurring under Alternative D would deplete approximately 80% of the estimated uranium resource in the proposed withdrawal area. Direct impacts associated with mineral resources are considered long term and permanent.

Indirect impacts would include the possible relocation of uranium mines from federal to nearby state or private lands, and the potential for exposure of remnant low-grade uranium ore in the subsurface from backfill or rock displacement. Indirect impacts associated with mineral resources are considered long term.

Cumulative Impacts

The partial withdrawal under Alternative D would withdraw an additional approximately 478 square miles; the partial withdrawal under Alternative D would result cumulatively in approximately 55% of the lands with high mineral potential for uranium being unavailable for mineral location and entry. Cumulative impacts associated with the withdrawal of mineral resources are considered long term; however, these cumulative impacts may not be permanent, as the withdrawal may not be renewed after the withdrawal period expires.

Cumulative impacts from the development of leasable and salable minerals would continue as described under Alternative A.

4.4 WATER RESOURCES

4.4.1 Impact Assessment Methodology and Assumptions

Table 4.4-1 is a summary of the condition impact definitions used for the water resources assessment. Table 4.4-2 is a summary of the definitions for the expected duration of an impact, which are the same as those defined in Table 4.1-2. Duration of impact is analyzed separately from magnitude of impact. Resource condition indicators for water resources include the following:

- **Perched Aquifer Water Quantity.** Quantity of water discharge at springs and wells supported by perched groundwater zones that may be depleted by drainage into nearby subsurface openings related to mining.
- **Perched Aquifer Water Quality.** Chemical quality of water discharge at springs and wells supported by perched groundwater zones that may be affected by operations at nearby mine sites, with emphasis on metals.
- **R-aquifer[6] Water Quantity.** Quantity of water discharge at springs and deep wells supported by the R-aquifer system that may be depleted by mine water supply wells.
- **R-aquifer Water Quality.** Chemical quality of water discharge at springs and deep wells supported by the R-aquifer system that may be affected by operations at mine sites, with emphasis on metals.
- **Condition of Surface Waters.** Quantity and chemical quality (with emphasis on metals), and hydrologic function of perennial and ephemeral surface drainages that receive discharge from springs and/or surface water runoff. Quantity and quality of water retained in non-mine surface impoundments.

Potential changes in these resource condition indicators were evaluated quantitatively where sufficient data were available and qualitatively where data were insufficient for quantitative analysis.

[6] The R-aquifer is the regional carbonate aquifer composed of the Redwall Limestone, Temple Butte Formation, undifferentiated Cambrian dolomites, and Muav Limestone; this aquifer is also referred to as the Redwall-Muav aquifer or the regional aquifer. Perched aquifers are separated from the R-aquifer by low-permeability confining layers and are typically thin and discontinuous.

Table 4.4-1. Summary of Definitions for Direct and Indirect Water Resource Impacts

Condition Indicators	Impact Definitions	Impact Thresholds
No Impact		
Perched Aquifer Springs/ Wells		
Water Quantity/Quality	No change in the volume of spring discharge or water levels in non-mine wells would occur. No change in concentrations of uranium and arsenic in groundwater would occur.	No new and existing mines would be located within the groundwater drainage areas that support perched aquifer springs and wells.
R-aquifer Springs		
Water Quantity	No change in the volume of discharge would occur.	The total anticipated volume of water withdrawn from mine-related R-aquifer wells would be 0% of the estimated aggregate flow from R-aquifer springs located downgradient from mine production wells.
Water Quality	No change in concentrations of uranium and arsenic in groundwater would occur.	No mines would contribute impacted water to the R-aquifer.
R-aquifer Wells		
Water Quantity	No changes in water levels in non-mine R-aquifer wells would occur.	No decrease in water levels observed in non-mine R-aquifer wells would occur.
Water Quality	No change in concentrations of uranium and arsenic would occur in groundwater yielded to non-mine R-aquifer wells.	No mines would contribute impacted water to non-mine R-aquifer wells.
Surface Waters	No changes in stream flow, water quality, or sediment loads would occur.	No water quantity or water quality impacts to perched aquifer or R-aquifer springs that support surface water flow, and no surface disturbance would occur as a result of mining-related activities.
Negligible Impact		
Perched Aquifer Springs		
Water Quantity / Quality	Mines could be located within the groundwater drainage area of perched aquifers that support springs. Impact defined by the probability that a perched aquifer spring would have a mine located within its groundwater drainage area. Probability is estimated in accordance with methodology described in Section 4.4.1.	Between 0% and 5% estimated probability that a perched aquifer spring would have a mine located within its groundwater drainage area. This range of values indicates more than a 95% probability that any spring would not be impacted.
Perched Aquifer Wells		
Water Quantity / Quality	New or existing mines could be located within the groundwater drainage area of perched aquifers that support wells. Impact defined by the number of existing and new mines that might impact perched aquifer wells.	One to five mines might impact one well each. Rationale based on North Parcel, where 103 records for existing wells are reported. Five wells is less than 5% of the existing wells, many of which are likely inactive or abandoned, and 10 mines is about 25% of the new and existing mines anticipated for the North Parcel under Alternative A.

Table 4.4-1. Summary of Definitions for Direct and Indirect Water Resource Impacts (Continued)

Condition Indicators	Impact Definitions	Impact Thresholds
Negligible Impact, continued		
R-aquifer Springs		
Water Quantity	Changes in the volume of discharge would not be expected to be detectable, based on reported accuracies of measurement methods (Harmel et al. 2006).	The total anticipated volume of water withdrawn from mine-related R-aquifer wells would be between 0% and 5% of the estimated aggregate flow from R-aquifer springs located downgradient from mine production wells.
Water Quality	Changes in the concentrations of uranium and arsenic in groundwater would not be expected to result in exceedance of estimated ambient concentrations.	At least one mine might contribute impacted water to the R-aquifer, but the resultant concentration of uranium or arsenic would not be expected to exceed estimated ambient levels.
R-aquifer Wells		
Water Quantity	Changes in water levels in non-mine R-aquifer wells might be detectable but would be expected to have a negligible effect on the operation of the wells impacted.	Decrease in water levels observed in non-mine R-aquifer wells would be expected to range between 0 and 10 feet after 5 years of pumping any single mine well, which is equivalent to the ADWR criterion for acceptable impact in Active Management Areas (AMAs).
Water Quality	Changes in the concentrations of uranium and arsenic in groundwater would not be expected to result in exceedance of estimated ambient concentrations.	At least one mine might contribute impacted water to the R-aquifer, and the resultant concentration of uranium or arsenic would not be expected to exceed estimated ambient levels.
Surface Waters		
Water Quantity	Changes in the volume of discharge from R-aquifer springs that support stream flow would not be expected to be detectable. The probability of a mine being located within the drainage area of perched springs that support stream flow would be between 0% and 5%. Changes in the quantity of ephemeral stream flow would not be expected to be detectable and would be expected to be limited in extent.	Water quantity impacts to perched aquifer or R-aquifer springs that support stream flow would be negligible (as defined above). Surface disturbance would not be located in or adjacent to areas of steep topography; resulting changes in quantity of ephemeral stream flow would be expected to be limited to the immediate vicinity of roadways, exploration sites, and mine sites (as discussed in Section 4.5).
Water Quality	Changes in the concentrations of uranium, or arsenic in surface water supported by springs would not be expected to result in exceedance of estimated ambient concentrations. Changes in the quality of ephemeral runoff would not be expected to result in exceedance of estimated ambient concentrations and would be expected to be limited in extent.	Water quality impacts to perched aquifer or R-aquifer springs that support stream flow would be negligible (as defined above). Distribution of contaminants in soil/sediment and increased erosion would be minor (as defined in Section 4.5) and mining related disturbances would not be located in or adjacent to areas of steep topography; resulting changes in quality of ephemeral stream flow would be expected to be negligible (as defined for R-aquifer springs) and limited to the immediate vicinity of roadways, exploration sites, and mine sites.
Stream Function	Changes in quantity of stream flow and sediment loads would not be expected to result in adverse impacts to overall stream morphology or function.	Surface disturbance or increased erosion and sedimentation, would be minor (as defined in Section 4.5); resulting impacts to runoff and/or stream sedimentation would be expected to be limited to the immediate vicinity of roadways, exploration sites, and mine sites.

Table 4.4-1. Summary of Definitions for Direct and Indirect Water Resource Impacts (Continued)

Condition Indicators	Impact Definitions	Impact Thresholds
Moderate Impact		
Perched Aquifer Springs		
Water Quantity / Quality	Mines could be located within the groundwater drainage area of perched aquifers that support springs. Impact defined by the probability that a perched aquifer spring would have a mine located within its groundwater drainage area. Probability is estimated in accordance with methodology described in Section 4.4.1.	5% to 20% estimated probability that a perched aquifer spring would have a mine located within its groundwater drainage area. This range of values generally indicates more than an 80% probability that any spring would not be impacted.
Perched Aquifer Wells		
Water Quantity / Quality	New or existing mines could be located within the groundwater drainage area of perched aquifers that support wells. Impact defined by the number of existing and new mines that might impact perched aquifer wells.	Six to 10 mines might impact one well each. Rationale based on North Parcel, where 103 records for existing wells are reported. Ten wells is less than 10% of the existing wells, many of which are likely inactive or abandoned, and 10 mines is about half of the new and existing mines anticipated for the North Parcel under Alternative A.
R-aquifer Springs		
Water Quantity	Changes in the volume of discharge might be detectable, but would not be substantial.	The total anticipated volume of water withdrawn from mine-related R-aquifer wells might be 5% to 10% of the estimated aggregate flow from R-aquifer springs located downgradient from mine production wells.
Water Quality	Changes in concentrations of uranium and arsenic in groundwater might result in exceedance of estimated ambient concentrations, but would not be expected to result in exceedance of drinking water standards.	At least one mine might contribute impacted water to the R-aquifer, and the resultant concentration of uranium or arsenic might exceed ambient levels, but not drinking water standards (30 µg/L uranium or 10 µg/L arsenic).
R-aquifer Wells		
Water Quantity	Changes in water levels in non-mine R-aquifer wells might be detectable and might have a small adverse effect on the operation of the wells impacted.	Decrease in water levels observed in non-mine R-aquifer wells might range from 10 to 20 feet in the first 5 years of pumping any single mine well. This threshold is up to twice as much as the ADWR criterion for acceptable impact in AMAs.
Water Quality	Changes in concentrations of uranium and arsenic in groundwater might result in exceedance of estimated ambient concentrations but would not be expected to result in exceedance of drinking water standards.	At least one mine might contribute impacted water to the R-aquifer, and the resultant concentration of uranium or arsenic might exceed ambient levels, but would not be expected to exceed drinking water standards (30 µg/L uranium or 10 µg/L arsenic).

Table 4.4-1. Summary of Definitions for Direct and Indirect Water Resource Impacts (Continued)

Condition Indicators	Impact Definitions	Impact Thresholds
Moderate Impact, continued		
Surface Waters		
Water Quantity	Changes in the volume of discharge from R-aquifer springs that support stream flow might be detectable, but would not be substantial. The probability of a mine being located within the drainage area of perched springs that support stream flow would be between 5% and 20%. Changes in the quantity of ephemeral stream flow might be detectable and might extend beyond the immediate vicinity of sites of disturbance.	Water quantity impacts to perched aquifer or R-aquifer springs that support stream flow would be moderate (as defined above). Surface disturbance might be located in or adjacent to areas of steep topography and resulting changes in quantity of ephemeral stream flow might extend beyond the immediate vicinity of roadways, exploration sites, and mine sites.
Water Quality	Changes in concentrations of uranium or arsenic in surface water supported by springs might result in exceedance of estimated ambient concentrations, but would not be expected to result in exceedance of drinking water standards. Changes in the quality of ephemeral runoff would not be expected to result in exceedance of estimated ambient concentrations, but might extend beyond the immediate vicinity of sites of disturbance.	Water quantity impacts to perched aquifer or R-aquifer springs that support stream flow would be moderate (as defined above). Distribution of contaminants in soil/sediment and increased erosion would be moderate (as defined in Section 4.5) and mining related disturbances might be located in or adjacent to areas of steep topography; resulting changes in quality of ephemeral stream flow would be expected to be negligible (as defined for R-aquifer springs), but might extend beyond the immediate vicinity of roadways, exploration sites, and mine sites.
Stream Function	Changes in quantity of stream flow and sediment loads might result in small adverse impacts to overall stream morphology or function.	Surface disturbance or increased erosion and sedimentation would be moderate (as defined in Section 4.5); resulting impacts to runoff and/or stream sedimentation might extend beyond the immediate vicinity of roadways, exploration sites, and mine sites.
Major Impact		
Perched Aquifer Springs		
Water Quantity / Quality	Mines could be located within the groundwater drainage area of perched aquifers that support springs. Impact defined by the probability that a perched aquifer spring would have a mine located within its groundwater drainage area. Probability is estimated in accordance with methodology described in Section 4.4.1.	More than 20% estimated probability that a perched aquifer spring would have a mine located within its groundwater drainage area. This range of values generally indicates less than an 80% probability that any spring would not be impacted.
Perched Aquifer Wells		
Water Quantity / Quality	New or existing mines could be located within the groundwater drainage area of perched aquifers that support wells. Impact defined by the number of existing and new mines that might impact perched aquifer wells.	More than 10 mines might impact one well each. Rationale based on North Parcel, where 103 records for existing wells are reported. Ten wells is less than 10% of the existing wells, many of which are likely inactive or abandoned, and 10 mines is about half of the new and existing mines anticipated for the North Parcel under Alternative A.

Table 4.4-1. Summary of Definitions for Direct and Indirect Water Resource Impacts (Continued)

Condition Indicators	Impact Definitions	Impact Thresholds
Major Impact, continued		
R-aquifer Springs		
Water Quantity	Changes in the volume of discharge could be detectable and might be substantial.	The total anticipated volume of water withdrawn from mine-related R-aquifer wells might be more than 10% of the estimated aggregate flow from R-aquifer springs located downgradient of mine production wells.
Water Quality	Changes in concentrations of uranium and arsenic in groundwater might result in exceedance of estimated ambient concentrations and drinking water standards.	At least one mine might contribute impacted water to the R-aquifer and the resultant concentration of uranium or arsenic might exceed ambient levels and drinking water standards (30 µg/L uranium or 10 µg/L arsenic).
R-aquifer Wells		
Water Quantity	Changes in water levels in non-mine R-aquifer wells could be detectable and might have a substantial adverse effect on the operation of the wells impacted.	Decrease in water levels observed in non-mine R-aquifer wells might exceed 20 feet of decline in the first 5 years of pumping any single mine well.
Water Quality	Changes in concentrations of uranium and arsenic in groundwater might result in exceedance of estimated ambient concentrations and drinking water standards.	At least one mine might contribute impacted water to the R-aquifer and the resultant concentration of uranium or arsenic might exceed ambient levels and drinking water standards (30 µg/L uranium or 10 µg/L arsenic).
Surface Waters		
Water Quantity	Changes in the volume of discharge from R-aquifer springs that support stream flow could be detectable and might be substantial. The probability of a mine being located within the drainage area of perched springs that support stream flow would be more than 20%. Changes in the quantity of ephemeral stream flow might be detectable and might extend well beyond the immediate vicinity of sites of disturbance.	Water quantity impacts to perched aquifer or R-aquifer springs that support stream flow would be major (as defined above). Surface disturbance might be located in areas of steep topography and resulting changes in quantity of ephemeral stream flow might extend well beyond the immediate vicinity of roadways, exploration sites, and mine sites (as discussed in Section 4.5).
Water Quality	Changes in concentrations of uranium or arsenic in surface water supported by springs might result in exceedance of estimated ambient concentrations and drinking water standards. Changes in the quality of ephemeral runoff would not be expected to result in exceedance of estimated ambient concentrations, but might extend well beyond the immediate vicinity of sites of disturbance.	Water quantity impacts to perched aquifer or R-aquifer springs that support stream flow would be major (as defined above). Distribution of contaminants in soil/sediment and increased erosion would be major (as defined in Section 4.5) and mining related disturbances might be located in areas of steep topography; resulting changes in quality of ephemeral stream flow might be moderate to major (as defined for R-aquifer springs), and might extend well beyond the immediate vicinity of roadways, exploration sites, and mine sites.
Stream Function	Changes in quantity of stream flow and sediment loads might result in substantial adverse impacts to overall stream morphology or function.	Surface disturbance or increased erosion and sedimentation would be major (as defined in Section 4.5); resulting impacts to runoff and/or stream sedimentation might extend well beyond the immediate vicinity of roadways, exploration sites, and mine sites.

Table 4.4-2. Water Resource Impact Duration

Duration	
Temporary	Up to 1 year (periods of development and reclamation)
Short-term	1 to 5 years
Long-term	Greater than 5 years

The study area for the water resources analysis was selected to include local surface water drainage areas and groundwater basins that could potentially be impacted by reasonably foreseeable activities in the proposed withdrawal area. This impact assessment area includes the proposed withdrawal area and downstream/downgradient areas of the Grand Canyon watershed that are tributary to the Colorado River and the Little Colorado River, along with downstream/downgradient areas that are tributary to the Virgin River watershed. Additional areas remote from the proposed withdrawal area, such as the Virgin River in Utah and near Littlefield, Arizona, were also considered because of potential hydrologic connections.

The proposed withdrawal area is administrated by either the BLM or the Forest Service. Areas downstream in the Grand Canyon watershed include lands administered by the NPS, State of Arizona, Havasupai Tribe, Hualapai Tribe, and Navajo Nation and include areas of private land. Within the water resources study area, a uniform set of water resource condition indicators were used for evaluation of resources and assessment of impacts (see Table 4.4-1).

Issues specific to the North and East parcels concern the potential for remote water resource impacts in southern Utah and the Virgin River watershed. The Utah state boundary is near the northeastern edge of the North Parcel. As shown on Figure 3.4-11, surface water drainage over most of the North Parcel is generally toward Kanab Creek and its tributaries, which drain south toward the Colorado River. Surface water in the westernmost part of the North Parcel drains to Clayhole Wash, which is tributary to Fort Pierce Wash (a tributary of the Virgin River), south of St. George, Utah, located about 35 miles northwest of the North Parcel. As described in Section 3.4 (see Figure 3.4-14), R-aquifer groundwater along the western, northwestern, and northeastern margins of the North Parcel is likely to move to the north toward areas in south and central Utah. The R-aquifer dips deeply northward from near the Grand Canyon to thousands of feet in depth (see Figure 3.4-4) and does not directly feed springs along the Virgin River north of the North Parcel (Cordova 1981; Dutson 2005). Only oil and gas wells are known to penetrate to these depths in Utah, where the R-aquifer is not considered a viable drinking water supply.

As described in Section 3.4, the R-aquifer crops out along the Virgin River near Littlefield, Arizona, and upstream in the lower Virgin River gorge in the northwest corner of Arizona (see Figure 3.4-9), about 46 miles northwest from the boundary of the North Parcel. Discharge from springs related to these outcrops has been reported by various sources to range from about 9,000 to 22,000 gpm at the spring complex of the lower Virgin River gorge and about 10,000 gpm at the Littlefield spring complex (personal communication, Don Bills, USGS 2010b). The potential for a hydraulic connection in the R-aquifer between the North Parcel and these spring complexes is not known. Several major north-trending fault zones, including the Sevier, Toroweap, Hurricane, and Main Street faults, occur between the North Parcel and the Virgin River area in northwest Arizona (see Figure 3.4-9). These faults are thought to function like the Mesa Butte Fault Zone south of the Grand Canyon, which provides a preferential pathway where groundwater is intercepted and conveyed along the fault zone to spring systems along the Little Colorado River to the north and the Verde River valley to the south (see Figure 3.4-3). Another example is the West Kaibab Fault Zone (including the Muav and Sinyala faults), which is believed to intercept westward-moving groundwater from the Kaibab Plateau and convey it south and north (see westernmost faults shown on Figure 3.4-15). The fault zones west of the North Parcel, as well as ancient cave systems, likely collect and convey groundwater chiefly north toward central and southern Utah and lesser amounts south toward the Grand Canyon, and they may prevent or limit westward movement of R-

aquifer groundwater from the North Parcel across the faults to the Virgin River area in northwest Arizona. In addition, although the R-aquifer and other formations at the north end of the Virgin Mountains are abundantly faulted and fractured, the main body of the north-south-trending crystalline bedrock core of the Virgin Mountains east and southeast from the Littlefield spring complex likely functions as a barrier to east-west groundwater movement. Nonetheless, it is possible that R-aquifer groundwater in the North Parcel reaches springs along the Virgin River of northwestern Arizona. However, if such a connection does occur, the contribution to large spring flow along the Virgin River from groundwater in the R-aquifer of the North Parcel would likely be small.

A small area (about 2 square miles) of the northernmost extent of the East Parcel lies within the surface water drainage area of the Paria River, which drains a short distance northward into Utah and then returns to Arizona and is tributary to the Colorado River at Lees Ferry. The R-aquifer occurs at depth along the Paria River and does not discharge to the Paria River. R-aquifer groundwater in the small area at the northernmost extent of the East Parcel may move northward into Utah or southward into the main body of the East Parcel. However, similar to groundwater in the North Parcel, any groundwater moving north into Utah is unlikely to discharge at any of the large springs along the Virgin River in southern Utah.

There is no similar potential for remote watershed resource impacts from the South Parcel. All potential impacts would be limited to the Cataract Creek watershed, Little Colorado River watershed, or small watersheds along the South Rim, all of which are local to the South Parcel and tributary to the Grand Canyon watershed.

Rate of groundwater movement in the unsaturated zone and in aquifers is controlled by type of flow regime (fractures, karst, or porous media), permeability and porosity of aquifer and unsaturated zone media, degree of saturation, and hydraulic gradient. These properties vary widely in the rock strata of the Grand Canyon and Virgin River watersheds and provide a wide range of temporal variation in potential impacts. These variations can be characterized but not quantified with the existing data. Geological and hydrologic conditions in the study area are relatively complex in some areas and have received various levels of investigation and data collection. Therefore, the level of uncertainty in hydrologic relationships is relatively high for some locations, whereas such relationships are relatively certain for other locations.

Quantity of Discharge from Perched Aquifer Springs and Wells

SPRINGS

A potential impact to the quantity of water that can discharge from springs fed by perched aquifers is the seepage of groundwater from the source aquifer into mine openings or down exploration drill holes at nearby mine sites. In the proposed withdrawal area, seeps and springs issue from fractures, bedding planes, or sandstone strata in perched aquifers in the Chinle, Moenkopi, Kaibab, and Toroweap formations, Coconino Sandstone, and Supai Group along the walls and channels of canyons or from outcrops on the plateaus. Springs that issue from rock strata younger than the Chinle Formation do not occur on the parcels and would not be impacted by any of the alternatives; therefore, these springs were not considered in the impact analysis. Similarly, perched aquifer springs that are located outside the parcels and issue from rock strata substantially elevated topographically with respect to correlative strata within the parcels, especially those with bedding that slopes away from the parcels (as occurs north of the North Parcel), would not be impacted and were not considered in the impact analysis. In addition, perched aquifer springs located east of Kanab Creek and south of Snake Gulch (near the North Parcel), east of the Colorado River (near the East Parcel), west of Cataract Creek, or east of the Little Colorado River (near the South Parcel) were not considered because any such springs are hydraulically separated by canyons from potential mining operations on the parcels.

Perched aquifer zones in the proposed withdrawal area are characterized as being commonly small, thin, discontinuous, and generally dependent on annual recharge to sustain yield to springs and wells (Bills et al. 2010; Montgomery et al. 2000). This condition is associated with relatively small groundwater drainage areas and, therefore, requires mining activities to be in relatively close proximity to a perched aquifer spring to present a potential impact. Although the number of perched aquifer springs is low and the reported flow rates are small, the springs support sensitive/unique ecological environments. Perched aquifer conditions are complex and data are generally insufficient to project the degree of potential impact to discharge from a perched aquifer spring that might occur if a mine were located within the groundwater drainage area of the spring. Therefore, potential impact to an individual perched aquifer spring can only be characterized as ranging from none to major, with duration of impact ranging from short term (1 to 5 years) to long term (greater than 5 years) (defined in Table 4.4-2). However, the probability of a future mine's being located within the groundwater drainage area of a perched aquifer spring can be calculated. The probability can then be assigned an impact threshold with which to evaluate the impact of a particular alternative on each parcel. Calculation of the probability requires the following information:

1. the number, location, and flow rates of perched aquifer springs reported for the proposed withdrawal area and non-withdrawal area of each parcel under each alternative (available in Appendix D);
2. the total of the groundwater drainage areas for these springs (needs to be estimated);
3. the total non-withdrawal area of each parcel under each alternative (available in Chapter 2); and
4. the total number of anticipated breccia pipe uranium mines within the non-withdrawal area of each parcel under each alternative (available in Appendix B).

As indicated above, except for the groundwater drainage area of the perched aquifer springs, all the necessary information for calculating the probability of impact is available in Chapter 2 and the appendices. For the proposed withdrawal area, data for existing conditions at perched aquifer springs were evaluated to estimate the potential groundwater drainage areas that support the springs. Protective buffer areas were then defined around these springs to establish areas to be considered for withdrawal and to identify potential for effects of mine operations (Figures 4.4-1, 4.4-2, and 4.4-3).

Although potential impacts to perched aquifer springs from breccia pipe mines might occur rapidly (within a year), such impacts also might not occur for several years and might not be discernible until after a mine has been reclaimed. The potential rate of drainage of perched groundwater to mine openings is controlled by several site-specific factors that are difficult to determine, including recharge, spatial configuration of the perched groundwater zone with respect to location of the mine openings and spring, and hydraulic parameters that affect the rate of groundwater movement. It is not known exactly where future mines might be constructed. Therefore, it is not possible to project the potential rate or degree of depletion of discharge from a spring that might be expected to occur. The buffer areas were selected assuming that an eventual impact within the groundwater drainage area of a spring might occur; no estimate of temporal aspects of potential impacts was made.

The groundwater drainage area for each perched aquifer spring was estimated using the following method:

1. The instantaneous flow rate recorded for each spring was used to develop perched aquifer groundwater drainage areas, based on the assumption that discharge at each spring is in equilibrium with recharge to the aquifer. In the event that multiple flow rate measurements or estimates were available, the maximum value recorded was used to provide a conservatively large groundwater drainage area (see Appendix D). Most of the instantaneous discharge measurements reported for perched aquifer springs in the parcels and adjacent areas that might be impacted were 1 gpm or less; therefore, a constant discharge rate of 1 gpm was assumed for all these springs to

be conservative. Three perched springs that exceed 1 gpm are located in the North Parcel and were assigned their maximum measured values of 1.1, 1.4, and 5.8 gpm (see Appendix D). Springs that have no reported discharge, or a reported rate of zero, were assigned a discharge rate of 1 gpm because it was assumed that the discharge rate is no greater than the typical reported discharge for other springs in the vicinity. This assumption is considered reasonable because it is likely that distinctly larger flows would have been noted by administrating agencies or estimated/noted when the springs were located during surveys conducted by previous investigations.

2. A conservatively small value of 8 inches for average annual precipitation was selected for each parcel, based on the data shown on Figure 3.4-10. The smaller the value for precipitation, the larger the estimated groundwater drainage area and potential impact area for each spring.

3. A recharge rate, as a percentage of precipitation, was selected for each spring area. Metzger (1961) estimated average annual recharge to the principal aquifer in the region (the R-aquifer) to be about 0.3 inch per year (inch/yr), which is about 2% of the average annual precipitation measured at Grand Canyon Village. Montgomery et al. (2000) estimated a recharge rate of about 4% of the average precipitation for the Coconino and San Francisco plateaus based on total groundwater discharge from the principal aquifers. Amount of recharge to the perched aquifer zones has not been estimated; however, it is assumed the average available recharge for the perched aquifers is the same as for the deeper R-aquifer under equilibrium conditions. The smaller recharge value of 2% was selected to provide a conservatively large estimated groundwater drainage area and potential impact area for each perched aquifer spring.

4. The groundwater drainage area for each perched aquifer spring was then calculated using the following equation, which relates the amount of spring discharge to the amount of precipitation and resultant recharge:

$$A = \frac{Q \times C}{R \times P}$$

where: A = groundwater drainage area, in square miles (mi^2)
Q = discharge at spring, in gpm
C = conversion factor = 0.03 inch-mi^2/gpm-yr
R = recharge as fraction of precipitation, in percent
P = average annual precipitation (inch/yr)

For example, the groundwater drainage area for a 1-gpm spring is calculated as follows:

$$A = \frac{1 \text{ gpm} \times 0.03 \text{ inch-mi}^2\text{/gpm-yr}}{0.02 \times 8 \text{ inch/yr}} = 0.2 \text{ mi}^2$$

5. The shape of groundwater drainage areas for the perched aquifer springs may range widely as a result of weathering and more abundant fractures along canyon rim areas. However, it was assumed that all the springs might be fed by an elongated groundwater drainage area associated with a local fracture system. This assumption has the effect of lengthening the estimated groundwater drainage area, thereby providing a conservatively large potential impact area for the springs. It was assumed that the length of the groundwater drainage areas might be 10 times the width. Solving for such a rectangle with an area of 0.2 square mile (from the equation above) provides a groundwater drainage area length of about 1.4 miles. The length for the three slightly larger springs in the North Parcel was similarly calculated; the length of the groundwater drainage area for the largest perched spring, Clearwater Spring (5.8 gpm), was calculated by this method to be about 3.4 miles.

6. Because the directional orientation of the assumed local fracture system is not known, all directions of the compass were addressed by drawing a circle with a radius equal to the calculated length of groundwater drainage area, centered on each spring. This circle establishes the estimated potential impact area around each of the perched aquifer springs. It was assumed that

mine sites within this radius of the springs might impact the quantity of discharge from the springs. Using a circle with a diameter equal to the largest dimension of the rectangle described above results in a calculated area 7.8 times the actual area of the rectangle; therefore, the area of potential impact is overestimated by the same amount. An exception is where the circle includes areas where the perched aquifer does not occur, such as beyond canyon walls that completely cut the aquifer.

After the groundwater drainage areas for the perched aquifer springs have been estimated, the probability of impact can be calculated. The appropriate formula for calculating the probability of impacting a perched aquifer spring in a given parcel under a given alternative is the binomial distribution formula (Kreyszig 1999). This method assumes a random distribution for new mines in the area of consideration, which is appropriate for this analysis. For Alternatives B, C, and D in the North Parcel only, an additional similar calculation was needed to account for the seven anticipated new mines that could be located anywhere on the parcel (see Appendix B), including the withdrawn areas; the two probabilities for each of these alternatives for the North Parcel were then combined by subtracting the product of the probabilities from the sum of the probabilities. Conservative features of this methodology include 1) groundwater drainage areas for many springs were calculated assuming a flow rate of 1 gpm, even though the springs had no flow measurements or flow measured at less than 1 gpm; 2) if any part of the buffer area around a spring overlapped an area of consideration, the entire estimated drainage area for the spring was included in the calculation for probability of impact; 3) the buffer area was overestimated by a factor of 7.8 to account for the uncertainty in the directional orientation of the groundwater drainage area and caused some drainage areas to be included in the calculations that otherwise might not have been; and 4) several springs occur in clusters that have overlapping buffer areas; however, each spring was considered separately, thereby overestimating the probability of impact.

WELLS

Perched aquifer wells may pump perched groundwater at various rates determined by the well and pump capacity, the perched aquifer permeability and volume of groundwater in storage, depth to groundwater, and water demand and pumping schedule of the well user. Unlike a spring, the well yield is not directly related to the groundwater drainage area of the perched groundwater zone or the annual recharge to that zone. Although these factors ultimately limit the amount of groundwater that a well can pump from storage in the perched aquifer, they cannot be estimated in the same inflow-outflow manner described in the previous discussion for perched aquifer springs because the outflow point (the well) is not a natural part of the flow system and well discharge rate does not depend directly on perched aquifer recharge. In addition, because the perched groundwater zones are small and discontinuous, it is not possible with available data to estimate their location and extent where they do not have numerous wells or a natural drainage point such as a spring. Furthermore, wells can potentially be located anywhere and to any depth in the future, and data for pumping rate, aquifer hydraulic properties, and chemical quality of most wells are not required to be reported or are not available in the parcel areas. Therefore, it is not possible to reasonably calculate or locate protective buffer areas for perched aquifer wells, as was done for perched aquifer springs. It is assumed that breccia pipe uranium mine openings near perched aquifer wells might impact both the quantity and chemical quality of discharge from the wells in a manner similar to the impacts that might occur to perched aquifer springs and that potential impacts on any particular well could range from none to major and have a duration ranging from short term to long term. Impact of each alternative on each parcel was defined by the number of existing and new mines that might impact perched aquifer wells in accordance with Table 4.4-1.

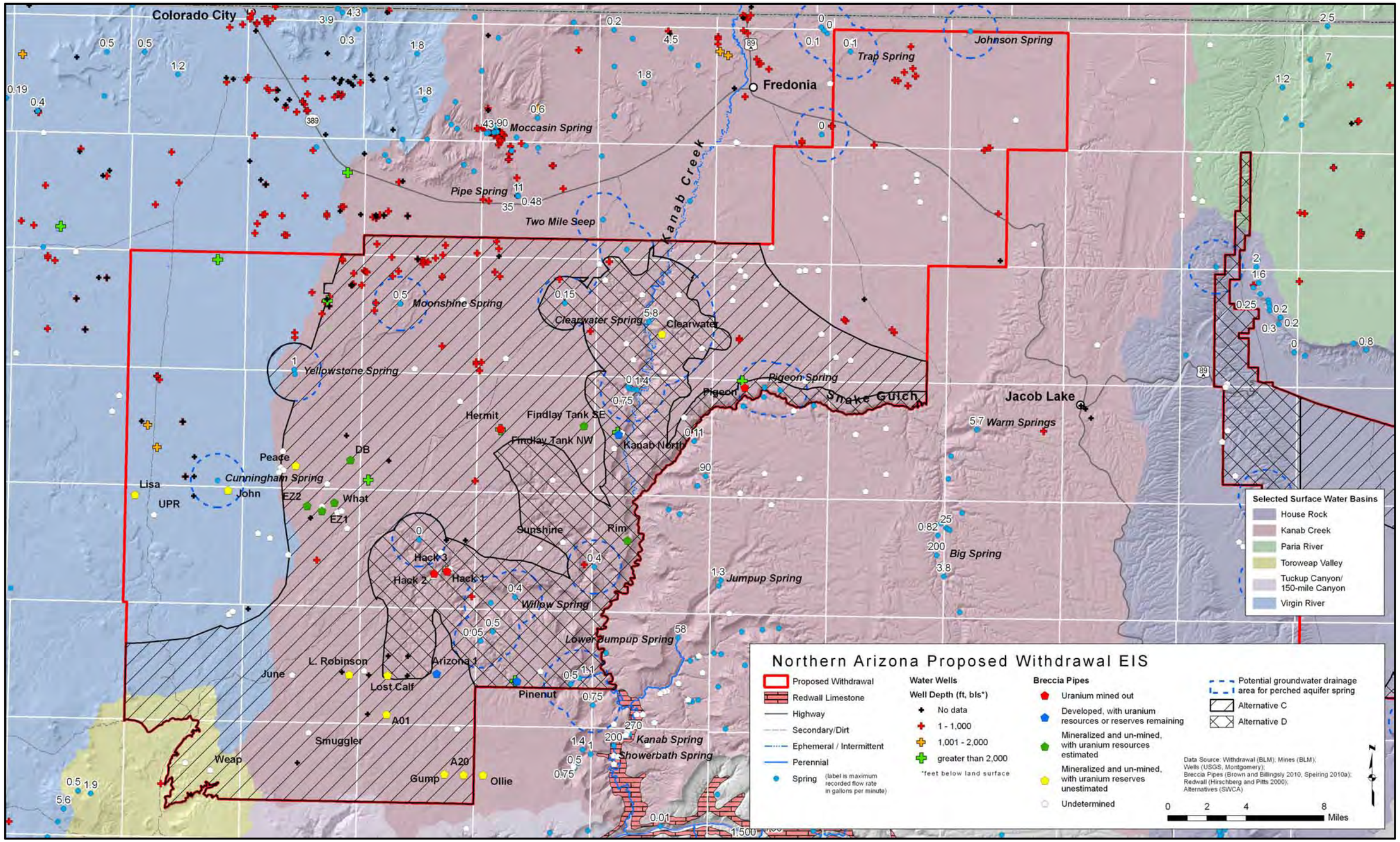

Figure 4.4-1. North Parcel locations of alternative withdrawal areas, protective spring buffers, springs, and water wells.

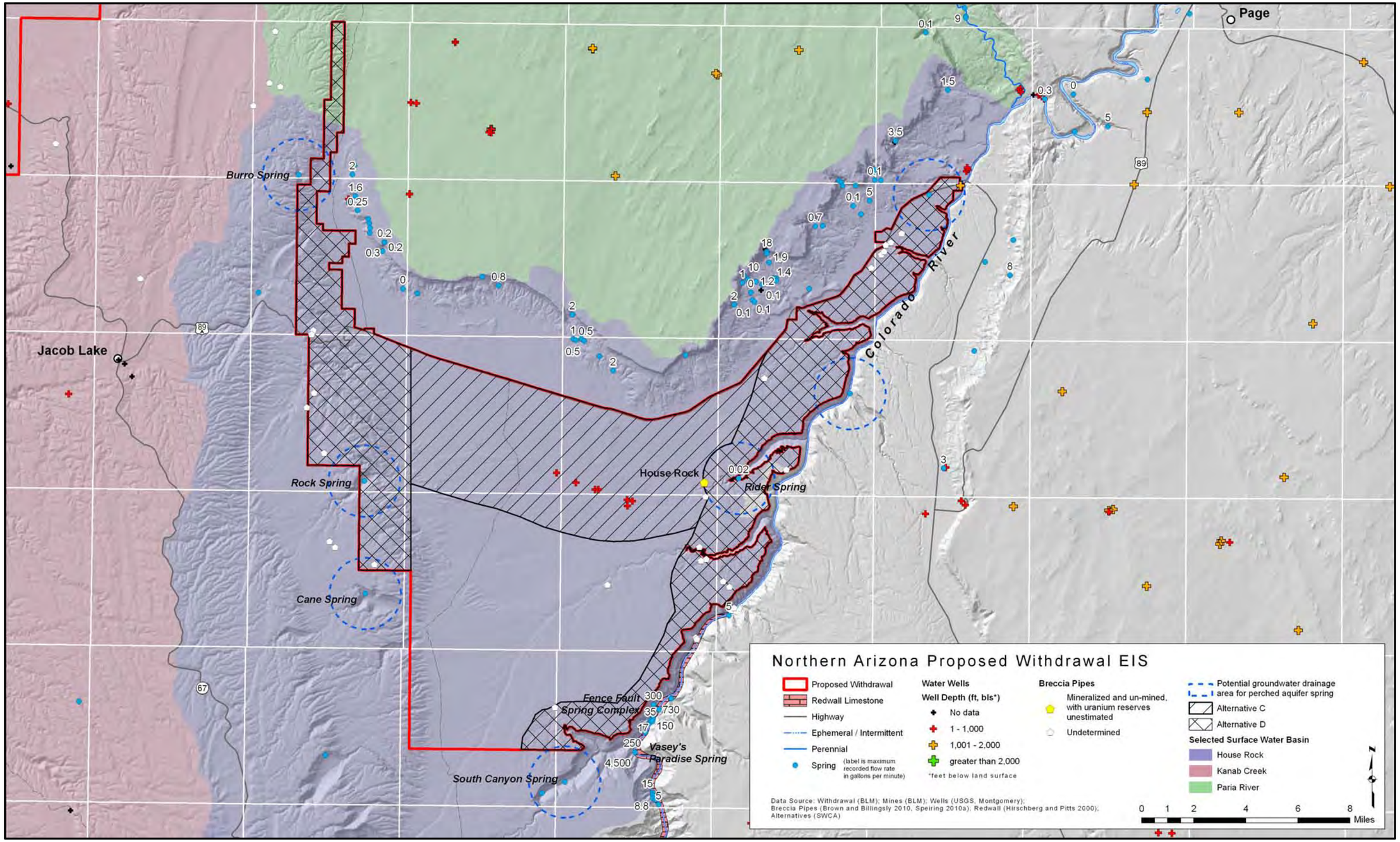

Figure 4.4-2. East Parcel locations of alternative withdrawal areas, protective spring buffers, springs, and water wells.

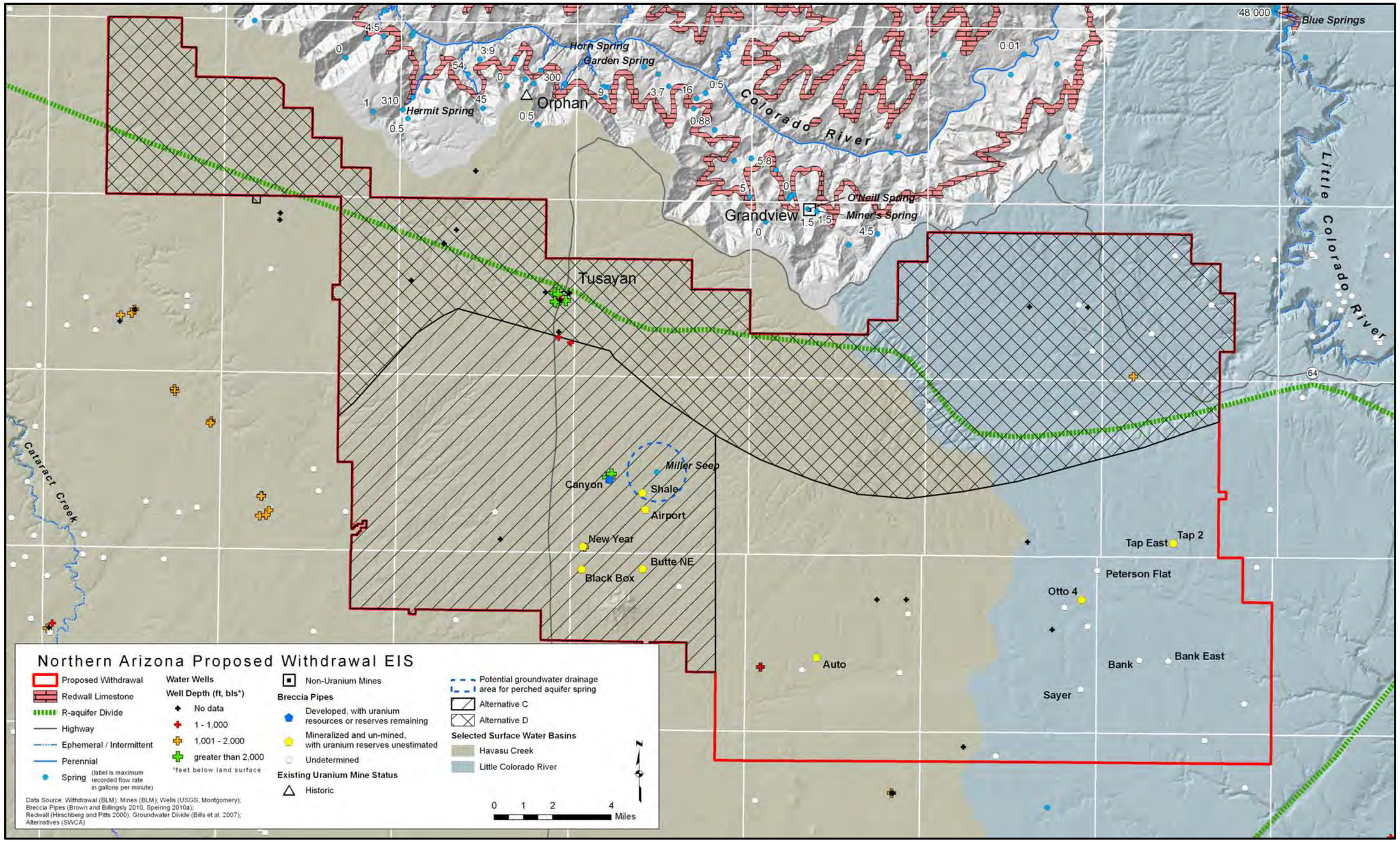

Figure 4.4-3. South Parcel locations of alternative withdrawal areas, protective spring buffers, springs, and water wells.

Well records (see Appendix C) indicate that, of the 103 records reported for wells drilled shallower than the R-aquifer in the North Parcel, only five of the non-mineral-exploration wells were drilled in the past 20 years. Of the seven wells reported for the East Parcel, none were drilled in the past 38 years. Of the 16 records reported for wells drilled shallower than the R-aquifer in the South Parcel, none of the non-mineral-exploration wells were drilled in the past 42 years. Many of the recorded wells are likely either unused or abandoned. Where no date for a non-mineral-exploration well is given, it was assumed that the well was drilled prior to the 1980 Groundwater Management Act or that the well was not actually drilled. In addition, livestock grazing operations on the parcels have declined over the past few decades, the number of quarries and sand and gravel operations is not expected to increase significantly over the next 20 years, and a substantial permitting process is required to install new wells on federal lands. Based on this information, the number of new perched aquifer water wells anticipated to be drilled in the parcels over the next 20 years is none to few.

Deep mineral exploration boreholes and R-aquifer water supply wells for the mines might provide potential conduits for movement of groundwater from perched aquifers to deeper formations. However, AAC Title 12, Chapter 15, Article 8 requires proper construction and abandonment of wells to prevent cross-contamination of different aquifers. The following excerpts from Article 8 are pertinent to definition, applicability, and restrictions on exploration and water wells:

> **R12-15-801.13:** “Exploration well” means a well drilled in search of geophysical, mineralogical, or geotechnical data.
>
> **R12-15-802:** This Article shall apply to man-made openings in the earth through which water may be withdrawn or obtained from beneath the surface of the earth, including all water wells, monitor wells and piezometer wells. It shall also apply to geothermal wells to the extent provided by ARS 45-591.01, and all exploration wells and grounding or cathodic protection holes greater than 100 feet in depth. (This Article shall not apply to R12-15-802.4: Drilled boreholes in the earth less than 100 feet in depth, which are made for purposes other than withdrawing or encountering groundwater, such as exploration wells and grounding or cathodic protection holes; except that in the event that groundwater is encountered in the drilling of a borehole, this Article shall apply.)
>
> **R12-15-811.B.1:** [Surface Seal] Except as provided in subsections (2) and (4) of this subsection, and R12-15-817(B)(1), all wells shall be constructed with a surface seal as herein provided. The seal shall consist of steel casing, one foot of which shall extend above ground level, and cement grout placed in one continuous application from the bottom of the zone to be grouted to the land surface. If a pitless adaptor is utilized, the cement grout may terminate at the bottom of the pitless adaptor. The minimum length of the steel casing shall be 20 feet. The minimum annular space between the casing and the borehole for placement of grout shall be one and one-half inches. Curing additives, such as calcium chloride, shall not exceed ten percent of the total volume of grout. Bentonite as an additive shall not exceed five percent of the total volume. The minimum length of the surface seal shall be 20 feet. Any annular space between the outer casing and an inner casing shall be completely sealed to prevent contamination of the well.
>
> **R12-15-811.F.3:** [Fluids and Solids Control] Drilling fluids and cuttings shall be contained in a manner which prevents discharge into any surface water.
>
> **R12-15-812.B:** [Cross Contamination] Mineralized or polluted water. In all water-bearing geologic units containing mineralized or polluted water as indicated by available data, the borehole shall be cased and grouted so that contamination of the overlying or underlying groundwater zones will not occur.
>
> **R12-15-816.G:** [Abandonment] The abandonment of a well shall be accomplished through filling or sealing the well so as to prevent the well, including the annular space outside the casing, from being a channel allowing the vertical movement of water.

R12-15-816.I.1: [Abandonment] A well penetrating a single aquifer system with no vertical flow components shall be filled with cement grout, concrete, bentonite drilling muds, clean sand with bentonite, or cuttings from the well.

R12-15-816.I.2: [Abandonment] A well penetrating a single or multiple aquifer system with vertical flow components shall be sealed with cement grout or a column of bentonite drilling mud of sufficient volume, density, and viscosity to prevent fluid communication between aquifers.

R12-15-817.B.1: [Construction and Abandonment] If an exploration well which is to be left open for re-entry at a later date encounters groundwater, it shall be cased and capped in accordance with R12-15-811, R12-15-812, and R12-15-822.

R12-15-817.B.2: [Construction and Abandonment] Exploration wells not left open for re-entry shall be abandoned in accordance with R12-15-816.

For the purposes of this EIS, it must be assumed that the state and federal regulations have been and are being met. Therefore, because the regulations are protective of groundwater, deep drilling operations that occurred after the regulations were adopted on March 5, 1984 (ADWR 2008), are considered to represent no impact or a negligible impact to the quantity and quality of perched groundwater available to perched aquifer springs or wells. Duration of the negligible impact would likely range from temporary to short term (see Table 4.4-2).

Exploration wells drilled prior to March 5, 1984, might not necessarily meet the assumption of proper abandonment used for discussion of direct and indirect impacts. However, it is assumed that the pre-1984, pre-regulation wells represent a negligible impact because 1) the typical borehole is 6 inches in diameter, whereas mine openings can be 150 feet or more in diameter, so that if the well encountered ore, the surface area available for dissolving minerals is limited; 2) the mineral deposits typically encountered by exploration drilling would be much less disturbed than exposed mineralized deposits inside the mine, which would also limit the surface area available for dissolving minerals; and 3) wells drilled prior to 1984 were typically drilled using low-permeability bentonite clays as a drilling fluid additive, which would be expected to provide a seal. Duration of the negligible impact would likely range from temporary to long term (defined in Table 4.4-2).

ADWR records indicate that, for all but one of the existing and abandoned mine water supply wells completed in the R-aquifer, the well annulus is sealed with cement at casing reduction points, thereby preventing water from moving down the wellbore via the annulus between the borehole wall and the casing. Although not sealed during operation, the Hack Canyon Complex well was abandoned by filling with cement. The Pigeon Mine well was also abandoned by filling with cement (personal communication, Roger Smith, formerly with Energy Nuclear Fuels, Inc. 2010).

Existing wells of record (see Appendix C) that are not reported to be abandoned or cancelled (not drilled) are shown in Figures 3.4-9, 3.4-11, 3.4-12, and 3.4-13. However, for the following reasons, the wells shown may not be an accurate representation of all water wells in each parcel that could be subject to impact:

1. Errors in well registration may have resulted in some records that do not clearly report status or well type (i.e., some wells may not actually be water wells, or may have never been drilled, or may have been abandoned).
2. Some “pre-code wells” (wells drilled prior to establishment of the Arizona Groundwater Code) may have never been registered and are not in the ADWR databases.
3. Some wells may be damaged or have malfunctioning pump equipment that cannot be removed, thereby rendering the wells unusable.
4. Some wells may be dry.

Chemical Quality of Perched Aquifer Springs and Wells

In some mineralized breccia pipes, ore targeted for mining may occur in or above perched groundwater zones, as well as below. In these cases, there might be the potential for mining operations to impact the chemical quality of the perched groundwater by causing oxidation and mobilization of chemical constituents in exposed residual ore and waste rock remaining in the mine after reclamation. The inward dip of bedding in rock units adjacent to the breccia pipes is thought to induce local inward flow of perched groundwater toward the pipe. If the perching layer is re-established during mine reclamation, replenishment of perched groundwater in the pipe depression might occur over time, and groundwater flow paths, locally influenced by bedding orientations near the pipe, might intersect the old mine workings, where trace elements might be mobilized and transported toward points of discharge from the aquifer. Therefore, mines located within the groundwater drainage area of a nearby perched aquifer spring or well might impact the chemical quality of discharge at the spring or well.

The probability of an impact to water quality at a perched aquifer spring is considered to be the same as the probability of an impact to the quantity of water at the spring, which was discussed previously and is defined in Table 4.4-1. Accordingly, the same protective buffer areas established for quantity of discharge from the perched aquifer springs were considered suitable for protection of chemical quality of the perched springs. For the reasons described in the preceding discussion, it is not possible to reasonably calculate or locate protective buffer areas for perched aquifer wells. However, as with springs, the potential magnitude of impact to water quality at a particular perched aquifer well is considered the same as the potential magnitude of impact to water quantity at the well, as defined in Table 4.4-1.

Because the reported discharge rates are small for the perched aquifer springs located in the parcels, there is little opportunity for dilution to attenuate such impacts. Therefore, if an impact were to occur, it could be major. The same relations generally apply for perched aquifer wells. Therefore, potential impact to water quality at an individual perched aquifer spring or well can only be characterized as ranging from none to major, with duration of impact ranging from short term to long term (defined in Table 4.4-2). However, impact of an alternative on perched aquifer springs in a parcel is evaluated using the probability method described previously.

Discharge from Regional R-Aquifer Springs and Wells

SPRINGS

Although the base of typical mine openings would be more than 1,000 feet above groundwater in the regional R-aquifer system, deep groundwater supply wells would likely be constructed at many of the mine sites to provide water from the R-aquifer for mine operations. Potential yield of groundwater to wells constructed in perched aquifers is small and typically unreliable; therefore, the regional R-aquifer is the most likely source of well water for the mines, and most of the existing and historic breccia pipe uranium mines have or had these wells. Depending on well location, amount of pumping, and the magnitude of spring discharge, groundwater withdrawal from the R-aquifer could potentially reduce the discharge from R-aquifer springs. To assess these impacts, the projected mine water use given in Appendix B was compared with the discharge from R-aquifer spring systems that might be impacted. A value of 5% of the aggregate reported spring discharge was used as a threshold for impact determination because it is less than the minimum probable uncertainty in typical stream flow measurements reported by Harmel et al. (2006). This amount of decrease would also likely be less than or within the natural variation of spring flow for those springs.

WELLS

The only existing non-mine R-aquifer wells within the parcels are three wells located at Tusayan on the South Parcel (see Table 3.4-1, Figure 3.4-13). These wells provide an important source of public drinking water to the community of Tusayan. It is possible that the small population centers at Tusayan and to the south at Valle might drill additional R-aquifer production wells to meet increases in demand for public water supply. As described in Section 4.4.4, R-aquifer Wells Quantity, under Alternative A, no new non-mine R-aquifer wells are projected to be drilled on or near the North and East parcels for the 20-year period of this analysis.

The potential water level drawdown in the R-aquifer from the use of mine wells as described in Appendix B can be projected using the methods and aquifer hydraulic properties described for the computer-based groundwater flow model of the Coconino Plateau constructed by Montgomery (1999) for the Tusayan Growth EIS. Using this method, drawdown was projected for a well pumping 5 gpm continuously for 4 years.[7] Results indicate that the 5-foot water level drawdown contour could extend about 270 feet from the mine well in relatively unfractured aquifer areas and much less than 1 foot from the well in major fault zones. Although this analysis carries uncertainty, and actual drawdown could vary, depending on site-specific conditions, these results suggest that the off-mine-site drawdown caused by mine wells is expected to be small and that recovery of water levels is expected to be rapid after pumping stopped. The projected water level drawdown can be compared to the criterion used by the ADWR for acceptable well impact in Active Management Areas (AMAs). The criterion for acceptable water level drawdown impact caused by one well to a nearby well is less than 10 feet in the first 5 years of pumping. Based on the location of existing wells and the projected construction of new wells, it is not likely that mines would be located sufficiently near a non-mine R-aquifer water supply well to cause more than a negligible water level drawdown impact to the non-mine well, according to the criteria given in Table 4.4-1. Because it is anticipated that no more than six mines would be in operation at any one time (see Appendix B, Section B.8.1.8), the potential total drawdown impact to existing wells at Tusayan, Valle, or more distant areas from pumping mine wells would be expected to be negligible, according to the criteria given in Table 4.4-1. Duration of the negligible impact would likely range from short term to long term (defined in Table 4.4-2).

Chemical Quality of Regional R-Aquifer Springs and Wells

The principal mine-related constituent of concern for water quality in the parcels and surrounding regions is uranium. Other trace elements reported to be associated with uranium in mineralized breccia pipes include antimony, arsenic, barium, cadmium, cobalt, copper, lead, molybdenum, nickel, silver, strontium, vanadium, and zinc (Wenrich et al. 1994). However, not all of these constituents necessarily correlate with dissolved uranium in water. Bills et al. (2010) evaluated historic water quality data compiled for the region to identify exceedances of drinking water standards and health-based guidance levels for the following additional constituents of concern: arsenic, lead, mercury, and molybdenum. The following uranium-series decay products were identified by Hinck et al. (2010) to present a potential hazard to fish and wildlife in the area if present in the environment: uranium, thallium, thorium, bismuth, radium, radon, protactinium, polonium, actinium, and francium. Unfortunately, very few data exist for these radionuclides and metals (other than uranium and arsenic) in the study area; therefore, uranium and arsenic data must be used as a proxy for assessing potential levels of metals and decay-chain products. Hinck et al. (2010) report uranium concentration guidance values that are for protective limits for various species in the region as ranging from 2.6 to 69,000 μg/L.

[7] Aquifer hydraulic properties used from Montgomery (1999) include transmissivity ranging from 1,000 gpd/foot for relatively unfractured areas to 400,000 gpd/foot for major fault systems; storage coefficient ranging from 0.001 for relatively unfractured areas to 0.005 for major fault systems; average aquifer saturated thickness of 600 feet; and both confined and unconfined aquifer conditions.

SPRINGS

It is important to acknowledge that the travel time for some impacts to wells and springs may be longer than the time that has passed since uranium mining began in the North Parcel. It is also important to recognize that, based on the information described in Section 3.4, there is currently no conclusive evidence from well and spring sampling data that breccia pipe uranium mining operations in the North Parcel have impacted the chemical quality of groundwater in the regional R-aquifer. As described in Section 3.4, the low permeability conditions associated with ore deposits in the breccia pipes and adjacent rock strata between the base of mine openings and R-aquifer are thought to retard the downward movement of any perched groundwater drainage into the mines and, therefore, are not favorable for downward migration of dissolved minerals from the mine openings. These conditions result in low risk of impacts to the R-aquifer and support the assumption that it is entirely possible for there to be no impact to R-aquifer water quality. If an impact were to occur, the potential magnitude is addressed by the methodology and assumptions given below.

The Orphan Lode Mine, located north of the South Parcel, is the only closed and unreclaimed breccia pipe uranium mine where impacts on chemical quality of perched groundwater draining through the mine down to R-aquifer strata have been documented (Liebe 2003). This mine is located at the South Rim of the Grand Canyon, where the entire section of rock units from the Kaibab Formation to the base of the R-aquifer is exposed and subject to weathering and near-rim fracture enhancement, as discussed in Section 3.4. These conditions are not expected to occur along the shallower tributary canyons of the North Parcel, as demonstrated by conditions encountered in the Hack Canyon Complex, Kanab North, and Pigeon mines. However, such conditions might be expected along the west rim of Marble Canyon, which borders the eastern boundary of the East Parcel. In addition, the Orphan Lode Mine is located only about 0.5 mile from the location where samples collected by Liebe (2003) showed high concentrations of mine-related dissolved uranium in groundwater. Because the Liebe (2003) samples were taken so near the mine, the samples do not show the effects of dilution and attenuation from movement through the aquifer that would occur at other springs of concern. Therefore, the Liebe (2003) results are considered to represent a condition where the mine drainage has recently entered the aquifer and has not traveled far. An assessment using conservative assumptions was conducted to ascertain potential impacts if mine drainage were to reach the R-aquifer and migrate to points of natural discharge from the aquifer.

Assumptions for this assessment include the following:

- Half of the number of mines predicted for each parcel in the RFD scenarios (see Table B-49, Appendix B) would continue to drain 1 gpm through the mine for the 20-year period of this EIS analysis. Perched aquifers do not occur at all locations; therefore, it is reasonable to assume that half of the mines might encounter perched groundwater zones of an extent capable of yielding continuous flow to the mine openings, although this number could be more or less than half. A long-term continuous groundwater drainage of 1 gpm from the perched aquifer system penetrated by mine openings would exceed the conditions historically encountered in the existing and reclaimed breccia pipe mines on the North Parcel (see Section 3.4). Further, most of the perched aquifer springs that have been measured or estimated on the North, East, and South parcels discharge 1 gpm or less.
- The potential drainage from these mines could contain dissolved uranium concentrations of up to 400 µg/L (see Appendix F) when it reaches the R-aquifer, which is the highest concentration detected in water samples obtained directly below the Orphan Lode Mine (Liebe 2003). Even though the near-rim and unreclaimed conditions at the Orphan Lode Mine are not considered to be comparable to conditions at existing and historic breccia pipe uranium mines on the North Parcel, as described in Chapter 3, chemical analyses reported by Liebe (2003) are the only data available for water that moved through an unreclaimed breccia pipe uranium mine after mining operations had ceased.

- The highest concentration of dissolved uranium detected in the sump of the Hermit Mine during mining operations was 36,600 µg/L (see Appendix F); however, this value probably represents concentrations in water that has moved over fresh high-grade exposures of unmined uranium ore as well as being exposed to uranium dust in haulage tunnels and other conditions that tend to increase concentrations in an active mine. The sump water is pumped out to the evaporation pond at land surface during mining operations. After the sites are mined out and mine reclamation is complete, the waste rock and small amount of residual ore would continue to provide a lesser source of uranium and other metals if perched groundwater were to continue to move through the mine. None of the studies conducted for water quality at the R-aquifer mine wells on the North Parcel, one of which included periodic sampling data for up to 9 years after completion of mining activities (Hermit Mine well), concluded that uranium mining activities have affected the R-aquifer. Based on their 2009 water quality sampling study, which included sampling of the Pinenut and Canyon mine wells, Bills et al. (2010) concluded that relationships between the occurrence of dissolved uranium and 13 other trace elements and mining activities were few and inconclusive. Therefore, the concentrations in the Hermit Mine sump were not considered representative for post-mining drainage at mines in the proposed withdrawal area, nor would similar concentrations be expected in R-aquifer groundwater. The water samples obtained by Liebe (2003) below the Orphan Lode Mine provide the only example available of water that has been demonstrated to be affected by mine drainage (see isotope evaluation in subsection of Section 3.4 titled Legacy Impacts to Water from Uranium Mining) and that has been exposed to attenuating processes of dilution and adsorption/absorption in the fine-grained rock units between the mine openings and the R-aquifer but has likely not experienced significant attenuation and dilution during transport in the aquifer as a result of the relatively close proximity of the mine to the spring system.
- The water samples reported by Liebe (2003) were not analyzed for arsenic and cannot be used to provide a similar estimate for constituent concentrations in groundwater impacted by mine drainage. Therefore, to assess the potential impacts for arsenic, the arsenic value of 90 µg/L detected for a water sample obtained inside the Orphan Lode Mine (Hom 1986) was assumed for the potential mine drainage for this assessment.

- The potential mine drainage is not affected by attenuation or dilution in the aquifer during transport and is only modified by instantaneous mixing with the volume of water discharging at the R-aquifer spring system for the basin analyzed. This assumption would tend to provide resultant concentrations that are conservatively high; however, sufficient data are not available to characterize flow paths and dilution rates in the R-aquifer from future mines.

The indicator threshold values used for chemical quality in this impact assessment were the EPA drinking water MCLs for total dissolved uranium (30 µg/L) and arsenic (10 µg/L) (EPA 2009). The EPA has established National Primary Drinking Water Regulations that set mandatory water quality standards for drinking water contaminants. These are enforceable standards called MCLs, which are established to protect the public against consumption of drinking water contaminants that present a risk to human health. An MCL is the maximum allowable amount of a contaminant in drinking water that is delivered to the consumer. Indicator threshold values used for assessment of potential chemical and radiation toxicity impacts on aquatic and terrestrial biota, including those given in Table 6 of Hinck et al. (2010), are discussed in Section 4.7, Fish and Wildlife Resources.

An example of the methodology is given by the assessment for dissolved uranium concentrations projected for Alternative A at the Havasu Springs complex, which is the point of discharge for the

Cataract Creek groundwater basin that drains most of the South Parcel (see discussion in Section 3.4). The assumptions and calculations include the following:

1. Zero to about half (four) of the seven mines predicted for the South Parcel might contribute 1 gpm of water containing 400 µg/L of dissolved uranium to the R-aquifer. It is assumed that zero to four of these mines would occur in the Havasu Springs groundwater drainage basin. It is assumed that this contribution of impacted water would reach the Havasu Springs system undiminished, mixing instantaneously with the average discharge of 29,000 gpm.

2. The average ambient concentration of dissolved uranium is about 6 µg/L in the discharge from Havasu Springs, based on monitoring data (see Appendix F).

3. The mass flux of dissolved uranium in the hypothetical mine drainage is calculated using the following equation:

$$\Phi_{mine} = n \times C_{mine} \times Q_{mine} \times K$$

where: Φ_{mine} = uranium mass flux in mine drainage, in micrograms per minute (µg/min)

n = number of mines contributing impacted water to R-aquifer

C_{mine} = concentration of dissolved uranium in contribution of impacted water, in µg/L

Q_{mine} = rate of drainage of impacted water from mine, in gpm

K = conversion factor = 3.79 liters (L) per gallon

The example calculation would be:

Φ_{mine} = 4 mines × 400 µg/L × 1 gpm × 3.79 = 6,000 µg/min (rounded to significant digits)

4. The mass flux of dissolved uranium at Havasu Springs is calculated using the following equation:

$$\Phi_{spring} = C_{spring} \times Q_{spring} \times K$$

where: Φ_{spring} = uranium mass flux at Havasu Springs, in µg/min

C_{spring} = concentration of dissolved uranium in the spring discharge, in µg/L

Q_{spring} = discharge rate of Havasu Springs, in gpm

The example calculation would be:

Φ_{spring} = 6 µg/L × 29,000 gpm × 3.79 = 700,000 µg/min (rounded)

5. The resulting potential concentration due to the addition of mine drainage (C_{result}) of dissolved uranium at Havasu Springs is then calculated using the following equation, which divides the total mass flux ($\Phi_{spring} + \Phi_{mine}$) by the total flow rate ($Q_{spring} + [n \times Q_{mine}]$):

$$C_{result} = \frac{\Phi_{spring} + \Phi_{mine}}{(Q_{spring} + [n \times Q_{mine}]) \times K}$$

where: Φ_{spring} = uranium mass flux at Havasu Springs, in µg/min

C_{spring} = concentration of dissolved uranium in the spring discharge, in µg/L

Q_{spring} = discharge rate of Havasu Springs, in gpm

The example calculation would be:

$$C_{result} = \frac{700{,}000\ \mu g/min + 6{,}000\ \mu g/min}{(29{,}000\ gpm + [4\ mines \times 1\ gpm]) \times 3.79} = 6\ \mu g/L\ (rounded)$$

This concentration, rounded to the nearest significant digit to show level of accuracy, is equal to the ambient concentration of dissolved uranium at Havasu Springs. The assumption of zero mines contributing impacted water to the R-aquifer would produce a projected concentration of 0 µg/L contributed by mines. These concentrations would be considered to represent a range from no impact to a negligible impact, according to the criteria given in Table 4.4-1. The range of calculated mine-related contributions of 0 µg/L to the ambient level of 6 µg/L for dissolved uranium can then be compared with the following threshold values:

- EPA drinking water MCL for dissolved uranium of 30 µg/L, based on human consumption
- Examples of protective guidance values for dissolved uranium for exposed aquatic and terrestrial biota given in Table 6 of Hinck et al. (2010) include the following:
    - 457 to 6,915 µg/L — Range based on all aquatic life uses for Arizona, Colorado, New Mexico, and Utah
    - 3.5 µg/L — Arizona Water Quality Criteria for aquatic life
    - 2.6 µg/L — Chronic Tier II threshold for aquatic life
    - 7,000 µg/L — No adverse effect level wild-mammal benchmark based on drinking water for white tailed deer
    - 69,000 µg/L — Lowest adverse effect level benchmark based on drinking water for rough winged swallow

Guidance values for biota are defined, compared, and applied in the impact analysis given in Section 4.7, Fish and Wildlife Resources.

WELLS

The R-aquifer wells at Tusayan are located along the Vishnu Fault zone, which caused abundant fracturing of the R-aquifer and overlying strata. This fault zone constitutes a southwest-trending, linear, high-permeability feature in the aquifer in the South Parcel. Based on the groundwater flow modeling conducted for the Coconino Plateau by Montgomery (1999), pumping of the R-aquifer wells at Tusayan would be expected to create an elongate area oriented along the associated fault zone that would yield groundwater to the wells. This area is often referred to as the capture zone of the wells. The exact shape and extent of the capture zone is uncertain; however, based on the modeling results, the capture zone would be expected to extend a relatively short distance (estimated to be 1 to 2 miles) from the wells to the southwest along the fault. Southwest, or downgradient, of that capture zone extent, groundwater in the R-aquifer would be expected to move downgradient along various flow paths toward the Havasu Springs complex and not be captured by the Tusayan wells. If mine drainage were to occur from a breccia pipe uranium mine within this capture zone and, although it is unlikely, if the mine drainage were to reach the R-aquifer and not be mitigated, it would be possible for the mine drainage to eventually become part of the groundwater yielded to the Tusayan wells at a highly diluted concentration. The R-aquifer wells downgradient to the south in Valle likely yield groundwater that is partly from the R-aquifer beneath the South Parcel. The Valle wells could similarly yield groundwater affected by mine drainage if the conditions described above were to occur. These conditions could affect any new R-aquifer wells installed in the parcels or adjacent areas if located downgradient of or sufficiently near a breccia pipe mine and if the conditions described above were to occur. Although possible, these impacts are not considered likely because of the removal of contaminated sump water during mining, reclamation of the mines, monitoring, and the low permeability conditions that typically occur in the breccia pipe and in the hundreds of feet of intervening rock formation between the aquifer and the mine openings. Because data are insufficient to estimate the specific flow paths and dilution in the aquifer at future mines, it is not possible to quantitatively project the potential impacts to chemical quality at non-mine R-aquifer wells, if such impact were to occur. Therefore, it is assumed that the potential impact would range from none to

major. Duration of the impact would likely be long term (defined in Table 4.4-2). As described in a preceding part of Section 4.4.1 on perched aquifer wells, it is assumed that the state and federal regulations for drilling exploration wells and water wells have been and are being met; therefore, deep drilling operations are projected to represent no impact or a negligible impact to R-aquifer water quality.

Condition of Surface Waters

Except for the main stem of the Colorado River, the base flow of all streams and rivers in the Grand Canyon watershed, including the Little Colorado River, is derived from the discharge of groundwater at springs in the watershed. The Virgin River watershed near Littlefield, Arizona, also depends on discharge from springs, which, although it is unlikely, might receive a contribution of flow from R-aquifer groundwater in the North Parcel, as described in Section 3.4. Therefore, potential impacts to these receiving surface waters are indirectly related to potential impacts to the associated groundwater systems and springs. It is assumed for the purposes of this impact analysis that the impact to surface streams is equivalent to the impact on the springs supplying discharge. This assumption could lead to a conservative overestimation of impacts if a stream is fed by multiple springs that are not all impacted and because in-stream attenuation is ignored.

The quantity of surface water runoff might be affected by soil disturbance, soil compaction, loss of vegetation, and diversion or re-routing of surface water drainages at roads, exploration sites, and mine sites. Chemical quality of surface water runoff might be affected by incorporation of material eroded from mine sites into native stream sediments, as well as constituents that might be dissolved from this material. Lastly, there is the potential for increased sedimentation from increased erosion along roads and at exploration and mine sites. Major increased sedimentation in perennial and ephemeral streams could adversely affect channel morphology, stream function, and associated riparian habitats. Because potential impacts to surface water runoff and stream function are dependent on impacts to soil resources, the analysis includes an evaluation of results of Sections 3.5 and 4.5 of this EIS. Impacts to ephemeral surface water drainages were assessed generically, rather than site specifically.

Cumulative Impacts

Assumed past, present, and future activities or conditions that might contribute to cumulative impacts on groundwater and surface water dependent on groundwater include the following:

- Other drilling (for oil, gas, and/or water), fluid mineral leasing programs, and mining activities (copper mines, small-scale stone quarries, or sand and gravel operations);
- Withdrawal of groundwater for use in wildlife water projects;
- Past uranium exploration projects, as summarized in the RFD scenarios in Appendix B; and
- Past uranium mining activities at the closed Hack Canyon, Hack 1, Hack 2, Hack 3, Hermit, and Pigeon mines in the North Parcel, and the Orphan Mine near the South Parcel.

Assumed past, present, and future activities and conditions that could contribute to cumulative impacts on surface waters that receive runoff include the following:

- Fuels management and noxious weed removal programs;
- Wildlife management;
- Past wildfires and fire suppression; past livestock grazing; and past drought conditions;
- Recreation and tourism, including use, development, and maintenance of campgrounds and trails;
- Installation of roads and utilities (water and power lines);

- Development on private land, including development in response to population growth;
- Other drilling (for oil, gas, and/or water) and other mining activities (previous copper mines, small-scale stone quarries, or sand and gravel operations) and past uranium exploration projects, as summarized in the RFD scenarios; and
- Past uranium mining activities at the closed Hack Canyon, Hack 1, Hack 2, Hack 3, Hermit, and Pigeon mines in the North Parcel and at the Orphan Mine near the South Parcel.

Impacts from these activities were combined with direct and indirect impacts from the activities described in the RFD scenarios; total impacts were evaluated to determine whether the impact category listed in Table 4.4-3 might change as a result of inclusion of impacts from additional activities. If addition of the activities outlined in the RFD scenarios was not likely to be the cause of an increase in impact magnitude, the magnitude assignment was not changed.

The spatial scale of cumulative impact analysis for stream function is different from that considered for direct and indirect impacts in that the impacts may not necessarily be related solely to the locations of uranium mining activities. In fact, the overall disturbance and increased erosion impacts resulting from RFD-scenario activities would be very small, compared with such impacts from other activities. Impacts from all past and present activities or conditions and from non-uranium mining activities or conditions that are reasonably foreseeable are difficult to quantify for stream function. Therefore, descriptions established in Table 4.4-1 are not used for discussion of cumulative impacts to stream function. Instead, cumulative impacts are analyzed through comparison of the relative magnitude, in qualitative terms, of impacts resulting from reasonably foreseeable uranium-mining activities and impacts resulting from other past, present, or reasonable foreseeable activities and conditions listed in Section 4.4.1.

4.4.2 Incomplete or Unavailable Information

Incomplete and unavailable information adds to uncertainty of analyses. This uncertainty cannot be readily quantified; however, where possible and appropriate, uncertainties have been addressed by the use of best available information and conservative assumptions when projecting potential impacts. For example, incomplete or unavailable data for monitoring for perched aquifers were addressed by assuming that any uranium mine within a conservatively estimated groundwater drainage area for a perched aquifer spring could cause a major impact to the spring. Therefore, reasonable assessments were made to provide the decision-maker with an adequate basis for weighing the relative potential for impacts to water resources from each alternative. It should be emphasized that detailed, site-specific environmental analysis would be required for any new mines in the proposed withdrawal area and that the data necessary to assess the potential impacts on a case by case basis would be obtained and evaluated at that time. In addition, the ADEQ may require new Aquifer Protection Program (APP) permits for reactivation of existing mines operating under interim management plans; these permits can include measures for monitoring and environmental mitigation (for example, see ADEQ 2009d).

The data compiled for springs, streams, and wells chiefly comprise locations that have single results for measurement of spring discharge or stream flow, groundwater level measurements, or water sample analyses. Therefore, the temporal variation in these parameters has only been documented at several selected, but important, locations.

Because of the relative remoteness of areas north of the Colorado River, few quantitative data are available for springs and wells. Many perched aquifer springs and shallow wells have no data other than location, thereby limiting documentation of both spatial and temporal variation. Although remote, the parcels have historically received substantial visitation by various entities (administering agencies, American Indians, researchers, public and private interests, and recreationists), and it is unlikely that

sources of water supply used and relied on in this arid region would be missing from the records. However, it is possible that undiscovered or unreported perched aquifer springs occur and are not considered in this assessment. Ephemeral perched aquifer springs may occur only after periods of precipitation and may not be documented. Records and assumptions for relative magnitude of discharge from perched aquifer springs in and near the North and East parcels were qualitatively corroborated by site visit reports by the BLM and NPS. The amount of vegetation visible on satellite and aerial imagery was also useful for the analysis.

Direction of groundwater movement in the regional aquifer of the North and East parcels has been estimated by previous investigations; however, these estimates were based on professional judgment and knowledge of the areas, supplemented with the few measured groundwater levels in the area. Further analyses using groundwater flow models are available for groundwater movement in the South Parcel; however, these models are based in part on sparse well data, are regional in scale, and are of limited use for assessment of site-specific groundwater flow conditions. Groundwater monitoring in the deep aquifer at mine sites was limited to data from a single well at each site.

Detailed documentation of specific reclamation results for the five reclaimed mines (Hack 1, 2, and 3; Hermit; and Pigeon) on the North Parcel was either incomplete or unavailable for this analysis. General documentation was available in documents submitted to the administering agencies, and helpful details were obtained from discussions with former mine personnel (personal communication, Pat Hillard, formerly with Energy Nuclear Fuels, Inc. 2010; personal communication, Roger Smith, formerly with Energy Nuclear Fuels, Inc. 2010; personal communication, John Stubblefield, Denison 2010) and written communication with a breccia pipe expert (personal communication, Karen Wenrich, geologist and breccia pipe uranium deposit expert 2010b, 2010c). This information was then used along with other available information to address the potential for mine drainage and associated impacts. No documentation was available for reclamation of the older (pre-1980) Hack Canyon Mine.

4.4.3 Compliance with Environmental Regulations and Permitting

In accordance with current regulations, impacts to water resources resulting from mine operations are reduced and controlled by way of implementation of appropriate design features and standard operating procedures. Descriptions of measures employed to address water resource impacts were obtained from the final plan of operations for the EZ-1, EZ-2, and What mine (JBR Environmental Consultants 2010) and the APP recently issued by ADEQ for the Arizona 1 Mine (ADEQ 2009d). Active mine sites are routinely audited for compliance with their approved plans of operation and other permits. Measures to limit and control soil resource impacts are discussed in Section 4.5; these measures are also generally applicable to protection of surface water resources and will not be repeated in this section. To limit and control water resource impacts, the following practices are typically implemented:

- Nearby surface water features are identified to address any concerns regarding potential impacts that might occur to the features.
- Lined below-grade evaporation ponds are used to contain on-site runoff and mine drainage pumped from the collection sump at the bottom of the mine. These ponds are regulated by ADEQ's APP, which generally requires BADCT to minimize leakage potential by way of a double liner and automated leak detection systems. APP permits include requirements to maintain proper fluid levels in the pond at all times and a contingency to ensure that this occurs. The evaporation pond is sized to retain stormwater runoff from a 100-year, 24-hour flood event.
- Perimeter berms and diversion channels are engineered and constructed to withstand a 500-year, 24-hour flood event outside the mine site perimeter. These structures are required pursuant to

plans of operation and APP permits. The perimeter berm is intended to contain mining-generated materials and soil within the site by preventing run-on from entering the site and run-off from leaving the site. Engineering designs for these berms are based on site-specific hydrologic models. Although failure or overtopping of the berms is not reasonably foreseeable, ADEQ would require remedial action under the APP permit in the unlikely event that waste rock, ore, and/or material from the evaporation pond were released from the site.

- Engineered ore pads are constructed to contain stockpiled waste rock and ore and prevent leaching of excavated material to native surface soil during rainfall events. Waste rock/ore stockpiles are regulated by ADEQ APP requirements, which include BADCT.
- Control of mine drainage is accomplished through the following APP permit requirements: total mine shaft depth is limited; the mine shaft(s) and sump(s) are required to be continuously dewatered; and the bottom of the sumps must pass permeability requirements and not have visible fractures or other secondary porosity features or must be sealed with bentonite.
- Monitoring requirements pursuant to the APP permit are as follows: the main mine shaft sump must be monitored monthly for the first year and annually thereafter; and the evaporation pond leak detection system monitoring data must be reported on a quarterly basis.
- The APP establishes the point of compliance as a contingency measure to be installed in the event of a known release of pollutants to groundwater, which typically consists of monitor wells located downgradient of the site. If groundwater inflow to the mine does not decrease over the first 3 years of operation, a monitor well must be installed into the R-aquifer.
- Reclamation efforts include an extensive radiometric survey of the areas of operation. Any material encountered that exceeds the acceptable radiation standard for long-term exposure (10 mrem/yr) is removed from the site or buried in the mine workings before the area is graded and covered with soil. At closure, soils are required to meet ADEQ SRLs.

4.4.4 Impacts of Alternative A: No Action (No Withdrawal)

Direct and Indirect Impacts

Potential direct impacts to water resources include 1) impacts to local perched aquifers that support nearby perched aquifer springs and/or wells in or adjacent to each parcel; 2) impacts to the R-aquifer in and adjacent to each parcel and to R-aquifer springs and wells in or adjacent to each parcel; and 3) impacts to surface water resources and surface water drainage channels in or adjacent to each parcel. Potential indirect impacts to groundwater resources include impacts to R-aquifer springs and wells located outside and at a distance from each parcel. Potential indirect impacts to surface water resources and surface water drainage channels are those that are located outside and at a distance from each parcel.

GROUNDWATER

For this analysis, groundwater resources include perched aquifer springs and wells, as well as R-aquifer springs and wells. Resource condition indicators for groundwater resources are listed at the beginning of Section 4.4.1. Total number of existing and anticipated mines for Alternative A is 21 mines for the North Parcel, two mines for the East Parcel, and seven mines for the South Parcel (see Table B-14, Appendix B). Projected total water use for these mines is 221 mgal (average of 21 gpm for 20 years) for the North Parcel, 21 mgal (average of 2 gpm for 20 years) for the East Parcel, and 74 mgal (average of 7 gpm for 20 years) for the South Parcel (see Table B-14, Appendix B). The average pumping rate for each parcel is based on pumping each mine well at the rate of 5 gpm continuously for 4 years and then averaging the total groundwater pumped over the 20-year period.

Potential impacts for the four EIS alternatives, assigned by resource condition indicator, parcel, and type of impact (direct and indirect, or cumulative), are summarized in Table 4.4-3.

Perched Aquifer Springs and Wells Quantity and Quality

North Parcel Springs: Based on the potential impact area (buffer area) calculation for perched aquifer springs described in Section 4.4.1, none of the three existing mines (Kanab North, Pinenut, Arizona 1) are located within a potential impact area (see Figure 4.4-1). It is not known where the other 18 anticipated mines estimated in the RFD scenarios may be located. As described in Section 4.4.1, change in the quantity or chemical quality of the discharge from perched aquifer springs cannot be projected with the data available. Therefore, it is assumed that any mine located within the potential impact area calculated for a spring might cause an impact ranging from none to major to that spring. However, the probability that a spring might be impacted by implementation of an alternative was evaluated for each parcel using the methods and assumptions described in Section 4.4.1. Results of this evaluation are summarized in Table 4.4-4. Estimated probability of an impact to quantity or quality of discharge at a perched aquifer spring in the North Parcel is 13.2%, which is classified as a moderate impact according to the definitions given in Table 4.4-1. Duration of this impact would likely range from short term to long term (defined in Table 4.4-2).

East Parcel Springs: The sole potential mine identified for the East Parcel is House Rock. It is not known where either of the two anticipated mines estimated in the RFD scenarios may be located. There are seven perched aquifer springs mapped in the East Parcel (see Figure 4.4-2). Estimated probability of an impact to quantity or quality of discharge at a perched aquifer spring in the East Parcel is 1.3%, which is classified as a negligible impact, according to the definitions given in Table 4.4-1. Duration of this impact would likely range from short term to long term (defined in Table 4.4-2).

South Parcel Springs: The existing mine (Canyon) identified for the South Parcel is not located within the potential impact area calculated for a perched aquifer spring (Figure 4.4-3). It is not known where the other six anticipated mines estimated in the RFD scenario may be located. There is one perched aquifer spring mapped in the South Parcel (Figure 4.4-3). Estimated probability of an impact to quantity or quality of discharge at a perched aquifer spring in the South Parcel is 0.2%, which is classified as a negligible impact, according to the definitions given in Table 4.4-1. Duration of this impact would likely range from short term to long term (defined in Table 4.4-2).

Wells: Whereas the locations and characteristics of springs are defined by natural processes, the location, depth, and characteristics of water wells in the proposed withdrawal area are defined by both natural processes and human-directed processes, such as need, physical access, and regulations. Perched aquifer wells might cause mutual water level impacts on each other and on discharge from perched aquifer springs. Water quantity and water quality impacts to wells may be caused by numerous factors related to local variations in the aquifers and the design and operation of the wells. Perched aquifer wells are an important source of water for ranching operations and small industrial uses, and pumped water may also be used by wildlife. Because the perched groundwater zones are small and discontinuous, it is not possible to know their location and extent where they do not support the discharge from a spring or well. Wells can potentially be located anywhere and to any depth in the future, and data for pumping rate, aquifer hydraulic properties, and chemical quality of most wells are not available in the proposed withdrawal area. Therefore, it is not possible to reasonably calculate or locate protective buffer areas for perched aquifer wells. It is assumed that breccia pipe uranium mines, if located near perched aquifer wells, might impact both the quantity and chemical quality of discharge from the perched aquifer wells. However, it is also possible that these impacts might not occur.

Table 4.4-3. Summary of Potential Water Resources Impacts

Resource Condition Indicator	Alternative A North Parcel	Alternative A East Parcel	Alternative A South Parcel	Alternative B North Parcel	Alternative B East Parcel	Alternative B South Parcel	Alternative C North Parcel	Alternative C East Parcel	Alternative C South Parcel	Alternative D North Parcel	Alternative D East Parcel	Alternative D South Parcel
Perched Aquifer Springs												
Water Quantity and Quality	Moderate	Negligible	Negligible	Moderate	None	None	Moderate	None	None	Moderate	None	Negligible
Perched Aquifer Wells												
Water Quantity and Quality	None to Major	None to Negligible	None to Negligible	None to Negligible	None	None to Negligible	None to Moderate	None to Negligible	None to Negligible	None to Moderate	None to Negligible	None to Negligible
R-aquifer Springs												
Water Quantity	Negligible	Negligible	Negligible for Havasu and Blue Springs; None to Major for South Rim springs	Negligible	None	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible
Water Quality	None to Moderate	None to Moderate	None to Negligible for Havasu and Blue Springs; None to Major for South Rim springs	None to Moderate	None	None to Negligible	None to Moderate	None to Moderate	None to Negligible	None to Moderate	None to Moderate	None to Negligible
R-aquifer Wells												
Water Quantity	None	None	Negligible	None	None	Negligible	None	None	Negligible	None	None	Negligible
Water Quality	None	None	None to Major	None	None	None to Major	None	None	None to Major	None	None	None to Major
Surface Waters												
Water Quantity	Negligible to Moderate	Negligible to Moderate	Negligible to Major	Negligible to Moderate	None	Negligible	Negligible to Moderate	Negligible	Negligible	Negligible to Moderate	Negligible	Negligible to Moderate
Water Quality	Negligible to Moderate	Negligible to Moderate	Negligible to Major	Negligible to Moderate	None	Negligible	Negligible to Moderate	Negligible	Negligible	Negligible to Moderate	Negligible	Negligible to Moderate
Stream Function	Negligible to Moderate	Negligible to Moderate	Negligible to Moderate	Negligible to Moderate	None	Negligible	Negligible to Moderate	Negligible	Negligible	Negligible to Moderate	Negligible	Negligible to Moderate
Cumulative Impacts												
Perched Aquifer Springs	Moderate	Negligible	Negligible	Moderate	None	None	Moderate	None	None	Moderate	None	Negligible
Perched Aquifer Wells	None to Major	None to Negligible	None to Negligible	None to Negligible	None	None to Negligible	None to Moderate	None to Negligible	None to Negligible	None to Moderate	None to Negligible	None to Negligible
R-aquifer Springs	None to Moderate	None to Moderate	None to Negligible for Havasu and Blue Springs; None to Major for South Rim springs	None to Moderate	None	None to Negligible	None to Moderate	None to Moderate	None to Negligible	None to Moderate	None to Moderate	None to Negligible
R-aquifer Wells	None	None	None to Major	None	None	None to Major	None	None	None to major	None	None	None to major

Note: See Table 4.4-1 for definitions of impacts.

Table 4.4-4. Probability of Impact to Perched Aquifer Springs Quantity or Quality

Parcel	Total New Mines in Parcel[a]	Total New Mines in Non-withdrawal Area[b]	Total Perched Springs for Parcel[c]	Total of Spring Drainage Areas in Parcel[d] (square miles)	Total of Spring Drainage Areas in Non-withdrawal Area[e] (square miles)	Total Withdrawal Area of Parcel (square miles)	Total Non-withdrawal Area of Parcel (square miles)	Estimated Probability of Impact[f] (%)
Alternative A								
North	18	18	29	6.8	6.8	0	865.8	13.2
East	2	2	7	1.4	1.4	0	210.1	1.3
South	6	6	1	0.2	0.2	0	503.4	0.2
Alternative B								
North	7	0	29	6.8	0	865.8	0	5.4
East	0	0	7	1.4	0	210.1	0	0
South	0	0	1	0.2	0	503.4	0	0
Alternative C								
North	10	3	29	6.8	1.4	556.4	309.4	6.6
East	1	1	7	1.4	0	141.0	69.1	0
South	3	3	1	0.2	0	322.9	180.5	0
Alternative D								
North	17	10	29	6.8	4.1	173.7	692.1	10.9
East	1	1	7	1.4	0	87.9	122.2	0
South	4	4	1	0.2	0.2	208.2	295.2	0.3

[a] Total number of new mines anticipated for the entire parcel for each alternative, including areas proposed for withdrawal and not proposed for withdrawal.

[b] Total number of new mines anticipated outside the proposed withdrawal area for the indicated parcel. This number is the same as the total number of new mines anticipated for the entire parcel, except for Alternatives B, C, and D in the North Parcel, where seven of the new mines could be located anywhere on the parcel, regardless of the proposed withdrawal area (see Appendix B).

[c] Total number of groundwater drainage area buffers for perched aquifer springs that are within or overlap the parcel boundary; see Figures 4.4-1 through 4.4-3 for location of buffer areas around each spring.

[d] Sum of the groundwater drainage areas (estimated using the method described in Section 4.4.1) for perched aquifer springs whose buffer areas are within or overlap the parcel boundary. If any part of the buffer area for a spring overlaps the parcel boundary, the entire groundwater drainage area estimated for that spring was included in this sum and in the calculation of impact probability.

[e] Sum of the groundwater drainage areas (estimated using the method described in Section 4.4.1) for perched aquifer springs whose buffer areas are within or overlap the non-withdrawal area of the parcel. If any part of the buffer area for a spring overlaps the non-withdrawal area of a parcel, the entire groundwater drainage area estimated for that spring was included in this sum and in the calculation of impact probability.

[f] Probability (calculated using the method described in Section 4.4.1) that a new breccia pipe uranium mine would be located within the groundwater drainage area of a perched aquifer spring located in or adjacent to the parcel.

As described in Section 4.4.1, deep mineral exploration boreholes and R-aquifer water supply wells for the mines might provide potential conduits for movement of perched aquifer groundwater and mineralized groundwater drainage to the R-aquifer. AAC Title 12, Chapter 15, Article 8 requires proper construction and abandonment of wells to prevent cross-contamination of different aquifers. For the purposes of this EIS, it must be assumed that state and federal regulations have been and are being met. Therefore, because the regulations are protective of groundwater, deep drilling operations that occurred after the regulations were adopted on March 5, 1984 (ADWR 2008), are considered to represent no impact or a negligible impact to the quantity and quality of perched groundwater available to perched aquifer springs or wells. Duration of the negligible impact would likely range from temporary to short term (see Table 4.4-2). Based on the factors described in Section 4.4.1, pre-1984, pre-regulation wells represent a negligible impact to the quantity and quality of perched groundwater available to perched aquifer springs or wells. Duration of this negligible impact would likely range from temporary to long term (defined in Table 4.4-2).

The following salient conclusions can be made regarding perched aquifer wells in the parcels:

- The primary risk to existing and future perched aquifer wells from breccia pipe uranium mines on the parcels is the depletion of the small, thin, and discontinuous perched aquifer zones by groundwater drainage into mine openings.
- Because of the localized nature of perched aquifers, only perched aquifer wells that are relatively near a mine might be expected to be impacted. The perched aquifers at mineralized breccia pipes commonly contain poor quality groundwater due most commonly to the sulfide mineralization in the breccia pipes at the level of the perched groundwater above the Hermit Formation and therefore are not preferred targets for perched aquifer water supplies.
- As described in Section 4.4.1, available well records (see Appendix C) indicate that, during the past 20 years, only five non-mineral-exploration wells have been completed in perched aquifers in the North Parcel, and none have been drilled in the East and South parcels; many of the recorded wells are likely either unused or abandoned. These wells are commonly installed to supply grazing or surface mining operations; grazing activity has declined on the parcels over the past 20 years, and anticipated growth in surface mining operations is expected to be very limited. These factors, together with the permitting necessary to drill on federal lands, indicates that the number of new perched aquifer wells on the parcels will likely be none or few during the next 20 years.
- If mine reclamation or preventive measures taken during mine operations successfully re-establish the perching layer penetrated by the mine openings, the perched groundwater zone would be expected to be replenished by local recharge over time. The amount of time required for the recovery to pre-mining conditions is dependent on many factors and is uncertain, but might be on the order of several years or more. If no such reclamation or preventive measures are taken, then depletion of the perched aquifer would be expected to continue, and groundwater drainage from the aquifer would decrease until it reached equilibrium with the meager natural recharge to the local perched aquifer. Groundwater yield to impacted perched aquifer wells would diminish accordingly.

For the purposes of this EIS, potential impact to the quantity and quality of discharge from perched aquifer wells was assumed to be directly related to the anticipated number of mines for each parcel under each alternative. It was assumed that zero to half of the anticipated number of mines might be located within the perched groundwater zone that supports a well for the 20-year period of this analysis. Based on this assessment, it was assumed that this number of mines is zero to 11 for the North Parcel, zero to one for the East Parcel, and zero to four for the South Parcel. These assumptions are classified as no impact to major impact for the North Parcel and no impact to negligible impact for the East and South parcels, according to the criteria given in Table 4.4-1. Duration of these impacts would likely range from short term to long term (defined in Table 4.4-2).

R-aquifer Springs Quantity

North Parcel: Potential impact to quantity and quality of discharge from R-aquifer springs is considered both a direct and indirect impact in the North Parcel because the nearest reported R-aquifer springs (Kanab and Showerbath springs, see Figure 4.4-1) are located about 2 linear miles south of the North Parcel boundary but more than 20 miles from the more distant parts of the North Parcel groundwater system that likely flows southward. Travel time for groundwater is directly related to length of flow path. Therefore, travel time for R-aquifer groundwater from the North Parcel could range widely. The combined average groundwater demand over 20 years for all 21 mines predicted for the North Parcel is 21 gpm (see Appendix B), which is about 4.5% of the aggregate discharge of 470 gpm from Kanab and Showerbath springs (see Appendices D and F). This aggregate discharge rate is based on a single

measurement at each of these locations; therefore, average discharge is uncertain. In addition, although Kanab and Showerbath springs are distinct point locations for groundwater discharge (start of perennial flow and large volume input source, respectively), the reach between them is a gaining reach, where groundwater discharge located within the channel is composed of diffuse, rather than point, sources (personal communication, S. Rice, Grand Canyon National Park 2010). The locations and discharge from the diffuse sources along the creek are unknown. In addition, it is difficult to measure all the discharge from such diffuse systems. Therefore, the actual aggregate discharge from the R-aquifer in this reach of Kanab Creek is likely larger than the reported measurements for Kanab and Showerbath springs. Impacts, if any, from pumping of distant mine wells would likely be distributed over the diffuse spring discharge area and would be less than impacts projected using only the discharge from Kanab and Showerbath springs.

Because of groundwater divides that occur in the North Parcel, it is not likely that all of these mine wells would be located in the groundwater basin of Kanab and Showerbath springs. However, even if it is assumed that all of the projected groundwater pumping for mining under this alternative would cause a direct decrease in discharge from these springs, the decrease would likely be less than the error of measurement for commonly used stream gaging methods (Harmel et al. 2006). Potential impact, therefore, would be expected to be negligible, according to the criteria given in Table 4.4-1. Duration of this impact would likely be long term (defined in Table 4.4-2).

As described in Sections 3.4 and 4.4.1, it is unlikely that R-aquifer groundwater in the North Parcel reaches springs along the Virgin River of northwestern Arizona. However, if such a connection does occur, the contribution of flow to large spring complexes (flow about 9,000 to 22,000 gpm at the spring complex of the lower Virgin River gorge and about 10,000 gpm at the Littlefield spring complex [personal communication, Don Bills, USGS 2010b]) along the Virgin River from groundwater in the R-aquifer of the North Parcel would likely be small. If no spring flow is contributed from the North Parcel, there would be no impact. If flow is contributed, a very conservative assessment of potential impact can be made using the following assumptions. Considering the lowest of the reported aggregate spring flow rates (9,000 gpm) and even assuming that all 21 mines anticipated under Alternative A for the North Parcel would be located within the Virgin River groundwater basin (total mine pumping of 21 gpm over the 20-year period of this analysis), the maximum calculated decrease in discharge would be less than 0.5%, which is negligible and not measurable. Duration of this impact would likely be long term (defined in Table 4.4-2).

East Parcel: Similar to the North Parcel, potential impact to quantity and quality of discharge from R-aquifer springs is considered both a direct and indirect impact in the East Parcel because the nearest reported R-aquifer springs, the Fence Fault spring complex, are located within 1 mile of the parcel boundary but more than 15 miles from the more distant parts of the East Parcel, resulting in a wide range of groundwater travel times. The combined average groundwater demand over 20 years for the two mines predicted for the East Parcel is 2 gpm (see Appendix B). Groundwater discharge from the R-aquifer at the Fence Fault complex occurs at several springs on both sides of the Colorado River and in the river channel where it occurs in the R-aquifer. The average aggregate estimated discharge for only the springs on the west side of the river near South Canyon is about 3,700 gpm (see Appendices D and F). If R-aquifer discharge in the Colorado River channel could be measured, this aggregate value would likely be much larger. If it is assumed that all of the projected groundwater pumping for mining under this alternative would cause a direct decrease in discharge from these springs, the decrease would be less than 0.1% of the estimated aggregate discharge (using 3,700 gpm) and would be considered a negligible impact and not measurable (see Table 4.4-1). Duration of this impact would likely be long term (defined in Table 4.4-2).

South Parcel: The South Parcel is adjacent to Grand Canyon National Park on the north and is separated from the South Rim of Grand Canyon by a strip of NPS land ranging in width from less than 1 mile to

about 5 miles. More than 15 small to moderate-sized springs issue from the R-aquifer along the south wall of Grand Canyon north of the South Parcel and support important local ecosystems. There is disagreement among researchers about whether or not many of these springs are too poorly connected hydraulically to the R-aquifer to be significantly impacted by R-aquifer wells located several miles from the South Rim. For the purposes of this EIS, it is assumed that these springs may or may not be sufficiently connected hydraulically to the regional aquifer to be impacted if the wells are located along or north of the near-rim groundwater divide estimated for the R-aquifer by Bills et al. (2007) (see Figure 4.4-3).

The sole existing mine well (Canyon) is more than 5 miles south of this groundwater divide, in the groundwater basin that drains to the distant Havasu Springs. It is not known where the other six anticipated mines estimated in the RFD scenarios might be located; however, based on the location of other identified breccia pipes, it could be assumed that one of the mines might be located north of the groundwater divide, in the near-rim groundwater basin that drains to R-aquifer springs along the South Rim of Grand Canyon. The remaining mines could be assumed to be located several miles south of the groundwater divide in the Havasu Springs groundwater basin and/or north of the groundwater divide in the groundwater basin that drains to the large Blue Springs system along the Little Colorado River. Because of the distance from the South Parcel, potential impacts assumed for Havasu Springs and Blue Springs are considered to be indirect. The potential impacts assumed for springs along the South Rim of Grand Canyon are considered to be direct as a result of proximity.

The combined average groundwater demand over 20 years for the seven mines predicted for the South Parcel is 7 gpm (see Appendix B). Average discharge from Havasu Springs is about 29,000 gpm. Even if it is assumed that all of the projected groundwater pumping for mining under this alternative would cause a direct decrease in discharge from Havasu Springs, the decrease would be less than 0.1% and would be considered a negligible impact and not measurable, according to the criteria given in Table 4.4-1. Duration of this impact would likely be long term (defined in Table 4.4-2).

Based on the estimates given in Appendix B (see Section B.8.1.14), combined groundwater demand for six of the anticipated mines is calculated to be about 194 acre-feet over 20 years, or an average of 6 gpm. Average discharge from the nearest part of the Blue Springs complex is assumed to be about 46,000 gpm (see Figure 4.4-3). Even if it is assumed that all of the projected groundwater pumping for these six mines under this alternative would cause a direct decrease in discharge from the nearest part of the Blue Springs complex, the decrease would be less than 0.1% and would be considered a negligible impact and not measurable, according to the criteria given in Table 4.4-1. Duration of this impact would likely be long term (defined in Table 4.4-2).

Based on the estimates given in Appendix B (see Section B.8.1.14), average groundwater demand for a single mine would be 5 gpm over a 4-year period. To provide an assessment for potential impacts to springs along the south wall of the Grand Canyon, it was assumed that an R-aquifer spring having an average discharge of 5 gpm might or might not be impacted by one of the anticipated mines if located in the northern part of the parcel. Under this assumption, the decrease in discharge at this spring might range from 0% to 100% and would be considered either no impact or a major impact, respectively (see Table 4.4-1). Duration of this impact would likely be long term (defined in Table 4.4-2). If the mine were located in the groundwater basin for either the Hermit Springs complex or the Garden Springs complex (aggregate discharge for each is about 300 gpm) and would impact these springs, the decrease in aggregate discharge at one of these spring complexes would be less than 2% and would be considered a negligible impact and not measurable, according to the criteria given in Table 4.4-1. Duration of this impact would likely be long term (defined in Table 4.4-2).

It should be noted that each of the groundwater drainage areas that support the Hermit Springs and Garden Springs complexes likely extends southwestward along the associated southwest-trending fault

zones that intersect the Grand Canyon at these locations. These groundwater drainage areas may extend further southwest than indicated by the R-aquifer groundwater divide estimated by Bills et al. (2007) and shown in Figure 4.4-3.

R-aquifer Wells Quantity

As described for perched aquifer wells, R-aquifer wells may cause water level impacts on each other (mutual impacts) and on discharge from R-aquifer springs. Water quantity and water quality impacts to wells may be caused by numerous factors related to the local variations in the aquifers and the design and operation of the wells. The only existing non-mine R-aquifer wells within the parcels are three wells located at Tusayan on the South Parcel (see Table 3.4-1, Figure 3.4-13). These wells provide an important source of public drinking water to the community of Tusayan. The next nearest non-mine R-aquifer wells are two wells that provide public drinking water supply at the community of Valle, located about 10 miles south from the South Parcel. The following salient conclusions and assumptions can be made regarding R-aquifer wells in the parcel areas:

- The impact to the R-aquifer from water level drawdown related to groundwater withdrawals from mine supply wells is expected to be very small because the amount of groundwater projected to be withdrawn for mine use is very small (about 5 gpm for 4 years on average; see Appendix B). The only existing non-mine R-aquifer wells in the proposed withdrawal area are located at Tusayan on the South Parcel. Therefore, Alternative A for the South Parcel appears to carry a potential for water level drawdown impact at existing non-mine R-aquifer wells as a result of pumping at mine wells.
- The regional R-aquifer is deep, and costs for drilling, construction, and pump equipment are very high; total cost can exceed $3 million for one well. Records indicate that no non-commercial, non-industrial, non-municipal, or non-agency entities have installed R-aquifer wells on the parcels, even though the R-aquifer is recognized as the only reliable undeveloped source of groundwater in this water-short area. Although groundwater yield from the R-aquifer is prolific where fractures are abundant, interconnected, and solution-enhanced, there is significant risk that wells may not encounter these fracture zones and may be dry. Therefore, financial risk is significant for R-aquifer well construction. Based on these factors and projected demand, no new non-mine R-aquifer wells are anticipated to be drilled on or near the North and East parcels for the 20-year period of this analysis. It is assumed that demand for water supply in the Fredonia area north of the North Parcel could be met by wells in the shallower, more easily accessed groundwater system there. However, it is possible that the small population centers at Tusayan and Valle might drill additional R-aquifer production wells to meet potential increases in demand for public water supply.

As described in Section 4.4.1, results of analysis suggest that the off-mine-site drawdown caused by mine wells would be determined to be acceptable using the criterion used by ADWR for well impact in AMAs. Based on the location of existing wells and the projected construction of new wells, it is not likely that mines would be located sufficiently near a non-mine R-aquifer water supply well to cause more than a negligible water level drawdown impact to the non-mine well, according to the criteria given in Table 4.4-1. Because it is anticipated that no more than six mines would be in operation at any one time (see Appendix B, Section B.8.1.8), the potential total drawdown impact to existing wells at Tusayan, Valle, or more distant areas from pumping mine wells would be expected to be negligible, according to the criteria given in Table 4.4-1. Duration of the impact would likely range from short term to long term (defined in Table 4.4-2).

R-aquifer Springs Quality

The same assumptions used for the parcels in previous parts of the Alternative A analysis for mine locations, direct versus indirect impacts, and potentially impacted springs apply to this discussion. The following analysis applies the assessment methodology described in Section 4.4.1. Results of calculations for the R-aquifer spring water quality assessment are summarized in Table 4.4-5.

North Parcel: The following assumptions were made for this assessment:

1. Zero to half of the 21 mines (11 mines) predicted for the North Parcel are assumed to contribute 1 gpm of water containing 400 µg/L of dissolved uranium and 90 µg/L of dissolved arsenic into the R-aquifer, and this contribution of impacted water would reach the nearest R-aquifer springs undiminished (Kanab and Showerbath springs).
2. The average ambient concentration of dissolved uranium in the aggregate discharge (470 gpm) from these springs is 4.9 µg/L, and the concentration of dissolved arsenic is about 2 µg/L (see Table 4.4-5).

The resulting projected total concentration of dissolved uranium at the springs ranges from 4.9 to 11 µg/L and the projected concentration of dissolved arsenic ranges from 2 to 3 µg/L (see Table 4.4-5). The smaller value of each range equals the ambient concentration. None of these concentrations exceed the EPA MCLs for drinking water (30 µg/L for uranium; 10 µg/L for arsenic) for humans, but the larger values of each range do represent increases from ambient concentrations. These results would represent a range from no impact to moderate impact, according to the criteria given in Table 4.4-1. Duration of this impact would likely be long term (defined in Table 4.4-2). Comparisons with the threshold guidelines for biota (Hinck et al. 2010) are given in Section 4.7, Fish and Wildlife Resources.

As described previously, it is unlikely that R-aquifer groundwater in the North Parcel reaches springs along the Virgin River of northwestern Arizona, about 46 miles northwest from the boundary of the North Parcel. However, if such a connection does occur, the contribution of flow to large spring complexes (flow about 9,000 to 22,000 gpm at the spring complex of the lower Virgin River gorge and about 10,000 gpm at the Littlefield spring complex [personal communication, Don Bills, USGS 2010b]) along the Virgin River from groundwater in the R-aquifer of the North Parcel would likely be small. Further, the portion of any contribution of flow from the North Parcel that is attributable to potential drainage from breccia pipe uranium mines would be zero or exceedingly small (11 gpm total assumed for the preceding analysis). Additional factors that would likely diminish metal concentrations in any mine drainage include the large distance from the North Parcel and the long residence time of the solution in the aquifer, the geochemical characteristics of the groundwater system, which tend to remove metals from groundwater, and the ample opportunities for further dilution along the long and complex flow path that the groundwater would need to traverse to reach the Virgin River. Therefore, even if there is a contribution to the Virgin River from the R-aquifer beneath the North Parcel, the potential impact on water quality attributable to drainage from North Parcel breccia pipe uranium mines would be negligible and not measurable. Duration of any such impact would be long term (defined in Table 4.4-2).

East Parcel: The following assumptions were made for this assessment:

1. Zero to one of the two mines predicted for the East Parcel is assumed to contribute 1 gpm of water containing 400 µg/L of dissolved uranium and 90 µg/L of dissolved arsenic to the R-aquifer, and this contribution of impacted water would reach the nearest R-aquifer springs undiminished (west side Fence Fault complex in Marble Canyon).
2. The average ambient concentration of dissolved uranium in the aggregate discharge (3,700 gpm) from these springs is 1.7 µg/L, and the concentration of dissolved arsenic is about 10 µg/L (see Table 4.4-5).

Table 4.4-5. Summary of Projected Impact on R-aquifer Spring Water Quality

Parcel	Number of Mines Contributing Impacted Water[a]	Spring	Spring Flow Rate[b] (gpm)	Constituent	Ambient Concentration[c] (µg/L)	Projected Concentration[d] (µg/L)
Alternative A						
North	0–8	Kanab / Showerbath	470	Uranium	4.9	4.9–11
				Arsenic	2	2–3
East	0–1	Fence Fault complex	3,700	Uranium	1.7	1.7–1.8
				Arsenic	10[e]	10[e]
South	0–4	Havasu Springs	29,000	Uranium	6	6
				Arsenic	10[e]	10[e]
	0–4	Blue Springs	46,000	Uranium	7	7
				Arsenic	5	5
	0–1	Hermit complex	300	Uranium	3	3–4
				Arsenic	10[e]	10[e]
	0–1	Indian Garden complex	300	Uranium	3	3–5
				Arsenic	4	4
	0–1	Small South Rim spring	5	Uranium	4	4–70[e]
				Arsenic	10[e]	10[e]–30[e]
Alternative B						
North	0–5	Kanab / Showerbath	470	Uranium	4.9	4.9–9.0
				Arsenic	2	2–3
South	0–1	Havasu Springs	29,000	Uranium	6	6
				Arsenic	10[e]	10[e]
Alternative C						
North	0–6	Kanab / Showerbath	470	Uranium	4.9	4.9–9.9
				Arsenic	2	2–3
East	0–1	Fence Fault complex	3,700	Uranium	1.7	1.7–1.8
				Arsenic	10[e]	10[e]
South	0–2	Havasu Springs	29,000	Uranium	6	6
				Arsenic	10[e]	10[e]
Alternative D						
North	0–8	Kanab / Showerbath	470	Uranium	4.9	4.9–11
				Arsenic	2	2–3
East	0–1	Fence Fault complex	3,700	Uranium	1.7	1.7–1.8
				Arsenic	10[e]	10[e]
South	0–3	Havasu Springs	29,000	Uranium	6	6
				Arsenic	10[e]	10[e]

[a] Assumed number of mines that might contribute impacted water to the R-aquifer.

[b] Flow rate estimated as follows: Kanab / Showerbath is sum of both springs from Bills et al. (2010); Fence Fault complex represents sum of average spring flow listed in Appendix D for R-Aquifer springs along west bank of Colorado River in the vicinity of the Fence Fault (including Vasey's Paradise); Havasu and Blue springs are average flow rates from Appendix D; Hermit and Indian Garden complexes estimated from Montgomery (1999); Small South Rim spring is an average of spring flow data for South Rim R-aquifer springs from Appendix D, excluding Hermit, Indian Garden, and Pipe Springs.

[c] Ambient concentrations are the average of values for each spring or complex listed in Appendix F.

[d] Projected concentrations based on mass flux calculations assuming mine drainage to the R-aquifer occurs at a long-term average rate of 1 gpm, with a concentration of 400 µg/L for uranium and 90 µg/L for arsenic. It is assumed that the only attenuation of the mine drainage is dilution with the total volume of water discharging at each spring (see Section 4.4.1 for explanation of the method).

[e] Concentration equals or exceeds EPA MCL for drinking water (30 µg/L for uranium; 10 µg/L for arsenic).

The resulting projected total concentration of dissolved uranium at the springs ranges from 1.7 to1.8 µg/L, and the projected concentration of dissolved arsenic is 10 µg/L (see Table 4.4-5). The smaller uranium value and the arsenic value equal the ambient concentrations. The uranium concentrations do not exceed the EPA MCL for drinking water (30 µg/L) for humans, but the larger value does represent an increase from the ambient concentration. The ambient arsenic concentration is equal to the EPA MCL for drinking water (10 µg/L). These results would represent a range from no impact to moderate impact, according to the criteria given in Table 4.4-1. Duration of this impact would likely be long term (defined in Table 4.4-2). Comparisons with the threshold guidelines for biota (Hinck et al. 2010) are given in Section 4.7, Fish and Wildlife Resources.

As described in Chapter 3, breccia pipe mines located adjacent to deep canyon walls, which cut the low-permeability breccia and rock units between the mine openings and the R-aquifer, are subject to increased risk of enhanced fracture development, which may decrease these rocks' ability to retard the downward movement of perched groundwater that might enter the mine openings. Therefore, there is an increased risk at such mines for mine drainage that might occur to reach and impact the R-aquifer. The only area on the parcels where such conditions might occur is along the west wall of Marble Canyon, which forms the eastern boundary of the East Parcel. It is unknown whether the House Rock breccia pipe is near enough to the canyon walls to be at increased risk of these conditions (see Figure 4.4-2).

South Parcel: The following assumptions were made for this assessment:

1. Zero to half (four) of the seven mines predicted for the South Parcel are assumed to contribute 1 gpm of water containing 400 µg/L of dissolved uranium and 90 µg/L of dissolved arsenic into the R-aquifer, and this contribution of impacted water would reach the nearest downgradient R-aquifer springs undiminished. Zero to four of the mines contributing impacted water are assigned to the Havasu Springs groundwater basin, and zero to one of the mines is assigned to the Blue Springs groundwater basin and the near-rim area that supports springs along the South Rim of Grand Canyon. The discharge from these springs used in the calculations is 29,000 gpm for the Havasu Springs complex, 46,000 gpm for the nearest part of the Blue Springs complex, 5 gpm for a typical small R-aquifer spring along the South Rim, and 300 gpm spring each for Hermit and Garden springs (see Table 4.4-5).
2. The average ambient concentration of dissolved uranium is about 6 µg/L in the discharge from Havasu Springs, about 7 µg/L for Blue Springs, about 4 µg/L for a small R-aquifer spring along the South Rim, and about 3 µg/L for either Hermit or Garden springs (see Table 4.4-5).
3. The average ambient concentration of dissolved arsenic is about 10 µg/L in the discharge from Havasu Springs, about 5 µg/L for Blue Springs, about 10 µg/L for a small R-aquifer spring along the South Rim, about 10 µg/L for Hermit Springs, and about 4 µg/L for Garden Springs (see Table 4.4-5).

The resulting projected total concentration of dissolved uranium is 6 µg/L for Havasu Springs and 7 µg/L for the nearest part of Blue Springs (see Table 4.4-5). The projected concentration of dissolved arsenic is 10 µg/L for Havasu Springs and 5 µg/L for the nearest part of Blue Springs. None of these concentrations exceed the ambient levels. The ambient arsenic concentration for Havasu Springs is equal to the EPA MCL for drinking water (10 µg/L) for humans. These results would represent a range from no impact to negligible impact, according to the criteria given in Table 4.4-1. Duration of this impact would likely be long term (defined in Table 4.4-2).

The resulting projected total concentration of dissolved uranium at a typical small R-aquifer spring along the South Rim ranges from 4 to 70 µg/L (see Table 4.4-5). The projected concentration of dissolved arsenic ranges from 10 to 30 µg/L. The larger value in the projected uranium range represents an increase from ambient levels and exceeds the EPA MCL for drinking water (30 µg/L). The ambient arsenic

concentration is equal to the EPA MCL for drinking water (10 µg/L), and the larger value in the projected arsenic range represents an increase from ambient levels and exceeds the MCL. These results would represent a range from no impact to major impact, according to the criteria given in Table 4.4-1. Duration of this impact would likely be long term (defined in Table 4.4-2).

The resulting projected total concentration of dissolved uranium at the other South Rim springs ranges from 3 to 4 µg/L for Hermit Springs and ranges from 3 to 5 µg/L for Garden Springs (see Table 4.4-5). The projected concentration of dissolved arsenic is 10 µg/L for Hermit Springs and 4 µg/L for Garden Springs. The larger values in each projected uranium range represent an increase from ambient levels but do not exceed the EPA MCL for drinking water (30 µg/L). The ambient arsenic concentration for Hermit Springs is equal to the EPA MCL for drinking water (10 µg/L), but none of the projected arsenic concentrations exceed ambient levels. These results would represent a range from no impact to moderate impact, according to the criteria given in Table 4.4-1. Duration of this impact would likely be long term (defined in Table 4.4-2).

Comparisons with the threshold guidelines for biota (Hinck et al. 2010) are given in Section 4.7, Fish and Wildlife Resources.

R-aquifer Wells Quality

North Parcel: Based on the description given in Section 4.4.1 of potential impacts to R-aquifer quantity and quality, together with the description given in the present discussion for R-aquifer quantity, no R-aquifer wells are projected to occur in the North Parcel for the 20-year period of this analysis. This result would be considered to represent no impact, according to the criteria given in Table 4.4-1.

East Parcel: Similar to the North Parcel, no R-aquifer wells are projected to occur in the East Parcel for the 20-year period of this analysis. This result would be considered to represent no impact, according to the criteria given in Table 4.4-1.

South Parcel: Based on the description given in Section 4.4.1 of potential impacts to R-aquifer quantity and quality, together with the description given in the present discussion for R-aquifer quantity, it is considered unlikely but possible that water quality at R-aquifer wells at Tusayan or Valle could be impacted by anticipated mining operations in the South Parcel for the 20-year period of this analysis. This result would be considered to represent a range from no impact to major impact, according to the criteria given in Table 4.4-1. Duration of the impact would likely be long term (defined in Table 4.4-2).

SURFACE WATERS

Surface waters that could potentially be impacted by mining-related activities in the proposed withdrawal area include perennial and ephemeral stream flow, the channels that convey the flow and associated riparian habitat, and surface water retention features, such as tanks, ponds, or playas. Potential impacts include the following:

- Impacts on water quantity resulting from reduced spring discharge; diversion or re-routing of surface water drainages for installation of roads and mine sites; or changes in runoff characteristics associated with disturbed soils.
- Impacts on water quality from spring discharge affected by mine drainage or from runoff impacted by waste materials eroded at mine sites and deposited in off-site stream channels and surface water impoundments.
- Impacts on stream morphology and function from increased sedimentation following ground disturbance or altered storm runoff related to disturbed areas.

These potential impacts would be considered direct impacts for nearby surface water drainages or retention structures, such as Kanab Creek for the North Parcel, and indirect impacts for more distant surface water drainages or retention structures, such as the Colorado River at its confluence with Kanab Creek. Duration of all direct impacts to surface waters would likely range from short term to long term (defined in Table 4.4-2). Duration of all potential impacts to the Colorado River would likely range from short term to long term.

Water Quantity

The magnitude of impacts to the quantity of perennial surface water discharge for streams within the proposed withdrawal area depends on the estimated potential impact to the springs that supply base flow to individual streams. Impacts to spring water quantity range from negligible to moderate for perched aquifer springs. Perched aquifer springs would be expected to show negligible impact where the probability of a mine's being located within the groundwater drainage area of any perched aquifer spring would be less than 5% (East and South parcels; see Table 4.4-4). Moderate impacts are defined as a 5% to 20% probability of a mine's being located within the drainage areas of any perched aquifer spring (North Parcel). Mines located in the drainage area of perched aquifer springs might result in the complete dewatering of the perched aquifer by mine openings, which would dry up the spring and any portion of surface flow dependent on the affected springs. Most perennial streams in the region are supplied by spring flow from the R-aquifer.

Impacts to R-aquifer springs range from none to major. No impacts would be expected to occur where mine supply wells are installed south of the R-aquifer groundwater divide in the South Parcel; however, some larger springs along the South Rim of the Grand Canyon might have larger drainage areas that cross the estimated location of the divide and thus might be impacted. Any impact to small South Rim springs might be major. Impact to the Colorado River from reduced spring flow would not be detectable (i.e., negligible impact) because of the large volume of water typically carried by the river, which averages a minimum of about 1.6 million gpm for USGS gaging stations from Glen Canyon Dam to Diamond Creek (USGS 2010d). The maximum possible reduction in flow from all potentially impacted R-aquifer springs is equal to the total foreseeable demand from 30 mine wells, which is an average of 30 gpm for all three proposed withdrawal parcels over the 20-year period of this analysis. This flow rate is less than 0.002% of the average minimum Colorado River discharge and thus far less than the minimum probable uncertainty of 5% in typical stream flow measurements reported by Harmel et al. (2006). Because all R-aquifer springs related to the East Parcel discharge very close to the Colorado River, no perennial streams apart from the Colorado River are supported by R-aquifer springs; thus, surface water impacts related to R-aquifer spring quantity are negligible for the East Parcel. Ephemeral stream flow might be impacted by altered runoff characteristics from disturbed areas during flooding, which might result in changes in peak flow rates and total flow volume. Changes in ephemeral stream flow are likely to be generally negligible (i.e., not detectable) because of the limited areas of surface disturbance anticipated in the RFD scenarios. However, where mines are located in or adjacent to areas of steep topography, changes in ephemeral stream flow might be detectable and might extend beyond the immediate vicinity of roadways, exploration sites, and mine sites (as described in Section 4.5).

The volume of water available to surface water impoundments might be altered as a result of diversion of surface water drainage channels to accommodate mine sites and possibly roads in some areas prone to erosion. The effect might be either 1) to increase the volume if additional surface water drainage is directed to the structures or if more water is available as a result of increased runoff, or 2) to decrease the volume if surface water drainage supplying the impoundment is re-routed or increased sedimentation reduces the impoundment capacity. Additionally, impacts to wells that may supply surface impoundments for stock or wildlife use might be impacted along with the aquifer, as discussed in the previous paragraph. Overall, these impacts would be expected to be localized to areas near roads, exploration sites, and mine sites, given the design features in place to retain natural surface water drainage and to reduce and control

erosion and runoff where possible. Because of the relative scarcity of surface water impoundments in the parcels, these impacts are also unlikely to be a concern except at specific sites, and potential surface water drainage impacts would be addressed in site-specific analysis when a plan of operations is submitted.

Overall water quantity impacts to surface waters under Alternative A range from negligible to moderate for the North and East parcels and negligible to major for the South Parcel (see Table 4.4-3).

Water Quality

The magnitude of impacts to the quality of perennial surface water discharge depends on the estimated potential impact to the springs that supply base flow to individual streams. Impacts to spring water quality, and thus surface flow dependent on spring discharge, range from negligible to moderate for perched aquifer springs. Impact is defined as the probability of a mine's being located within the drainage area of any perched aquifer spring because any mine located in the groundwater drainage area of a perched aquifer spring might introduce impacted water from the mine into the small discharge associated with the spring (see Table 4.4-4). Impacts to R-aquifer springs range from negligible to major because, whereas the introduction of mine drainage would have a negligible impact (concentrations of uranium and arsenic remain at ambient levels) where spring flow is large (East and South parcels), there might be a major impact (exceedances of drinking water quality standards) where spring flow is small (South Rim springs north of South Parcel; see Table 4.4-5). Impact to the Colorado River from contaminated spring flow would be expected to be below the level of natural variation as a result of the large volume of water typically carried by the river (average minimum of 1.6 million gpm). Spencer and Wenrich (2010) projected that the change in concentration of dissolved uranium in the Colorado River in response to a hypothetical spill of 30 tons of high-grade uranium ore would be undetectable. Because all R-aquifer springs related to the East Parcel discharge very close to the Colorado River, no perennial streams apart from the Colorado River are supported by R-aquifer springs; thus, surface water impacts related to R-aquifer spring quality are negligible for the East Parcel.

Direct impacts to surface waters could occur if water bodies are located in close proximity to mine sites where impacts to soils and/or sediment could occur. Increased erosion might result in negligible increases in suspended sediment and turbidity of runoff near sites of surface disturbance or beyond a few hundred feet from disturbed areas where moderate erosion might occur. However, given that erosion of soils typically occurs only during large rainfall events, these levels of suspended sediments and turbidity would not be expected to exceed ambient levels. Impacts to soil and sediment from mine-related constituents are expected to be generally minor and to occur within close proximity to mine sites based on the impact assessment for soils provided in Section 4.5. Transport of contaminants in stormwater runoff at the mine sites is adequately controlled by perimeter berms surrounding mine sites, which are designed to retain runoff within the mine site or prevent run-on from entering the mine site.[8] Thus, the primary mechanism of contaminant dispersal outside mine perimeters is fugitive dust. Wind-deposited constituents could impact perennial streams or impounded surface waters by direct deposition. Because surface water bodies are scarce in the region, such impacts are unlikely, would be expected to occur only periodically depending on weather conditions, and would be expected to be limited in potential surface area of exposure. Direct impact to ephemeral streams by deposition of wind-transported constituents would be expected to occur where washes are located within a few hundred feet of mine sites. Such direct impacts are equivalent to the impacts to soils/sediment discussed in Section 4.5. Overall, direct impacts to surface waters from distribution of mine-related constituents would be expected to be negligible in all three parcels.

[8] The chance of a flood breaching a properly designed, constructed, and maintained berm over 20 years is about 4%, based on the following recurrence interval equation: probability = $1 - (1 - 1/T)^n$, where T is the flood recurrence interval and n is the number of years under consideration (Costa and Baker 1981).

Where distribution of uranium and arsenic in soil and sediment extends beyond the immediate vicinity of mine sites at or above the SRLs,[9] changes in the quality of ephemeral runoff might extend beyond the immediate vicinity of sites of disturbance. These moderate impacts might occur where mines are located in or adjacent to areas of steep topography or large surface water drainage channels (such as canyons). Distributed mine-related constituents could indirectly impact ephemeral surface water by dissolution of the dispersed trace elements from impacted soils and suspension of impacted clay particles in runoff; impacted runoff could mix downgradient with perennial surface water. However, there is a low probability that new mines would be located in or adjacent to areas of steep topography or canyons, based on the relatively few mines that have previously been located in such areas within the proposed withdrawal area (e.g., only the Kanab North Mine and Hack Canyon complex).

An example of water transport of mine-related contaminants from a mine site is provided by the Hack Canyon Mine complex, which consisted of four separate mines located in relatively close proximity within Hack Canyon and tributary canyons. Mineralized mine waste rock was reported to have been transported up to 1 mile downstream of the mine sites as a result of a flood that occurred at the Hack 1 Mine during operations. Review of photographs of the Hack 1 Mine suggests that the mine was not protected by a perimeter berm because of space restrictions at the site (Energy Fuels Nuclear, Inc. 1988b; Otton et al. 2010). Investigations conducted by USGS in 2009 (Otton et al. 2010) indicated that scattered fragments of mineralized waste rock were found up to 0.5 mile downstream of the mines. These fragments could have been dispersed by the 1984 flood or from floods that eroded reclaimed surfaces since mine closure. Sampling of sediments within Hack Canyon by Carver (1999) in September 1998 and May 1999 and by Otton et al. (2010) in fall 2009 indicated that average concentrations of trace elements in fine-grained sediments collected upstream of the mines were approximately equal to average concentrations downstream of the mine. Otton et al. (2010) reports that concentrations of most trace elements approach background levels within about 2 to 3 miles downstream of the mines.

From the investigation of Hack Canyon conducted by the USGS in fall 2009, Otton et al. (2010) concluded that mine-derived particulates in stream sediments are diluted by large quantities of native fine-grained sediments during flooding, thus effectively diluting the contaminants in alluvial sediments to levels indistinguishable from background levels at some distance from the source of the release. Similarly, the impact on the quality of surface water in Kanab Creek and ephemeral runoff in Hack Canyon from dispersal of trace elements adhering to fine-grained particles during fluvial transport would likely result in concentrations approximately at ambient levels because of the dilution effect of storm runoff. Carver (1999) concluded that the primary media for constituent transport is clay and fine sediment in suspension during flooding, rather than dissolved elements being carried in solution. This conclusion is supported by results of Kanab Creek water samples, which indicate little difference between average concentrations of uranium and arsenic in water samples collected at several locations along the creek from Clearwater Spring to the confluence with the Colorado River from 1982 through 1991 (Energy Fuels Nuclear, Inc. 1988c; Taylor 1996; see Appendix F, this EIS). This result was confirmed by Carver (1999) from water samples collected in Kanab Creek in September 1998 and May 1999 upstream and downstream of the mouth of Hack Canyon. Thus, although the extent of changes in the concentrations of uranium and arsenic in the runoff might extend beyond the immediate vicinity of mine sites, such changes would not be expected to result in increases above ambient levels, except possibly in localized areas where low-flow conditions are persistent in the vicinity of exposed waste rock. This condition is possible only if a release occurs during mining or erosion exposes buried mine waste after reclamation, both of which may have occurred at the Hack Canyon mines. Erosion of reclaimed areas may have also occurred at the Pigeon Mine, which was reclaimed more than 20 years ago; however, dispersion of contaminants in off-site soils and sediments from erosion of reclaimed surfaces by runoff appears to be limited in extent (Otton et al. 2010).

[9] SRLs are 200 ppm for uranium and 10 ppm for arsenic (see Section 4.5).

Overall, water quality impacts to surface waters range from negligible to moderate for the North and East parcels and negligible to major for the South Parcel (see Table 4.4-3).

Stream Function

Increased runoff might result from ground disturbance as a result of the removal of vegetation and compaction or re-routing of drainage to accommodate roads and mine-site design features. Large changes in surface stream sediment load and discharge could result in adjustment of stream gradient and/or the cross-sectional area of the active channel and/or cause changes in stream sinuosity. Such changes can result in reduced riparian habitat (e.g., shallow pools or lack of well-developed pool and riffle sequences, reduced bank-stabilizing vegetation, etc.). Such impacts to stream channels typically occur where surface water drainage basins have been subject to denudation following substantial removal of ground cover over large areas, such as that resulting from grazing, drought, and/or wildfires. The area of ground disturbance anticipated in the RFD scenarios would not be expected to encompass a large enough area to generate changes in flow rate and/or sediment loads that would result in substantial impacts on overall stream morphology or function. Although unlikely, moderate effects on stream morphology might occur in areas of steep topography, where the potential for increased erosion is greater. Such impacts might include measurable increases in sediment loads and slight adjustments in channel gradient and/or cross-sectional area. The impacts could occur downgradient of sites of activity and might extend beyond the immediate vicinity of the sites (few hundred feet) but would be expected to be localized to a relatively short distance along stream channels and could be similar in magnitude to changes resulting from seasonal storms. In general, erosion-related impacts are effectively controlled under existing regulations; therefore, the overall impact to stream function in all three parcels would be expected to be negligible but might be moderate in some locations (see Table 4.4-3).

SURFACE WATER/GROUNDWATER INTERACTION

Surface water/groundwater interaction in the parcel areas includes discharge of groundwater at springs to surface water drainages and recharge of ephemeral, intermittent, and perennial stream flow along surface water drainages. Potential impacts to groundwater that might affect surface water resources have been evaluated in previous discussions for this alternative.

Stream flow on the parcels is chiefly ephemeral and occurs only during snowmelt or stormwater runoff events. Potential for impacts to surface water resources as a result of mining operations has been evaluated in previous discussions for this alternative. Impacts to quantity of recharge water are anticipated to be negligible because significant changes in runoff and infiltration capacity would not be expected because of the relatively small total area of anticipated surface disturbance. Because of the large dilution and attenuation capacity of stormwater runoff, potential water quality impacts from recharge via infiltration through affected surface sediments would be expected to be negligible.

Cumulative Impacts

Potential cumulative impacts to groundwater resources include additional potential changes to the resource condition indicators caused by previous uranium mining-related activities and other activities listed in Section 4.4.1 in the proposed withdrawal area and general surrounding area. Previous uranium mines considered for this analysis are the five reclaimed mines (Hack Canyon 1, 2, and 3; Hermit; Pigeon) on the North Parcel and the partly reclaimed Orphan Lode Mine, located at the South Rim, north of the South Parcel. The RFD scenario describes previous exploration activities (1980–1988) as including 1,211 exploration wells in the Arizona Strip District (North and East parcels) and 900 exploration wells in the Kaibab National Forest (South Parcel). Of these, about one out of every two or three was deeper than 600 feet.

GROUNDWATER

Potential impacts to groundwater from previous uranium mines include potential declines in spring discharge or water levels in wells and introduction of mine drainage to aquifers. Potential decline in present perched aquifer spring discharge or water levels in perched aquifer wells might occur where old mines are located within the groundwater drainage area of perched aquifers; however, equilibrium conditions would be expected to have been re-established at these old mines, so further impacts are unlikely. Similarly, potential declines in regional spring discharge and water levels in R-aquifer wells from previous pumping of R-aquifer mine supply wells would likely have been negligible and would have recovered. Impact to springs from old mines might be somewhat more likely because old mines, particularly those that have not been reclaimed, might provide a continual source of mine drainage; one spring complex has been documented to have mine-related water quality impacts (Horn Spring complex in Grand Canyon National Park).

Additional potential impact to groundwater quality might be caused by previously drilled exploration wells. Exploration wells drilled prior to March 5, 1984, might not necessarily meet the assumption of proper abandonment used for discussion of direct and indirect impacts. However, because of the factors described in Section 4.4.1, it is assumed that the pre-1984, pre-regulation wells represent a negligible impact. Because of the regulations regarding drilling and abandonment for the oil and gas industry [AAC, Title 12, Chapter 7, Oil and Gas Conservation Commission], potential impact from future oil or gas wells would not be expected to contribute to cumulative impacts for the same reasons that exploration wells would not be expected to present a cumulative impact (as described in Section 4.4.1).

Potential impacts to groundwater quantity and quality from non-uranium mining activities might occur where other mines or quarries were, are, or will be established in the groundwater drainage area of perched aquifers. It is assumed that because such mines are not deep, they do not present a risk to the deeper R-aquifer, which is protected by confining layers such as the Hermit Formation. Other mines established in the groundwater drainage area of perched aquifers might impact springs and present a cumulative impact if uranium mines are also located in the perched aquifer spring groundwater drainage area. It is assumed that the magnitude of cumulative impact for individual springs would likely be no greater than the potential impact that might result from the uranium mines because either mine might result in drainage of the aquifer or exceedances of water quality standards. Cumulative impact to perched aquifer wells would be expected to be about the same as direct and indirect impacts for all parcels and across all alternatives because, as discussed in Section 4.4.1, the number of future water wells is expected to be none or few.

Non-uranium mine wells or municipal supply wells could impact the deep regional aquifer if drilled to support future operations or a growing population; however, as discussed previously, installation of additional R-aquifer supply wells is unlikely during the 20-year period of this assessment, except possibly at Tusayan or Valle (presented in Section 4.4.1 and the preceding discussion of Alternative A).

Perched Aquifer Springs

North Parcel: Only one (Pigeon Mine) of the five old uranium mines considered for cumulative impacts on the North Parcel lies within the calculated groundwater drainage area of a perched aquifer spring (Pigeon Spring). No data are available to assess current or past impacts to the spring. A water sample collected by the USGS prior to mining in 1982 showed that the total natural uranium concentration in water from Pigeon spring was 44.0 µg/L (Hopkins et al. 1984b; see Appendix F, this EIS), which exceeds the EPA drinking water standard (30 µg/L).

Other mines, specifically old copper mines located adjacent to the parcel and eight separate sand and gravel or quarry operations within the parcel, might impact perched aquifer springs. However, only two

existing sand and gravel operations and quarries are located near perched aquifer springs. It is not known whether these quarries have impacted any springs. Future shallow mines could be developed in the North Parcel, particularly for gypsum or sand and gravel. Because the impact criteria for perched aquifer springs is based on the probability of a mine's being located in the drainage area of a perched aquifer spring, the probability of this occurring from placement of future non-uranium mines or quarries might increase. This potential increase is difficult to estimate but would not be expected to change the impact category.

Perched aquifer wells might have a cumulative impact on nearby perched aquifer springs if such springs would also be impacted by either non-uranium mines or uranium mines. Review of Figure 4.4-1 indicates that approximately less than 10 shallow wells occur within the groundwater drainage areas for perched aquifer springs. Impact from perched aquifer wells would be expected to have a much smaller impact than mine openings because their use may be intermittent and the volume of water that may be produced from such wells is limited. Therefore, the cumulative impact from perched aquifer wells would not be expected to change the impact category.

Overall cumulative impacts to North Parcel perched aquifer springs would be expected to be generally moderate.

East Parcel: No previous uranium mines have been developed in the East Parcel. A few old mines may be located along the Vermilion Cliffs, and two sand and gravel and quarry operations are located in the parcel. These mines would not represent a cumulative impact to perched aquifer springs because no springs along the cliffs would be impacted by uranium-mining activities on the parcel and the two mines within the parcel are not near perched aquifer springs. Cumulative impact to East Parcel perched aquifer springs would be expected to be the same as direct and indirect impacts. The threshold criterion for potential impacts to quantity and quality of perched aquifer springs is based on the probability of a mine's being located within the drainage area of the drainage area of a perched aquifer spring, which would increase if more mines were developed in the future (see Table 4.4-1). However, based on the number of existing mines, it is unlikely that enough new mines will be developed to increase the probability of impact above 5%. There would be expected to be no cumulative impact from perched aquifer wells because there are no shallow wells within the groundwater drainage areas for perched aquifer springs (see Figure 4.4-2). Overall cumulative impacts to East Parcel perched aquifer springs would be expected to be the same as direct and indirect impacts (negligible).

South Parcel: The Orphan Lode Mine is located a few miles north of the South Parcel at the South Rim of Grand Canyon. Kolb Spring, which is a perched aquifer spring located about 1 mile southeast from the Orphan Lode Mine near the head of an adjacent surface water drainage developed along the Bright Angel Fault Zone, might be subject to impact from the mine. Given the location of the spring relative to the mine, impacts from the mine are unlikely. No perched aquifer springs are mapped in the vicinity of the Grandview Mine. Other mines in the South Parcel are located southwest and southeast of the Canyon Mine; these mines are a limestone quarry and shallow copper pit mines that are not located in the groundwater drainage areas of a perched aquifer spring, Miller Seep (see Figure 3.4-9). Thus, the impact assessment would not be expected to change from direct and indirect impacts because of the relatively small number of existing non-uranium mines and perched aquifer springs in the South Parcel. Similarly, there would be expected to be no cumulative impact from perched aquifer wells because there are no shallow wells within the groundwater drainage areas for perched aquifer springs (see Figure 4.4-3). Overall cumulative impacts to South Parcel perched aquifer springs would be expected to be the same as direct and indirect impacts (negligible).

R-aquifer Springs and Wells

North Parcel: Three R-aquifer wells were used as a water supply for the five reclaimed mines on the North Parcel. The Hermit Mine well is presently capped, with no pump, and is not used. Records indicate

the Hack Mine well and Pigeon Mine well were abandoned by filling with cement. Similarly, non-uranium mine R-aquifer wells do not exist in the North Parcel or vicinity and are not foreseen to be installed during the next 20 years. Therefore, no cumulative impacts to water quantity of the R-aquifer would be expected from R-aquifer wells because the existing wells are either abandoned or not in use. For water quality impacts, the five reclaimed mines on the North Parcel can be factored into the assessment for calculating potential impacts on the chemical quality of the nearest R-aquifer springs by increasing the total number of mines that are assumed to be contributing impacted water to the R-aquifer (see Table 4.4-5) from a range of zero to eight mines to a range of zero to 11 mines (adding half the number of reclaimed mines). Using this method, the projected concentrations in water discharging at Kanab and Showerbath springs range from 0 to 14 µg/L for uranium and from 0 to 3.6 µg/L for arsenic. These concentrations, which represent no impact to moderate impact to water quality as defined in Table 4.4-1, are the same as those for the direct and indirect impact categories given in Table 4.4-3.

East Parcel: No previous uranium mines have been developed in the East Parcel. A few old mines may be located along the Vermilion Cliffs (see Figure 3.4-9), but these mines would not represent a cumulative impact to the R-aquifer because these mines are expected to be shallow. Cumulative impact to the R-aquifer in the East Parcel would be expected to be the same as direct and indirect impacts. There would be no cumulative impact from R-aquifer wells or on R-aquifer wells because no such wells exist in the East Parcel and no non-mine R-aquifer wells are anticipated to be drilled during the next 20 years.

South Parcel: The Orphan Lode and Grandview Mines are located outside the South Parcel and on the opposite side of an R-aquifer groundwater divide from the majority of the parcel. These mines are abandoned and do not use groundwater from the R-aquifer. Therefore, no cumulative impacts to water quantity of the R-aquifer would be expected from these mines. However, there might be a potential cumulative water quality impact for the R-aquifer groundwater basins that drain north from the parcel. If an additional mine were to impact Horn Creek springs, the resultant concentrations of arsenic and uranium might be greater than those documented by Liebe (2003) at some sampling locations. Given the already high concentrations of uranium (up to 400 µg/L) and arsenic (90 µg/L) detected, the addition of new uranium mining activities would not be expected to increase the impact category at Horn Creek springs because they already show a major impact. In addition, it should be noted that it is very unlikely that any new mines would be located in the groundwater drainage area of Horn Creek because it is a small spring (reported discharge is about 0.5 gpm) that is located about 4 miles from the parcel boundary.

Two R-aquifer springs are mapped immediately to the southeast (Miner's or Page Spring) and northwest (O'Neil Spring) from the Grandview Mine (Alter et al. 2009). No data are available from O'Neil Spring; however, data collected between 1981 and 2001 at Miner's Spring indicate that the average uranium concentration is 3.6 µg/L, and the average arsenic concentration is 18.8 µg/L (see Appendix F). The uranium concentration is consistent with ambient levels for all small South Rim R-aquifer springs reported in Table 4.4-5; however, the arsenic concentration is about 9 µg/L above the average concentration for small R-aquifer springs on the South Rim. Thus, it is possible, but cannot be confirmed as a result of a lack of pre-mining data, that the Grandview Mine has impacted Miner's Spring with respect to arsenic. Since ambient levels of arsenic in Miner's Spring may currently be above drinking water standards for arsenic (10 µg/L), another mine impacting Miner's Spring would not result in a change to the potential impact category for this alternative, which already shows a potential major impact. Impact to uranium levels from mining would not be cumulative because the Grandview Mine has not impacted uranium levels. For the purpose of this analysis, it is assumed that conditions for O'Neil spring are similar to those for Miner's Spring.

The additional R-aquifer groundwater withdrawals anticipated to result from uranium mining activities (average 7 gpm over 20 years; see Table B-13) would be expected to be considerably smaller than reported in Table 3.4-1 for existing wells at Tusayan, Valle, and the Havasupai Reservation (about 350 gpm). This increase would have a negligible impact on Havasu Springs (29,000 gpm) and would not

be expected to result in more than 10 feet of decline in R-aquifer wells in the first 5 years of pumping any mine well (ADWR criteria for acceptable well impact in an AMA). New supply wells might be installed at Tusayan and Valle, or in population centers outside the study area, such as Williams (possibly linked to the Havasu Springs basin) or Flagstaff (possibly linked to the Blue Springs basin). New wells installed to support these growing population centers would represent a much larger and longer-term impact, compared with the relatively small amount of foreseen withdrawal for uranium mines; the number and location of such wells are not reasonably foreseeable. Thus, no cumulative impact is assessed for the potential future demand from population centers. Because no previous uranium mining has occurred in the South Parcel, no cumulative water quality impacts would occur. Potential cumulative impact from future uranium mining might occur in downgradient areas from the South Parcel in the Havasu Springs groundwater basin on state or private lands. Even if such off-parcel mining would equal the projected direct and indirect impacts of the South Parcel for quantity and quality of Havasu Springs, it would not change the impact category given in Table 4.4-3 from the volume of the spring complex.

Overall cumulative impacts to the R-aquifer in the South Parcel would be expected to be the same as those assigned for direct and indirect impacts.

SURFACE WATER

Perennial surface water (base flow) might be subject to additional impacts on water quantity and quality beyond direct and indirect impacts where cumulative impacts to perched aquifer and R-aquifer springs occur. Thus, cumulative impacts to perennial surface water streams are the same as those discussed for perched and R-aquifer springs. Cumulative impact to surface water quality could result if new mines are located immediately adjacent to or within areas of Hack Canyon that are currently impacted by previous mining activities at the Hack Canyon Mine complex. Such impacts would be expected to be moderate, as defined in Table 4.5-1, because impacts from the Hack Canyon mine would be expected to remain the same or decrease from conditions observed by the USGS in fall 2009 (Otton et al. 2010).

Drainages receiving ephemeral surface water runoff might be subject to additional impacts to quantity of flow, quality of flow, and stream function from moderate to major increased runoff, erosion, and subsequent sedimentation. Areas exposed to moderate to major ground disturbance and associated increased runoff might experience severe flash floods, which would be expected to be shorter in duration but much larger in magnitude than for undisturbed areas with similar vegetative and soil properties. Major increased erosion could affect water quality by raising the total suspended sediment content of stormwater runoff. Such large magnitude changes in both ephemeral discharge and sediment loads could adversely impact stream morphology, function, and associated riparian habitats in streams receiving perennial flow. Disturbance and increased soil loss related to past, present, and future activities or conditions other than those outlined in the RFD scenario are potentially several orders of magnitude larger in intensity and areal extent than impacts from activities outlined in the RFD scenario. Addition of uranium mining related activities in the RFD scenario would result in a very small contribution to the overall level of disturbance and soil loss in the proposed withdrawal area. Thus, other actions or conditions listed in Section 4.4.1, particularly past wildfires, livestock grazing, and drought, could generate moderate to major impacts to ephemeral runoff, regardless of impacts from RFD scenario–related activities. More information regarding land disturbance in the study area is presented in Section 4.5. Erosion impacts would be expected to be effectively controlled for all activities approved and reviewed by federal and state agencies with jurisdiction in the area. Similarly, former, current, and future exploration drilling sites for uranium or other minerals (including water) also would not be expected to generate severe ground disturbance; even if some disturbance occurs, it would be reclaimed following the conclusion of the project.[10]

[10] According to the RFD scenarios (see Appendix B), disturbance for exploration drilling does not include disturbance related to temporary road construction because sites for breccia pipe exploration are typically reached by overland travel.

4.4.5 Impacts of Alternative B: Proposed Action (~1 Million Acres, 20-Year Withdrawal)

Direct and Indirect Impacts

The definition of direct and indirect impacts for Alternative B is the same as described for Alternative A.

GROUNDWATER

Resource condition indicators for groundwater resources for Alternative B are the same as described for Alternative A. Total number of existing and anticipated mines for Alternative B is 10 mines for the North Parcel, no mines for the East Parcel, and 1 mine for the South Parcel (Table B-22). Projected total water use for these mines is 105 mgal (average of 10 gpm for 20 years) for the North Parcel, 0 gallons for the East Parcel, and 11 mgal (average of 1 gpm for 20 years) for the South Parcel (Table B-22). The average pumping rate for each parcel is based on pumping each mine well at the rate of 5 gpm continuously for 4 years and then averaging the total groundwater pumped over the 20-year period.

Perched Aquifer Springs and Wells Quantity and Quality

North Parcel Springs: Based on the potential impact area (buffer area) calculation for perched aquifer springs described in Section 4.4.1, none of the three existing mines (Kanab North, Pinenut, Arizona 1) are located within a potential impact area (see Figure 4.4-1). However, it is not certain where the other seven mines anticipated in Appendix B will be located. Estimated probability of an impact to quantity or quality of discharge at a perched aquifer spring in the North Parcel is 5.4% (see Table 4.4-4), which is classified as a moderate impact according to the definitions given in Table 4.4-1. Duration of this impact would likely range from short term to long term (defined in Table 4.4-2).

East Parcel Springs: No mines are included in the East Parcel for Alternative B. Thus, there is no impact projected, according to the criteria given in Table 4.4-1.

South Parcel Springs: The existing mine (Canyon) identified for the South Parcel is not located within the potential impact area calculated for the sole perched aquifer spring (see Figure 4.4-3). Thus, there is no impact projected, according to the criteria given in Table 4.4-1.

Wells: Following the analysis given for Alternative A, potential impact to the quantity and quality of discharge from perched aquifer wells was assumed to be directly related to the anticipated number of mines for each parcel. It was assumed that zero to half of the anticipated number of mines might be located within the perched groundwater zone that supports a well for the 20-year period of this analysis. Based on this assessment, it was assumed that this number of mines is zero to 5 for the North Parcel, zero for the East Parcel, and zero to one for the South Parcel. These assumptions are classified as no impact to negligible impact for the North and South parcels and no impact for the East Parcel, according to the criteria given in Table 4.4-1. Duration of these impacts would likely range from short term to long term (defined in Table 4.4-2).

R-aquifer Springs Quantity

North Parcel: Following a similar analysis to the one given for Alternative A, potential impacts to quantity of discharge from the nearest reported R-aquifer springs (Kanab and Showerbath springs, see Figure 4.4-1) is assessed as follows. The combined average groundwater demand over 20 years for the 10 mines predicted for the North Parcel is 10 gpm (see Appendix B), which is about 2.1% of the aggregate discharge of 470 gpm from Kanab and Showerbath springs (see Appendices D and F).

Therefore, even if it is assumed that all of the projected groundwater pumping for mining under this alternative would cause a direct decrease in discharge from these springs, the decrease would likely be less than the error of measurement for commonly used stream gaging methods (Harmel et al. 2006). Potential impact, therefore, would be expected to be negligible, according to the criteria given in Table 4.4-1. Duration of this impact would likely be long term (defined in Table 4.4-2). Potential impacts to the Virgin River watershed are the same as those projected for Alternative A.

East Parcel: No mines are included in the East Parcel for Alternative B. Thus, there is no impact projected, according to the criteria given in Table 4.4-1.

South Parcel: Following a similar analysis to the one given for Alternative A, the sole existing mine well (Canyon) on the South Parcel is located more than 5 miles south from the groundwater divide (see Figure 4.4-3), in the groundwater basin that drains to the distant Havasu Springs. The mine site is not located along any major fault zones. Average discharge from Havasu Springs is about 29,000 gpm. The combined average groundwater demand over 20 years for this mine is 1 gpm (see Appendix B). The projected decrease in discharge at Havasu Springs as a result of this mine water demand would be less than 0.01% and would be considered a negligible impact and not measurable, according to the criteria given in Table 4.4-1. Duration of this impact would likely be long term (defined in Table 4.4-2).

R-aquifer Wells Quantity

Following the analysis given for Alternative A, no new non-mine R-aquifer wells are projected to be drilled on or near the North and East parcels for the 20-year period of this analysis. It is possible that the small population centers at Tusayan and Valle might drill additional R-aquifer production wells to meet increases in demand for public water supply. Based on the location of existing wells and the projected construction of new wells, it is not likely that mines would be located sufficiently near a non-mine R-aquifer water supply well to cause more than a negligible water level drawdown impact to the non-mine well, according to the criteria given in Table 4.4-1. Because it is anticipated that no more than one mine would be in operation (see Appendix B, Section B.8.1.8), the potential total drawdown impact to existing wells at Tusayan, Valle, or more distant areas from pumping mine wells would be expected to be negligible, according to the criteria given in Table 4.4-1. Duration of this impact would likely range from short term to long term (defined in Table 4.4-2).

R-aquifer Springs Quality

The same assumptions used for the parcels in previous parts of the Alternative B analysis for mine locations, direct versus indirect impacts, and potentially impacted springs apply to this discussion. The following analysis applies the assessment methodology described in Section 4.4.1. Results of calculations for the R-aquifer spring water quality assessment are summarized in Table 4.4-5.

North Parcel: The following assumptions were made for this assessment:

1. Zero to half of the 10 mines (5 mines) predicted for the North Parcel are assumed to contribute 1 gpm of water containing 400 µg/L of dissolved uranium and 90 µg/L of dissolved arsenic into the R-aquifer, and this contribution of impacted water would reach the nearest R-aquifer springs undiminished (Kanab and Showerbath springs).
2. The average ambient concentration of dissolved uranium in the aggregate discharge (470 gpm) from these springs is 4.9 µg/L, and the concentration of dissolved arsenic is about 2 µg/L (see Table 4.4-5).

The resulting projected total concentration of dissolved uranium at the springs ranges from 4.9 to 9.0 µg/L, and the projected concentration of dissolved arsenic ranges from 2 to 3 µg/L (see Table 4.4-5).

The smaller value of each range equals the ambient concentration. None of these concentrations exceed the EPA MCLs for drinking water (30 µg/L for uranium; 10 µg/L for arsenic) for humans, but the larger values of each range do represent increases from the ambient concentrations. These results would represent a range from no impact to moderate impact, according to the criteria given in Table 4.4-1. Duration of this impact would likely be long term (defined in Table 4.4-2). Comparisons with the threshold guidelines for biota (Hinck et al. 2010) are given in Section 4.7, Fish and Wildlife Resources.

East Parcel: No mines are included in the East Parcel for Alternative B. Thus, there is no impact projected, according to the criteria given in Table 4.4-1.

South Parcel: The following assumptions were made for this assessment:

1. Zero to one mine predicted for the South Parcel is assumed to contribute 1 gpm of water containing 400 µg/L of dissolved uranium and 90 µg/L of dissolved arsenic into the R-aquifer, and this contribution of impacted water would reach the nearest downgradient R-aquifer springs (Havasu Springs) undiminished. The discharge used in the calculations for the Havasu Springs complex is 29,000 gpm (see Table 4.4-5).
2. The average ambient concentration of dissolved uranium is about 6 µg/L in the discharge from Havasu Springs, and the average ambient concentration of dissolved arsenic is about 10 µg/L (see Table 4.4-5).

The resulting projected total concentration of dissolved uranium for Havasu Springs is 6 µg/L, and the projected concentration of dissolved arsenic is 10 µg/L (see Table 4.4-5). None of these concentrations exceed the ambient levels. The ambient arsenic concentration for Havasu Springs is equal to the EPA MCL for drinking water (10 µg/L) for humans. These results would represent a range from no impact to negligible impact, according to the criteria given in Table 4.4-1. Duration of this impact would likely be long term (defined in Table 4.4-2). Comparisons with the threshold guidelines for biota (Hinck et al. 2010) are given in Section 4.7, Fish and Wildlife Resources.

R-aquifer Wells Quality

Following the same analysis given for Alternative A, the potential impacts and duration for Alternative B are the same as those assigned to Alternative A.

SURFACE WATERS

The nature of impacts to surface waters would be expected to be the same as described for Alternative A; however, the magnitude of the impacts would be considerably smaller because of less mineral development and the reduction or elimination of mines in Alternative B that might be located in areas with sensitive soils or in areas near springs and streams. Evaluation of the impact thresholds described in Table 4.4-1 for surface waters in the North Parcel are the same as for Alternative A because substantial mining activity is still foreseen to occur, regardless of the proposed withdrawal (see Table 4.4-3).
No impacts to surface waters would occur in the East Parcel because no uranium mining is foreseen under Alternative B. In the South Parcel, only the Canyon Mine would be developed; therefore, the only perennial stream flow under Alternative B that might be impacted is the stream below Havasu Springs; water quantity and quality impacts would be expected to be at most negligible because of the large discharge of the springs. No water quality impact to the perennial stream as a result of discharge from Havasu Springs would occur in the event that no mines contribute impacted water to the R-aquifer, as discussed for Alternative A. Impacts to ephemeral streams associated with the Canyon Mine would also be expected to be negligible because the mine site is not in an area of steep topography. Duration of all direct impacts to surface waters would likely range from short term to long term (defined in Table 4.4-2). Duration of all potential impacts to the Colorado River would likely range from short term to long term.

Cumulative Impacts

GROUNDWATER

Potential cumulative impacts to springs and wells in all three parcels would be expected to be the same as direct and indirect impacts for Alternative B because the additional impacts projected for Alternative A, which represents the maximum potential impact of all alternatives considered, would not be expected to result in a change to the impact categories (see Table 4.4-3). There would be no cumulative impact in the East Parcel under Alternative B because no uranium mines would be developed.

SURFACE WATER

Potential cumulative impacts to quality and quantity of surface waters in all three parcels would be expected to be the same as direct and indirect impacts for Alternative B because the additional impacts projected for Alternative A, which represents the maximum potential impact of all alternatives considered, would not be expected to result in a change to the impact categories (see Table 4.4-3).
The nature of potential cumulative impacts to stream function would the same as described for Alternative A; however, the magnitude would be expected to be considerably less because of less mineral development. The decrease in the magnitude of the impact would be expected to be directly proportional to the decrease in disturbed acreage provided in the RFD scenario and discussed in Section 4.5.
There would be no cumulative impact in the East Parcel under Alternative B because no uranium mines would be developed.

4.4.6 Impacts of Alternative C: Partial Withdrawal (~700,000 Acres)

Direct and Indirect Impacts

The definitions of direct and indirect impacts for Alternative C are the same as described for Alternative A.

GROUNDWATER

Resource condition indicators for groundwater resources for Alternative C are the same as described for Alternative A. Total number of existing and anticipated mines for Alternative C is 13 mines for the North Parcel, one mine for the East Parcel, and four mines for the South Parcel (see Table B-31). Projected total water use for these mines is 137 mgal (average of 13 gpm for 20 years) for the North Parcel, 11 mgal (average of 1 gpm for 20 years) for the East Parcel, and 42 mgal (average of 4 gpm for 20 years) for the South Parcel (see Table B-31). The average pumping rate for each parcel is based on pumping each mine well at the rate of 5 gpm continuously for 4 years and then averaging the total groundwater pumped over the 20-year period.

Perched Aquifer Springs and Wells Quantity and Quality

North Parcel Springs: Based on the potential impact area (buffer area) calculation for perched aquifer springs described in Section 4.4.1, none of the three existing mines (Kanab North, Pinenut, Arizona 1) are located within a potential impact area (see Figure 4.4-1). It is not known where the other 10 mines estimated in Appendix B may be located. Estimated probability of an impact to quantity or quality of discharge at a perched aquifer spring in the North Parcel is 6.6% (see Table 4.4-4), which is classified as a moderate impact, according to the definitions given in Table 4.4-1. Duration of this impact would likely range from short term to long term (defined in Table 4.4-2).

East Parcel Springs: All seven of the perched aquifer springs mapped in the East Parcel (see Figure 4.4-2) are located within the Alternative C proposed withdrawal area. Thus, there is no impact projected, according to the criteria given in Table 4.4-1.

South Parcel Springs: The existing mine (Canyon) identified for the South Parcel is not located within the potential impact area calculated for a perched aquifer spring (see Figure 4.4-3). There is one perched aquifer spring mapped in the South Parcel (see Figure 4.4-3); however, it is located within the Alternative C proposed withdrawal area. Thus, there is no impact projected, according to the criteria given in Table 4.4-1.

Wells: Following the analysis given for Alternative A, potential impact to the quantity and quality of discharge from perched aquifer wells was assumed to be directly related to the anticipated number of mines for each parcel. It was assumed that zero to half of the anticipated number of mines might be located within the perched groundwater zone that supports a well for the 20-year period of this analysis. Based on this assessment, it was assumed that this number of mines is zero to seven for the North Parcel, zero to one for the East Parcel, and zero to two for the South Parcel. These assumptions are classified as no impact to moderate impact for the North Parcel, and no impact to negligible impact for the East and South parcels, according to the criteria given in Table 4.4-1. Duration of this impact would likely range from short term to long term (defined in Table 4.4-2).

R-aquifer Springs Quantity

North Parcel: Following a similar analysis to the one given for Alternative A, potential impacts from Alternative C to quantity of discharge from the nearest reported R-aquifer springs (Kanab and Showerbath springs, see Figure 4.4-1) can be no greater than the negligible impact category assigned to Alternative A. Therefore, the impact category and duration for Alternative C are the same as those assigned to Alternatives A and B (see Table 4.4-3). Potential impacts to the Virgin River watershed are the same as projected for Alternative A.

East Parcel: Following a similar analysis to the one given for Alternative A, potential impacts under Alternative C to quantity of discharge from the nearest reported R-aquifer springs (Fence Fault complex, see Figure 4.4-2) can be no greater than the negligible impact category assigned to Alternative A. Therefore, the impact category and duration for Alternative C are the same as those assigned to Alternative A (see Table 4.4-3).

South Parcel: Following a similar analysis to the one given for Alternative A, the sole existing mine well (Canyon) on the South Parcel is located more than 5 miles south from the groundwater divide (see Figure 4.4-3) in the groundwater basin that drains to the distant Havasu Springs. It is not known where the other three anticipated mines estimated in the RFD scenarios may be located; however, based on the location of the Alternative C proposed withdrawal boundary, the other three anticipated wells must be several miles south of the groundwater divide in the Havasu Springs groundwater basin. Therefore, potential impacts under Alternative C to quantity of discharge from the Havasu Springs complex can be no greater than the negligible impact category assigned to Alternative A for impact to these springs. Therefore, the impact category and duration for Alternative C are the same as those assigned to Alternative B (see Table 4.4-3).

R-aquifer Wells Quantity

Following the same analysis given for Alternative A, the potential impacts and duration for Alternative C are the same as those assigned to Alternatives A and B.

R-aquifer Springs Quality

The same assumptions used for the parcels in previous parts of the Alternative C analysis for mine locations, direct versus indirect impacts, and potentially impacted springs apply to this discussion. The following analysis applies the assessment methodology described in Section 4.4.1. Results of calculations for the R-aquifer spring water quality assessment are summarized in Table 4.4-5.

North Parcel: Following a similar analysis to the one given for Alternative A, potential impacts under Alternative C to quality of discharge from the nearest reported R-aquifer springs (Kanab and Showerbath springs, see Figure 4.4-1) can be no greater than the range from no impact to moderate impact assigned to Alternative A. Therefore, the impact category and duration for Alternative C are the same as those assigned to Alternatives A and B (see Table 4.4-3).

East Parcel: The assumptions, results, and assigned impact category and duration are the same for Alternative C as those described for Alternative A (see Table 4.4-3).

South Parcel: Following a similar analysis to the one given for Alternative A, all of the existing and anticipated mines in the South Parcel must be located within the Havasu Springs groundwater drainage basin. Therefore, potential impacts under Alternative C to quality of discharge from the Havasu Springs complex can be no greater than the range from no impact to negligible impact assigned to Alternative A for impact to these springs. Therefore, the impact category and duration for Alternative C are the same as those assigned to Alternative B (see Table 4.4-3).

Comparisons with the threshold guidelines for biota (Hinck et al. 2010) are given in Section 4.7, Fish and Wildlife Resources.

R-aquifer Wells Quality

Following the same analysis given for Alternative A, the potential impacts and duration for Alternative C are the same as those assigned to Alternatives A and B.

SURFACE WATERS

The nature of impacts to surface waters would be the same as described for Alternative A; however, the magnitude would be expected to be somewhat smaller because of less mineral development and the reduction or elimination of mines under Alternative C that might be located in areas with sensitive soils or in areas near springs and streams. Evaluation of the impact thresholds described in Table 4.4-1 for surface waters in the North Parcel are the same as under Alternative A because substantial mining activity is still foreseen to occur, regardless of the proposed withdrawal (see Table 4.4-3). The only perennial stream flow in or adjacent to the East Parcel is the Colorado River (see Figure 4.4-2), which would be expected to be at most negligibly impacted, as discussed under Alternative A. Similarly, the only perennial stream flow associated with the South Parcel under the Alternative C proposed withdrawal area is supported by the Havasu and Blue springs systems, which discharge large volumes of water from the R-aquifer, and thus would be expected to exhibit no more than a negligible impact. No water quality impact to these three perennial streams from the springs would occur in the event that no mines contribute impacted water to the R-aquifer, as discussed under Alternative A. Impacts to ephemeral streams in the East and South parcels would also be expected to be negligible because mines would not be expected to be located in sensitive areas. Duration of all direct impacts to surface waters would likely range from short term to long term (defined in Table 4.4-2). Duration of all potential impacts to the Colorado River would likely range from short term to long term.

Cumulative Impacts

GROUNDWATER

Potential cumulative impacts to springs and wells in all three parcels would be expected to be the same as direct and indirect impacts for Alternative C because the additional impacts projected for Alternative A, which represents the maximum potential impact of all alternatives considered, would not be expected to result in a change to the impact categories (see Table 4.4-3).

SURFACE WATER

Potential cumulative impacts to quality and quantity of surface waters in all three parcels would be expected to be the same as direct and indirect impacts for Alternative C because the additional impacts projected for Alternative A, which represents the maximum potential impact of all alternatives considered, would not be expected to result in a change to the impact categories (see Table 4.4-3).
The nature of potential cumulative impacts to stream function would the same as described for Alternative A; however, the magnitude would be expected to be somewhat less because of less mineral development. The decrease in the magnitude of the impact would be expected to be directly proportional to the decrease in disturbed acreage provided in the RFD scenario and discussed in Section 4.5.

4.4.7 Impacts of Alternative D: Partial Withdrawal (~300,000 Acres)

Direct and Indirect Impacts

The definitions of direct and indirect impacts for Alternative D are the same as those described for Alternative A.

GROUNDWATER

Resource condition indicators for groundwater resources for Alternative D are the same as those described for Alternative A. Total number of existing and anticipated mines for Alternative D is 20 mines for the North Parcel, one mine for the East Parcel, and five mines for the South Parcel (see Table B-40). Projected total water use for these mines is 210 mgal (average of 20 gpm for 20 years) for the North Parcel, 11 mgal (average of 1 gpm for 20 years) for the East Parcel, and 53 mgal (average of 5 gpm for 20 years) for the South Parcel (see Table B-40). The average pumping rate for each parcel is based on pumping each mine well at the rate of 5 gpm continuously for 4 years and then averaging the total groundwater pumped over the 20-year period.

Perched Aquifer Springs and Wells Quantity and Quality

North Parcel Springs: Based on the potential impact area (buffer area) calculation for perched aquifer springs described in Section 4.4.1, none of the three existing mines (Kanab North, Pinenut, Arizona 1) are located within a potential impact area (see Figure 4.4-1). It is not known where the other 17 mines estimated in Appendix B may be located. Estimated probability of an impact to quantity or quality of discharge at a perched aquifer spring in the North Parcel is 10.9% (see Table 4.4-4), which is classified as a moderate impact, according to the definitions given in Table 4.4-1. Duration of this impact would likely range from short term to long term (defined in Table 4.4-2).

East Parcel Springs: All seven of the perched aquifer springs mapped in the East Parcel (see Figure 4.4-2) are located within the Alternative D proposed withdrawal area. Thus, there is no impact projected, according to the criteria given in Table 4.4-1.

South Parcel Springs: The existing mine (Canyon) identified for the South Parcel is not located within the potential impact area calculated for a perched aquifer spring (see Figure 4.4-3). It is not known where the other four anticipated mines estimated in the RFD scenario may be located. There is one perched aquifer spring mapped in the South Parcel (see Figure 4.4-3). Estimated probability of an impact to quantity or quality of discharge at a perched aquifer spring in the South Parcel is 0.3%, which is classified as a negligible impact, according to the definitions given in Table 4.4-1. Duration of this impact would likely range from short term to long term (defined in Table 4.4-2).

Wells: Following the analysis given for Alternative A, potential impacts from Alternative D to the quantity and quality of discharge from perched aquifer wells were determined to be the same impact categories as were assigned for Alternative C (see Table 4.4-3).

R-aquifer Springs Quantity

North Parcel: Following a similar analysis to the one given for Alternative A, potential impacts from Alternative D to quantity of discharge from the nearest reported R-aquifer springs (Kanab and Showerbath springs, see Figure 4.4-1) can be no greater than the negligible impact category assigned to Alternative A. Therefore, the impact category and duration for Alternative D are the same as those assigned to Alternatives A, B, and C (see Table 4.4-3). Potential impacts to the Virgin River watershed are the same as projected for Alternative A.

East Parcel: Following a similar analysis to the one given for Alternative A, potential impacts from Alternative D to quantity of discharge from the nearest reported R-aquifer springs (Fence Fault complex, see Figure 4.4-2) can be no greater than the negligible impact category assigned to Alternative C. Therefore, the impact category and duration for Alternative D are the same as those assigned to Alternatives A and C (see Table 4.4-3).

South Parcel: Following a similar analysis to the one given for Alternative A, potential impacts from Alternative D to quantity of discharge from the Havasu Springs complex can be no greater than the negligible impact category assigned to Alternative A for impact to these springs. Therefore, the impact category and duration for Alternative D are the same as those assigned to Alternatives A, B, and C (see Table 4.4-3).

R-aquifer Wells Quantity

Following the same analysis given for Alternative A, the potential impacts for Alternative D are the same as those assigned to Alternatives A, B, and C (see Table 4.4-3).

R-aquifer Springs Quality

The same assumptions used for the parcels in previous parts of the Alternative D analysis for mine locations, direct versus indirect impacts, and potentially impacted springs apply to this discussion. The following analysis applies the assessment methodology described in Section 4.4.1. Results of calculations for the R-aquifer spring water quality assessment are summarized in Table 4.4-5.

North Parcel: Following a similar analysis to the one given for Alternative A, potential impacts from Alternative D to quality of discharge from the nearest reported R-aquifer springs (Kanab and Showerbath springs, see Figure 4.4-1) can be no greater than the range from no impact to moderate impact assigned to

Alternative A. Therefore, the impact category for Alternative D is the same as was assigned to Alternatives A, B, and C (see Table 4.4-3).

East Parcel: The assumptions, results, and assigned impact category were the same for Alternative D as were described for Alternatives A and C (see Table 4.4-3).

South Parcel: Following a similar analysis to the one given for Alternative A, all of the existing and anticipated mines in the South Parcel must be located within the Havasu Springs groundwater drainage basin. Therefore, potential impacts from Alternative D to quality of discharge from the Havasu Springs complex can be no greater than the range from no impact to negligible impact assigned to Alternative A for impact to these springs. Therefore, the impact category for Alternative D is the same as was assigned to Alternatives B and C (see Table 4.4-3).

Comparisons with the threshold guidelines for biota (Hinck et al. 2010) are given in Section 4.7, Fish and Wildlife Resources.

R-aquifer Wells Quality

Following the same analysis given for Alternative A, the potential impacts for Alternative D are the same as were assigned to Alternatives A, B, and C.

SURFACE WATERS

The nature of impacts to surface waters would be the same as described for Alternative A; however, the magnitude would be expected to be slightly smaller because of less mineral development and the reduction or elimination of mines under Alternative D that might be located in areas with sensitive soils or in areas near springs and streams. Evaluation of the impact thresholds described in Table 4.4-1 for surface waters in the North Parcel is the same as under Alternative A because substantial mining activity is still foreseen to occur, regardless of the proposed withdrawal (see Table 4.4-3). As under Alternatives B and C, the only perennial streams associated the East and South parcels are the Colorado River and streams supported by the Havasu and Blue springs systems; these streams would be expected to exhibit no more than a negligible impact. Impacts to ephemeral streams in the East Parcel would also be expected to be negligible because mines would not be expected to be located in sensitive areas. However, compared with the proposed withdrawal under Alternative C, more areas of steep topography, such as the Red Butte area and various drainage channels identified with a high erosion risk, are open to mineral development in the South Parcel (as discussed in the direct and indirect impact analysis for soil resources in Section 4.5). Given this and the larger number of mines foreseen under Alternative D in the South Parcel (five), mines might be located in one of these sensitive areas. Duration of all direct impacts to surface waters would likely range from short term to long term (defined in Table 4.4-2). Duration of all potential impacts to the Colorado River would likely range from short term to long term.

Cumulative Impacts

GROUNDWATER

Potential cumulative impacts to springs and wells in all three parcels would be expected to be the same as direct and indirect impacts for Alternative D because the additional impacts projected for Alternative A, which represents the maximum potential impact of all alternatives considered, would not be expected to result in a change to the impact categories (see Table 4.4-3).

SURFACE WATER

Potential cumulative impacts to quality and quantity of surface waters in all three parcels would be expected to be the same as direct and indirect impacts for Alternative D because the additional impacts projected for Alternative A, which represents the maximum potential impact of all alternatives considered, would not be expected to result in a change to the impact categories (see Table 4.4-3). The nature of potential cumulative impacts to stream function would the same as described for Alternative A; however, the magnitude would be expected to be slightly less because of less mineral development. The decrease in the magnitude of the impact would be expected to be directly proportional to the decrease in disturbed acreage provided in the RFD scenario and discussed in Section 4.5.

4.5 SOIL RESOURCES

Soil resources are an important component of the environment that provides a growth medium to support vegetation for wildlife habitat and forage for cattle. Properly maintained soils also have a direct relationship to overall watershed function by regulating sedimentation and the infiltration and storage of precipitation (runoff control). This section evaluates impacts to soil resources that would be caused by the construction, operation, and maintenance of exploration sites, uranium mine facilities, and associated infrastructure within the three proposed withdrawal parcels. A profile of impacts on soil resources was developed based on NRCS soil survey and TES data, site investigations, review of existing literature, and information provided by the BLM, Forest Service, and other agencies. The magnitude of soil impacts was determined through consideration of topography, soil types, foreseeable future mine development for each proposed withdrawal parcel, and a review of environmental assessment results of existing mine sites in the North Parcel. The largest impacts are removal of vegetation and changes in soil physical properties, such as soil compaction, resulting from disturbance of the land surface, potential increased soil erosion, and potential degradation of soil chemical quality by way of the release of contaminants during mining operations. In general, the degree of impact to soil resources under each alternative is related to the anticipated number of exploration boreholes, roads, and power lines and the total number of anticipated mines because the total disturbed acreage and the degree of potential exposure to the environment of mine waste rock and ore depend on the magnitude of mining-related activities. The magnitude, extent, and duration of impacts to soil resources for specific exploration or mining development depend on the amount of disturbed surface area exposed to water and wind, soil types affected, topography of the area, methods of mine and road construction employed, duration of exploration or mining operations, and success of reclamation efforts at each area of operation.

4.5.1 Impact Assessment Methodology and Assumptions

Condition indicator criteria used to evaluate the type and magnitude of soil-related impacts relative to the different proposed withdrawal parcels and alternatives are as follows:

- **Soil Disturbance.** Soils to be disturbed for installation of mine facilities, drill sites, access roads, and power lines would be adversely impacted because disturbed areas may be difficult to re-establish, which could result in a loss of productivity. The indicator values are the anticipated acreage (area) of disturbed soils.
- **Soil Erosion.** Removal of vegetation, soil compaction, and changes in drainage patterns related to anticipated surface disturbance could result in increased runoff and generation of fugitive dust, which contribute to soil loss and loss of productivity. Increased erosion might generate increased sedimentation in downstream areas. The indicators are qualitative evaluations of potential increased erosion rates relative to undisturbed conditions and the estimated extent of the impact, as modified by soil properties and topography.

- **Soil Contamination.** Potential distribution of contaminants in soil could result from erosion and subsequent deposition of mine waste-rock or ore from water and/or wind action, or leakage from detention ponds in the vicinity of each mine site. Indicators are expected levels of mine-related contaminants in soil, compared with background levels and SRLs.

A qualitative approach was used to assess the potential impact of existing mines and additional anticipated mining activities as outlined in Appendix B, Locatable Mineral Resources—Reasonably Foreseeable Development Scenarios; each condition indicator criterion was evaluated in terms of the estimated or potential magnitude or intensity and extent of the impact. Impacts from surface disturbance are most easily measured because the disturbance itself is the impact. However, accelerated erosion that results in actual soil loss or distribution of contaminants in soil is difficult to assess because such impacts depend on site-specific conditions and effectiveness of design features implemented to control impacts to soil. Thus, these impacts are discussed in terms of potential or likely effects, based on available information from past and current mining activities in the proposed withdrawal parcels.

Direct impacts were considered to be only those impacts occurring during mine development and operations within the boundaries of mining-related work sites and associated infrastructure. Indirect impacts were considered to be impacts occurring off-site or residual impacts occurring after reclamation. Past, current, and future actions or conditions occurring in the parcels were reviewed to assess the potential cumulative impact that might result when impacts from these actions overlap with impacts from mining-related activities outlined in the RFD scenarios. Impacts were analyzed within the boundaries of the three proposed withdrawal parcels only. Based on studies of 1980s-era mining in the North Parcel, it is unlikely that impacts to soil resources would extend beyond the boundaries of the parcels because of mine site features designed to control soil impacts, unless a specific mine is located very close to an area with steep topography or within or near drainage channels.

Impact assessment categories are defined as follows: potential durations of impacts to soil resources are the same as defined in Table 4.1-2. Durations of impacts are analyzed separately from the intensity and extent of impacts.

Table 4.5-3 is a summary of the outcomes for evaluation of soil impact criteria across all three proposed withdrawal parcels and alternatives under consideration.

Table 4.5-1. Magnitude and Degrees of Effects on Soil Resources

Attribute of Effect	Description Relative to Soil Resources
No Impact*	No changes in baseline soil resource conditions would occur. No acreage would be disturbed. Soil erosion would be at the regional baseline soil loss rate. Levels of contaminants in soil would be expected to be at background levels.
Minor	Changes in baseline soil resource conditions would be expected to be small in magnitude and limited in areal extent. Anticipated soil disturbance in each proposed withdrawal parcel would be less than 1% of the parcel area[b]. Increased erosion and sedimentation would be expected to be limited to the immediate vicinity[c] of roadways, power lines, drill sites, and mine sites. Concentrations of uranium and arsenic in soil would be expected to be at or above regional background levels off site, but generally at or below applicable[d] remediation standards; exceedance of standards would be expected to be limited to the immediate vicinity of mine sites.
Moderate	Changes in baseline soil resource conditions would be expected to be moderate in magnitude and areal extent. Anticipated soil disturbance in each proposed withdrawal parcel would be between 1% and 2% of the parcel area. Increased erosion and sedimentation might extend beyond the immediate vicinity of roadways, power lines, drill sites, and mine sites. Rates of erosion might be greater than that described for minor impact because of the presence of steep topography or sensitive soils. Concentrations of uranium and arsenic in soil might be generally at or above applicable remediation standards off site; such concentrations might extend beyond the immediate vicinity of mine sites.

Table 4.5-1. Magnitude and Degrees of Effects on Soil Resources (Continued)

Attribute of Effect	Description Relative to Soil Resources
Major	Changes in baseline soil resource conditions would be expected to be large in magnitude and distributed over a wide area. Anticipated soil disturbance in each proposed withdrawal parcel would be greater than 2% of the parcel area. Increased erosion and sedimentation might extend well beyond the immediate vicinity[e] of roadways, power lines, drill sites, and mine sites; impacts might reach adjacent basins. Concentrations of uranium and arsenic in soil might be generally above applicable remediation standards off site; such concentrations might extend beyond the immediate vicinity of mine sites.

* Applicable when no mining is anticipated to occur in the RFD scenario.

[†] Numeric thresholds for disturbance define the magnitude of the impact and do not imply a level of significance for disturbance-related impacts. Refer to direct and indirect impact analysis for discussion regarding magnitude of soil disturbance.

[‡] Increased erosion could vary from a few feet to several hundred feet from disturbed areas. Based on results of Otton et al. (2010), concentrations of uranium and arsenic in soil typically approach background levels or remedial standards at a distance of about 500 feet or less from mine sites, except in the case of mines located within canyons or large drainages (i.e., Hack Canyon Mines) where concentrations of uranium and arsenic above SRLs and/or background levels were detected up to about 0.5 mile from the mine sites.

[§] The non-residential SRL for uranium is 200 and 10 ppm for arsenic. AAC R18-7-203 permits operators to remediate soils to either SRLs or site-specific background levels. Site-specific background soil conditions in the vicinity of mineralized breccia pipes may exceed arsenic concentrations of 10 ppm.

[e] By definition, increased erosion might range from about 0.5 mile to several miles from disturbed areas, and distribution of uranium and arsenic to levels above SRLs or background might occur from 0.5 mile to several miles from mine sites.

Table 4.5.2. Duration Definition of Effects on Soil Resources

Duration	
Temporary	Up to 1 year (periods of development and reclamation)
Short-term	1 to 5 years
Long-term	Greater than 5 years

Table 4.5-3. Summary of Potential Direct and Indirect Impacts to Soil Resources

	Soil Disturbance	Soil Erosion	Soil Contamination
Alternative A			
North Parcel	Minor	Minor to Moderate	Minor to Moderate
East Parcel	Minor	Minor to Moderate	Minor to Moderate
South Parcel	Minor	Minor to Moderate	Minor to Moderate
Alternative B			
North Parcel	Minor	Minor to Moderate	Minor to Moderate
East Parcel	None	None	None
South Parcel	Minor	Minor	Minor
Alternative C			
North Parcel	Minor	Minor to Moderate	Minor to Moderate
East Parcel	Minor	Minor	Minor
South Parcel	Minor	Minor	Minor
Alternative D			
North Parcel	Minor	Minor to Moderate	Minor to Moderate
East Parcel	Minor	Minor to Moderate	Minor
South Parcel	Minor	Minor to Moderate	Minor to Moderate

Assumptions for Impact Analysis

Assumed activities described in the RFD scenarios related to the proposed withdrawal that could result in soil disturbance and/or accelerated erosion are as follows:

- Establishment of new exploration drill sites,

- Development of new mine facilities,
- Construction of new roads, and
- Installation of new power lines.

Assumed activities described in the RFD scenarios that are related to the proposed withdrawal and could impact soil chemical quality through potential distribution of contaminants include the following:

- Operation of mines under approved plans of operation,
- Establishment of new exploration drill sites, and
- Development of new mine facilities.

Assumed past, present, and future activities and conditions that might contribute to cumulative impacts on soil resources are as follows:

- Fuels management and noxious weed removal programs;
- Past wildfires and fire suppression, past cattle grazing, and past drought conditions;
- Recreation and tourism, including use, development, and maintenance of campgrounds (South Parcel) and trails;
- Installation of roads and utilities (water and power lines);
- Development on private lands, including development in response to population growth;
- Other drilling (for oil, gas, and/or water), fluid mineral leasing programs, other mining activities (copper mines, small-scale stone quarries, or sand and gravel operations); and past uranium exploration projects, as summarized in the RFD scenarios;
- Past uranium mining activities at the Hack Canyon, Hack 1, Hack 2, Hack 3, Hermit, and Pigeon mines in the North Parcel and the Orphan Mine near the South Parcel;
- Uranium mines currently operating under approved plans of operation, which include the Kanab North, Pinenut, and Arizona 1 mines in the North Parcel and Canyon Mine in the South Parcel.

The most significant limitation to this impact analysis is that the locations of new mines expected to be developed, as described in the RFD scenarios, are not known. Some impacts and potential risks are site-specific; thus, generalization of potential impacts was required through adoption of the following assumptions:

- Although the potential for accelerated soil loss varies somewhat, depending on the type of mining-related ground disturbance, the net impacts do not vary enough to change the assigned impact category.
- Data regarding the favorability of soils to be reclaimed were not available; it was assumed that soil productivity after reclamation would not be impaired enough to change the assigned impact category.
- Data are not available to assess site-specific conditions that may enhance soil contamination impacts; therefore, potential for soil contamination is assumed to be the same for all mines.
- Data on past and current conditions regarding distribution of mine-related constituents in soil and sediment were obtained primarily from a study conducted by the USGS in fall 2009 (Otton et al. 2010). These data are assumed to be a reasonable representation of past and present conditions and reasonably foreseeable future conditions in the proposed withdrawal area. Uranium and arsenic results from this study are used to represent overall impacts from uranium-mining related contamination of soil and sediment.

4.5.2 Compliance with Environmental Regulations and Permitting

In accordance with current regulations, impacts to soil resources resulting from mine operations are reduced and controlled by way of implementation of appropriate design features and standard operating procedures. As described in plans of operation for mine sites in the North Parcel, including the Arizona 1, Hermit, Kanab North, Pinenut, and EZ-1, EZ-2, and What mine sites, measures are implemented to minimize land disturbances and conserve soil resources (Energy Fuels Nuclear, Inc. 1984, 1986, 1987, 1988a; JBR Environmental Consultants 2010). In addition, aquifer protection and air quality control permits are required by ADEQ (2009d, 2009e). Active mine sites are routinely audited for compliance with their approved plans of operation and other permits. To limit disturbance and reduce impacts during development and operation activities, the following practices are typically implemented:

- Areas of disturbance are as small as is practicable, with surface facilities, stockpile, and disposal areas clustered together.
- During construction and excavation, existing vegetation is left in place to the extent practicable, and native soils are stockpiled for later use in site reclamation.
- Natural drainage features are maintained to the extent possible, and grading is designed to maintain natural drainage as much as is practicable. Access roads are graded to follow existing topography.
- Vehicle speed is limited to 25 mph on unpaved roads, and dust suppression, typically light water spraying, is used to control fugitive dust. These requirements are typically established through an ADEQ Air Quality Control permit.
- Procedures for recovery and cleanup of materials spilled during transport are established in emergency response plans, which may be required under APP permits or may be included in plans of operation.
- Lined below-grade evaporation ponds are used to contain on-site runoff and mine drainage pumped from the collection sump at the bottom of the mine. These ponds are regulated by ADEQ's APP, which generally requires BADCT to minimize leakage potential. APP permits include requirements to maintain proper fluid levels in the pond at all times and a contingency to ensure this occurs. The evaporation pond is sized to retain stormwater runoff from a 100-year, 24-hour flood event.
- Perimeter berms and diversion channels are engineered and constructed to withstand a 500-year, 24-hour flood event outside the mine site perimeter. These structures are required pursuant to plans of operation and APP permits. The perimeter berm is intended to contain mining-generated materials and soil within the site by preventing run-on from entering the site and runoff from leaving the site. Engineering designs for these berms are based on site-specific hydrologic models. Although failure or overtopping of the berms is not reasonably foreseeable, ADEQ would require remedial action under the APP in the unlikely event that waste rock, ore, and/or material from the evaporation pond were released from the site.
- Engineered ore pads are constructed to contain stockpiled waste rock and ore and prevent leaching of excavated material to native surface soil during rainfall events. Waste rock/ore stockpiles are regulated by ADEQ APP requirements, which include BADCT. Dust suppression procedures are used to control fugitive dust from stockpiles (covering or stabilization).

At the conclusion of mining activities, areas of operation must be fully reclaimed to state and federal requirements. General reclamation measures are described in the RFD scenarios. The plan of operations for individual mines includes a reclamation plan, and the agency having jurisdiction monitors reclamation activities for compliance prior to release of the reclamation bond (see Appendix B). As described in *Plan of Operations / Reclamation Plan & Reclamation Bond Estimate for the EZ-1, EZ-2, and What Breccia Pipe Mine*, measures would be implemented to provide for complete reclamation of disturbed areas after completion of mining activities (JBR Environmental Consultants 2010). Reclamation activities are designed to allow post-mining land uses that are consistent with the surface managing agency's applicable land use plan to return lands to a level of productivity consistent with pre-mining levels.
The following reclamation activities have been typically required under plans of operation for former mine sites:

- All surface plant equipment, buildings, materials, supplies, and mobile equipment are removed.
- Sediments accumulated in evaporation ponds are excavated and removed from the site or buried in the mine workings if concentrations of metals, radon, and uranium are detected at levels above background.
- Areas of operation are re-graded to the approximate original topographic contours, and native soil or natural sediments are placed to a uniform thickness. Disturbed areas are seeded with an approved seed mixture, and the disturbed soils are ripped or disked to reduce compaction impacts.
- Areas prone to erosion are armored with erosion-resistant aggregate.
- Diversion channels would remain in place to divert surface run-off around re-seeded areas and are re-contoured after vegetation has been adequately established.
- Access roads are fully reclaimed unless agencies request they be left in place as part of the regional road system. Roads having no further use are re-contoured to pre-disturbance topography, ripped to a depth of 18 to 24 inches to loosen compacted material, and seeded.
- Reclamation efforts include an extensive radiometric survey of the areas of operation. Any material encountered that exceeds acceptable radiation standard for long-term exposure (10 mrem/yr) is removed from the site or buried in the mine workings before the area is graded and covered with soil. At closure, soils are required to meet ADEQ SRLs (Background Remediation Standards).
- Reclaimed sites are monitored on a regular basis after closure to evaluate the effectiveness of the reclamation actions and to maintain the designed features against erosion.

4.5.3 Impacts of Alternative A: No Action (No Withdrawal)

In Alternative A, mineral exploration and development would proceed under existing law, regulation, and policy. The overall impact on soil resources would be expected to range from minor to moderate in all three proposed withdrawal parcels (see Table 4.5-3). The largest amount of mining development in each of the three parcels is foreseen (30 mines), resulting in larger estimated areas of land surface disturbance (1,364 acres) and the greatest potential for distribution of contaminants in soil at multiple locations during mining operations than under other alternatives. Soil impacts would be expected to be effectively controlled under current regulatory requirements.

Direct and Indirect Impacts

SOIL DISTURBANCE

Disturbance of soils associated with development of new drill sites,[11] mine facilities, roadways, and power lines to accommodate mining activities in the proposed withdrawal parcels would be expected to result in direct impacts on soil productivity; areas in use during mining operations would effectively support little or no vegetation. Mine site perimeter berms are part of this disturbance. The anticipated area of disturbance in each proposed withdrawal parcel would be less than 0.2% of the respective total parcel areas, or 945 acres out of about 554,000 acres for the North Parcel, 107 acres out of about 134,000 acres for the East Parcel, and 312 acres out of about 332,000 acres for the South Parcel. Even if the entire anticipated disturbance occurred in one sub-basin or area, which is not likely based on locations of past uranium mines, the impact to overall soil productivity and watershed function would be small because the level of disturbance represents a very small fraction of the respective parcel areas. In addition, the magnitude of the direct impact would be somewhat less than the total anticipated disturbed area because not all the disturbance would occur at once: some areas would be reclaimed prior to disturbance related to other sites. Thus, disturbance impacts would be minor because of the small amount of relative disturbance and would generally be of short duration, about 5 years, which is the average lifespan of a mine from development through reclamation activities. However, the duration of direct impacts could be different if the any of the uncertainty factors identified in the RFD scenario are encountered; for example, if the ore body is larger or smaller than estimated, or if the operator decides to initiate a temporary closure and conduct operations under the interim management plan in the approved plan of operations. In this case, the duration of the impact could be longer or shorter than the period for these activities estimated in the RFD scenarios.

Indirect disturbance impacts are those that may remain after reclamation. If reclamation efforts are not completely effective, disturbed areas may suffer some reduction in productivity after operations cease because of compaction and other changes in soil physical properties, such as a loss of organic matter and/or developed horizons. However, based on reclamation practices under existing regulations and results of reclamation efforts at former uranium mines in the North Parcel, such as the Hermit, Pigeon, and Hack Canyon mines (for example, see Energy Fuels Nuclear, Inc. 1988a), it is expected that reclamation efforts would be generally effective in returning the soil to levels of productivity that are similar to pre-disturbance conditions. Thus, indirect impacts would be expected to be minor but might be of a long duration (more than 5 years) because it may take several growing seasons or more to re-establish full productivity.

INCREASED SOIL EROSION

The degree to which soil resources may be susceptible to increased rates of erosion from water and wind action depends on geomorphic setting, topography, climate, and the physical, chemical, and mechanical properties of the dominant soil types encountered at each site. NRCS soil survey information for BLM-managed lands described in Section 3.5 indicate that the majority of soil types identified in the North and East parcels are moderately to severely susceptible to off-road erosion and generally exhibit a moderate hazard of erosion from unsurfaced roads, which do not include overland routes to reach drill sites. Wind erodibility in the North Parcel is reported by the NRCS to be generally low to moderate (WEG[12] of 8 to 5), and wind erodibility in the East Parcel is generally moderate to severe (WEG of 4 to 1). TES data described in Section 3.5 for the South Parcel indicate that the off-road erosion hazard is slight to moderate for most soils, and the suitability of soils for unsurfaced roads (related to erosion risk) is generally

[11] According to the RFD scenarios (see Appendix B), disturbance for exploration drilling does not include disturbance related to temporary road construction because sites for breccia pipe exploration are typically reached by overland travel.

[12] See Section 3.5 for description of WEGs.

severely limited. Wind erodibility for the South Parcel has not been established but is expected to be less than the North and East parcels because of the relatively dense vegetative cover, except in areas subject to severe wildfire damage. In general, soil erosion hazards are greater where slopes are steep or depth to bedrock is shallow, which occurs in several areas of each proposed withdrawal parcel. Additional information regarding the distribution of soil erosion hazard ratings is provided in Section 3.5. For the purposes of this impact assessment, specific areas identified to be potentially sensitive to erosion hazards include the following:

- **North Parcel.** Kanab Creek and major tributary canyons, the north-central portion of the parcel, and areas adjacent to the Kaibab National Forest in the northeastern portion of the parcel.
- **East Parcel.** Tributary canyons adjacent to the Colorado River, along with the western and north-central portions of the parcel.
- **South Parcel.** The Coconino Rim, Red Butte area, and various drainage channels tributary to the Little Colorado River and Cataract Creek identified as exhibiting a high risk of erosion in the TES.

Accelerated soil loss associated with exposure of soil particles to water and wind erosion could result from surface disturbance activities such as excavation, grading, and removal of vegetation. Additional soil erosion could also occur from increased stormwater runoff resulting from a reduction in infiltration capacity associated with soil compaction or from alteration of drainage patterns related to construction of roads and mine site perimeter berms. These direct soil loss impacts could occur at work sites during construction and operation activities.

At mine sites, soil is generally not lost from water action because containment berms form site boundaries. The probability of a flood breaching a properly designed, constructed, and maintained perimeter berm over 20 years is about 4%. Some soil might be lost from the backslope of the berms (side facing away from the mine) because of water erosion; however, this condition can be controlled through proper berm maintenance. Soil loss from wind erosion is likely at mine sites because of continual exposure of the soil and sources of dust, such as vehicle travel, within the mine site; this source of erosion may be controlled through an aggressive dust control program and stabilizing exposed surfaces susceptible to wind erosion where feasible.

Runoff-related increases in soil erosion from roads, drill sites, and power lines might be larger than those associated with mine sites because containment berms are absent. However, disturbance along power lines and drill sites is temporary and limited in extent. Once construction of the power line or drill site is complete, additional disturbance would occur occasionally for power lines, and only if maintenance is required, and additional disturbance would not occur for drill sites once drilling is complete. The extent of disturbances for power lines is limited to that required for pole placement, and the extent of a typical drill site is only about 1.1 acres, according to the RFD scenarios (temporary roads not typically required). In addition, drill sites are required to be reclaimed following completion of the exploration project. Construction and use of new roadways present a larger soil erosion potential than other activities considered. The number of haul trips may slightly increase erosion risks because repeated use of roads may result in additional compaction and/or displacement of soil particles; development of ruts that might create pathways for runoff, thus resulting in potentially greater soil loss; and extensively used roads could require increased maintenance, leading to additional compaction and displacement. However, these impacts would be expected to be effectively controlled through standard BMPs, and after mine closure, these roads would be reclaimed. Increased loss of soil from wind activity is possible at all disturbed areas; however, the potential volume of soil that could be lost from this process is relatively small because dust management practices would be expected to provide effective control. Overall, direct impacts to soil from erosion would be expected to be minor throughout most of the proposed withdrawal area under existing regulations and would be expected to be of short duration (4 to 5 years).

Land surface disturbance might cause increased erosion of natural drainage channels and/or sedimentation in natural channels, sinkholes, or humanmade retention basins (i.e., "tanks"). Such indirect impacts might occur off-site and even after reclamation is complete. However, these impacts would be expected to be largely limited to areas downgradient of and/or downwind from and in relative close proximity to drill sites, mine sites, power lines, and haul roads. Although eroded soil from mine sites would be contained by perimeter berms, alteration of drainage patterns around mine sites might result in increased downstream erosion. Moderate indirect impacts are possible where mine sites are located within or adjacent to large natural drainage channels and/or canyons because eroded soil has the potential to move farther away from the mine site during floods, periods of stream flow, or where wind can transport soils into canyons. In addition, soils on steep slopes or otherwise erosion-sensitive soils (thin, fine-grained, and/or poorly cohesive) have the potential to experience higher rates of erosion than other soils. All three proposed withdrawal parcels have some areas of steep topography or canyons and areas of sensitive soils. Although increased erosion impacts would be expected to be generally minor under Alternative A, moderate impacts might occur if specific roads, exploration sites, or mine sites are located in these steeper areas.

SOIL CONTAMINATION

Materials extracted from breccia pipes and brought to the surface by mining processes could directly impact surficial soils at the mine sites during mining operations by introducing contaminants. These direct impacts include potential mixing of ore and/or waste rock with native surface soils, leaching and subsequent infiltration of heavy metals and other toxic substances into the soil, and possible leakage or releases from on-site retention basins. Contamination of soils from exploration drilling is anticipated to be minimal, based on results of sampling in the vicinity of the Kanab South Pipe exploration site (Otton et al. 2010). Impacts at mine sites may exceed the ADEQ SRL of 200 ppm for uranium and 10 ppm for arsenic (ADEQ 2007); however, such a high magnitude of impact is expected to be temporary because of removal and/or covering of contaminated soils during reclamation activities. Thus, potential direct impacts on soil chemical quality would be expected to be minor; duration of the impact is expected to be about 5 years, which is the average lifespan of a mine from development through reclamation. However, the duration of direct impacts could be different if any of the uncertainty factors identified in the RFD scenarios are encountered; for example, if the ore body is larger or smaller than estimated, or the operator decides to initiate a temporary closure and conduct operations under the interim management plan in the approved plan of operations.

Indirect impacts might result from exposed waste rock and ore stockpiles that are susceptible to wind and water erosion; contaminants might be dispersed by wind and/or transported downslope during storm events and deposited off-site. Although levels of uranium and arsenic in soil or sediment might be above background levels and/or non-residential SRLs for uranium (200 ppm) and arsenic (10 ppm), concentrations would generally be expected to approach SRLs or background levels within a few hundred feet from mine sites (approximately 500 feet).[13] This conclusion is supported by data collected by Otton et al. (2010) at the Kanab North Mine, which represents 20 years of wind dispersion of material from exposed soils, mine-waste, and ore stock piles remaining on-site. In 22 soil samples collected within 420 feet from the unreclaimed Kanab North Mine, the uranium concentration in soil ranged from 2.9 to 80.2 ppm and averaged 27.8 ppm, and the arsenic concentration ranged from 3 to 27 ppm and averaged 12 ppm. The two samples collected farthest from the Kanab North site, at 300 and 420 feet away, contained 10.3 and 6.9 ppm of uranium and 9 and 8 ppm of arsenic, respectively. Concentrations of uranium and arsenic in the vicinity of other sites studies are higher (Pigeon Mine) and lower than these results (Hermit Mine). This could be because background conditions are different at these sites, or the

[13]The SRL for uranium was not generally found to be exceeded on- or off-site at reclaimed mines and off-site at mines operating under interim management (Otton et al. 2010). The SRL for arsenic was found to be exceeded both on- and off-site in many locations. However, this standard is based on estimated background for the state of Arizona; background conditions in the vicinity of mineralized breccia pipes may exceed 10 ppm. AAC R18-7-203 permits operators to remediate soils to either SRLs or site-specific background levels.

magnitude of the impact is different because of the intensity of mining activities. Impact to soils from distribution of mine-related constituents would be expected to be generally minor because exceedance of standards would be expected to be limited to the immediate vicinity of mine sites. After site reclamation, distribution of additional contaminants to off-site areas would be expected to be negligible. The magnitude of any off-site impacts (in undisturbed areas) would be expected to occur within close proximity to the mine sites; these impacts would be expected to be long term (greater than 5 years).

Impacts to soil chemical quality may remain at mine sites after closure, depending on the effectiveness of reclamation efforts. The chemical quality of soil within disturbed areas would represent materials used for reclamation and thus would be expected to generally meet current remedial standards (e.g., SRLs). Data collected by the USGS in 2009 (Otton et al. 2010) at the reclaimed Pigeon and Hermit mines support this conclusion; at the Pigeon Mine, only localized areas of soil were detected containing higher levels of trace elements than elsewhere on-site. These higher levels of mine-related constituents were likely related to the presence of mine-waste materials remaining on-site, possibly uncovered by erosion. These residual impacts are an example of reclamation efforts that were not completely successful; such impacts are minor because of their limited extent and could be mitigated through more aggressive remedial action and monitoring after closure. Impacts to soil from mine-related contaminants on-site after reclamation would be expected to be generally minor in terms of magnitude and extent; duration of the impact would be expected to be long term (greater than 5 years). Because undisturbed areas are not typically reclaimed, levels of mine-related constituents after reclamation would be expected to be about the same as at the end of the operational or interim management period.

As with soil erosion impacts, mines located within or adjacent to large drainage channels, canyons, or steep slopes present an additional risk of contaminant dispersal from wind and floods; the site-specific risk is evaluated during review of individual mine plans of operation. The impact associated with such mines might be moderate because the extent of dispersal and accumulation of mine-related constituents in soil and sediment to levels exceeding SRLs or background levels may extend beyond the immediate vicinity of the mine sites. Such impacts are possible from actions described in the RFD scenarios since all three proposed withdrawal parcels have some areas with canyons, large drainages, or steep slopes. Examples of previous and existing mines where similar impacts may have occurred include the Kanab North Mine and the Hack Canyon mines (Otton et al. 2010). In the case of the unreclaimed Kanab North Mine, some contaminant dispersal beyond 420 feet may have occurred because of the close proximity of the mine to the canyon of Kanab Creek. Although this impact is conceivable, no data were collected to confirm this possibility. Levels of dispersed contaminants accumulated in off-site soils would still likely be below the SRL for uranium or a few ppm above the SRL for arsenic because the maximum uranium concentration measured was 80.2 ppm and the maximum arsenic concentration measured was 27 ppm. An example of an increased risk of constituent dispersal from flooding in canyons and drainage channels is provided by the reclaimed Hack Canyon Mine complex, which was located on the floor of a large canyon. Flood events reported to have occurred during mining operations and/or floods that were inferred to have eroded reclaimed areas and displaced covered mine-waste materials are thought to have dispersed contaminants some distance from the Hack Canyon Mine sites (Otton et al. 2010). Data collected by Carver (1999) in September 1998 and May 1999 found that mean concentrations of trace elements in sediment samples collected upstream from the mines were equal to those collected downstream from the mines; this result was confirmed by the USGS from samples collected in fall 2009 (Otton et al. 2010), as they found that concentrations of most trace elements in sediment collected within about 2 to 3 miles downstream of the mines were about the same as those collected upstream. It should be noted that the Hack Canyon Mine complex was not protected by perimeter berms because of space constraints on the canyon floor. Thus, although mines located within major drainage channels might result in dispersion of contaminants that is moderate in extent, dispersion of mine-generated materials at the Hack Canyon Mine complex represents an atypical scenario because few mines are likely to be located in canyons or lack perimeters berms based on past locations of mines.

Cumulative Impacts

Cumulative impacts to soils are related to increases in the total amount of disturbed acreage, overlapping erosion impacts from exploration sites, roadways, power lines, and approved mines in close proximity to one another or to other activities or conditions occurring in the parcels, or increases in the total number of contaminated sites and overlapping contamination from mines in close proximity. All the activities or conditions listed in the analysis assumptions (see Section 4.5.1) could result in ground disturbance and subsequent increased rates of erosion. Cumulative contamination impacts, if present, are likely to only result from past uranium mining and future non-uranium mining activities. Duration of cumulative impacts would be expected to be long term (more than 5 years).

The spatial scale of cumulative impact analysis is different from that considered for direct and indirect impacts in that the impacts may not necessarily be related solely to the locations of uranium mining activities. Impacts from all past and present activities or conditions and non-uranium mining activities or conditions that are reasonably foreseeable are difficult to quantify. Thus, because of these different factors, descriptions established in Table 4.5-1 are not appropriate for discussion of cumulative impacts. Instead, cumulative impacts are analyzed through comparison of the relative magnitude, in qualitative terms, of impacts resulting from reasonably foreseeable uranium mining activities (i.e., "RFD-scenario activities") and impacts resulting from other past, present, or reasonable foreseeable activities and conditions (i.e., "other activities") listed in Section 4.5.1. Overall, disturbance and increased erosion impacts resulting from RFD-scenario activities would be very small, compared with such impacts from other activities; however, distribution of contaminants in soil and sediment from RFD-scenario impacts would be expected to be similar or larger in areal extent to impacts from other activities.

Thousands of acres in the proposed withdrawal area have been disturbed because of activities and conditions other than those outlined in the RFD scenarios; such disturbance is anticipated to continue into the future at a lower rate than in the past. These disturbances have impacted large portions of the proposed withdrawal area. Activities and conditions in the region associated with the largest and most aerially extensive impacts related to disturbance and increased erosion are previous cattle grazing, wildfires, and droughts that have occurred over the past 150 years. The loss of vegetation from these disturbances has resulted in increased erosion throughout the area and, in some cases, allowed the introduction of invasive species of grasses and shrubs, which has increased the risk of wildfires. Recent wildfires in the area include the X-Fire in the South Parcel (2,000 acres southeast from Tusayan in 2008) and the Warm Fire (39,100 acres west of the East Parcel in 2006) (Forest Service 2009g). The Warm Fire did not occur within the proposed withdrawal area; however, increased erosion from this large wildfire might have resulted in sedimentation along the western margin of the East Parcel. Recent drought conditions that occurred from 1998 to 2004 have resulted in increased risk of wildfire and loss of vegetation in the parcels, such as widespread mortality of pinyon-juniper and ponderosa trees. Future wildfires and droughts are foreseeable in the region; however, their effects and timing cannot be reasonably estimated. Additional impact from cattle grazing would be expected to be relatively small, compared with past cattle-grazing activities as a result of current permit requirements, modern management techniques, and reduced stocking rates. Past, current, and foreseeable future activities resulting in somewhat smaller disturbance and erosion impacts than cattle grazing, wildfire, and drought include fuels reduction and noxious weed removal programs, fire suppression (construction of temporary access roads), mine and quarry development,[14] exploration and water well drilling, and development and use of roads and trails. Although the individual impact from these activities may be relatively small, the cumulative impact would be expected to be large. Anticipated population growth in the region, primarily in southern Utah, might accelerate disturbance by way of increased development on private property

[14] Includes the following numbers of separate sand and gravel or quarry operations: eight in the North Parcel, two in the East Parcel, and one in the South Parcel.

(primarily in the North Parcel) and increased development and use of recreation areas (such as trails and campgrounds).

Disturbance and increased soil loss related to past, present, and future, activities or conditions other than those outlined in the RFD scenarios are potentially several orders of magnitude larger in intensity and areal extent than impacts from activities outlined in the RFD scenarios. Thus, addition of uranium mining related activities in the RFD scenarios would result in a very small contribution to the overall level of disturbance and soil loss in the proposed withdrawal area. In addition, erosion control measures would be expected to be largely effective for all activities approved and reviewed by federal and state agencies with jurisdiction in the area.

Under Alternative A, the number of uranium mines that are reasonably foreseeable would be equal to or greater than past and current uranium and non-uranium mining activities. For example, in the North Parcel, there could be 18 new uranium mines, compared with eight reclaimed/existing uranium mines. Thus, the addition of potential RFD-scenario impacts to impacts from previous uranium and non-uranium mines could result in a large increase in the total areal extent of impacted soils and number of sites where contamination might occur. However, it should be recognized that the type of constituents that may contaminate soils in the vicinity of non-uranium mines and/or quarries may be different than those associated with uranium mines. Thus, because no previous uranium mining has occurred in the East and South parcels, it is unlikely that cumulative impacts related to contamination would occur in these parcels.

Increases in the concentration of contaminants in soil to levels above those projected under direct and indirect impacts might result from overlapping areas of contamination by transport and deposition of materials away from mine sites. Transport of materials from sites by water would not be expected to occur for any mine operating under approved plans of operation because of the general requirement for perimeter berms surrounding the sites. Transport of materials away from reclaimed mine and exploration sites, including the Pigeon and Hermit mines, would not be expected to contribute to cumulative contamination-related impacts because the reclaimed soils at these sites have been stabilized and re-vegetated. Overlap of contamination impacts from dispersal and subsequent deposition of fine-grained materials by wind would also be unlikely because breccia pipes close enough to one another to have measurably overlapping dust plumes would typically be served by a single surface site, such as the EZ-1, EZ-2, and What pipes. Reclaimed mines and mines operating under approved plans of operation were surveyed by the USGS in 2009 (Otton et al. 2010), and sample results indicated that levels of contaminants in surface soils generally approach SRLs for uranium and arsenic within about 500 feet or less from the mines sites. An exception to this might occur in areas of steep topography or large drainage channels where sufficient energy may be available to move contaminants farther away from the sites by wind or water action (including water erosion of soils impacted by wind dispersion). This appears to have occurred at the reclaimed Hack Canyon Mine complex, where exceedance of the arsenic SRL and background levels were detected about 0.5 mile downstream of the mines (Otton et al. 2010). However, transport of materials by water for large distances also results in dilution of the mine-related constituents by incorporation of native fine-grained sediments into stream bed loads.

No cumulative impacts would be expected from the Orphan Mine near the South Parcel because it is located in an area that is directly tributary to the Colorado River, while streams in the South Parcel are tributary to either Cataract Creek or the Little Colorado River (see Figure 4.4-3). Erosion-related impacts would not be expected to extend far enough to have a cumulative impact downstream in the Colorado River. Similarly, potential contaminants transported away from the Orphan Mine or new mines by wind would not likely travel far enough to have a cumulative impact on concentrations of mine-related constituents in soil because the Orphan Mine is about 3.5 miles away from the South Parcel.

Unavoidable Adverse Impacts

Adverse impacts to soil resources that are inherent in the process of mine development and operation would be expected to be minimal under existing regulations. Such impacts include loss of soil from road construction and mine site development that would occur following surface disturbance from both water and wind action, soil compaction, and removal of vegetation. Loss of soil at mine sites during operations is minimal, given that site perimeters include substantial containment berms. Reclaimed mine sites would be expected to have rates of soil loss comparable to pre-disturbance conditions. Loss of soil from new roadways and power lines could be larger but are effectively controlled under existing regulations. Impacts from soil compaction would also be expected to be reduced during reclamation by ripping or disking the disturbed soils to aid in revegetation. Some dispersal of uranium contamination by wind might be unavoidable at certain sites, but based on studies at reclaimed mines and mines operating under interim management the off-site impact would range from minor to moderate because concentrations of trace elements in surficial media would be expected to be at or below the SRL for uranium (200 ppm) and may meet applicable standards for arsenic, depending on determination of background conditions at each site. In disturbed areas, soils would be reclaimed to meet SRL standards.

4.5.4 Impacts of Alternative B: Proposed Action (~1 Million Acres, 20-Year Withdrawal)

Under Alternative B, mineral development would proceed under existing law, regulation, and policy; however, mining activities would be limited to mines with valid existing rights. The overall impact on soil resources would be expected to range from none to moderate (see Table 4.5-3). The relative impact would be expected to be the smallest under Alternative B, compared with all other alternatives. The smallest amount of mining development (11 mines) in each of the three parcels is projected to occur under this alternative, resulting in the smallest estimated area of land surface disturbance (164 acres) and the smallest potential for distribution of contaminants in soil during mining operations than under other alternatives. There is no anticipated impact for the East Parcel because no mining would take place under this alternative. Soil impacts in the North and South parcels would be expected to be effectively controlled under current regulatory requirements.

Direct and Indirect Impacts

SOIL DISTURBANCE

The nature of potential soil disturbance impacts in the North and South parcels would be the same as described for Alternative A. However, the amount of soil disturbance that is anticipated under Alternative B is the smallest for all the alternatives; there would be no impact in the East Parcel. Nearly all of the disturbance would be in the North Parcel (163 acres, which is about 0.03% of the total area of the North Parcel). The soil anticipated disturbance in the South Parcel is only 1 acre (new power line), which represents a negligible impact.

INCREASED SOIL EROSION

The nature of potential impacts on soils resulting from accelerated erosion in the North and South parcels would be the same as described for Alternative A; however, the total amount of impacted area would be considerably smaller because of less ground disturbance. Alternative B proposes to withdraw all areas of steep topography, canyons, and areas of soils susceptible to erosion from new mine development. Such areas include Kanab Creek and major tributary canyons in the North Parcel, the north-central portion of the North Parcel, areas adjacent to the Kaibab National Forest in the northeastern part of the North Parcel,

and the Coconino Rim and Red Butte areas in the South Parcel. Regardless of withdrawing these areas, some roads, exploration sites, and mines associated with valid existing rights that are anticipated to be developed in the North Parcel might be located adjacent to Kanab Creek or tributary canyons or in areas with sensitive soils; in addition, the Kanab North Mine is currently adjacent to Kanab Creek. Therefore, moderate impacts from increased soil erosion might occur in the North Parcel where roads, exploration sites, or mines are located in areas of steep topography or sensitive soils, but impacts would be expected to be minor in other areas. Soil erosion impacts in the South Parcel are anticipated to be minor because the only mining that would occur is associated with the existing Canyon Mine site, which is not located in an area of severe erosion risk. No impact would occur in the East Parcel.

SOIL CONTAMINATION

The nature of potential soil contamination impacts in the North and South parcels would the same as described for Alternative A; however, the total volume of potentially impacted soils would be considerably smaller in the North and South parcels for Alternative B. Although all areas of steep topography or canyons are withdrawn under this alternative, some mines with valid existing rights might still be located in these areas in the North Parcel. Therefore, moderate impacts from contaminant dispersal beyond the immediate vicinity of the mine sites might occur in the North Parcel, but impacts would be expected to be minor in most areas. Soil contamination impacts in the South Parcel are anticipated to be minor because the only mining that would occur is associated with the existing Canyon Mine site, which is not in an area of steep topography. No impact would occur in the East Parcel.

Cumulative Impacts

The nature of cumulative impacts under Alternative B related to soil disturbance and increased erosion would be the same as described for Alternative A; however, the magnitude of additional disturbance from RFD-scenario activities is considerably smaller than under Alternative A for all three proposed withdrawal parcels. The amount of surface disturbance for the North Parcel would be expected to be about 80% less than anticipated under Alternative A, based on relative acreages. The very small amount of anticipated disturbance for the South Parcel (1 acre) would result in negligible cumulative impact. No cumulative disturbance impact would occur in the East Parcel because no disturbance is anticipated.

The nature of cumulative contamination impacts to soil would be the same as described for Alternative A, except less anticipated mineral development means that the total potential area of impacted soil and number of potential impacted sites would be considerably smaller. For the North Parcel, seven new mines are anticipated to be developed, compared with 18 mines under Alternative A; adding these seven mines to the seven mines that are reclaimed and currently operating under approved plans of operation would be expected to result in a 100% increase in the total number of potentially impacted sites. No cumulative impacts related to soil contamination would be expected to occur in the East and South parcels because no previous or current uranium mining has occurred in these parcels.

Unavoidable Adverse Impacts

Unavoidable adverse impacts would be the same as described for Alternative A.

4.5.5 Impacts of Alternative C: Partial Withdrawal (~700,000 Acres)

Under Alternative C, mineral development would proceed under existing law, regulation, and policy; new mines would be permitted only in areas with no or minimal sensitivity to resource impacts. The overall impact on soil resources would be expected to range from minor to moderate (see Table 4.5-3).

The relative impact would be expected to be smaller than either Alternative A or D. Less mining development in each of the three parcels is projected to occur under Alternative C (18 mines), compared with Alternatives A or D (30 and 26 mines, respectively), resulting in smaller estimated areas of land surface disturbance (532 acres, compared with 1,364 and 951 acres, respectively) and a smaller potential for distribution of contaminants in soil during mining operations. Soil impacts would be expected to be effectively controlled under current regulatory requirements.

Direct and Indirect Impacts

SOIL DISTURBANCE

The nature of potential soil disturbance impacts would be the same as described for Alternative A; however, the amount of soil disturbance anticipated under Alternative C is smaller than the other alternatives, except for Alternative B. The relative percentage of anticipated disturbance in each proposed withdrawal parcel ranges from 0.04% in the East Parcel (54 of 134,454 acres) to 0.06% in the North Parcel (320 of 554,124 acres); the percentage for the South Parcel is 0.05% (158 of 332,198 acres). Thus, soil disturbance impacts are minor in all three withdrawal parcels.

INCREASED SOIL EROSION

The nature of potential impacts on soils resulting from accelerated erosion would be the same as described for Alternative A; however, the total amount of impacted area would be considerably smaller because of less ground disturbance. Alternative C proposes to withdraw most areas of steep topography, canyons, and areas of soils susceptible to erosion from new mine development. Such areas include Kanab Creek and major tributary canyons in the North Parcel, the north-central portion of the North Parcel, areas adjacent to tributary canyons to the Colorado River in the East Parcel, the majority of the western and north-central portions of the East Parcel, and the Coconino Rim and Red Butte in the South Parcel. Some mines anticipated to be developed in the North Parcel might be located adjacent to Kanab Creek or tributary canyons or areas of sensitive soils in the northeastern portion of the North Parcel; in addition, the Kanab North Mine is located adjacent to Kanab Creek. Therefore, minor to moderate impacts from increased soil erosion might occur in the North Parcel where roads, exploration sites, or mines are located in areas of steep topography or sensitive soils, but impacts would be minor in other areas. Although some steep areas along the southwestern margin of the East Parcel are not withdrawn under Alternative C, only one mine is anticipated to be developed; thus, it is unlikely that the mine would be located in this relatively small area. Therefore, no mines would be expected to be located in sensitive areas in either the East or South parcels because such areas would be largely withdrawn; therefore, only minor increases in erosion are anticipated in the East and South parcels.

SOIL CONTAMINATION

The nature of potential soil contamination impacts would be the same as described for Alternative A; however, the total volume of potentially impacted soils would be considerably smaller. Although most areas of steep topography or canyons are withdrawn under this alternative, some mines could be located in these areas in the North Parcel. Therefore, moderate impacts from contaminant dispersal beyond the immediate vicinity of the mine sites might occur in the North Parcel, where mines are located in or immediately adjacent to canyons or other steep areas, but impacts would be expected to be minor in other areas. No mines would be expected to be located in canyon or steep areas in either the East or South parcels because such areas would be largely withdrawn; therefore, only minor contamination impacts are anticipated in the East and South parcels.

Cumulative Impacts

The nature of cumulative impacts under Alternative C related to soil disturbance and increased erosion would be the same as described for Alternative A; however, the magnitude of additional disturbance from RFD-scenario activities based on relative acreages would be expected to be about 70% less for the North Parcel and about 50% for the South and East parcels.

The nature of cumulative contamination impacts to soil would be the same as described for Alternative A, except less anticipated mineral development means that the total potential area of impacted soil and number of potential impacted sites would be somewhat smaller. For the North Parcel, 10 new mines are anticipated to be developed, compared with 18 mines under Alternative A; adding these 10 mines to the eight mines that are reclaimed and currently operating under approved plans of operation would be expected to result in about a 125% increase in the total number of potentially impacted sites. No cumulative impacts related to soil contamination would be expected to occur in the East and South parcels because no previous or current uranium mining has occurred in these parcels.

Unavoidable Adverse Impacts

Unavoidable adverse impacts would be the same as described for Alternative A.

4.5.6 Impacts of Alternative D: Partial Withdrawal (~300,000 Acres)

In Alternative D, mineral development would proceed under existing law, regulation, and policy, and new mines would be possible in all but the most resource-sensitive areas. The overall impact on soil resources would be expected to be minor in all three proposed withdrawal parcels (see Table 4.5-3). The relative impact on soil resources would be expected to be smaller than under Alternative A but possibly greater than under the other alternatives. Up to 26 mines are projected to occur under this alternative, resulting in a larger estimated area of land surface disturbance (951 acres, compared with 532 acres for Alternative C) and greater potential for distribution of contaminants in soil during mining operations than under the other alternatives, except for Alternative A. Soil impacts would be expected to be effectively controlled under current regulatory requirements.

Direct and Indirect Impacts

SOIL DISTURBANCE

The nature of potential soil disturbance impacts would be the same as described for Alternative A. However, the amount of soil disturbance that is anticipated under Alternative D would be larger than under Alternatives B or C and somewhat smaller than under Alternative A. The relative percentage of anticipated disturbance in each proposed withdrawal parcel ranges from 0.04% in the East Parcel (54 of 134,454 acres) to 0.12% in the North Parcel (668 of 554,124 acres); the percentage for the South Parcel is 0.06% (209 of 332,198 acres). Thus, soil disturbance impacts are minor in all three withdrawal parcels.

INCREASED SOIL EROSION

The nature of potential impacts on soils resulting from accelerated erosion would be the same as described for Alternative A; however, the total amount of impacted area would be somewhat smaller under Alternative D because of less ground disturbance. Alternative D proposes to withdraw most areas of steep topography and canyons and areas of soils susceptible to erosion from new mine development. Such areas include Kanab Creek and major tributary canyons in the North Parcel, areas adjacent to

tributary canyons to the Colorado River in the East Parcel, the majority of the western portion of the East Parcel, and the Coconino Rim in the South Parcel. Some mines anticipated to be developed in the North Parcel might be located adjacent to Kanab Creek or tributary canyons or areas of sensitive soils in the northeastern and north-central portions of the North Parcel; in addition, the Kanab North Mine is located adjacent to Kanab Creek. Similarly, some mines anticipated to be developed in the East Parcel might be located in the north-central portion of the parcel where the soils are susceptible to wind erosion. Also, compared with the proposed withdrawal under Alternative C, more areas of steep topography, such as the Red Butte area and various drainage channels identified with a high erosion risk, are open to mineral development in the South Parcel. Given this condition and the larger number of mines foreseen under Alternative D in the South Parcel (five), mines might be located in one of these areas. Therefore, minor to moderate impacts from increased soil erosion might occur in all three proposed withdrawal parcels, where roads, exploration sites, or mines are located in areas of steep topography or sensitive soils. Increased soil erosion generally would be expected to be minor at most locations, especially in the East and South parcels, because a relatively small proportion of each parcel area not withdrawn includes canyons or steep topography.

SOIL CONTAMINATION

The nature of potential soil contamination impacts would be the same as described for Alternative A; however, the total volume of potentially impacted soils would be somewhat smaller. Although most areas of steep topography and canyons are withdrawn under this alternative, some mines could be located in the North Parcel either in or immediately adjacent to canyons or other steep areas. Therefore, moderate impacts from contaminant dispersal beyond the immediate vicinity of the mine sites might occur in the North Parcel where mines are located in or immediately adjacent to canyons or other steep areas, but impacts would be expected to be minor in other areas. Impacts related to contamination in the East Parcel would be expected to be minor because it is unlikely that the one anticipated mine would be located in or immediately adjacent to remaining steep areas not withdrawn (discussed under Alternative C erosion impacts). However, because of the four anticipated new mines in the South Parcel and the presence of some steep areas not included in the proposed withdrawal under Alternative D, contamination impacts might range from minor to moderate in the South Parcel. Impacts in other areas, which form most of the South Parcel, would be expected to be minor.

Cumulative Impacts

The nature of cumulative impacts under Alternative D related to soil disturbance and increased erosion would be the same as described for Alternative A; however, the magnitude of additional disturbance from RFD-scenario activities based on relative acreages would be expected to be about 30% less for the North Parcel and South parcels and about 50% for the East Parcel.

The nature of cumulative contamination impacts to soil would be the same as described for Alternative A, except less anticipated mineral development means that the total potential area of impacted soil and number of potential impacted sites would be slightly smaller. For the North Parcel, 17 new mines are anticipated to be developed, compared with 18 mines under Alternative A; adding these 17 mines to the eight mines that are reclaimed and currently operating under approved plans of operation would be expected to result in a more than 200% increase in the total number of potentially impacted sites. No cumulative impacts related to soil contamination would be expected to occur in the East and South parcels because no previous or current uranium mining has occurred in these parcels.

Unavoidable Adverse Impacts

Unavoidable adverse impacts would be the same as described for Alternative A.

4.6 VEGETATION RESOURCES

4.6.1 Impact Assessment Methodology and Assumptions

Quantitative and qualitative approaches used to estimate impacts to vegetation included calculations of vegetation impacts relative to the availability of vegetation in the proposed withdrawal area, the disturbance footprint of mines and exploration sites, and the spatial nature of impacts.

Impacts are quantified where possible; however, some potential impacts to vegetation resulting from future mining activity are largely uncertain. In the absence of quantitative data, the best available science and professional judgment were used. Impacts are sometimes described using ranges of potential impacts or in qualitative terms, if appropriate. Table 4.6-1 provides thresholds and descriptions used during analysis for vegetation resource impacts.

Table 4.6-1. Magnitude and Degrees of Effects on Vegetation Resources

Attribute of Effect	Description Relative to Vegetation Resources
Magnitude	
No Impact	Project-related activities would not produce impacts to the vegetative character and overall density and diversity of vegetation resources.
Minor	Project-related impacts would occur to existing vegetation; however, impacts to overall density and diversity of vegetation resources would not be measurable or apparent.
Moderate	Project-related impacts would occur to existing vegetation; impacts to the overall density and diversity of vegetation resources would be measurable but not apparent.
Major	Project-related impacts would create a high degree of change within the existing vegetative character; impacts to the overall density and diversity of vegetation resources would be measurable and apparent.

Duration of impacts is quantified where possible; however, some potential impacts to vegetation as a result of future mining activity are largely uncertain. Impacts are described using ranges of the length of time the resource will be affected. Table 4.6-2 provides thresholds and descriptions used during analysis for duration of impacts to vegetation resources.

Table 4.6-2. Duration of Impact Description

Duration	
Temporary	Transient (period of project right-of-way construction and de-construction)
Short-term	Less than 5 years
Long-term	Greater than 5 years

The analysis of vegetation, which includes structure, productivity, vigor, abundance, and diversity, was based on likely changes relative to movement toward or away from current or natural vegetation conditions.

Vegetation is a fundamental and vitally important component of the biological resources in the proposed withdrawal area. The effects of vegetation resulting from implementing any of the proposed alternatives would also affect other resources. Impacts to the vegetation resource could result in reduced biological productivity, weed invasion, and unwanted changes in the composition and structure of vegetation communities. These changes, in turn, could influence forage availability for wildlife and livestock. Where

actions result in loss or reduction of vegetative cover and/or soil erosion or compaction, cultural, wildlife, water, soil, and air resources could be impacted.

The direct and indirect effects of mining-related activities on vegetation may vary widely, depending on a variety of factors such as the location of the mine facilities, type of soils, soil moisture, topography, and plant reproductive characteristics. Direct impacts are generally caused by construction activities; the establishment, use, maintenance, closing, or rehabilitation of roads; and the introduction, spread, and treatment of noxious and invasive species. Indirect impacts are generally caused by dust accumulation immediately adjacent to roads and would include lowered vigor or death of plants and changes in plant abundance and/or species composition resulting from modified nutrient cycling as a result of soil compaction and soil erosion.

Exploration, mining, and the construction of new access roads and power lines could result in direct impacts to the following vegetation types: Great Basin Desertscrub, Plains and Great Basin Grassland, Great Basin Conifer Woodland, and Petran Montane Conifer Forest. Direct impacts to vegetation could include injury or loss of vegetation from crushing or removal of plants. The exact acres of vegetation lost by type cannot be estimated because no specific exploration or mine locations have been proposed at this time. Mining-related disturbance would have localized impacts on vegetation community structure and species richness, as well as overall vegetation productivity on an ecosystem level. The magnitude of these impacts cannot be fully understood until specific mine locations are known. The time required for successful reclamation would depend on soil, topography, rainfall, vegetation type, and the reclamation method used.

Indirect impacts on vegetation may include chemical toxicity as a result of uptake of uranium through soil water. Soils containing between 10 and 100 mg/kg of uranium may have adverse effects on vegetation. These effects may include chlorosis, early leaf abscission, and reduction in root growth. As summarized by the USGS (Hinck et al. 2010), there are few data available about the effect of other radionuclides on vascular plants. However, thallium is a radionuclide that occurs in the uranium decay series. Thallium can be released into surface water, sediment, and soil during the mining process. Thallium can be taken up by plant roots and translocated to aboveground vegetation. The effects of thallium include impaired chlorophyll synthesis, impaired seed germination, reduced transpiration, growth reduction, stunting of roots, and chlorosis (Hinck et al. 2010). Polonium is another radionuclide occurring in the uranium decay series that is found in the leaves of plants. However, polonium also occurs naturally in small amounts throughout the earth's crust at levels that preclude chemical toxicity as a primary hazard. Polonium is also not readily translocated by plant tissues. There is no information available for other radionuclides associated with uranium (Hinck et al. 2010). In general, effects of radiation on plants may include growth inhibition, reduced reproductive capacity, and reduced survival. Environmental factors, such as temperature, light, and surrounding vegetation, can influence the response to radiation. Species that reproduce vegetatively (asexually) are more resistant to the effects of radiation than plants that reproduce by seed (sexually) (Hinck et al. 2010).

Indirect effects on the vegetation of the greater Grand Canyon watershed may also include changes in native species richness, abundance, productivity, and structure as a result of the inadvertent introduction of invasive species during the process of mine operations and the associated disturbance. Indirect impacts would also include soil erosion (both wind and water), soil compaction, and watershed impacts from construction and installation of mine facilities, drill sites, access roads, and power lines as effective ground cover is decreased. Removal of cryptobiotic soil crusts, which help hold soils in place, would contribute to these impacts within the proposed withdrawal area and adjacent areas.

4.6.2 Compliance with Environmental Regulations and Permitting

Site-specific operating requirements and conditions of approval regarding construction and reclamation measures to prevent unnecessary or undue degradation on BLM and Forest Service lands would be developed during individual plan of operations review and approval (BLM 2007; Forest Service 2007, 2008f). Our analysis assumes that the following standard operating procedures and conservation measures are used for all mining projects.

1. All surface disturbances, including road construction and associated travel, shall be kept to the minimum necessary to accomplish the task. Road upgrade and realignment requests on BLM lands shall include plans for reclamation.
2. All new temporary or existing upgraded roads on BLM lands may require mitigation to reduce the potential adverse impact of fugitive dust as specified by the authorized officer.
3. Where soil characteristics warrant, topsoil shall be stockpiled. Stockpiles will be of a depth and width to maintain soil biotic community health.
4. All surface-disturbing activities on slopes greater than 15% shall include measures to stabilize soils and control surface water runoff. Vehicles will stay on designated driving routes to avoid excessive soil and vegetation disturbance to minimize the introduction and spread of noxious weeds.
5. To prevent fire, all equipment, including small gas engines for generators and water pumps, will have spark arrestors. All equipment on-site and going to and from the site will have chemical fire extinguishers, which are to be readily accessible during drilling operations. Drill rigs and water pumps will have hoses with nozzles with pressure suitable for use in the event of a fire. On-site smoking will be subject to agency rules and guidelines, and no smoking materials such as cigarette butts will be discarded on the ground.
6. Reclamation of all surface disturbances must be initiated immediately upon completion of activities, unless otherwise approved by the authorized officer. Reclamation of disturbed areas shall, to the extent practicable, include contouring disturbances to blend with the surrounding terrain, replacing topsoil, smoothing and blending the original surface colors to minimize impacts to visual resources, and seeding the disturbed areas with a mix specified by the authorized officer.
7. Revegetation efforts must establish a stable biological groundcover equal to that which occurred prior to disturbance. Mulching may be appropriate for conserving moisture and holding seed on-site, thus improving the chances for successful establishment.
8. Roads shall be reclaimed immediately upon termination of the project. Recontouring all cut slopes to approximately the original contour shall be required. Reclaimed roads shall be barricaded or signed to protect them until reclamation is achieved. All existing roads that require upgrading shall be reclaimed to their original dimensions upon completion of the project. Exceptions must be approved in writing by the authorized officer.

4.6.3 Impacts of Alternative A: No Action (No Withdrawal)

Under Alternative A, approximately 1,364 acres would be impacted by new mining. To support the mines, approximately 22.4 miles of new roads and power lines would increase the impact area by approximately 67.6 acres. A total of 300,165 ore haul trips would be required under this alternative. Impacts associated with mining activities would include loss or injury of plants as a result of crushing or

removal of plants, burial under piles of extracted material, toxic responses from chemicals and/or radiation hazards, and increased exposure to dust and other contaminants.

Vehicles traveling on roads would deposit dust on individual plants. This could lead to a decrease in plant vigor and a decrease in vegetation productivity adjacent to these roads. Productivity may be reduced as a result of depressed photosynthetic capability over time, after repeated deposition of dust on vegetation during active times of mine operations. Vegetation productivity would be expected to return to pre-project conditions following the completion of reclamation activities, when deposition of dust would not be occurring regularly.

Indirect impacts may also include exposure of vegetation to uranium or other radionuclides via contaminated water, soil, or dust, which may result in the effects described above, including chlorosis, early leaf abscission, and reduction in root growth, reproductive capacity, or survival. The increase of uranium is expected to be minor and almost non-detectable from existing and naturally occurring levels (see Section 4.4, Water Resources).

Infestation of invasive species may also occur as an indirect effect of vehicular travel along the access roads, as part of mining operations and reclamation. Preventive measures, such as power washing of all construction vehicles prior to their entry onto construction sites and monitoring reclamation sites, would minimize establishment and spread of invasive species as part of reclamation activities.

Vegetation in riparian areas may be affected by increased runoff, flooding, and erosion events as an indirect impact from mining operation activities in upland areas. The increased sedimentation and soil erosion may also occur as a result of construction activities and increased vehicular travel. These impacts could range from minor to moderate, depending on the location of mine facilities, the severity of rain events, and subsequent erosion.

Direct impacts from mining activity to specific vegetation communities cannot be fully calculated at this time because exact locations of mines are not known. In general, these impacts are estimated to be minor to moderate, depending on the location of the impacts, and are considered a long-term impact, given the fact that impacts would be scattered spatially (30 mining projects; 728 exploration projects), comparatively small in scale (approximately 20 acres per mine site and approximately 1.1 acres per exploration site) or linear in nature (22.4 miles of access roads, removing approximately 38 acres of vegetation). Although measurable, the decrease in vegetative cover would be considered a minor to moderate impact, given the relatively small areas that would be affected.

4.6.4 Impacts of Alternative B: Proposed Action (~1 Million Acres, 20-Year Withdrawal)

Under Alternative B, approximately 164 acres would be impacted by new mining. To support the mines, approximately 6.4 miles of new roads and power lines would increase the impact area by approximately 39 acres. No development is anticipated on the East Parcel, and exploration and mining on the North and South parcels would be limited to valid existing claims. Exploration, mining, and the construction of new access roads would result in impacts to 163 acres on the North Parcel and 1 acre on the South Parcel. These impacts represent approximately 0.02% of the proposed withdrawal area. Total acres of vegetation disturbed is approximately a 71% decrease, compared with Alternative A, and the number of ore haul trips would be 88,885, a 70% decrease, compared with Alternative A. The types of impacts would be similar to those described under Alternative A; however, the extent of potential impacts to vegetation resources would be reduced under this alternative.

An increase in sedimentation and soil erosion may also occur as a result of construction activities and increased vehicular travel. Vegetation in riparian areas may be affected by increased runoff, flooding, and erosion events as an indirect impact from mining operation activities in upland areas. These impacts could range from minor to moderate, depending on the severity of rainstorms and subsequent erosion.

Impacts to vegetation are similar to those described under Alternative A. When comparing potential impacts of Alternatives A and B, Alternative B provides more protection to vegetation resources within the proposed withdrawal area from uranium mine related impacts than Alternative A.

Direct impacts from mining activity to specific vegetation communities cannot be fully calculated at this time because exact locations of mines are not known. In general, vegetation impacts associated with Alternative B are estimated to be minor and are considered a long-term impact, given the fact that impacts would be scattered spatially (seven mining projects; 11 exploration projects), comparatively small in scale (approximately 20 acres per mine site and approximately 1.1 acres per exploration site) or linear in nature (6.4 miles of access roads and power lines removing approximately 39 acres of vegetation). Although measurable, the decrease in vegetative cover would be considered a minor impact, given the relatively small areas that would be affected.

4.6.5 Impacts of Alternative C: Partial Withdrawal (~700,000 Acres)

Under Alternative C, approximately 532 acres would be impacted by new mining. To support exploration and development, approximately 12.1 miles of new roads and power lines would increase the impacts by 72 acres. The types of impacts would be similar to those described under Alternative A; however, the extent of potential impacts to vegetation resources would be reduced under this alternative. All of the Petran Montane Conifer Forest on the South Parcel and riparian vegetation (Kanab Creek) and the majority of Great Basin Conifer Woodland on the North Parcel would be withdrawn from possible mineral exploration and development. Exploration, mining, and the construction of new access roads would result in impacts (such as crushing and removal of plants, dust deposition, and potential for introduction and spread of invasive species) to approximately 532 acres: 320 acres on the North Parcel, 54 acres on the East Parcel, and 158 acres on the South Parcel. This represents approximately 0.05% of the proposed withdrawal area and a decrease of 46%, compared with Alternative A, and the number of ore haul trips would be 166,725, a 44% decrease, compared with Alternative A.

Under Alternative C, specific areas with higher valued habitat resources proposed for withdrawal under this alternative include Kanab Creek on the North Parcel, areas adjacent to Marble Canyon on the East Parcel, and several major drainages on the South Parcel. By removing these highly valued habitat resources from future mining, Alternative C will benefit general and sensitive species populations more than Alternative A but less than Alternative B, which removes the entire potential withdrawal area from future mining claims.

Direct impacts from mining activity to specific vegetation communities cannot be fully calculated at this time because exact locations of mines are not known. In general, vegetation impacts associated with Alternative C are estimated to be minor and considered a long-term impact, given the fact that impacts would be scattered spatially (18 mining projects; 207 exploration projects), comparatively small in scale (approximately 20 acres per mine site and approximately 1.1 acres per exploration site), or linear in nature (12.1 miles of access roads and power lines removing approximately 72 acres of vegetation). The decrease in vegetative cover would be considered a minor impact, given the relatively small areas that would be affected.

4.6.6 Impacts of Alternative D: Partial Withdrawal (~300,000 Acres)

Under Alternative D, approximately 951 acres would be impacted by new mining. To support exploration and development, approximately 19.1 miles of new roads and power lines will increase the impacts by 114 acres. The types of impacts would be similar to those described under Alternative A; however, the potential for impacts to vegetation resources would be reduced under this alternative. The majority of the Petran Montane Conifer Forest on the South Parcel and riparian vegetation (Kanab Creek) and much of the Great Basin Conifer Woodland on the North Parcel would be removed from possible exploration and development. Exploration, mining, and the construction of new access roads would result in impacts to approximately 1,065 acres: 688 acres on the North Parcel, 54 acres on the East Parcel, and 209 acres on the South Parcel. This represents approximately 0.09% of the proposed withdrawal area is a 15% reduction, compared with Alternative A. The number of ore haul trips would be 255,685, which also represents a 15% reduction, compared with Alternative A.

Under Alternative D, specific areas with higher valued habitat resources proposed for withdrawal under this alternative include Kanab Creek on the North Parcel, areas adjacent to Marble Canyon on the East Parcel, and several major drainages on the South Parcel. By removing these highly valued habitat resources from future mining, Alternatives C and D both protect these resources from future mining, but Alternative D does not withdraw as much terrestrial habitat, which is occupied by threatened and endangered species. These areas are located in the northeastern and northwestern portions of the North Parcel, where several threatened and endangered plants species occur

Direct impacts from mining activity to specific vegetation communities cannot be fully calculated at this time because exact locations of mines are not known. In general, these impacts are estimated to be minor to moderate, depending on the location of the impacts, and are considered a long-term impact, given the fact that impacts would be scattered spatially (26 mining projects; 431 exploration projects), comparatively small in scale (approximately 20 acres per mine site and approximately 1.1 acres per exploration site), or linear in nature (19.1 miles of access roads and power lines, removing approximately 114 acres of vegetation).

Although measurable, the decrease in vegetative cover would be considered a minor to moderate impact, given the relatively small areas that would be affected.

Cumulative Impacts

The analysis area for vegetation resources is the proposed withdrawal area, Grand Canyon National Park, and the Kaibab Creek Wilderness. Mine-related cumulative impacts include the potential impacts of further development of the VANE claims (South Parcel) and Denison's Arizona 1 and EZ-1/EZ-2/What Mine (North Parcel). These actions may result in the loss of vegetation, lower vegetation productivity, higher rates of erosion and sedimentation in drainages/waterways, increased deposition of dust on vegetation adjacent to roadways, introduction and spread of invasive plants, and exposure of vegetation to uranium and its associated radionuclides. Reclamation actions will counter some of the reduction in vegetative cover. Preventive measures to inhibit the spread of invasive plants could curtail infestation by species such as cheatgrass.

Other factors that may augment the effects of the mining projects include recreation, tourism, timber harvesting, livestock grazing, and other management programs. Vehicles that use the same roadways and are not subject to the same preventive measures may act as vectors to carry invasive species seeds into areas under development for mining activities. Recently disturbed soil is readily invaded by such species.

Grazing may also increase the chances for invasive species infestation, as livestock animals often carry seeds in their hooves and fur.

Given the relatively small area of surface impact, it is anticipated that none of the alternatives would result in significant cumulative impacts to vegetation resources when added to other past, present, and reasonably foreseeable activities in the withdrawal area.

4.7 FISH AND WILDLIFE

As previous discussed in Chapter 2, the BLM and Forest Service require the preparation of plans of operation for all uranium mining projects. Plans of operation include standard operating and reclamation measures to minimize or mitigate impacts to fish and wildlife resources. The BLM RMP for the Arizona Strip Field Office establishes policy to manage resources on the Arizona Strip (North and East parcels) to preserve vital habitat for fish and wildlife species. As discussed in the Arizona Strip ROD/RMP, essential habitats, important migration routes, required flows, and water quality will be protected and maintained in lentic and lotic systems (BLM 2008b). Actions that degrade riparian habitat or reduce the potential of the area to support riparian vegetation will be modified, restricted, or prohibited (BLM 2008b). No net loss will occur in the quality and quantity of suitable habitat for endemic fish, amphibians, and aquatic invertebrate species (BLM 2008b).

The Kaibab National Forest manages resources under the Kaibab LRMP/ROD (Forest Service 1988). The Kaibab LRMP/ROD considers the relative values of all renewable resources, including the relationship of nonrenewable resources, such as minerals, to renewable resources and strives for the protection and, where appropriate, improvement of the quality of renewable resources. In particular, the Kaibab LRMP/ROD discusses avoidance or mitigation of impacts on wildlife habitats, including breeding, calving, and fawning areas; requires site-specific survey; and evaluates assessment areas during mining project design and plan (Forest Service 1988). The Forest Service manages vegetation resources in such a manner to maintain no fewer than three age classes of woody riparian species, with 10% of the woody plant cover in sprouts, suckers, seedlings, and saplings (Forest Service 1988).

The impacts discussion of this EIS assumes all mining projects within the study area would comply with standard environmental regulatory requirements and procedures. Typical compliance procedures include equipment and waste fluids are contained at all times and are disposed of at approved off-site disposal facilities; all drill cuttings are confined to a mud pit, and radioactive drill cuttings are encapsulated in sealable metal containers and re-deposited in the drill hole, or removed for appropriate disposal; mud pits are covered with topsoil such that radioactivity levels on the surface are returned to pre-drilling levels; berms are constructed around mine sites to prevent in-flows and out-flows of water (built to withstand 500-year flood events); and operators maintain all roads to assure adequate drainage and to minimize or, where practicable, eliminate damage to soil, water, and other resource values.

Even with these measures, the loss of and disturbance to vegetation and aquatic resources, along with alterations to the topographic features of the area, may impact habitat for numerous species and may result in mortality of individuals. Indirect effects on wildlife include noise, dust, and light impacts resulting from mining and transportation. As a result of groundwater drawdown, surface and groundwater environments may be impacted. These impacts may affect the water quality or quantity of area seeps, springs, and other water bodies within and adjacent to the study area and may result in mortality of aquatic-dependent species such as aquatic plants, algae, benthic invertebrates, amphibians, and fish. As discussed in Section 3.4, groundwater found on the North Parcel has geological connections to and appears to have groundwater connectivity to the Virgin River; therefore, a withdrawal in groundwater from the North Parcel could influence aquatic and riparian habitat along the Virgin River.

This groundwater connection is not anticipated to have more than a minor influence on overall water quality and quantity at the Virgin River.

The groundwater flow systems in the study area are divided into smaller perched water-bearing zones and larger regional aquifer systems (Bills et al. 2010). The perched water-bearing zones are contained in unconsolidated alluvium, volcanic rocks, and consolidated sedimentary rocks located 1,000 feet or more above the main regional aquifer systems. These perched zones generally are small and discontinuous in the subsurface. Fractures, faults, sinkholes, and breccia pipes occur throughout the study area and are pathways for downward migration of surface water and groundwater. Collapse features and breccia pipes in particular can intercept precipitation, runoff, and groundwater in perched water-bearing zones and can direct that water deeper into the subsurface. In areas containing mineralized pipes, this process can dissolve trace elements and radionuclides in the deposits and transport them to groundwater deeper in the subsurface (Bills et al. 2010).

Habitats in the Grand Canyon and its environs support a diverse flora and fauna. High-elevation areas of the Kaibab anticline are a mix of Rocky Mountain subalpine conifer forest, montane conifer forest, and subalpine grassland. The canyon lands in the region consist almost entirely of Mohave desertscrub, with isolated areas of riparian habitat that support most of the species diversity in the region (Grand Canyon Wildlands Council 2004). Vegetation has a significant effect on the occurrence and flow of water, both on the surface and in the subsurface. Areas of riparian habitat occur within the proposed withdrawal area, have exceptional biodiversity, and are critical for the plants and animals that live in the area. Many of the springs originate in water-bearing zones in the Redwall and Muav limestones and flow into canyons of the greater Grand Canyon area. These spring habitats support a species diversity that is 100 to 500 times greater than that of the surrounding landscape (Grand Canyon Wildlands Council 2004).

Mining activity can result in changes to these habitats that may increase exposure of the biological resources to chemical elements, including uranium, radium, and other radioactive decay products. Uranium and other radionuclides can affect the survival, growth, and reproduction of plants and animals. The identification of biological pathways of exposure and the compilation of the chemical and radiological hazards for these radionuclides are important for understanding potential effects of uranium mining on the northern Arizona ecosystem.

Aboveground deposits on soils, plants, and surface water expose a variety of biota to chemical and radiation exposure. Uranium and its decay products can be transported by way of infiltration into groundwater and surface waters. In addition to aquatic exposure pathways, wildlife can be exposed to chemical and radiation hazards through other various pathways, including ingestion of soil and food (prey species), inhalation, and various cell absorption processes. As discussed by the USGS (Bills et al. 2010), some seeps, springs, and other water bodies within the proposed withdrawal area contain high concentrations of dissolved trace elements and radionuclides owing to past mining activities and natural processes of evaporation, weathering, and erosion. Aquatic organisms and plants rely on these water bodies; thus, minor deviations in water quality and quantity could result in mortality of fish and other aquatic organisms or in degradation of their habitat.

Limited research has occurred regarding radionuclides from the ^{238}U decay series related to microbial, plant, and animal species and on effects linked to exposure to uranium and other radionuclides. The USGS (Hinck et al. 2010) compiled available chemical and radiation toxicity information for plants and animals from scientific literature on naturally occurring uranium and associated radionuclides. As summarized by Hinck et al. (2010), the ecotoxicity data of biological responses are best discussed in two major categories: chemical hazards and radiation hazards. Chemicals may attain hazardous concentrations that are toxic to biota in the proposed withdrawal area when encountered through the ingestion of prey and water, incidental ingestion of soil, ingestion of plant materials, inhalation of airborne contaminants, and dermal uptake. These radionuclides also present radiation hazards if exposure pathways are complete

and exposure is sufficient to yield adverse effects in receptors. Radiation (ionized, alpha, beta, and gamma) can be harmful to humans, and presumably to wildlife, if the materials are inhaled, swallowed, or absorbed through open wounds (Hinck et al. 2010).

Figures 4.7-1 and 4.7-2 document the potential linkages between chemical and radiation hazards associated with mining and biota. As discussed in more detail in Section 4.4, existing water quality conditions within the proposed withdrawal area already exceed these thresholds in some instances. Species-specific uranium threshold levels were available for two endangered fish species known to inhabit waters adjacent to the proposed withdrawal area and are discussed in more detail in Section 4.8.1. Hinck et al. (2010) suggest that caution be used when directly applying taxa specific threshold values to the proposed withdrawal area, given the unique habitat and life history strategies of flora and fauna in the proposed withdrawal area and the fact that some guidance values are based on models rather than empirical (laboratory or field) data.

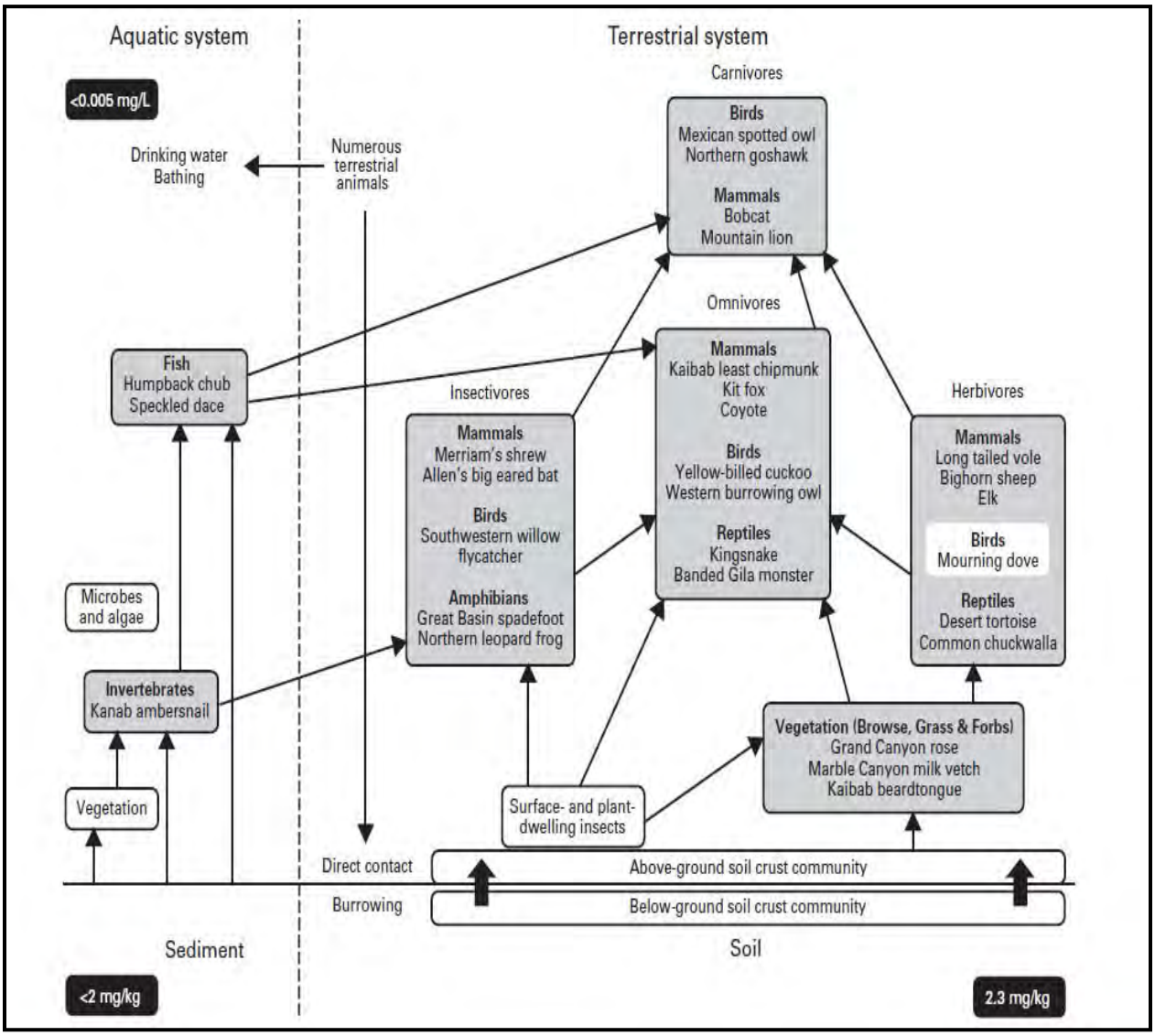

Figure 4.7-1. Potential linkage between chemical and radiation hazards associated with mining operations and biota (from Hinck et al. 2010).

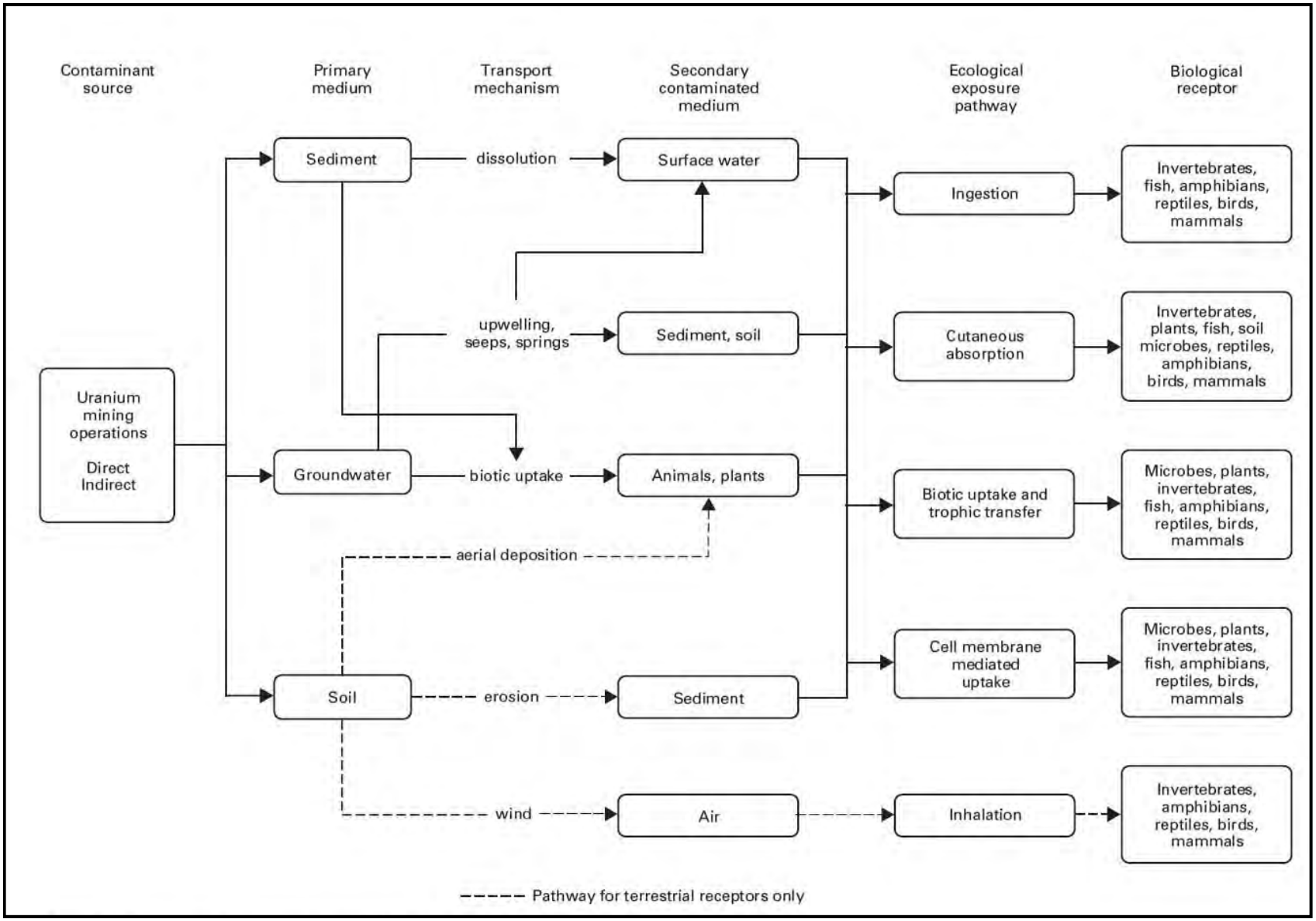

Figure 4.7-2. Exposure Pathways among generalized terrestrial and aquatic habitats (from Hinck et al. 2010).

The potential severity of impacts to wildlife is influenced by the life history strategy and habitat requirements of a particular organism. For wildlife, the use of subterranean habitats (e.g., burrows) in uranium-rich areas or reclaimed mining areas is of particular concern in the proposed withdrawal area. Certain species of reptiles, birds, and mammals spend considerable amounts of time in subterranean habitats where individuals could potentially inhale, ingest, or be directly exposed to uranium and other radionuclides while digging, eating, preening, and/or hibernating. Herbivores and omnivores may also be exposed through the ingestion of radionuclides that have been aerially deposited on vegetation or concentrated in surface water and deposited on soil at mine sites or nearby seeps, springs, or other water bodies. Benthic invertebrates, amphibians, and fish could be directly exposed to radionuclides through water and the consumption of prey species. Terrestrial wildlife and migratory birds could also be exposed to radionuclides, as these species seasonally use these isolated and rare aquatic resources.

Chemical toxicity data for algae, cyanobacteria, and aquatic microorganisms are limited, and responses to uranium exposure varied (Hinck et al. 2010). As discussed by Hinck et al. (2010), uranium inhibits the growth of aquatic microflora, diatom survival is reduced, and algae experiences growth inhibition; in addition, aquatic invertebrates, amphibian, and fish responses vary widely and include reproductive impacts and mortality. Toxicity data for aquatic vascular plants are limited, uptake and incorporation of uranium from water to plant tissues yield relatively low tissue residues, and translocation of uranium from root to foliage is low; therefore, foliage generally has lower uranium concentrations than roots (Hinck et al. 2010).

The following range of threshold values, by taxa, were assembled from available data and suggest negative impacts to aquatic biota by uranium radionuclides: algae 1.0 to 36.3 mg/L; benthic invertebrates 0.005 to 0.13 mg/L; mollusks 0.00057 to 0.365 mg/L; amphibians 1.75 to 54.3 mg/L; fish 0.02 to 46 mg/L; and mammals (non-fish-eaters) 0.05 to 16 mg/L (Hinck et al. 2010). Very limited information is available for birds in aquatic settings; however, a threshold of 69 mg/L for non-fish-eaters was documented in Table 6 from Hinck et al. (2010). Uranium and its constituents can also impact terrestrial biota. The following terrestrial environment (soil) threshold values were pulled from available data and suggest adverse impacts to biota by uranium radionuclides: terrestrial plants, 0.01 to 40.0 mGy/h, terrestrial invertebrates 0.2 to 40 mGy/h, mammals, 0.004 to 40.0 mGy/h; and birds, 0.14 to 5 mGy/h (Hinck et al. 2010).

Impacts to wildlife using these thresholds vary from reproductive and growth/developmental impacts to mortality. As discussed in Hinck et al. (2010), very little research has actually been performed to develop taxa specific plant and wildlife threshold levels for uranium or other metals such as, thallium, thorium, bismuth, radium, radon, and polonium. These uranium threshold values discussed above serve as means to generally evaluate the potential impact of direct exposure of radionuclides on wildlife.

4.7.1 Impact Assessment Methodology

Quantitative and qualitative approaches used to estimate impacts to fish and wildlife include calculations of terrestrial, riparian, and aquatic habitat impacts relative to the availability of those resources within the proposed withdrawal area; the disturbance footprint of exploration and mine sites and the spatial nature of those impacts; published literature on disturbance-related impacts to wildlife; and existing agency management plans and reports addressing surface impact management. The spatial boundaries of analysis vary by resource, cross political, administrative, and state boundaries, and were expanded beyond the proposed withdrawal area to include the larger extent of regional drainages to account for seasonal movements, the large geographic range of many species, and the potential for long-term indirect impacts.

For fish and wildlife resources, resource condition indicators include the following:

- acres and type of terrestrial and/or aquatic habitat loss and/or degradation;
- changes in water quality or quantity at aquatic sites;
- changes in migratory and/or foraging behavior;
- avoidance or adaptation of wildlife species to noise source/visual intrusion;
- acres of habitat loss or degradation as a result of establishment of invasive species caused by mineral exploration and development activities; and
- habitat fragmentation of critical winter range or calving, fawning, or nesting areas subject to disturbance at a given time.

Effects are quantified where possible. In the absence of quantitative data, the best professional judgment was used. Impacts are sometimes described using ranges of potential impacts or in qualitative terms, if appropriate. Table 4.7-1 provides thresholds and descriptions, and Table 4.7-2 provides durations used during analysis for general fish and wildlife resource impacts. Special status species, which include several aquatic-dependent and terrestrial wildlife species, are discussed in more detail in Section 4.8.

Table 4.7-1. Magnitude and Degrees of Effects on Fish and Wildlife Resources

Attribute of Effect	Description Relative to Fish and Wildlife Resources
Magnitude	
No Impact	Would not produce changes in aquatic, riparian, and/or terrestrial habitat components or impact the behavior or overall viability and distribution of fish and wildlife populations.
Minor	Project-related impacts would occur to aquatic, riparian, and/or terrestrial habitat components; however, physical and chemical alterations to plants and animals, alterations to water quantity or quality at area seeps, springs and other water bodies, and impacts to overall quality and quantity of unfragmented habitat would not be measurable or apparent. Individuals (fish and wildlife) may experience reduced viability or mortality; however, these impacts would not alter fish and wildlife distribution in the study area or result in changes to overall fish and wildlife population viability.
Moderate	Project-related impacts would occur to aquatic, riparian, and/or terrestrial habitat components. Physical and chemical alterations to plants and animals, alterations to water quantity or quality at area seeps and springs and other water bodies, and/or impacts to overall quality and quantity of unfragmented habitat would be measurable but not apparent. Individuals (fish and wildlife) may experience reduced viability or mortality; these impacts could alter fish and wildlife population distributions in the study area, but would not result in changes to overall fish and wildlife population viability.
Major	Project-related impacts would occur to aquatic, riparian, and/or terrestrial habitat components. Physical and chemical alterations to plants and animals, alterations to water quantity or quality at area seeps, springs and other water bodies, and/or impacts to overall quality and quantity of unfragmented habitat would be measurable and apparent. These impacts would cause reduced viability or mortality of individuals (fish and wildlife) and could threaten the viability and distribution of one or more fish and wildlife population in the study area.

Table 4.7-2. Duration Definition of Effects on Fish and Wildlife Resources

Duration	
Temporary	Transient (period of project right-of-way construction and de-construction)
Short-term	Less than 5 years
Long-term	Greater than 5 years

4.7.2 Incomplete or Unavailable Information

Although some research has been performed, a more detailed, quantitative analysis of the possible effects of chemical and radiation hazards to general wildlife species that occur within the proposed withdrawal area would be useful for future project analysis.

In addition to a more detailed understanding of how chemical and radiation hazards impact wildlife, more precise information on the locations of exploration sites, mine sites, and roads would be useful to better understand the magnitude, extent, and duration of impacts to wildlife and fish species.

As discussed in Bills et al. (2010), only a few trace patterns were found between trace-element concentrations in groundwater and the mining activities. Consequently, patterns or the lack of patterns in trace-element chemistry with respect to mining conditions was considered inconclusive and to merit additional investigations.

A more detailed collection and analysis of additional water-chemistry data from springs and wells in the r- aquifer within the proposed withdrawal area to determine groundwater flow characteristic north of the Colorado River that affect mobility of radionuclides near ore deposits and mined areas would be useful for future project analysis. Such an investigation would require the drilling of new observation wells in this area.

Monitoring of water levels in wells developed in the R-aquifer could provide information about the hydraulic connections between mined areas, springs, and seasonal precipitation in the area.

To assist future project specific assessments, the agencies should establish a network of surface-water and water-quality monitoring sites in Kanab Creek Basin (North Parcel). These sites would allow sampling of runoff that can then be analyzed for total radionuclide flux in this area.

4.7.3 Fish and Aquatic Resources

Direct and Indirect Impacts

Impacts to fish and aquatic resources are expected to occur for each of the alternatives and are discussed below. Impacts to wildlife and migratory birds are discussed in Sections 4.7.4 and 4.7.5, respectively. It should also be noted that many aquatic-dependent species are discussed in Section 4.8, Special Status Species.

Aquatic resources within the proposed withdrawal area are mostly ephemeral drainages that flow directly or indirectly into the Colorado River. Most of the tributaries that drain the north of the Colorado River are ephemeral, except for short perennial reaches supported by groundwater discharge. Kanab Creek is the only perennial stream within the proposed withdrawal area. Kanab Creek, the largest tributary north of the Colorado River, drains 2,360 square miles and contains many breccia pipes, many mines and prospects for copper and other ore, and six uranium mines. South of the Colorado River, all tributaries on the Coconino Plateau are ephemeral, except for short perennial reaches supported by groundwater discharge. On the south, the largest tributaries that drain to the Colorado River are the Little Colorado River and Havasu Creek.

Impacts of Alternative A: No Action (No Withdrawal)

Under Alternative A, the No Action Alternative, the proposed withdrawal area would remain open to location and entry under the Mining Law. New mining claims could be located, and exploration and

development activities would continue to be processed by the BLM or the Forest Service. Alternative A analysis estimates that the removal of 969 acre-feet of water from the R-aquifer over 20 years is equivalent to approximately 30 gpm, or a reduction in flow of approximately 1% to 2% over 20 years. Alternative A estimates that approximately 316 mgal of water would be required over a 20-year period or up to approximately 11 mgal per year. As discussed in Section 3.4, the discharge rate at study area R-aquifer springs range from approximately 1,000 gpm to approximately 100,000 gpm. Groundwater within the North Parcel flows into two major drainages, the Virgin River and Kanab Creek. While an overall 1% to 2% decrease in flow may seem minor over 20 years, this reduction has the potential to produce impacts to the quantity and quality of aquatic and riparian habitats that support a host of aquatic and terrestrial species. A measurable reduction in flow at the Virgin River is not anticipated.

Mining-related impacts on perched aquifers include a potential of reduced flow related to downward migration of flows from the perched aquifer as a result of the mine drill shaft. This in effect, has the potential to reduce flow or dry up seeps and springs connected to the perched aquifer. Perched aquifers, which typically have less flow volumes than springs associated with the R-aquifer, would have a greater magnitude of impacts. Flows at many study area seeps and springs are connected to perched aquifers that deliver as little as a few gallons of water per minute to several hundred gallons per minute. Therefore, a reduction in flow has the potential to impact the density of aquatic and riparian habitats that are linked to perched aquifer sources and could cause the impact magnitude to range from minor to major. The duration of this impact could range from short term to long term, depending on the success of mine reclamation to plug the mine shaft to eliminate downward flow from the perched aquifer.

Impacts to aquatic habitats would further reduce cover and prey species for both aquatic and terrestrial organisms, increased competition for remaining resources, increased predation, and loss of potential dispersal and foraging habitat. Aquatic-dependent individuals may experience reduced viability or mortality; however, these impacts would not likely alter the overall fish and wildlife distribution in the study area or result in changes to overall fish and wildlife population viability. The study area is located in an arid region that may experience extreme drought conditions for many years. During these extreme drought conditions, the additional strain on groundwater (11 mgal per year) has the potential to impact the size and quality of aquatic and riparian habitats. The aquatic resources of the study area are vital regional habitat components for many wildlife species and represent important life-sustaining resources associated with regional wildlife. For a more detailed discussion on wildlife impacts, see Section 4.7.4.

As mentioned, Alternative A could impact water quantity at area seeps, springs, and other water bodies within the study area, including Kanab Creek, which is a significant aquatic resource within a designated wilderness; however, these impacts are not anticipated to alter the overall fish and wildlife distribution in the study area or result in changes to overall fish and wildlife population viability. Impacts associated with acres lost of aquatic and riparian habitat were not calculated but could be assumed to be measurable but not apparent during any given year within the 20-year study time frame. Impacts to water quantity are considered short term in duration because reductions in flow would be eliminated after the mine is closed.

Uranium is naturally present in many surface waters within the proposed withdrawal area. Increased uranium levels in groundwater associated with implementation of Alternative A could impact surface waters (seeps, springs, and other water bodies) in the study area. As is evident with the previously mentioned thresholds, impacts to plants and animals could occur with even minor increases of uranium concentrations. Estimated levels of uranium are anticipated to increase by barely detectable amounts under Alternative A; however, even minor increases in uranium levels could have the potential to impact individual aquatic organisms. Impacts from increased uranium levels in surface waters could occur at every level of the foodweb. These impacts include decreased viability, increased resource competition with other individuals or species that may be more uranium tolerant, and even mortality. The increases of uranium in area surface waters are anticipated to be localized and non-detectable once mixed with the

larger flows of the Colorado River. The specific location of a mine along with the type of aquifer (R-aquifer or perched aquifer) impacted would determine the magnitude of impacts.

Some mines have been in interim management mode for decades as world uranium prices fluctuate. When a mine is in interim management mode, portions of the mine are shut down and equipment is possibly even removed; however, risk of contamination is still a possibility. Several recent studies at uranium mines in northern Arizona that are in interim management mode have shown that radiation and chemical hazards are still present in and around the mine sites. Soil and water samples collected documented increased levels of uranium and its decay constituents. Based on the impact discussions above, Alternative A has the potential to impact aquatic resources and organisms within the study area. Depending on the location of the mine, number of years in operation, and impacts on local aquifers, impacts could range from minor to major and would be considered long term in duration.

In summary, Alternative A could increase uranium levels at area seeps, springs, and other water bodies and could result in mortality of individuals or reduced viability of individuals; however, these impacts are not anticipated to alter the overall distribution of fish and aquatic organisms in the study area, nor result in changes to overall fish and wildlife population. Although reclamation of breccia pipes can be nearly fully mitigated when a mine is closed (reduce or eliminate uranium and other contaminants from moving into aquifers), the potential for impacts associated with chemical and radiation exposure would remain in aquatic resources for more than 20 years; therefore, the duration of impact is considered long term.

Impacts of Alternative B: Proposed Action (~1 Million Acres, 20-Year Withdrawal)

Alternative B, the Proposed Action, would withdraw the entire 1,010,776 acres of federal mineral estate within the three parcels for 20 years from operation of the Mining Law, subject to valid existing rights. Alternative B would prohibit the location and entry of new mining claims within the proposed withdrawal area as well as the exploration or development on existing mining claims not supported by a discovery under the Mining Law. On mining claims where valid existing rights are determined to exist, drilling and mining activities would continue to be processed by the BLM or the Forest Service. Portions of the North Parcel are located within the Kanab Creek Wilderness management area, which has moderate to high potential for uranium. The Arizona Wilderness Act of 1984 withdrew the area to entry under the mining and mineral leasing laws, subject to rights established before the date of its wilderness designation. The bottoms of Kanab Creek and Snake Gulch form a portion of the northern and western boundaries of the Grand Canyon National Game Preserve, which is also closed to locatable mineral entry. There is a narrow strip of land, north of Snake Gulch and west of Kanab Creek, which is outside the Grand Canyon National Game Preserve but within this wilderness area. Numerous mining claims were located in this portion of the management area prior to its wilderness designation in 1984 and could continue to operate under this and all other alternatives.

Under Alternative B, approximately 355 acre-feet of water would be removed from the R-aquifer over 20 years. This equates to approximately a 66% reduction in water use over Alternative A. Under Alternative B, no development is anticipated on the East Parcel, and exploration and development on the North and South parcels would be limited to valid existing claims. The portion of the North Parcel that appears to have groundwater connections to the Virgin River would be removed from future mining under this proposal. Under Alternative B, potential impacts to aquatic habitats in the proposed withdrawal area (e.g., in Kanab Creek) are anticipated as a result of possible mining at Pinenut, Kanab North, and Canyon mines. Alternative B estimates that approximately 116 mgal of water would be required over a 20-year period, or up to approximately 5 mgal per year. The magnitude of the impact depends on the location of the mine, potential mine related impacts on perched aquifers, the length of time the mine is open or in interim management mode, and when reclamation occurs.

Impacts discussion under Alternative B would be similar to those under Alternative A; however, given the reduced water use, impacts to the quantity or quality of aquatic resources at area seeps, springs, and other water bodies would not be measurable or apparent and would be considered minor. Under this Alternative, vital surface water resources within the North Parcel would still be impacted by existing mining claims, but with the removal of new mining claims under Alternative B, it would further reduce the amount of impacts to area's aquatic resources. Under Alternative B, these resources are afforded more proposed protection than under Alternative A. Depending on the location of the mine, number of years in operation, and impacts on local aquifers, the impacts are considered long term in duration.

Impacts of Alternative C: Partial Withdrawal (~700,000 Acres)

Alternative C would withdraw 652,986 acres of federal mineral estate within the three parcels for 20 years from operation of the Mining Law, subject to valid existing rights. This alternative would withdraw the largest contiguous area identified on the resource overlays with concentrations of biological resources that could be adversely affected by locatable mineral exploration and development (see Figures 2.4-2 through 2.4-4 in Section 2.4.4). As previously mentioned, portions of the North Parcel are located within the Kanab Creek Wilderness Area, which is a significant biological resource within the proposed withdrawal area. Even though this area is removed from future mining projects, this area still contains existing and valid mining claims that could still be operated under this alternative. Alternative C would leave the remaining portion of the proposed withdrawal area with isolated or low concentrations of these resources open to operation under the Mining Law.

Under Alternative C, areas with potential aquatic resources or hydrologic resource value proposed for withdrawal include Kanab Creek on the North Parcel, areas adjacent to Marble Canyon on the East Parcel, and several major ephemeral drainages on the South Parcel. The portion of the North Parcel that appears to have groundwater connections to the Virgin River would remain available to future mining claims under this alternative. Approximately 581 acre-feet of water would be removed from the R-aquifer over 20 years. This represents a 40% decrease in water use, compared with Alternative A. Implementation of Alternative C would require the use of approximately 190 mgal of water over a 20-year period, or up to approximately 7 mgal per year. The magnitude of the impact depends on the location of the mine, potential mine related impacts on perched aquifers, the length of time the mine is open or in interim management mode, and when reclamation occurs.

Impacts discussion under Alternative C would be similar to those under Alternative A; however, given the reduced water use, impacts to the quantity or quality of aquatic resources at area seeps, springs, and other water bodies would not be measurable or apparent and would be considered minor. Under this alternative, vital surface water resources within the North Parcel would still be impacted by existing mining claims, but with the removal of new mining claims from this area, further reductions in the amount of impacts to area aquatic are anticipated over Alternative A. Alternatives B and C both preserve this portion of the North Parcel from future mining claims; however, Alternative B would use approximately 29% less water than Alternative C. Depending on the location of the mine, number of years in operation, and impacts on perched aquifers, the impacts are considered long term in duration.

Impacts of Alternative D: Partial Withdrawal (~300,000 Acres)

Alternative D would withdraw approximately 300,681 acres of federal mineral estate within the three parcels for 20 years from operation of the Mining Law, subject to valid existing rights. This alternative would withdraw the contiguous area identified on the resources overlays where there is a high concentration of biological resources that could be adversely affected by locatable mineral exploration and development (see Figures 2.4-5 through 2.4-7 in Section 2.4.5). Alternative D would leave the remaining portion of the proposed withdrawal area with isolated or low concentrations of these resources

open to operation under the Mining Law. The mitigation of potential effects from exploration or development would continue under the applicable surface managing agency regulations.

Under Alternative D, approximately 840 acre-feet of water would be removed from the R-aquifer over 20 years. This equates to approximately a 13% reduction in water use, compared with Alternative A. The portion of the North Parcel that appears to have groundwater connection to the Virgin River would remain available for future mining under this Alternative. Under Alternative D, potential impacts to springs or other aquatic habitats in the proposed withdrawal area (e.g., in Kanab Creek) are anticipated as a result of existing mining at Pinenut, Kanab North, and Canyon mines. Alternative D estimates that approximately 274 mgal of water would be required over a 20-year period or up to approximately 11 mgal per year. The magnitude of the impact depends on the location of the mine, potential mine related impacts on perched aquifers, the length of time the mine is open or in interim management mode, and when reclamation occurs.

Impact discussion under Alternative D would be similar to those of Alternative A; however, given the reduced water use, impacts to the quantity or quality of aquatic resources at area seeps, springs, and other water bodies would not be measurable or apparent and would be considered minor. Under this Alternative, vital surface water resources within the North Parcel would still be impacted by existing mining claims, but with the removal of new mining claims from this area, further reductions in the amount of impacts to area aquatic are anticipated over Alternative A. Alternatives C and D both preserve this portion of the North Parcel from future mining claims; however, Alternative C removes more land from future mining and uses approximately 37% less water than Alternative D. Depending on the location of the mine, number of years in operation and impacts on perched aquifers, the impacts are considered long term in duration.

Cumulative Impacts

The analysis area for fish and aquatic resources is the proposed withdrawal area (North, East, and South parcels), the Park, and the North Kaibab Ranger District. This study area has the potential for impacts to springs. Based on the alternatives discussed above, mining would increase groundwater use in the proposed withdrawal area. When combined with the impacts of these other foreseeable projects, all of the alternatives could contribute to higher rates of erosion, an increased potential for sedimentation and contamination in drainages/waterways, and increased water use in the study area. Furthermore, mining-related impacts (downward migration of water) on perched aquifers, when considered in combination with other non-mining-related perched aquifer wells, could reduce flows at areas seeps and springs and contribute to additional impacts on these rare surface water resources.

Given the relatively small area of surface impact and limited water use, it is anticipated none of the alternatives would result in significant cumulative impacts to fish and aquatic resources when added to other past, present, and reasonably foreseeable activities in the proposed withdrawal area.

4.7.4 General Wildlife Species

Direct and Indirect Impacts

Direct impacts to wildlife would result from habitat alteration and fragmentation, wildlife vehicle collisions, temporary displacement during construction, operation, and reclamation activities, and increased potential to exposure of chemical and radiation hazards associated with bioaccumulation in air, soil, vegetation, and prey species. Acres of impact to wildlife habitat include direct impacts related to acres disturbed by the mine site, roads, and power lines, plus an additional 0.5-mile area around road corridors to account for indirect impacts associated with roadway noise, air, and visual disturbances that

could adversely affect animal behaviors. The Transportation Research Board reported that most roadway-related direct and indirect impacts to mammals were undetectable 600 m (1,980 feet) away from a road (National Cooperative Highway Research Program 2008).

The following habitat/vegetation types could potentially be impacted by any of the alternatives: Great Basin Desertscrub, Plains and Great Basin Grassland, Great Basin Conifer Woodland, and Rocky Mountain (Petran) (Brown 1994). The acres of habitat lost by vegetation type cannot be fully estimated at this time because exact locations of exploration and development operations are not known (see Section 4.6 for more discussion on vegetation impacts). Since the location of mines is not known, the exact locations of roads and power lines cannot be determined either.

Table 4.7-3 contains a list of Forest Service MIS considered for analysis. It should be noted that Section 4.8 has many aquatic and terrestrial species that are addressed under the Special Status Species discussion later in Section 4.8 instead of in this section for general wildlife.

Connectivity between aquatic and terrestrial habitats ensures transfers of uranium across environmental habitats. Uranium in ore deposits accumulates in soils and reaches surface waters and sediments through physical processes mediated by natural and/or human-aided mechanisms. Biota of concern, based on the food web include soil microorganisms (including soil crust and microbial communities), aquatic microorganisms, terrestrial and aquatic vascular plants, terrestrial and aquatic invertebrates, fish, amphibians and reptiles, birds, and mammals.

Table 4.7-3. Forest Service Management Indicator Species on the Proposed Withdrawal Area

Management Indicator Species	Scientific Name	Habitat or Habitat Component	Proposed Withdrawal Area
Invertebrates			
Aquatic macroinvertebrates	Includes mayflies, stoneflies, and caddisflies	Riparian	North Parcel
Birds			
Northern goshawk	*Accipiter gentilis*	Late-seral ponderosa pine	South Parcel
Merriam's turkey	*Meleagris gallopavo merriami*	Late-seral ponderosa pine	East and South parcels
Hairy woodpecker	*Picoides villosus*	Snags in ponderosa pine, mixed-conifer, and mixed-conifer with aspen habitats	South Parcel
Juniper titmouse	*Baeolophus ridgwayi*	Late-seral pinyon-juniper and snags in pinyon-juniper	All parcels
Pygmy nuthatch	*Sitta pygmaea*	Late-seral ponderosa pine	East and South parcels
Lucy's warbler	*Vermivora luciae*	Late-seral low-elevation riparian	North Parcel
Yellow-breasted chat	*Icteria virens*	Late-seral low-elevation riparian	North Parcel
Mammals			
Elk	*Cervus elaphus*	Early-seral ponderosa pine, mixed conifer, spruce-fir	South Parcel
Mountain lion	*Puma concolor*	Mixed conifer, pinyon-juniper and early- and late-seral grassland	All parcels
Mule deer	*Odocoileus hemionus*	Early-seral aspen and pinyon-juniper	All parcels
Pronghorn	*Antilocapra americana*	Early- and late-seral grassland	East and South parcels
Abert's squirrel	*Sciurus aberti*	Early-seral ponderosa pine	South Parcel

Uranium and other radionuclides can be transported through the environment and contribute to exposure of biological receptors via atmospheric deposition, dust, runoff, erosion and deposition, groundwater and surface water, and the food chain. As a result, biological receptors can be exposed to radionuclides through various pathways, including ingestion (soil, food, or water), inhalation, cell membrane–mediated uptake, cutaneous absorption, and biotic uptake/trophic transfer. Biological soil crusts are assemblages of lichens, fungi, cyanobacteria, and mosses that colonize soil surfaces and represent up to 70% of the living groundcover in arid land environments (Belnap and Lange 2001; Belnap et al. 2005). Biological soil crusts are critical to the transfer of nutrients from seasonal surface runoff.

The uptake of uranium and uranium decay series products into animals is similar to that of other metals. Metals that have a similar size and charge to essential trace metal nutrients can be taken up across biological membranes through specific transport mechanisms (for example, sodium/potassium exchange pumps). In general, the liver and kidney are the primary sites of uranium accumulation, with bones, scales, gonads, gills, and gastrointestinal tract variously contributing to the accumulated uranium load (Colley and Thomson 1991; Holdway 1992). Ecotoxicity data were compiled to provide relevant information on chemical hazards to aquatic and terrestrial biota of concern; data were limited to radionuclides of the ^{238}U decay series, including uranium, thallium, thorium, radium, and radon, because they are relatively long-lived.

The USGS (Otton et al. 2010) researched past uranium mining impacts at several uranium mines in northern Arizona. Uranium and arsenic were consistently the most abundant trace elements of concern at mined sites. Soil samples were collected within about 420 feet outside the fenced mine site had an average uranium concentration of 27.8 ppm (more than 10 times background concentration) and an arsenic concentration of 12 ppm. Wind appears to be the dominant process dispersing material off-site. The USGS also sampled exploratory mine locations. Although uranium has not been mined at this breccia pipe site, elevated concentrations of uranium and other trace elements are found at these sites and in the vicinity.

The sensitivity of biota to radiation and chemical exposures is also influenced by the size of the organism, i.e., mass. For example, large-bodied species are typically more vulnerable to high levels of radiation exposure than small-bodied species because of the greater collision potential (i.e., larger target) between the ionizing radiation and biota (Bytwerk 2006; Higley and Bytwerk 2007). A species' life history may also affect its sensitivity to radiation.

Exposures to high levels of ionizing radiation produce adverse biological effects, such as increased cell death, decreased life expectancy, reduced growth, and altered behavior. Alpha particles released during radionuclide decay can cause adverse effects during radiation exposures through ingestion or inhalation in animals or uptake and translocation in plants (Sample et al. 1997). Early developmental stages or life stages with rapid growth are generally more sensitive to radiation exposure than older, relatively mature organisms of the same species. Embryos and fetuses are typically more sensitive to ionizing radiation because these early life stages are dominated by rapidly dividing cells (Brenner et al. 2003; Huettermann and Koehnlein 1978; Riley 1994). Cells undergoing division though mitosis are more susceptible than cells that are not proliferating, and damage to the cellular DNA often results in cell death.

Radiation effects data for soil biota, terrestrial plants, and terrestrial animals include more acute studies than chronic studies and are generally too limited to establish presumptive no-effect levels (Woodhead and Zinger 2003). Reproductive capacity is the most frequently studied effect of acute radiation exposure in all biota; however, data on morbidity, mortality, and mutation are also available. Morbidity, or the general health of biota, is the most common effect reported for chronic exposures, although survival and effects on reproduction are also found. Radiation dose rates rarely exceeded 10 mGy/h, and threshold effects levels were generally 0.10 mGy/h.

Soil fauna consist of a large variety of species ranging from protozoa to earthworms and arthropods. Chronic and acute radiation effects data, primarily related to mortality, are available but limited for these receptors (Woodhead and Zinger 2003). For example, effects data for low acute doses (less than 5 mGy/h) were rarely reported, and chronic exposure data relied predominantly on survival. Relatively sedentary animals, such as earthworms, are vulnerable to internal exposure by alpha radiation because they directly forage in the soil and can experience decreases in population sizes after chronic exposure (Woodhead and Zinger 2003). Woodhead and Zinger (2003) reported that soils with elevated natural background levels of radiation (0.001–0.002 mGy/h) contained fewer earthworms and insect larvae, compared with reference areas.

Chemical and radiation effects thresholds for radionuclides are consistently limited to only a few species for most biological receptors, and limited data are available for wildlife species. Minimal chemical toxicity data are available for microbes, aquatic vascular plants, terrestrial invertebrates, and amphibians, and no data were found for reptiles, birds, or mammalian wildlife. Toxicity data are most abundant, but still limited, for aquatic invertebrates, fish, and laboratory test mammals.

Potential exposure to chemical and radiation hazards could result in direct and indirect impacts to wildlife. Available data suggest negative impacts to biota by uranium radionuclides for terrestrial plants from 0.01 to 40.0 mGy/h, terrestrial invertebrates from 0.2 to 40 mGy/h, mammals from 0.004 to 40.0 mGy/h, and birds from 0.14 to 5 mGy/h (Hinck et al. 2010). The potential magnitude of impacts would be influenced by the life history strategy and habitat requirements of a particular animal (Hinck et al. 2010). For wildlife, the use of subterranean habitats (e.g., burrows) in uranium-rich areas, or reclaimed mining areas, is of particular concern in the proposed withdrawal area. Certain species of reptiles, birds, and mammals spend considerable amounts of time in subterranean habitats, where individuals could potentially inhale, ingest, or be directly exposed to uranium and other radionuclides while digging, eating, preening, and/or hibernating. Herbivores may also be exposed through the ingestion of radionuclides that have been aerially deposited on vegetation or concentrated in surface water at mine sites or nearby seeps, springs, or other water bodies.

Impacts of Alternative A: No Action (No Withdrawal)

Under Alternative A, approximately 1,364 acres would be impacted by new mining. To support the exploration and development projects, approximately 22.4 miles (67.6 acres) of new dirt roads and 22.4 miles (67.6 acres) of new power lines would also be constructed. An average width of 25 feet was used for both roads and power line facility calculations. An estimated 300,165 ore haul trips would be required on these new roads. For impact discussions, an additional 0.5-mile area on either side of the dirt roads was added to the calculations to account for noise and visual intrusions that could affect wildlife behavior. It was also assumed that the power lines would follow dirt roads and therefore were included in this 0.5-mile indirect impact area. This 0.5-mile area on either side of a new road equates to an additional 22.4 square miles (14,336 acres) of indirect impacts to wildlife habitat. The total acres of disturbance under Alternative A over a 20-year time frame has been calculated at approximately 1,500 acres of direct impact related to mining, roads, and power line impacts and an additional 14,336 acres of indirect impacts associated with the 0.5-mile area for a total of 15,836 acres impacted, or approximately 1.5% of the proposed withdrawal area. The North Parcel would have the most impacts, with approximately 11,540 acres impacted, or 2% of available land within that parcel. The East Parcel would have approximately 1,657 acres impacted, or 1.2% of available land within that parcel. The South Parcel would have approximately 2,638 acres impacted, or 0.8% of available land within that parcel.

Wildlife may be injured or killed by collisions with vehicles traveling on the road system. Impacts from collisions typically affect individuals, although populations could be adversely affected if the species is rare or collisions are frequent. Birds, reptiles, and small mammals are among the species most commonly hit by vehicles. The potential to impact small mammals or other wildlife with small home ranges is

possible with the 20-acre mine site but is considered minor based on the amount of available habitat remaining within the proposed withdrawal area. Large mammals with winter range, calving, and/or fawning habitat in the proposed withdrawal area include mountain lions, elk, mule deer, pronghorn, and desert bighorn sheep. Although there would be no targeted protection of critical winter range, calving, fawning, or nesting areas for general wildlife species, impacts are expected to be minimal, given the amount of acres disturbed and the implementation of low speed limits.

The average speed for most roads in the proposed withdrawal area is generally less than 35 mph, but some vehicles associated with mining operations (i.e., haul/ore trucks) are restricted to speeds of 25 mph or less. Collisions are expected to be infrequent in the proposed withdrawal area. Only a few roads are paved (SR 64, SR 67, and U.S. 89A) which would allow speeds in excess of 50 mph, and there are no plans to pave any roads as part of any alternative. The noise and visual disturbances associated with roads and mines may influence wildlife foraging behavior, as some species would be displaced during construction, use, and reclamation. Construction noise and disturbance from human activity would continue until the completion of reclamation activities.

In addition to direct habitat impacts and possible vehicle-wildlife collisions, indirect impacts to wildlife include the following: dust settling on vegetation adjacent to roads could temporarily reduce habitat productivity; and increased noise and visual intrusions could temporarily impact animal behaviors. New roads also increase habitat fragmentation while the roads are in use. Habitat fragmentation varies in magnitude and intensity by wildlife species and location of roads within the proposed withdrawal area. As depicted in Figure 3.7-1, recognized wildlife linkages within the proposed withdrawal area are associated with existing paved roads (U.S. 89A, SR 64, and SR 67) (Arizona Wildlife Linkages Workgroup 2006), although wildlife can and do move anywhere within the entire proposed withdrawal area in search of food and shelter. As part of implementation of Alternative A, it is assumed that new access roads could tie directly into regional paved road; therefore, impacts associated with new access points would create another linear transportation feature within these established wildlife corridors that would need to be studied as part of the plan of operations as well as for the Arizona Department of Transportation right-of-way application that is required for temporary construction within an existing transportation corridor.

Impacts to overall quality and quantity of unfragmented habitat would be measurable but not apparent. Individuals may experience reduced viability or mortality; however, these impacts would not alter wildlife distribution in the study area or result in changes to overall wildlife population viability. These impacts are considered moderate, given the amount of acres impacted (1.5%), and long term, as impacts would be scattered spatially and temporally (30 mining projects over 20 years; 728 exploration projects over 20 years). New access roads would be reclaimed when the mine is closed. Access roads would be shared when multiple mines are located in the general vicinity, which would further reduce the physical footprint of new roads but would extend the duration of select roads for as much as 20 years, while others may be open and closed within a 3- to 5-year time frame.

Impacts of Alternative B: Proposed Action (~1 Million Acres, 20-Year Withdrawal)

Under Alternative B, approximately 164 acres would be impacted by new mining. To support the exploration and development projects, approximately 6.4 miles (19.3 acres) of new dirt roads and 6.4 miles (19.2 acres) of new power lines would also be constructed. An average width of 25 feet was used for both roads and power line facilities. An estimated 88,885 ore haul trips would be required on these new roads. For impact discussions, an additional 0.5-mile area on either side of new roads was added to the calculations to account for noise and visual intrusions that may affect wildlife behavior. It was also assumed that the power lines would follow the dirt roads, and they were therefore included in this 0.5-mile area. This area equates to an additional 6.4 square miles (4,096 acres) of indirect wildlife habitat

impacts. The total acres of disturbance under Alternative B over a 20-year time frame has been calculated at approximately 203 acres of direct impact related to mining, road, and power line impacts and an additional 4,096 acres of indirect impacts associated with a 0.5-mile area, for a total of 4,300 acres impacted, or approximately 0.4% of the proposed withdrawal area. The North Parcel would have the greatest amount of impacts, with approximately 4,095 acres impacted, or 0.7% of available land within that parcel. The East Parcel would not have any impacts under this alternative. The South Parcel would have approximately 1 acre impacted, or <0.01% of available land within that parcel.

Impacts to wildlife are similar to those described under Alternative A; however, given the reduced impacts (fewer acres directly and indirectly affected, fewer roads and power lines built, fewer haul trips generated) associated with Alternative B, the magnitude of these impacts is significantly less. Impacts to overall quality and quantity of unfragmented habitat would not be measurable or apparent. Individuals may experience reduced viability or mortality; however, these impacts would not alter wildlife distribution in the study area or result in changes to overall wildlife population viability. These impacts are considered minor, given the amount of acres impacted (0.4%), and long term, as impacts would be scattered spatially and temporally (10 mining projects over 20 years; 11 exploration projects over 20 years).

Impacts of Alternative C: Partial Withdrawal (~700,000 Acres)

Under Alternative C, approximately 532 acres would be impacted by new mining. To support the exploration and development projects, approximately 12.1 miles (36 acres) of new dirt roads and 12.1 miles (36 acres) of new power lines would also be constructed. An estimated 166,725 ore haul trips would be required on these new roads. For impact discussions, an additional 0.5-mile area on either side of the dirt roads was added to the calculations to account for noise and visual intrusions that may affect wildlife behavior. It was also assumed that the power lines would follow the dirt roads and therefore were included in this 0.5-mile area. This area equates to an additional 12.1 square miles (7,744 acres) of indirect wildlife habitat impacts. The total acres of disturbance under Alternative C over a 20-year time frame has been calculated at approximately 604 acres of direct impact related to mining, road, and power line impacts and an additional 7,744 acres of indirect impacts associated with a 0.5-mile area for a total of 8,348 acres impacted, or approximately 0.8% of the proposed withdrawal area. The North Parcel would have the greatest amount of impacts, with approximately 6,216 acres impacted, or 1.1% of available land within that parcel. The East Parcel would have approximately 829 acres impacted, or 0.6% of available land within that parcel. The South Parcel would have approximately1,321 acres impacted, or 0.4% of available land within that parcel.

Under Alternative C, specific areas with high potential wildlife resource value proposed for withdrawal include Kanab Creek on the North Parcel, areas adjacent to Marble Canyon on the East Parcel, and several major drainages on the South Parcel. By removing these high potential wildlife resources from future mining, Alternative C will benefit general wildlife populations more than Alternative A but less than Alternative B, which removes the entire potential withdrawal area from future mining claims.

Impacts to wildlife are similar to those described under Alternative A; however, given the reduced impacts (fewer acres directly and indirectly affected, fewer roads and power lines built, fewer haul trips generated) associated with Alternative C, the magnitude of these impacts is less. Impacts to overall quality and quantity of unfragmented habitat would not be measurable or apparent. Individuals may experience reduced viability or mortality; however, these impacts would not alter wildlife distribution in the study area or result in changes to overall wildlife population viability. These impacts are considered minor, given the amount of acres impacted (0.8%), and long term, as impacts would be scattered spatially and temporally (26 mining projects over 20 years; 207 exploration projects over 20 years).

Impacts of Alternative D: Partial Withdrawal (~300,000 Acres)

Under Alternative D, approximately 951 acres would be impacted by new mining. To support the exploration and development projects, approximately 19.1 miles (57 acres) of new dirt roads and 19.1 miles (57 acres) of new power lines would also be constructed. An estimated 255,685 ore haul trips would be required on these new roads. For impact discussions, an additional 0.5-mile area on either side of the dirt roads was added to the calculations to account for noise and visual intrusions that may affect wildlife behavior. It was also assumed that the power lines would follow the dirt roads and therefore were included in this 0.5-mile area. This area equates to an additional 19.1 square miles (12,224 acres) of indirect wildlife habitat impacts. The total acres of disturbance under Alternative D over a 20-year time frame has been calculated at approximately 1,065 acres of direct impact related to mining, road, and power line impacts and an additional 12,224 acres of indirect impacts associated with a 0.5-mile area, for a total of 13,289 acres impacted, or approximately 1.3% of the proposed withdrawal area. The North Parcel would have the greatest amount of impacts, with approximately 10,702 acres impacted, or 1.9% of available land within that parcel. The East Parcel would have approximately 829 acres impacted, or 0.6% of available land within that parcel. The South Parcel would have approximately1,760 acres impacted, or 0.5% of available land within that parcel.

Although proposed withdrawal parcels with high potential wildlife resource value under this alternative are reduced in size, compared with Alternative C, they still include the majority of Kanab Creek on the North Parcel, areas adjacent to Marble Canyon on the East Parcel, and several major drainages on the South Parcel that are considered high value wildlife habitat. The majority of the vegetation on the South Parcel and riparian habitat (Kanab Creek) and much of the vegetation on the North Parcel would be removed from possible exploration and development.

Impacts to wildlife are similar to those described under Alternative A, with only a minimal reduction in acres disturbed. Impacts to overall quality and quantity of unfragmented habitat would be measurable but not apparent. Individuals may experience reduced viability or mortality; however, these impacts would not alter wildlife distribution in the study area or result in changes to overall wildlife population viability. These impacts are considered moderate, given the amount of acres impacted (0.8%), and long term, as impacts would be scattered spatially and temporally (26 mining projects over 20 years; 207 exploration projects over 20 years).

Cumulative Impacts

This study area encompasses the seasonal movement corridors and winter and summer ranges of elk, deer, and other large wildlife species in the project area and vicinity, including into surrounding states. When combined with the impacts of these other activities, all of the alternatives could contribute to additional wildlife habitat impacts, a decrease in habitat productivity, an increase in collisions, disturbance-related displacement, poaching of wildlife, and/or fragmentation of wildlife movement corridors.

Improved access into the study area associated with new mine roads could result in an increase in human activity, prompting additional disturbances of animal behavior. Although not designed for recreational purposes, the new roads have the potential to facilitate recreational activities and could lead to displacement of wildlife or decreased use of wildlife corridors related to increased human disturbances. Foot traffic through sensitive areas could disturb wildlife and/or prevent successful feeding or breeding activities.

Given the relatively large area (more than 1 million acres) and the fact that uranium would be processed off-site, it is anticipated none of the alternatives would result in significant cumulative impacts to wildlife

resources when added to other past, present, and reasonably foreseeable activities in the proposed withdrawal area.

4.7.5 Migratory Birds

Direct and Indirect Impacts

Impacts to migratory birds would result from habitat alteration and fragmentation, vehicle collisions, and possible uranium contamination related to bioaccumulation in prey species and increased levels in ponds and fluid pits around mine sites. The sensitivity of biota to radiation and chemical exposures is also influenced by body size. Large-bodied species are typically more vulnerable to high levels of radiation exposure than small-bodied species because of the greater collision potential between the ionizing radiation and biota (Bytwerk 2006; Higley and Bytwerk 2007). A species' life history may also affect its sensitivity to radiation. Birds may be at greater risk to radiation exposure than other wild vertebrates because of their natural history related to foraging and ingestion of grit, which effectively increases radiation dose (Driver 1994).

The types of impacts would be similar to those described previously in 4.7.3, Fish and Aquatics, and 4.7.4, General Wildlife, and would include habitat alteration, resulting in a decrease in vegetation productivity, which would affect food supply, nest damage or injury to young during the breeding season, collisions with vehicles, and displacement from breeding or wintering areas during mining and reclamation. As discussed in Section 4.7.4, impacts to aquatic habitat can affect wading birds. Under the withdrawal proposal, mining claims filed before the proposal date will not be withdrawn from further development. These pre-existing mining claims occupy varying percentages of each of the proposed withdrawal parcels: for the North Parcel, approximately 474 square miles, or 49.8% of the area; for the East Parcel, approximately 4.4 square miles, or 1.9% of the area; and for the South Parcel, approximately 149 square miles, or 29% of the area. Based on the existing valid claims, portions of the proposed withdrawal area will be open to uranium mining under any of the alternatives; therefore, the alternative that preserves the greatest amount of wildlife habitat from new mineral exploration and development would represent the best alternative to reduce impacts to migratory birds.

Impacts of Alternative A: No Action (No Withdrawal)

Acres of direct and indirect impacts to migratory bird habitat would be identical to acres of vegetation disturbances, i.e., approximately 1.5% of the total habitat acres available in the proposed withdrawal area. Migratory birds may be attracted to new buildings and power pole structures as well as new water sources that may be associated with a mine. A total of 19.1 miles of new roads and power lines would be constructed for mine access, and the number of ore haul trips would be 301,165, which has the potential to increase impacts, including mortality with migratory birds.

In addition to physical habitat losses or degradation, bioaccumulation impacts of uranium and other metals may occur to migratory birds if Alternative A is implemented. These impacts include reduced individual viability from reduced prey items and/or from reproductive and cell mutations to mortality related to chemical and radiation exposure. Exposures to high levels of ionizing radiation produce adverse biological effects, such as increased cell death, decreased life expectancy, reduced growth, and altered behavior. Factors related to the location of a mine and the duration of operations could influence the magnitude of these impacts on migratory birds. Mines that secondarily impact perched aquifers could have significant effects on smaller seeps and springs. Kanab Creek is a major migratory bird attractant that is currently impacted by past mining operations. If several additional mines were to operate in the general vicinity of Kanab Creek, this vital resource may experience additional, long-term habitat-altering affects.

As a result of implementation of Alternative A, project-related impacts could occur to aquatic, riparian, and/or terrestrial habitat components. Physical and chemical alterations to plants and animals, alterations to water quantity or quality at area seeps and springs and other water bodies, and/or impacts to overall quality and quantity of unfragmented habitat could occur and be measurable but not apparent. Therefore, impacts to migratory birds could be considered minor to moderate in magnitude and long term in duration.

Impacts of Alternative B: Proposed Action (~1 Million Acres, 20-Year Withdrawal)

Impacts to migratory bird habitat associated with Alternative B would be similar to those described for Alternative A; however, the extent of impacts to migratory birds would be reduced under this alternative. No development is anticipated on the East Parcel, and important stopover habitat, such as Kanab Creek on the North Parcel and the area adjacent to Marble Canyon on the East Parcel, would not be subject to mineral exploration and development. Furthermore, development on the North and South parcels would be limited to valid existing claims. Impacts to acres of migratory bird habitat would be identical to those described for vegetation—approximately 0.02% of the total habitat acres in the proposed withdrawal area. A total of 6.4 miles of new roads and 6.4 acres of new transmission lines would be constructed for mine access, and the number of ore haul trips would be 88,885, which has the potential to increase impacts, including mortality with migratory birds.

As a result of implementation of Alternative B, project-related impacts would occur to aquatic, riparian, and/or terrestrial habitat components as a result of mines from existing valid claims. These existing claims include many surrounding Kanab Creek in the North Parcel, which is considered a significant regional resource for migratory birds. Physical and chemical alterations to plants and animals, alterations to water quantity or quality at area seeps and springs and other water bodies, and/or impacts to overall quality and quantity of unfragmented habitat could occur but would not be measurable or apparent. Therefore, impacts to migratory birds associated with implementation of Alternative B could be considered minor in magnitude and long term in duration.

Impacts of Alternative C: Partial Withdrawal (~700,000 Acres)

Impacts to migratory birds associated with Alternative C would be similar to those described in Alternative A; however, the extent of impacts to migratory birds would be reduced under this alternative. Potentially important migration stopover habitat would be withdrawn from mineral development; Kanab Creek on the North Parcel and areas adjacent to Marble Canyon on the East Parcel. Impacts to acres of migratory bird habitat would be identical to those described for vegetation; approximately 0.05% of the total habitat acres in the proposed withdrawal area could be impacted. A total of 12.1 miles of new roads would be constructed for mine access, a 46% decrease, compared with Alternative A, and the number of ore haul trips would be 166,725, a 44% decrease, compared with Alternative A.

As a result of implementation of Alternative C, project-related impacts would occur to aquatic, riparian, and/or terrestrial habitat components as a result of mines with existing valid claims. These existing claims include many surrounding Kanab Creek in the North Parcel, which is considered a significant regional resource for migratory birds. Physical and chemical alterations to plants and animals, alterations to water quantity or quality at area seeps and springs and other water bodies, and/or impacts to overall quality and quantity of unfragmented habitat could occur but would not be measurable or apparent. Therefore, impacts to migratory birds associated with implementation of Alternative C would be considered minor in magnitude and long term in duration.

Impacts of Alternative D: Partial Withdrawal (~300,000 Acres)

Impacts to migratory birds under Alternative D would be similar to those described for Alternative A; however, the potential for impacts to migratory birds would be reduced under this alternative. Under this alternative, potentially important migration stopover habitat would be withdrawn from mineral development: Kanab Creek on the North Parcel and areas adjacent to Marble Canyon on the East Parcel. Impacts to acres of migratory bird habitat would be identical to those described for vegetation: approximately 0.09% of the proposed withdrawal area would be affected. A total of 19.1 miles of new roads would be constructed for mine access, and the number of ore haul trips would be 255,685, which is a 15% reduction, compared with Alternative A.

As a result of implementation of Alternative D, project-related impacts would occur to aquatic, riparian, and/or terrestrial habitat components as a result of mines with existing valid claims. These existing claims include many surrounding Kanab Creek in the North Parcel, which is considered a significant regional resource for migratory birds. Physical and chemical alterations to plants and animals, alterations to water quantity or quality at area seeps and springs and other water bodies, and/or impacts to overall quality and quantity of unfragmented habitat could occur but would not be measurable or apparent. Therefore, impacts to migratory birds associated with implementation of Alternative D would be considered minor in magnitude and long term in duration.

Cumulative Impacts

The analysis area for migratory birds is the proposed withdrawal area (North, East, and South parcels), and a 0.5-mile buffer around this area. When combined with the impacts of these other activities, all of the alternatives could contribute to additional migratory bird habitat impacts, a decrease in habitat productivity, an increase in avian collisions and nest destruction, and disturbance-related displacement of migratory birds.

Given the relatively small area of surface impact, it is anticipated that none of the alternatives would result in significant cumulative impacts to migratory birds when added to other past, present, and reasonably foreseeable activities in the proposed withdrawal area.

4.8 SPECIAL STATUS SPECIES

Table 3.8-1 lists all special status species that may occur within or in close proximity to the proposed withdrawal area. It has been determined by agency resource specialists that some of those species would not be affected by actions proposed in this EIS. These species are therefore not analyzed further in this document. Table 4.8-1 lists special status species that will not be discussed in further detail, along with the rationale for their exclusion from further analysis.

4.8.1 Impact Assessment Methodology

As discussed in more detail in Chapter 2, the existing regulatory framework requires that all plans of operation be subject to subsequent site-specific NEPA analyses in compliance with laws, regulations, and policies and in conformance with applicable RMPs or forest plans. Both the BLM and Forest Service require a detailed plan of operation for proposed mine development projects. Based on site-specific analysis, mitigation and conservation measures are developed to avoid or minimize anticipated impacts and avoid unnecessary and undue degradation. Site-specific analysis of effects to threatened, endangered and proposed species is required for compliance with ESA regulations and agency management policies. Potential adverse effects would be avoided or minimized.

Table 4.8-1. Species Excluded from Further Analysis

Species	Documented within the Study Area?	ESA Status	Rationale for Excluding from Further Analysis
Birds			
California brown pelican (*Pelecanus occidentalis californicus*)	No	Delisted	This species is known from the Lower Colorado (below Lake Mead). No impacts to species or habitat are anticipated because of the distance from the proposed withdrawal area (i.e., no direct disturbance to individuals from mining activities would occur, nor would habitat alterations or destruction occur).
California least tern (*Sterna antillarum browni*)	No	Endangered w/CH	This species is known from the Lower Colorado (below Lake Mead). No impacts to species or habitat are anticipated because of the distance from the proposed withdrawal area (i.e., no direct disturbance to individuals from mining activities would occur, nor would habitat alterations or destruction occur).
Small Mammals			
Black-footed ferret (*Mustela nigripes*)	No	Endangered w/o CH	No significant prairie-dog populations are located near the proposed withdrawal area that would support the species; data from the AGFD indicate dispersal movement into the proposed withdrawal area is not likely because of the species' distance from the proposed withdrawal area.
Southwestern river otter (*Lontra canadensis sonora*)	No	No	The nearest confirmed sighting of this species is along the Colorado River below Lake Mead; no impacts to species or habitat are anticipated because of the distance from the proposed withdrawal area. Because of large volume of water in the Colorado River below the proposed withdrawal area, potential uranium levels in water would be diluted and undetectable.
Hualapai Mexican vole (*Microtus mexicanus hualpaiensis)*	No	Endangered w/o CH	The nearest confirmed sighting of this species is southwest of the proposed withdrawal area. There would be no impacts to the species, as there is no hydrology link to surface waters; no airborne impacts are likely because of the distance from the proposed withdrawal area.
Plants			
Jones cycladenia (*Cycladenia humilis* var. *jonesii*)	No	Threatened w/o CH	The closest population of the species is within the Lone Butte ACEC, located several miles from the proposed withdrawal area. There would be no impacts, as there is no hydrology link to surface waters; no airborne impacts are likely because of the distance from the proposed withdrawal area.
Welsh's milkweed (*Asclepia welshii*)	No	Threatened w/CH in UT	The closest population of the species is located within the Paria Canyon–Vermilion Cliffs Wilderness, located several miles from the proposed withdrawal area. There would be no impacts, as there is no hydrology link to surface waters; no airborne impacts are likely because of the distance from the proposed withdrawal area.
Pipe Springs cryptantha (*Cryptantha semiglabra*)	No	90-day finding indicates listing may be warranted; status review underway	Species population range is confined to a small area outside of Fredonia. There would be no impacts, as there is no hydrology link to surface waters; no airborne impacts are likely because of the distance from the proposed withdrawal area and the lack of ore hauling routes adjacent to occurrences of the species.
San Francisco Peaks groundsel (*Packera franciscana*)	No	Threatened w/CH	Species population range is confined to a small area outside the proposed withdrawal area. There would be no impacts, as there is no hydrology link to surface waters; no airborne impacts are likely because of the distance from the proposed withdrawal area.
Navajo sedge (*Carex specuicola*)	No	Threatened w/CH	Species population range is confined to a small area outside the proposed withdrawal area. There would be no impacts, as there is no hydrology link to surface waters; no airborne impacts are likely because of the distance from the proposed withdrawal area.

Table 4.8-1. Species Excluded from Further Analysis (Continued)

Species	Documented within the Study Area?	ESA Status	Rationale for Excluding from Further Analysis
Plants, continued			
Arizona cliffrose (*Purshia subintegra*)	No	Threatened w/o CH	Species population range is confined to a small area outside the proposed withdrawal area. There would be no impacts, as there is no hydrology link to surface waters; no airborne impacts are likely because of the distance from the proposed withdrawal area.
Arizona bugbane (*Cimicifuga arizonica*)	No	Conservation Agreement	Species population range is confined to a small area outside the proposed withdrawal area. There would be no impacts, as there is no hydrology link to surface waters; no airborne impacts are likely because of the distance from the proposed withdrawal area.
Mt. Trumbull beardtongue (*Penstemon distans*)	No	No	Populations are known from Whitmore, Parashant, and Andrus Canyons within the Shivwits Plateau. There would be no impacts, as there is no hydrology link to surface waters; no airborne impacts are likely because of the distance from the proposed withdrawal area.
September 11 stickleaf (*Mentzelia memorabilis*)	No	No	The species is located northwest of the proposed withdrawal area and is therefore not influenced by mining projects; there would be no impacts, as there is no hydrology link to surface waters and no airborne impacts are likely because of the distance from the proposed withdrawal area.
Black rock daisy (*Townsendia smithii*)	No	No	The closest population of the species is located approximately 30 miles west of the proposed withdrawal area. There would be no impacts, as there is no hydrology link to surface waters; no airborne impacts are likely because of the distance from the proposed withdrawal area.
Toana milkvetch/Diamond Butte milkvetch (*Astragalus toanus* var. *scidulus*)	No	No	The closest population of the species is located approximately 10 miles west of the proposed withdrawal area; endemic to a small area around Diamond and Twin buttes. There would be no impacts, as there is no hydrology link to habitat areas; no airborne impacts are likely because of the distance from the proposed withdrawal area
Crevice penstemon/Sheep Range beardtongue (*Penstemon petiolatus*)	No	No	The closest population of the species is located approximately 30 miles west of the proposed withdrawal area and is known from the Virgin Mountains and Beaver Dam Mountains. There would be no impacts, as there is no hydrology link to habitat areas; no airborne impacts are likely because of the distance from the proposed withdrawal area.
Silverleaf sunray (*Enceliopsis argophylla*)	No	No	The closest population of the species is located near Lake Mead and below Hurricane Cliffs. There would be no impacts, as there is no hydrology link to surface water or perched aquifers; no airborne impacts are likely because of the distance from the proposed withdrawal area.
Sticky wild buckwheat (*Eriogonum viscidulum*)	No	No	The closest population of the species is located west of the Virgin River. There would be no impacts, as there is no hydrology link to surface waters; no airborne impacts are likely because of the distance from the proposed withdrawal area.
Three hearts (*Tricardia watsonii*)	No	No	The closest population of the species is located approximately 30 miles southwest of proposed withdrawal area. There would be no impacts, as there is no hydrology link to surface waters; no airborne impacts are likely because of the distance from the proposed withdrawal area.
Sandhollow/Three-cornered milkvetch (*Astragalus geyeri* var. *triquetrus*)	No	No	The closest population of the species is located more than 30 miles west of the proposed withdrawal area and is known in Arizona from only the Sand Hollow Wash, Horsethief Canyon, and Beaver Dam Mountains. There would be no impacts, as there is no hydrology link to surface waters; no airborne impacts are likely because of the distance from the proposed withdrawal area.

Table 4.8-1. Species Excluded from Further Analysis (Continued)

Species	Documented within the Study Area?	ESA Status	Rationale for Excluding from Further Analysis
Plants, continued			
Gierisch mallow (*Sphaeralcea gierischii*)	No	Candidate	The closest population of the species is located more than 30 miles west of the proposed withdrawal area and is known in Arizona from the vicinity of Black Rock Gulch, Black Knolls, and Pigeon Canyon. There would be no impacts, as there is no hydrology link to surface waters; no airborne impacts are likely because of the distance from the proposed withdrawal area.
Holmgren milkvetch (*Astragalus holmgreniorum*)	No	Endangered w/CH	The closest population of the species is located more than 50 miles northwest of the proposed withdrawal area. There would be no impacts, as there is no hydrology link to surface water; no airborne impacts are likely because of the distance from the proposed withdrawal area.
Beaverdam breadroot (*Pediomelium castoreum*)	No	No	The closest population of the species is located west of proposed withdrawal area by approximately 30 miles. There would be no impacts, as there is no hydrology link to surface waters; no airborne impacts are likely because of the distance from the proposed withdrawal area.
Fish			
Apache trout (*Oncorhyncus gilae apache*)	No	Threatened w/o CH	This species occurs in the North Canyon Creek with no hydrologic link. This species is also located within the headwater reaches of the Little Colorado, Salt, and Blue rivers. There would be no direct impacts, as there is no hydrology link to surface waters.
Bonytail chub (*Gila elegans*)	No	Endangered w/CH	This species is known from the Lower Colorado (below Lake Mead). No impacts to species or habitat are anticipated because of the distance from the proposed withdrawal area.
Reptiles and Amphibians			
Chiricahua leopard frog (*Lithobates* [Rana] *chiricahuensis*)	No	Threatened w/o CH	The closest known population of this species is located more than 100 miles south of the proposed withdrawal area within the Verde River Watershed. There would be no direct impacts, as there is no hydrology link to surface waters.
Northern Mexico gartersnake (*Thamnophis eques megalops*)	No	Candidate	The closest known population of this species is located more than 100 miles south of the proposed withdrawal area within the Verde River Watershed. No direct impacts are anticipated because of the distance from the proposed withdrawal area.
Desert tortoise (*Gopherus agassizii*) (Mojave pop.)	No	Threatened w/CH	This species occurs approximately 40 miles west of the proposed withdrawal area. There would be no impacts to the species or critical habitat. No direct impacts are likely because of the distance from the proposed withdrawal area.
Desert tortoise (*Gopherus agassizii*) (Sonoran population)	No	12-month status review	This species occurs approximately 40 miles southwest of the proposed withdrawal area. The range of this species is limited by habitat change imposed by the Mogollon Rim. No direct impacts are likely because of the distance from the proposed withdrawal area.
Invertebrates			
MacNeill's sootywing (*Hesperopsis gracielae*)	No	No	This species occurs within the Lower Colorado (below Lake Mead), Virgin, Salt, and Gila river drainages. There would be no impacts, as the concentration of uranium from mines would be diluted to non-detectable levels by the time it reaches habitat areas for this species.

Note: CH = Critical habitat.

For purposes of this EIS, quantitative and qualitative approaches used to estimate impacts to special status species include 1) calculations of vegetation/habitat impacts relative to the availability of these resources within the proposed withdrawal area; 2) the disturbance footprint of mines and exploration sites and the nature of impacts; 3) calculations of water use relative and flows at nearby springs; 4) published literature on disturbance-related impacts to wildlife; and 5) existing agency management plans and reports that address surface impact management.

The spatial boundaries of analysis vary by resource and cross political and administrative boundaries but were established to accommodate concerns, given the large home ranges of many species and the potential for long-term indirect impacts to aquatic and terrestrial species. Effects are quantified where possible. In the absence of quantitative data, the best professional judgment was used. Impacts are sometimes described using ranges of potential impacts or in qualitative terms, if appropriate. Table 4.8-2 provides thresholds and descriptions used during analysis of fish and wildlife resources impacts.

Table 4.8-2. Magnitude and Degrees of Effects on Special Status Species

Attribute of Effect	Description Relative to Special Status Species
Magnitude	
No Impact	Would not produce changes in aquatic, riparian, and/or terrestrial habitat components or impact the behavior or overall health of special status species.
Minor	Project-related impacts would occur to aquatic, riparian, and/or terrestrial habitat components; however, physical and chemical alterations to plants and animals, alterations to water quantity or quality at area seeps, springs and other water bodies, and impacts to overall quality and quantity of unfragmented habitat would not be measurable or apparent. Individuals (special status species) may experience reduced viability or mortality; however, these impacts would not alter the distribution of special status species in the study area or result in changes to overall special status species' population viability.
Moderate	Project-related impacts would occur to aquatic, riparian, and/or terrestrial habitat components. Physical and chemical alterations to plants and animals, alterations to water quantity or quality at area seeps and springs and other water bodies, and/or impacts to overall quality and quantity of unfragmented habitat would be measurable but not apparent. Individuals (special status species) may experience reduced viability or mortality; these impacts could alter the distributions of special status species in the study area but would not result in changes to overall special status species' population viability.
Major	Project-related impacts would occur to aquatic, riparian, and/or terrestrial habitat components. Physical and chemical alterations to plants and animals, alterations to water quantity or quality at area seeps, springs, and other water bodies, and/or impacts to overall quality and quantity of unfragmented habitat would be measurable and apparent. These impacts would cause reduced viability or mortality of individuals (special status species) and could threaten the viability and distribution of one or more special status species population in the study area.

Table 4.8-3. Duration Definition of Effects on Special Status Species

Duration	
Temporary	Transient (period of project right-of-way construction and de-construction) up to one year.
Short-term	Less than 5 years
Long-term	Greater than 5 years

4.8.2 Incomplete or Unavailable Information

- A more detailed, quantitative analysis of the possible effects of chemical and radiation hazards to springs and waterways in the Park, and more precise information on the locations of exploration sites, mine sites, and roads would be useful for making a more reasoned choice among alternatives.

- A more thorough quantitative data investigation of water chemistry in the Grand Canyon region is required to better understand groundwater flow paths, travel times, and contributions from mining activities, in particular on the north side of the Colorado River.
- As presented in Bills et al. (2010), patterns or lack of patterns, in trace-element chemistry with respect to mining conditions was considered inconclusive and merit additional investigations.
- Quantitative data of terrestrial and aquatic bio receptors across taxa within the Grand Canyon watershed are not available to ascertain potential uranium contamination and bioaccumulation impacts related to mining activities.

4.8.3 Threatened, Endangered, and Candidate Species

Table 3.8-2 provides details of the 42 federally listed species being considered in this EIS and their possible occurrence within the proposed withdrawal area. As detailed in Table 4.8-1 and as determined by agency resource specialists, a total of 21 of these species would not be affected by actions proposed in this EIS. The remaining 21 species will be analyzed in more detail in the following impact discussions. ACECs in the proposed withdrawal area established to protect federally listed plants and include Moonshine Ridge and Johnson Spring for Siler pincushion cactus (listed threatened) on the North Parcel, and Marble Canyon for Brady pincushion cactus (listed endangered) on the East Parcel. Outside established ACECs, mining-related activities could impact Siler pincushion cactus, Fickeisen plains cactus (candidate species) on the North and East parcels, and Paradine (Kaibab) plains cactus on the East Parcel.

Direct and Indirect Impacts

As discussed in Section 4.7, mineral exploration and development under each alternative has the potential to impact both aquatic and terrestrial habitats within and adjacent to the proposed withdrawal area. As detailed in Table 4.7-1, numerous special status species, including several federally listed as either threatened, endangered, or candidate species, are thought to inhabit or use biological resources within or adjacent to the proposed withdrawal area. For a more detailed discussion on aquatic and terrestrial habitat impacts, see Sections 4.7 and 4.7.4. Connections between aquatic and terrestrial habitats ensure transfers of uranium across environmental habitats. Uranium in ore deposits accumulates in soils and reaches surface waters and sediments through physical processes mediated by natural and/or human-aided mechanisms. Threatened and endangered species discussed in more detail in this EIS include vascular plants, invertebrates, fish, amphibians, reptiles, and birds.

Riparian habitat in the Grand Canyon region, including within the North Parcel and adjacent to the South and East parcels, supports a diverse flora and fauna. These riparian areas have exceptional biodiversity and are critical for the plants and animals that live in the area. Many of the riparian areas are supported by springs that originate in water-bearing zones in the Redwall and Muav limestones and flow into canyons of the greater Grand Canyon area. These spring habitats support a species diversity that is 100 to 500 times greater than that of the surrounding landscape (Grand Canyon Wildlands Council 2004). Mining activity can result in changes to these habitats that may increase exposure of the biological resources to chemical elements, including uranium, radium, and other radioactive decay products. Uranium and other radionuclides can affect the survival, growth, and reproduction of plants and animals.

Direct and indirect impacts to threatened and endangered plant and animal species could result from habitat alteration and fragmentation, which could impact overall health of the plant or result in an increase in mortality. Because many species have small home ranges and very narrow habitat requirements, even small modifications to vegetation and soils could lead to pronounced effects on the species by reducing suitable habitat; facilitating weed invasion; increasing erosion; and increasing opportunities for mortality

through clearing, crushing, trampling, or reducing cover items, thereby increasing predation rates by other wildlife.

Uranium deposits on soils, plants, and surface water can expose a variety of biota to chemical and radiation exposure. Figures 4.7-1 and 4.7-2 document the potential linkages between chemical and radiation hazards associated with mining and biota. Uranium and its decay products can be transported by way of infiltration into groundwater and surface waters. In addition to aquatic exposure pathways, wildlife can be exposed to chemical and radiation hazards through various pathways, including ingestion of soil and food (prey species), inhalation, and various cell absorption processes. As discussed by the USGS (Bills et al. 2010), some streams, seeps, and springs within the proposed withdrawal area contain high concentrations of dissolved trace elements and radionuclides owing to past mining activities and natural processes of evaporation, weathering, and erosion. Aquatic organisms and plants rely on these water bodies, and minor changes in water quality and quantity could result in mortality of fish and other aquatic organisms or in degradation of their habitat.

Impacts of Alternative A: No Action (No Withdrawal)

Under Alternative A, approximately 1,364 acres would be impacted. To support the exploration and development, approximately 22.4 miles of new roads and power lines would also be constructed. An estimated 300,165 ore haul trips would be required on these new roads. The total acres of disturbance under Alternative A over a 20-year time frame has been calculated at approximately 1,500 acres of direct impact related to mining, roads, and power line impacts, or approximately 1.5% of the proposed withdrawal area. The North Parcel would have the most impacts, with approximately 2% of available land within that parcel being impacted. If Alternative A is implemented, approximately 2% of the available land within the North Parcel would be impacted, approximately 1.2% of the available land for the East Parcel would be impacted, and approximately 0.8% of available land within South Parcel would be impacted.

The potential to impact threatened or endangered species could result from physical land disturbances associated with exploration and mine sites, as well as roadways and power line facilities. These plants include Brady pincushion, sentry milkvetch, Fickeisen plains cactus, and Paradine (Kaibab) plains cactus. In addition to direct habitat impacts, indirect impacts to threatened and endangered plants could result from dust settling on vegetation adjacent to roads, which could temporarily reduce individual productivity. Site-specific studies and conservation measures would need to be implemented during construction and mining operations to reduce or eliminate impacts to these species.

Birds may be injured or killed by collisions with vehicles traveling on the road system. Birds of prey, including bald eagle, California condor, Mexican spotted owl, and American peregrine falcon, may be impacted by physical land disturbances associated with mining and increased risk of injury as a result of traffic power lines. Site-specific studies and conservation measures would need to be implemented during construction and mining operations to reduce or eliminate impacts to these species. Impacts to riparian habitats and water quality anywhere within the proposed withdrawal area could impact these bird species, as well as the southwestern willow flycatcher, found along Kanab Creek (North Parcel), and Yuma clapper rail, found along the Virgin River. The location of the mine facility and the influence of the mine on the quantity and quality of groundwater and surface flows at seeps, springs, and other bodies of water could influence the magnitude of these impacts on these bird species.

Impacts to riparian habitat and water quality of surface water could also affect fish, amphibian, and invertebrate species. Fish species associated with the Colorado River include the humpback chub and razorback sucker. These fish could be impacted by mining on any of the proposed withdrawal parcels. The Little Colorado spinedace is known from the Little Colorado River, which has a hydrologic link to portions of the South Parcel. A portion of the North Parcel could have some influence on groundwater

that also feeds surface flows along the Virgin River; therefore, several fish associated with the Virgin River, although unlikely, could have a potential to be impacted by implementation of Alternative A. These fish include the Virgin River chub, virgin spinedace, and woundfin. The location of the mine facility within the northwestern portion of the North Parcel and influence of the mine on the quantity and quality of groundwater and surface flows at seeps and springs and other surface waters could influencet the magnitude of these impacts on these Virgin River species.

Impacts to riparian habitats and water quality could affect several amphibian species and an aquatic-dependent invertebrate. These species include the relict leopard frog, northern leopard frog, lowland leopard frog, and Kanab ambersnail. The location of the mine facility and the influence of the mine on the quantity and quality of groundwater and surface flows at seeps and springs could influence the magnitude of these impacts on these amphibian and invertebrate species.

Although the exact location of mining under this alternative is not known, implementation of Alternative A can be assumed to have potential impacts on the overall quality and quantity of unfragmented terrestrial and riparian habitat within the proposed withdrawal area that could be measurable but not apparent. Individuals may experience reduced viability or mortality; however, these impacts would not alter species distribution in the study area or result in changes to overall species population viability. These impacts are considered moderate, given the amount of acres impacted (1.5%), the amount of water used (316 mgal), and the potential for additional uranium threats and bioaccumulation in Kanab Creek, which many of these species inhabit. The impacts are considered long term, as 728 exploration projects and 30 mining projects are anticipated over 20 years. New access roads would be reclaimed when the mines are closed. Access roads will be shared when multiple mines are located in the general vicinity, which would further reduce the physical footprint of new roads but could extend the duration of select roads to as much as 20 years, while others may be open and closed within a 3- to 5-year time frame.

Impacts of Alternative B: Proposed Action (~1 Million Acres, 20-Year Withdrawal)

Under Alternative B, approximately 164 acres would be impacted by new mining. To support the exploration and development projects, approximately 6.4 miles of new roads and new power lines would also be constructed. An estimated 88,885 ore haul trips would be required on these new roads. The total acres of disturbance under Alternative B over a 20-year time frame have been calculated at approximately 0.4% of the proposed withdrawal area. The North Parcel would have the greatest amount of impacts, with approximately 0.7% of available land within that parcel. The East Parcel would not have any impacts under this alternative. The South Parcel would have approximately 1 acre impacted, or <0.01% of available land within that parcel.

Impacts to species are similar to those described under Alternative A. When comparing potential impacts between Alternatives A and B, Alternative B provides more protection to biota from uranium mine-related impacts to the Little Colorado River (South Parcel) and within the East Parcel and to resources associated with the Colorado River and Marble Canyon. Within the North Parcel, this alternative provides better protection to threatened and endangered plant species than does implementation of Alternative A.

Impacts to species are similar to those described under Alternative A; however given the reduced impacts (fewer acres directly and indirectly affected, fewer roads and power lines built, fewer mining-related impacts on groundwater, and fewer haul trips generated) associated with Alternative B, the magnitude of these impacts is significantly less. Impacts to overall quality and quantity of unfragmented habitat would not be measurable or apparent. Individuals may experience reduced viability or mortality; however, these impacts would not alter species distribution in the study area or result in changes to overall wildlife population viability. These impacts are considered minor, given the amount of acres impacted (0.4%), and

long term, as impacts would be scattered spatially and temporally (10 mining projects over 20 years; 11 exploration projects over 20 years).

Impacts of Alternative C: Partial Withdrawal (~700,000 Acres)

Under Alternative C, approximately 532 acres would be impacted. To support the exploration and development projects, approximately 12.1 miles of new dirt roads and power lines would also be constructed. An estimated 166,725 ore haul trips would be required on these new roads. The total acres of disturbance under Alternative C over a 20-year time frame have been calculated at approximately 0.8% of the proposed withdrawal area. The North Parcel would have the greatest amount of impacts, with approximately 1.1% of available land within that parcel impacted. The East Parcel would have approximately 0.6% of available land within that parcel. The South Parcel would have approximately 1,321 acres impacted, or 0.4% of available land within that parcel.

Under Alternative C, specific areas with higher valued habitat resources proposed for withdrawal under this alternative include Kanab Creek on the North Parcel, areas adjacent to Marble Canyon on the East Parcel, and several major drainages on the South Parcel. By removing these highly valued habitat resources from future mining, Alternative C could benefit threatened and endangered species populations more than Alternative A but less than Alternative B, which removes the entire potential withdrawal area from future mining claims.

Impacts to species are similar to those described under Alternative A; however, given the reduced impacts (fewer acres directly and indirectly affected, fewer roads and power lines built, fewer mining-related impacts on groundwater, and fewer haul trips generated) associated with Alternative C, the magnitude of these impacts is less. Impacts to overall quality and quantity of unfragmented habitat would not be measurable or apparent. Individuals may experience reduced viability or mortality; however, these impacts would not alter species distribution in the study area or result in changes to overall species population viability. These impacts are considered minor, given the amount of acres impacted (0.8%) and the reduced potential for future mining near higher valued habitat, and are considered long term, as impacts would be scattered spatially and temporally (26 mining projects over 20 years; 207 exploration projects over 20 years).

Impacts of Alternative D: Partial Withdrawal (~300,000 Acres)

Under Alternative D, approximately 951 acres would be impacted by new mining. To support the exploration and development projects, approximately 19.1 miles of new dirt roads and power lines would also be constructed. An estimated 255,685 ore haul trips would be required on these new roads. The total acres of disturbance under Alternative D over a 20-year time frame have been calculated at approximately 1.3% of the proposed withdrawal area. The North Parcel would have the most impacts, with approximately 1.9% of available land within that parcel impacted. The East Parcel would have approximately 0.6% of available land impacted. The South Parcel would have approximately 0.5% of available land impacted.

Under Alternative D, specific areas with higher valued habitat resources proposed for withdrawal under this alternative include Kanab Creek on the North Parcel, areas adjacent to Marble Canyon on the East Parcel, and several major drainages on the South Parcel. By removing these highly valued habitat resources from future mining, Alternative D will benefit threatened and endangered species populations more than Alternative A but less than Alternative B, which removes the entire potential withdrawal area from future mining claims. Alternatives C and D both protect these resources from future mining, but Alternative D uses approximately 31% more water and therefore has a greater likelihood to have more impacts on aquatic habitats. Alternative D also does not withdraw as much terrestrial habitat, which is

occupied by threatened and endangered species. These areas are located in the northeastern and northwestern portions of the North Parcel, where several threatened and endangered plants species occur.

Impacts to species are similar to those described under Alternative A, with only a minimal reduction in acres disturbed. Impacts to overall quality and quantity of unfragmented habitat would be measurable but not apparent. Individuals may experience reduced viability or mortality; however, these impacts would not alter species distribution in the study area or result in changes to overall species population viability. These impacts are considered moderate, given the amount of acres impacted (0.8%), and the duration is considered long term, as impacts would be scattered spatially and temporally (26 mining projects over 20 years; 207 exploration projects over 20 years).

Cumulative Impacts

This analysis area encompasses foraging habitat for the Mexican spotted owl and California condor, whose distribution extends beyond the proposed withdrawal area. The analysis area also includes nesting habitat for Mexican spotted owl and California condor, nesting habitat for yellow-billed cuckoo, springs occupied by Kanab ambersnail, and occupied habitat for sentry milkvetch, humpback chub, razorback sucker, Virgin River chub, woundfin, and Virgin River spinedace. When combined with the impacts of other federally approved projects and agency management activities, all of the alternatives could contribute to direct habitat impacts, a decrease in habitat productivity, and an increase in the potential for disturbance, mortality, or injury of federally listed species. Critical habitat for the Mexican spotted owl would not be impacted, as these areas are already withdrawn from mineral entry.

Given the relatively small area of surface impact and the ESA requirements concerning impacts to listed species and critical habitat, all of the alternatives would result in minor and less than significant cumulative impacts to threatened, endangered, and candidate species when added to other past, present, and reasonably foreseeable activities in the proposed withdrawal area. Project-specific species surveys will be required prior to future mining within the proposed withdrawal area.

Conservation Measures

The following general measures must be applied to federally listed species in the proposed withdrawal area:

- All surface-disturbing activities within a special status species' ACEC or wildlife habitat area may be restricted seasonally to a period when the species is not active. This determination would be made by a BLM or Forest Service wildlife biologist in coordination with the AGFD and USFWS.
- Special status species habitat surveys will be required whenever surface disturbances occur within an area of known or suspected occupancy by special status species. Field surveys will be conducted during the appropriate time of year when detection of the species is most likely to occur. Based on the results of surveys, appropriate buffer zones will be identified.
- All surface disturbing activities will be restricted to remain 0.25 mile away from seeps, springs, and other drainages, whether flowing or not. This distance may be modified when specifically approved in writing by the BLM or Forest Service.
- All surface-disturbing activities would include conservation to reduce impacts to special status species and their habitat. Conservation measures developed for each listed or proposed species would be applied to any proposed project within the habitat of that species. Analysis of impacts and determinations of effects would include any and all mitigation and conservation measures.

- Prior to any surface-disturbing activity, a special status species review would occur to determine whether any such species would be present in the project area. The following species-specific measures would be applied to management actions in special status species habitats in the proposed withdrawal area (BLM 2008b; Forest Service 2008d). Necessary modifications of the conservation measures or impacts to federally protected species and habitat during implementation of management actions would be documented by the BLM or Forest Service biologist and coordinated with the USFWS. Impacts to these listed plant species are considered negligible and would result in little or no impact because mines and associated linear features (roads and transmission lines) can be located away from known locations. Provided below are conservation measures for California condor and Mexican spotted owl. California condor measures are from BLM (2008b). Mexican spotted owl measures are from Forest Service (2008d); more specific guidelines are described in greater detail in the Kaibab National Forest LRMP/ROD (Forest Service 1988).

CALIFORNIA CONDOR

- Management guidance for all BLM-authorized actions on the Arizona Strip states that immediately prior to the start of an authorized or permitted project, the BLM would contact personnel monitoring California condor locations and movements on the Arizona Strip to determine the locations and status of condors in or near the project area.
- The BLM or Forest Service would request that permit holders notify the wildlife team lead if California condors visit the worksite while permitted activities are underway. Project activities would be modified, relocated, or delayed if those activities could have adverse affects on condors.
- If California condors visit a worksite while activities are underway, the on-site supervisor would notify the wildlife team lead. Project workers and supervisors would be instructed to avoid interacting with condors. Project activities would be modified, relocated, or delayed if those activities could have adverse affects on condors. Operations would cease work until the bird leaves on its own or until techniques are employed by permitted personnel that result in the individual condor's leaving the area.
- Where condor nesting activity is known within 0.5 mile of activities that include operating heavy machinery, the BLM or Forest Service would direct the operator to cease equipment use during the active nesting season (February 1– November 30) or as long as the nest is viable. Where feasible and consistent with NEPA, the BLM or Forest Service may relocate operations to a site greater than 0.5 mile from the condor nest site.
- Where condors occur within 1 mile of activities that include blasting, the BLM or Forest Service would require that blasting be postponed until the condors leave the area or are hazed away by personnel permitted to haze condors. Where condor nesting activity is known within 1 mile of the project area, the BLM or Forest Service would cease blasting during the active nesting season (February 1–November 30) or as long as the nest is viable. These dates may be modified based on the most current information regarding condor nesting.
- The project site would be cleaned up at the end of each day work is being conducted (e.g., trash removed, scrap materials picked up) to minimize the likelihood of condors visiting the site. BLM or Forest Service may conduct site visits to the area to ensure adequate cleanup measures are taken.
- For projects where potential exists for leakage or spill of hazardous materials, a spill plan would be developed and implemented to prevent water contamination and potential poisoning of condors. The plan would include provisions for immediate cleanup of any hazardous substance and would define how each hazardous substance would be treated in case of leakage or spill. The

plan would be reviewed by the condor lead biologist to ensure that condors are adequately addressed.

- For projects where open pits or ponds are necessary, a cover or wire grid would be applied over the standing water to reduce the possibility of use by California condor and other birds.
- The BLM or Forest Service would implement the protective measures for California condors that are contained in the March 2004 *Recommended Protection Measures for Pesticide Applications in the Southwest Region of the U.S. Fish and Wildlife Service*.

MEXICAN SPOTTED OWL STANDARDS

- Surveys would be conducted of all potential spotted owl habitats, including protected, restricted, and other forest and woodland types within an analysis area plus the area 0.5 mile beyond the perimeter of the proposed mine area.

4.8.4 Bureau of Land Management Sensitive Species

Table 3.8-2 provides details of the 35 BLM Special Status species being considered in this EIS and their possible occurrence within the proposed withdrawal area. As detailed in Table 4.8-1, it was determined by agency resource specialists that a total of 10 of these plant species would not to be affected by actions proposed in this EIS. The remaining 25 species will be analyzed in more detail in the following impact discussions. BLM Sensitive species known to occur in the proposed withdrawal area include Grand Canyon rose, cliff milkvetch, Marble Canyon milkvetch, Paria Plateau fishhook cactus, Allen's lappet-browed bat, pale Townsend's big-eared bat, small-footed myotis, long-eared myotis, fringed myotis, long-legged myotis, big free-tailed bat, Houserock Valley chisel-toothed kangaroo rat, and western burrowing owl. Species with a reasonable potential to occur within the vicinity of the proposed withdrawal area include pocketed free-tailed bat, common chuckwalla, northern sagebrush lizard, banded Gila monster, flannelmouth sucker, desert sucker, and speckled dace. Fickeisen plains cactus is listed and discussed as a USFWS candidate species (see Section 4.8.3).

Direct and Indirect Impacts

As previously discussed, mining associated with each alternative has the potential to impact both aquatic and terrestrial habitats within and adjacent to the proposed withdrawal area. For a more detailed discussion on aquatic and terrestrial habitat impacts, see Sections 4.7 and 4.7.4. Although only 0.10% (1,052 acres) of the total habitat acres on the North and East parcels would be impacted, even small modifications to habitat could lead to potential effects on rare BLM Special Status Species. Site-specific conservation measures to avoid sensitive resources at the plan of operation at the project level, such as location of roads, power lines, and associated mine structures, could help reduce the potential for adverse impacts to BLM Sensitive species.

Uranium and other radionuclides can be transported through the environment and contribute to exposure of biological receptors via atmospheric deposition, dust, runoff, erosion and deposition, groundwater and surface water, and the food chain. As a result, biological receptors can be exposed to radionuclides through various pathways, including ingestion (soil, food, or water), inhalation, cell membrane–mediated uptake, cutaneous absorption, and biotic uptake/trophic transfer. The potential magnitude of impacts to wildlife is influenced by the life history strategy and habitat requirements of a particular organism.

For wildlife, the use of subterranean habitats (e.g., burrows), such as for birds, reptiles, and mammals in uranium-rich areas or reclaimed mining areas, is of particular concern in the proposed withdrawal area. These species spend a considerable amount of time in subterranean habitats where individuals could

potentially inhale, ingest, or be directly exposed to uranium and other radionuclides while digging, eating, preening, and hibernating. The bats listed as BLM Sensitive are insectivores and could be impacted by bioaccumulation of uranium in prey items and through ingestion of water.

Impacts of Alternative A: No Action (No Withdrawal)

The total acres of disturbance under Alternative A over a 20-year time frame has been calculated at approximately 1,500 acres of direct impact related to mining, roads, and power line impacts, or approximately 1.5% of the proposed withdrawal area. The North Parcel would have the greatest amount of impacts, with approximately 2% of available land within that parcel being impacted. If Alternative A is implemented, approximately 2% of the available land within the North Parcel would be impacted, approximately 1.2% of available land for the East Parcel would be impacted, and approximately 0.8% of available land within South Parcel would be impacted.

Impacts to riparian habitat and water quality of surface water could impact bat and fish species known to inhabit the proposed withdrawal area. Insectivorous bat species use all habitat types found within the proposed withdrawal area and may experience collisions with vehicles if mining operations occur at night. Bats are susceptible to bioaccumulation impacts as the consume prey items. The location of the mine facility and influence of the mine on the quantity and quality of groundwater and surface flows at seeps and springs and other surface waters could influence the magnitude of impacts on these bat species. Increased uranium levels within Kanab Creek are unlikely but could have impacts to flannelmouth sucker and desert sucker, which reside in the main stem Colorado River.

The potential to impact sensitive plant species could result from physical land disturbances associated with exploration and mine sites as well as roadways and power line facilities. In addition to direct habitat impacts, indirect impacts to BLM Sensitive plants could result from dust settling on vegetation adjacent to roads, which could temporarily reduce individual productivity. Site-specific studies and conservation measures would need to be implemented during construction and development operations to eliminate impacts to these species.

Although the exact location of mining under this alternative is not known, implementation of Alternative A can be assumed to have potential impacts the overall quality and quantity of unfragmented terrestrial and riparian habitat within the proposed withdrawal area that could be measurable but not apparent. Individuals may experience reduced viability or mortality; however, these impacts would not alter species distribution in the study area or result in changes to overall species population viability. These impacts are considered moderate, given the amount of acres impacted (1.5%), the amount of water used (316 mgal), and the potential for additional uranium threats and bioaccumulation in Kanab Creek, which many of these species inhabit. The impacts are considered long term, as 728 exploration projects and 30 mining projects are anticipated over 20 years. New access roads would be reclaimed when the mines are closed. Access roads will be shared when multiple mines are located in the general vicinity, which would further reduce the physical footprint of new roads but could extend the duration of select roads to as much as 20 years, while others may be open and closed within a 3- to 5-year time frame.

Impacts of Alternative B: Proposed Action (~1 Million Acres, 20-Year Withdrawal)

Under Alternative B, approximately 164 acres would be impacted by new mining. To support the exploration and development projects, approximately 6.4 miles of new roads and power lines would also be constructed. An estimated 88,885 ore haul trips would be required on these new roads. The total acres of disturbance under Alternative B over a 20-year time frame have been calculated at approximately 0.4% of the proposed withdrawal area. The North Parcel would have the most impacts, with approximately

0.7% of available land within that parcel. The East Parcel would not have any impacts under this alternative. The South Parcel would have approximately 1 acre impacted, or <0.01% of available land within that parcel.

Impacts to species are similar to those described under Alternative A. When comparing potential impacts between Alternatives A and B, Alternative B provides more protection to biota from uranium mine-related impacts to the South and East parcels to terrestrial habitats and removes the threat of uranium-related aquatic impacts affecting Colorado River species. Within the North Parcel, this alternative provides better protection to BLM Sensitive plant species than Alternative A.

Impacts to species are similar to those described under Alternative A; however, given the reduced impacts (fewer acres directly and indirectly affected, fewer roads and power lines built, fewer haul trips generated), decreased water use (64% reduction from Alternative A) associated with Alternative B, the magnitude of these impacts is significantly less. Impacts to overall quality and quantity of unfragmented habitat would not be measurable or apparent. Individuals may experience reduced viability or mortality; however, these impacts would not alter species distribution in the study area or result in changes to overall wildlife population viability. These impacts are considered minor, given the amount of acres impacted (0.4%), and long term, as impacts would be scattered spatially and temporally (10 mining projects over 20 years; 11 exploration projects over 20 years).

Impacts of Alternative C: Partial Withdrawal (~700,000 Acres)

Under Alternative C, approximately 532 acres would be impacted by new mining. To support the exploration and mining projects, approximately 12.1 miles of new dirt roads and power lines would also be constructed. An estimated 166,725 ore haul trips would be required on these new roads. The total acres of disturbance under Alternative C over a 20-year time frame have been calculated at approximately 0.8% of the proposed withdrawal area. The North Parcel would have the greatest amount of impacts, with approximately 1.1% of available land within that parcel impacted. The East Parcel would have approximately 0.6% of available land within that parcel. The South Parcel would have approximately1,321 acres impacted, or 0.4% of available land within that parcel.

Under Alternative C, specific areas with high valued habitat resources proposed for withdrawal under this alternative include Kanab Creek on the North Parcel, areas adjacent to Marble Canyon on the East Parcel, and several major drainages on the South Parcel. By removing these highly valued habitat resources from future mining, Alternative C will benefit BLM Sensitive species populations more than Alternative A but less than Alternative B, which removes the entire proposed withdrawal area from future mining claims (subject to valid existing rights).

Although the physical location of mines would not occur within Kanab Creek as part of this alternative, increased uranium in surface waters and bio-uptake of uranium by prey items may have minor impacts to foraging bats, flannelmouth sucker, and speckled dace, which use water resources outside the proposed withdrawal area. The increase in uranium is expected to be minor and almost non-detectable from existing and naturally occurring levels (see Section 4.4, Water Resources).

Impacts to species are similar to those described under Alternative A; however, given the reduced impacts (fewer acres directly and indirectly affected, fewer roads and power lines built, fewer haul trips generated) and decreased water use (a 40% reduction from Alternative A) associated with Alternative C, the magnitude of these impacts is less. Impacts to overall quality and quantity of unfragmented habitat would not be measurable or apparent. Individuals may experience reduced viability or mortality; however, these impacts would not alter species distribution in the study area or result in changes to overall species population viability. These impacts are considered minor, given the amount of acres impacted (0.8%) and reduced potential for future mining near higher valued habitat, and the duration is

considered long term, as impacts would be scattered spatially and temporally (26 mining projects over 20 years; 207 exploration projects over 20 years).

Alternative D: Partial Withdrawal

Under Alternative D, approximately 951 acres would be impacted by new mining. To support the exploration and development projects, approximately 19.1 miles of new dirt roads and power lines would also be constructed. An estimated 255,685 ore haul trips would be required on these new roads. The total acres of disturbance under Alternative D over a 20-year time frame have been calculated at approximately 1.3% of the proposed withdrawal area. The North Parcel would have the most impacts, with approximately 1.9% of available land within that parcel impacted. In the East Parcel, approximately 0.6% of available land within that parcel would be impacted. The South Parcel would have approximately 0.5% of available land within that parcel impacted.

Under Alternative D, specific areas with higher valued habitat resources proposed for withdrawal under this alternative include Kanab Creek on the North Parcel, areas adjacent to Marble Canyon on the East Parcel, and several major drainages on the South Parcel. By removing these highly valued habitat resources from future mining, Alternative D will benefit threatened and endangered species populations more than Alternative A but less than Alternative B, which removes the entire potential withdrawal area from future mining claims. Alternatives C and D both protect these resources from future mining, but Alternative D uses approximately 31% more water and therefore has a greater likelihood to have more impacts on aquatic habitats. Alternative D also does not withdraw as much terrestrial habitat that is occupied by BLM Sensitive Species. These areas are located in the northeastern and northwestern portions of the North Parcel, where several threatened and endangered plants species occur.

Impacts to species are similar to those described under Alternative A, with only a minimal reduction in acres disturbed. Impacts to overall quality and quantity of unfragmented habitat would be measurable but not apparent. Individuals may experience reduced viability or mortality; however, these impacts would not alter wildlife distribution in the study area or result in changes to overall wildlife population viability. These impacts are considered moderate, given the amount of acres impacted (0.8%) and decreased water use (13% from Alternative A) associated with Alternative D, and the duration is considered long term, as impacts would be scattered spatially and temporally (26 mining projects over 20 years; 207 exploration projects over 20 years).

Cumulative Impacts

Past, present, and reasonably foreseeable mining-related activities in the proposed withdrawal area include ongoing operations at the Arizona 1 mine, as well as the current review by the BLM of a plan of operations for the EZ1, EZ2, and What deposits in the North Parcel. Potential development of these deposits is included as part of the RFD scenarios predicting reasonably foreseeable future actions (see Appendix B). Site-specific analysis, findings, and decisions regarding this plan of operations would be made by the BLM after the project-specific environmental analysis is completed, not through this EIS on the proposed mineral withdrawal. No mining-related activities are proposed for the East Parcel.

When combined with the impacts of these other activities, all of the alternatives could contribute to minor short-term and long-term direct habitat impacts, a decrease in habitat productivity, and an increase in the potential for mortality of BLM sensitive species. However, given the relatively limited surface impacts, it is anticipated none of the alternatives would result in significant cumulative impacts to BLM Sensitive species when added to other past, present, and reasonably foreseeable activities in the proposed withdrawal area.

4.8.5 Forest Service Sensitive Species

Table 3.8-2 provides details of the 20 Forest Service Sensitive species being considered in this EIS and their possible occurrence within the proposed withdrawal area. All 20 Forest Service Sensitive species occur or have a reasonable potential to occur in the proposed withdrawal area, and several have been discussed in Sections 4.7 and 4.8. Forest Service Sensitive species include vascular plants, mammals, and reptile species. Mammal species comprise large herbivore, flying insectivores, and burrowing species.

Direct and Indirect Impacts

As previously discussed, mining activity under each alternative has the potential to impact both aquatic and terrestrial habitats within and adjacent to the proposed withdrawal area. For a more detailed discussion on aquatic and terrestrial habitat impacts, see Sections 4.7 and 4.7.4. Although only 0.10% (1,052 acres) of the total habitat acres on the North and East parcels would be impacted, even small modifications to habitat could lead to potential effects on Forest Service Sensitive species. Site-specific conservation measures to avoid sensitive resources in the plan of operations at the project level, such as location of roads, power lines, and associated mine structures, could help reduce the potential for adverse impacts to Forest Service Sensitive species.

Uranium and other radionuclides can be transported through the environment and contribute to exposure of biological receptors via atmospheric deposition, dust, runoff, erosion and deposition, groundwater and surface water, and the food chain. As a result, biological receptors can be exposed to radionuclides through various pathways, including ingestion (soil, food, or water), inhalation, cell membrane–mediated uptake, cutaneous absorption, and biotic uptake/trophic transfer. The potential severity of impacts to wildlife is influenced by the life history strategy and habitat requirements of a particular organism.

For wildlife, the use of subterranean habitats (e.g., burrows), such as for the birds, reptiles and mammals in uranium-rich areas or reclaimed mining areas, is of particular concern in the proposed withdrawal area. These species spend a considerable amount of time in subterranean habitats, where individuals could potentially inhale, ingest, or be directly exposed to uranium and other radionuclides while digging, eating, preening, and hibernating. The bats listed as Forest Service Sensitive species are insectivorous and could be impacted by bioaccumulation of uranium in prey items and through ingestion of water.

Compliance with Environmental Regulations and Permitting

The following conservation measures had previously been developed by the Forest Service to reduce the potential for impacts to rare plants resulting from proposed uranium exploration and mining in the South Parcel. These measures would also benefit habitat for sensitive animals. The impact analysis presented below assumes compliance with the following measures:

- Vehicles would stay on designated driving routes to avoid excessive soil or vegetation disturbance.
- If warranted, the immediate impacted project area, including access roads, will be surveyed 30 days before the project begins in order to locate suitable habitat and/or populations of rare plants.
- If populations of any rare plant species are found before or during project implementation, the project proponent will coordinate with the district rare plant coordinator in order to minimize negative impacts. Individuals would be marked and avoided during project activities.
- Purchased seed or mulch will not be used within populations of rare plants, in order to prevent the introduction of invasive species and to prevent attracting wild ungulates to the area.

- Wildlife exclusionary measures such as fencing and covers or wire grids over pits and other ponded water at mine sites would further reduce potential for uranium uptake by Forest Service Sensitive animals. Increases of uranium in surface waters and bio-uptake of uranium by prey items may have minor impacts to foraging bats.

Forest Service management standards for northern goshawk and other sensitive species are listed below. Also refer to Forest Service General Technical Report RM-217, titled "Management Recommendations for the Northern Goshawk in the Southwestern United States." Standards state to

- Survey the management analysis area prior to habitat-modifying activities, including a 0.5-mile buffer beyond the boundary.
- Establish, and delineate on a map, a post-fledgling family area that includes six nesting areas per pair of nesting goshawks for known nest sites, old nest sites, areas where historical data indicate goshawks have nested there in the past, and areas where goshawks have been repeatedly sighted over a 2-year or greater time period but where no nest sites have been located.
- Manage for uneven-age stand conditions for live trees and retain live reserve trees, snags, downed logs, and woody debris levels throughout woodland, ponderosa pine, mixed conifer, and spruce-fir forest cover types. Manage for old age trees such that as much old forest structure as possible is sustained over time across the landscape. Sustain a mosaic of vegetation densities (overstory and understory), age classes, and species composition across the landscape. Provide foods and cover for goshawk prey.
- Limit human activity in nesting areas during the breeding season.
- Manage the ground surface layer to maintain satisfactory soil conditions, i.e., minimize soil compaction and maintain nutrient cycles.
- When activities conducted in conformance with these standards and guidelines may adversely affect other threatened, endangered, or sensitive species or may conflict with other established recovery plans or conservation agreements, consult with USFWS to resolve the conflict.
- Within the ranges of the Paradine (Kaibab) plains cactus, and the Arizona leatherflower, management activities needed for the conservation of these two species that may conflict with northern goshawk standards and guidelines will be exempt from the conflicting northern goshawk standards and guidelines until conservation strategies or recovery plans (if listed) are developed for the two species.

Impacts of Alternative A: No Action (No Withdrawal)

The total acres of disturbance under Alternative A over a 20-year time frame has been calculated at approximately 1,500 acres of direct impact related to mining, roads, and power line impacts, or approximately 1.5% of the proposed withdrawal area. The North Parcel would have the greatest amount of impacts, with approximately 2% of available land within that parcel being impacted. If Alternative A is implemented, approximately 2% of the available land within the North Parcel will be impacted, approximately 1.2% for the East Parcel, and approximately 0.8% of available land within South Parcel.

Impacts to riparian habitat and water quality of surface water could impact mammal species known to inhabit the proposed withdrawal area. Insectivorous bat species use all habitat types found within the proposed withdrawal area and may experience collisions with vehicles if mining operations occur at night. Mammals are susceptible to bioaccumulation impacts, as they consume prey items. The location of the mine facility and influence of the mine on the quantity and quality of groundwater and surface flows at seeps and springs and other surface waters could influence the magnitude of impacts on these mammal species.

The potential to impact sensitive plant species is possible by physical land disturbances associated with exploration and mine sites as well as roadways and power line facilities. In addition to direct habitat impacts, indirect impacts to Forest Service Sensitive plants could result from dust settling on vegetation adjacent to roads, which could temporarily reduce individual productivity. Site-specific studies and conservation measures would need to be implemented during construction and mining operations to reduce or eliminate impacts to these species.

Although the exact location of mining under this alternative is not known, implementation of Alternative A can be assumed to have potential impacts to the overall quality and quantity of unfragmented terrestrial and riparian habitat within the proposed withdrawal area that could be measurable but not apparent. Individuals may experience reduced viability or mortality; however, these impacts would not alter species distribution in the study area or result in changes to overall species population viability. These impacts are considered moderate, given the amount of acres impacted (1.5%), the amount of water used (316 mgal), and the potential for additional uranium threats and bioaccumulation in Kanab Creek, which many of these species inhabit. The impacts are considered long term, as 728 exploration projects and 30 mining projects are anticipated over 20 years. New access roads would be reclaimed when the mines are closed. Access roads will be shared when multiple mines are located in the general vicinity, which would further reduce the physical footprint of new roads but could extend the duration of select roads to as much as 20 years, while others may be open and closed within a 3- to 5-year time frame.

Impacts of Alternative B: Proposed Action (~1 Million Acres, 20-Year Withdrawal)

Under Alternative B, approximately 164 acres would be impacted by new mining. To support the exploration and development projects, approximately 6.4 miles of new roads and power lines would also be constructed. An estimated 88,885 ore haul trips would be required on these new roads. The total acres of disturbance under Alternative B over a 20-year time frame have been calculated at approximately 0.4% of the proposed withdrawal area. The North Parcel would have the most impacts, with approximately 0.7% of available land within that parcel. The East Parcel would not have any impacts under this alternative. The South Parcel would have approximately 1 acre impacted, or <0.01% of available land within that parcel.

Impacts to species are similar to those described under Alternative A. When comparing potential impacts between Alternatives A and B, Alternative B provides more protection to biota from uranium mine-related impacts on terrestrial habitats on the South and East parcels and removes the threat of uranium-related aquatic impacts affecting Colorado River species. Within the North Parcel, this alternative provides better protection to Forest Service plant species than does Alternative A.

Impacts to species are similar to those described under Alternative A; however, given the reduced impacts (fewer acres directly and indirectly affected, fewer roads and power lines built, fewer haul trips generated) and decreased water use (64% reduction from Alternative A) associated with Alternative B, the magnitude of these impacts is significantly less. Impacts to overall quality and quantity of unfragmented habitat would not be measurable or apparent. Individuals may experience reduced viability or mortality; however, these impacts would not alter species distribution in the study area or result in changes to overall species population viability. These impacts are considered minor, given the amount of acres impacted (0.4%), and long term, as impacts would be scattered spatially and temporally (10 mining projects over 20 years; 11 exploration projects over 20 years).

Impacts of Alternative C: Partial Withdrawal (~700,000 Acres)

Under Alternative C, approximately 532 acres would be impacted by new mining. To support the exploration and development projects, approximately 12.1 miles of new dirt roads and power lines would also be constructed. An estimated 166,725 ore haul trips would be required on these new roads. The total acres of disturbance under Alternative C over a 20-year time frame have been calculated at approximately 0.8% of the proposed withdrawal area. The North Parcel would have the greatest amount of impacts, with approximately 1.1% of available land within that parcel impacted. The East Parcel would have approximately 0.6% of available land within that parcel. The South Parcel would have approximately 1,321 acres impacted, or 0.4% of available land within that parcel.

Under Alternative C, specific areas with high valued habitat resources proposed for withdrawal under this alternative include Kanab Creek on the North Parcel, areas adjacent to Marble Canyon on the East Parcel, and several major drainages on the South Parcel. By removing these highly valued habitat resources from future mining, Alternative C will benefit Forest Service Sensitive species populations more than Alternative A but less than Alternative B, which removes the entire potential withdrawal area from future mining claims.

Although the physical location of mines would not occur within Kanab Creek as part of this alternative, increased uranium in surface waters and bio-uptake of uranium by prey items may have minor impacts to foraging mammal species that use water resources outside the proposed withdrawal area. The increase in uranium is expected to be minor and almost non-detectable from existing and naturally occurring levels (see Section 4.4, Water Resources).

Impacts to species are similar to those described under Alternative A; however, given the reduced impacts (fewer acres directly and indirectly affected, fewer roads and power lines built, fewer haul trips generated) and the decreased water use (a 40% reduction from Alternative A) associated with Alternative C, the magnitude of these impacts is less. Impacts to overall quality and quantity of unfragmented habitat would not be measurable or apparent. Individuals may experience reduced viability or mortality; however, these impacts would not alter species distribution in the study area or result in changes to overall species population viability. These impacts are considered minor, given the amount of acres impacted (0.8%) and the reduced potential for future mining near higher valued habitat, and the duration is considered long term, as impacts would be scattered spatially and temporally (26 mining projects over 20 years; 207 exploration projects over 20 years).

Impacts of Alternative D: Partial Withdrawal (~300,000 Acres)

Under Alternative D, approximately 951 acres would be impacted by new mining. To support the exploration and development projects, approximately 19.1 miles of new dirt roads and power lines would also be constructed. An estimated 255,685 ore haul trips would be required on these new roads. The total acres of disturbance under Alternative D over a 20-year time frame have been calculated at approximately 1.3% of the proposed withdrawal area. The North Parcel would have the greatest amount of impacts, with approximately 1.9% of available land within that parcel impacted. In the East Parcel, approximately 0.6% of available land within that parcel would be impacted. The South Parcel would have approximately 0.5% of available land within that parcel impacted.

Under Alternative D, specific areas with higher valued habitat resources proposed for withdrawal under this alternative include Kanab Creek on the North Parcel, areas adjacent to Marble Canyon on the East Parcel, and several major drainages on the South Parcel. By removing these highly valued habitat resources from future mining, Alternative D will benefit Forest Service Sensitive species populations more than Alternative A but less than Alternative B, which removes the entire potential withdrawal area from future mining claims. Alternatives C and D both protect these resources from future mining, but

Alternative D uses approximately 31% more water and therefore has a greater likelihood to have more impacts on aquatic habitats. Alternative D also does not withdraw as much terrestrial habitat that is occupied by Forest Service Sensitive species.

Impacts to species are similar to those described under Alternative A, with only a minimal reduction in acres disturbed. Impacts to overall quality and quantity of unfragmented habitat would be measurable but not apparent. Individuals may experience reduced viability or mortality; however, these impacts would not alter species distribution in the study area or result in changes to overall species population viability. These impacts are considered moderate, given the amount of acres impacted (0.8%) and decreased water use (13% from Alternative A) associated with Alternative D, and the duration is considered long term, as impacts would be scattered spatially and temporally (26 mining projects over 20 years; 207 exploration projects over 20 years).

Cumulative Impacts

The analysis area for Forest Service Sensitive species consists of the proposed withdrawal area (North, East, and South parcels), the Park, and North Kaibab Ranger District. When combined with the impacts of these other activities, all of the alternatives could contribute to direct habitat impacts, a decrease in habitat productivity, an increase in disturbance, and an increase in the potential for mortality of Forest Service Sensitive species.

Given the relatively limited surface impacts, it is anticipated that none of the alternatives would result in significant cumulative impacts to Forest Service Sensitive species when added to other past, present, and reasonably foreseeable activities in the proposed withdrawal area.

4.8.6 National Park Service Species of Concern

Table 3.8-2 provides details of the 20 NPS Species of Concern being considered in this EIS and their possible occurrence within the proposed withdrawal area. All 20 NPS Species of Concern occur or have a reasonable potential of occurrence in the proposed withdrawal area, and several have been discussed in Sections 4.7 and 4.8. NPS Species of Concern include vascular plants, invertebrate, reptile, fish, and mammal species.

Direct and Indirect Impacts

As previously discussed, mining activity under each alternative has the potential to impact both aquatic and terrestrial habitats within and adjacent to the proposed withdrawal area. For a more detailed discussion of aquatic and terrestrial habitat impacts, see Sections 4.7 and 4.7.4. Although only 0.10% (1,052 acres) of the total habitat acres on the North and East parcels would be impacted, even small modifications to habitat could lead to potential effects on rare NPS Species of Concern. Site-specific conservation measures to avoid sensitive resources in the plan of operations at the project level, such as location of roads, power lines, and associated mine structures, could help reduce the potential for adverse impacts to NPS Species of Concern.

Uranium and other radionuclides can be transported through the environment and contribute to exposure of biological receptors via atmospheric deposition, dust, runoff, erosion and deposition, groundwater and surface water, and the food chain. As a result, biological receptors can be exposed to radionuclides through various pathways, including ingestion (soil, food, or water), inhalation, cell membrane–mediated uptake, cutaneous absorption, and biotic uptake/trophic transfer. The potential severity of impacts to wildlife is influenced by the life history strategy and habitat requirements of a particular organism.

For wildlife, the use of subterranean habitats (e.g., burrows), such as for reptiles in uranium-rich areas or reclaimed mining areas, is of particular concern in the proposed withdrawal area. These species spend a considerable amount of time in subterranean habitats, where individuals could potentially inhale, ingest, or be directly exposed to uranium and other radionuclides while digging, eating, preening, and hibernating. The bats listed as NPS Species of Concern are insectivorous and could be impacted by bioaccumulation of uranium in prey items and through ingestion of water.

Impacts of Alternative A: No Action (No Withdrawal)

The total acres of disturbance under Alternative A over a 20-year time frame has been calculated at approximately 1,500 acres of direct impact related to mining, roads, and power line impacts, or approximately 1.5% of the proposed withdrawal area. The North Parcel would have the greatest amount of impacts, with approximately 2% of available land within that parcel being impacted. If Alternative A is implemented, approximately 2% of the available land within the North Parcel would be impacted, approximately 1.2% for the East Parcel, and approximately 0.8% of available land within South Parcel.

Impacts to riparian habitat and water quality of surface water could impact mammal species known to inhabit the proposed withdrawal area. Insectivorous bat species use all habitat types found within the proposed withdrawal area and may experience collisions with vehicles if mining operations occur at night. Mammals and fish are susceptible to bioaccumulation impacts, as they consume prey items. The location of the mine facility and influence of the mine on the quantity and quality of groundwater and surface flows at seeps and springs and other surface waters could influence the magnitude of impacts on these mammal species.

The potential to impact sensitive plant species could result from physical land disturbances associated with exploration and mine sites as well as roadways and power line facilities. In addition to direct habitat impacts, indirect impacts to NPS Species of Concern plants could result from dust settling on vegetation adjacent to roads, which could temporarily reduce individual productivity. Site-specific studies and conservation measures would need to be implemented during construction and mining operations to reduce or eliminate impacts to these species.

Although the exact location of mining under this alternative is not known, implementation of Alternative A can be assumed to have potential impacts the overall quality and quantity of unfragmented terrestrial and riparian habitat within the proposed withdrawal area that could be measurable but not apparent. Individuals may experience reduced viability or mortality; however, these impacts would not alter species distribution in the study area or result in changes to overall species population viability. These impacts are considered moderate, given the amount of acres impacted (1.5%), the amount of water used (316 mgal), and the potential for additional uranium threats and bioaccumulation in Kanab Creek, which many of these species inhabit. The impacts are considered long term, as 728 exploration projects and 30 mining projects are anticipated over 20 years. New access roads would be reclaimed when the mines are closed. Access roads would be shared when multiple mines are located in the general vicinity, which would further reduce the physical footprint of new roads but could extend the duration of select roads to as much as 20 years, while others may be open and closed within a 3- to 5-year time frame.

Impacts of Alternative B: Proposed Action (~1 Million Acres, 20-Year Withdrawal)

Under Alternative B, approximately 164 acres would be impacted by new mining. To support the exploration and mining projects, approximately 6.4 miles of new roads and power lines would also be constructed. An estimated 88,885 ore haul trips would be required on these new roads. The total acres of disturbance under Alternative B over a 20-year time frame have been calculated at approximately 0.4% of

the proposed withdrawal area. The North Parcel would have the greatest amount of impacts, with approximately 0.7% of available land within that parcel. The East Parcel would not have any impacts under this alternative. The South Parcel would have approximately 1 acre impacted, or <0.01% of available land within that parcel.

Impacts to species are similar to those described under Alternative A. When comparing potential impacts between Alternatives A and B, Alternative B provides more protection to biota from uranium mine-related impacts on terrestrial habitats on the South and East parcels and removes the threat of uranium-related aquatic impacts affecting Colorado River species. Within the North Parcel, this alternative provides better protection to NPS Species of Concern plant species than does Alternative A.

Impacts to species are similar to those described under Alternative A; however, given the reduced impacts (fewer acres directly and indirectly affected, fewer roads and power lines built, fewer haul trips generated) and decreased water use (64% reduction from Alternative A) associated with Alternative B, the magnitude of these impacts is significantly less. Impacts to overall quality and quantity of unfragmented habitat would not be measurable or apparent. Individuals may experience reduced viability or mortality; however, these impacts would not alter species distribution in the study area or result in changes to overall species population viability. These impacts are considered minor, given the amount of acres impacted (0.4%), and long term, as impacts would be scattered spatially and temporally (10 mining projects over 20 years; 11 exploration projects over 20 years).

Impacts of Alternative C: Partial Withdrawal (~700,000 Acres)

Under Alternative C, approximately 532 acres would be impacted by new mining. To support the exploration and development projects, approximately 12.1 miles of new dirt roads and power lines would also be constructed. An estimated 166,725 ore haul trips would be required on these new roads. The total acres of disturbance under Alternative C over a 20-year time frame have been calculated at approximately 0.8% of the proposed withdrawal area. The North Parcel would have the greatest amount of impacts, with approximately 1.1% of available land within that parcel impacted. The East Parcel would have approximately 0.6% of available land within that parcel. The South Parcel would have approximately1,321 acres impacted, or 0.4% of available land within that parcel.

Under Alternative C, specific areas with highly valued habitat resources proposed for withdrawal under this alternative include Kanab Creek on the North Parcel, areas adjacent to Marble Canyon on the East Parcel, and several major drainages on the South Parcel. By removing these highly valued habitat resources from future mining, Alternative C will benefit NPS Species of Concern populations more than Alternative A but less than Alternative B, which removes the entire potential withdrawal area from future mining claims.

Although the physical location of mines would not occur within Kanab Creek as part of this alternative, increased uranium in surface waters and bio-uptake of uranium by prey items may have minor impacts to foraging mammal species that use water resources outside the proposed withdrawal area. The increase in uranium is expected to be minor and almost non-detectable from existing and naturally occurring levels (see Section 4.4, Water Resources).

Impacts to species are similar to those described under Alternative A; however, given the reduced impacts (fewer acres directly and indirectly affected, fewer roads and power lines built, fewer haul trips generated) and the decreased water use (a 40% reduction from Alternative A) associated with Alternative C, the magnitude of these impacts is less. Impacts to overall quality and quantity of unfragmented habitat would not be measurable or apparent. Individuals may experience reduced viability or mortality; however, these impacts would not alter species distribution in the study area or result in changes to overall species population viability. These impacts are considered minor, given the amount of acres

impacted (0.8%) and the reduced potential for future mining near higher valued habitat, and the duration is considered long term, as impacts would be scattered spatially and temporally (26 mining projects over 20 years; 207 exploration projects over 20 years).

Impacts of Alternative D: Partial Withdrawal (~300,000 Acres)

Under Alternative D, approximately 951 acres would be impacted by new mining. To support the exploration and development projects, approximately 19.1 miles of new dirt roads and power lines would also be constructed. An estimated 255,685 ore haul trips would be required on these new roads. The total acres of disturbance under Alternative D over a 20-year time frame have been calculated at approximately 1.3% of the proposed withdrawal area. The North Parcel would have the greatest amount of impacts, with approximately 1.9% of available land within that parcel impacted. In the East Parcel, approximately 0.6% of available land within that parcel would be impacted. The South Parcel would have approximately 0.5% of available land within that parcel impacted.

Under Alternative D, specific areas with higher valued habitat resources proposed for withdrawal under this alternative include Kanab Creek on the North Parcel, areas adjacent to Marble Canyon on the East Parcel, and several major drainages on the South Parcel. By removing these highly valued habitat resources from future mining, Alternative D will benefit NPS Species of Concern populations more than Alternative A but less than Alternative B, which removes the entire potential withdrawal area from future mining claims. Alternatives C and D both protect these resources from future mining, but Alternative D uses approximately 31% more water and therefore has a greater likelihood to have more impacts on aquatic habitats. Alternative D also does not withdraw as much terrestrial habitat that is occupied by Forest Service Sensitive species.

Impacts to species are similar to those described under Alternative A, with only a minimal reduction in acres disturbed. Impacts to overall quality and quantity of unfragmented habitat would be measurable but not apparent. Individuals may experience reduced viability or mortality; however, these impacts would not alter species distribution in the study area or result in changes to overall species population viability. These impacts are considered moderate, given the amount of acres impacted (0.8%) and decreased water use (13% from Alternative A) associated with Alternative D, and the duration is considered long term, as impacts would be scattered spatially and temporally (26 mining projects over 20 years; 207 exploration projects over 20 years).

Cumulative Impacts

The analysis area for NPS species of concern consists of the withdrawal area and the Park. When combined with the impacts of these other activities, all of the alternatives could contribute to potential sedimentation and contamination of drainages/waterways and springs and potential reduction in water quantity at springs in the Park.

Given the absence of direct impacts to NPS lands within the proposed withdrawal area, the limited potential for contamination and water quantity reduction, and the limited amount of foraging habitat removed, it is anticipated none of the alternatives would result in significant cumulative impacts to NPS species of concern when added to other past, present, and reasonably foreseeable activities in the proposed withdrawal area.

4.8.7 Arizona Game and Fish Department Species of Greatest Conservation Need

The AGFD has statutory authority and obligation under the ARS for fish and wildlife management in the state, including the proposed withdrawal area, except within Grand Canyon National Park. This statutory obligation includes management of both game and non-game wildlife. In cooperation with the AGFD, the BLM, and Forest Service develop management plans for wildlife species and habitats (BLM 2007). Many of the management directions for wildlife included in these habitat management plans are based on statewide goals of the AGFD in managing particular species. The BLM and Forest Service management plans include construction and maintenance of habitat improvement projects, primarily water developments for big- and small-game species, but many non-game species benefit from these projects as well. The AGFD Wildlife Action Plan provides a strategic framework and information resource designed to help conserve terrestrial and aquatic wildlife and their habitats in Arizona (AGFD 2010b). The action plan focuses on habitat types, provides recommended conservation actions for each habitat type on a regional basis and develops conservation priorities for the 183 SGCN in Arizona. Included among these SGCN are 28 crustaceans and mollusks, 33 fish, 12 amphibians, 26 reptiles, 49 birds, and 35 mammals. Special attention is given to federally listed species, federal candidate species, species currently petitioned for listing, recently delisted species, and species for which Conservation Agreements already exist.

Several species listed as SGCN occur in the proposed withdrawal area, and most of these are addressed in Section 3.8 as special status species. Among the SGCN addressed in Section 3.8 are Niobrara ambersnail, Kanab ambersnail, northern leopard frog, relict leopard frog, Sonoran desert tortoise, flannelmouth sucker, humpback chub, razorback sucker, speckled dace, olive-sided flycatcher, sage thrasher, western yellow-billed cuckoo, northern goshawk, American peregrine falcon, western burrowing owl, Mexican spotted owl, southwestern willow flycatcher, California condor, bald eagle, Yuma clapper rail, desert bighorn sheep, pronghorn, southwestern river otter, Mogollon vole, Merriam's shrew, Houserock Valley chisel-toothed kangaroo rat, black-footed ferret, greater western mastiff bat, western red bat, western yellow bat, and big free-tailed bat (AGFD 2010b). Several additional SGCN may occur on or are known to occur in the vicinity of the proposed withdrawal area. These include bluehead sucker, which occurs in Kanab Creek immediately south of the Kanab Plateau, and a variety of avian species found at higher elevations in habitats on the Kaibab Plateau (i.e., mixed conifer, spruce-fir, aspen) but not on the parcels themselves. Based on breeding distribution maps in Corman and Wise-Gervais (2005), these bird species include American three-toed woodpecker, western purple martin, red-naped sapsucker, Lewis's woodpecker, Lincoln's sparrow, MacGillivray's warbler, downy woodpecker, green-tailed towhee, ruby-crowned kinglet, and golden-crowned kinglet.

As previously discussed, mining associated with each alternative has the potential to impact both aquatic and terrestrial habitats within and adjacent to the proposed withdrawal area. For a more detailed discussion of aquatic and terrestrial habitat impacts, see Sections 4.7 and 4.7.4. Although only 0.10% (1,052 acres) of the total habitat acres on the North and East parcels would be impacted, even small modifications to habitat could lead to potential effects on these AGFD species. Site-specific conservation measures to avoid sensitive resources in the plan of operations at the project level, such as location of roads, power lines, and associated mine structures, could help reduce the potential for adverse impacts to NPS Species of Concern.

Impacts discussions in Section 4.7 and the previous discussion in this section document potential threats and impacts related to implementation of the various alternatives. The 183 species included by AGFD on the SGCN list in Arizona would mirror previous species impact discussions and alternative ranking statements. No further analysis for these AGFD species is needed.

4.9 VISUAL RESOURCES

4.9.1 Impact Assessment Methodology and Assumptions

Introduction

The visual resource impact analysis is an assessment of landscape changes that would result from potential exploration and development, as described for each alternative in Chapter 2. As discussed in Chapter 3, visual resources are the combination of visible physical features that create scenery and overall landscape character. The landscape character and scenery have been analyzed and assigned a visual resource designation by the applicable land management agency (BLM, Forest Service, NPS) that denotes the area's sensitivity to changes in the landscape.

Area of Analysis

The area of analysis for visual resource impacts includes the following:

- All areas within the proposed withdrawal area and selected Key Observation Points within and outside the proposed withdrawal boundary; and
- Selected Key Observation Points within Grand Canyon National Park.

Indicators and Methods of Analysis

As discussed in Chapter 3, visual analysis involves determining whether the potential visual impacts from the proposed mineral withdrawal would meet the management objectives established for the area. Agency management objectives are applicable to this visual analysis because the process used to determine specific area objectives takes into account the visual appeal of a tract of land, public concern for scenic quality, and determining whether the tract of land is visible from travel routes or Key Observation Points. This information is used to assign a visual quality rating and management objectives to a tract of land that are subsequently used to manage and analyze activities and uses of that land.

The visual contrast rating process used for this analysis involves comparing project features with the major features in the existing landscape using the basic design elements of form, line, color, and texture. Visual impacts are the increases in line, form, color, and texture contrasts imposed on the existing landscape. These contrasts can result from surface disturbances (e.g., road and structure construction), loss of vegetation, visual intrusions (e.g., vehicles, dust, equipment), and loss of long-distance viewing caused by vehicle exhaust emissions and dust. Sound, motion, scent, rising smoke, and reflectivity can cause the attention of casual observers to be distracted by minute landscape changes. Minor impacts would be those that tend to blend into the existing landscape; major impacts would be highly visible and would not blend in with the existing landscape. This analysis describes visual impacts in general terms of meeting the federal agency VRM goals and describes potential impacts from the Key Observation Points described in Chapter 3.

The following table shows the levels of impacts and their definitions as used to assess the degree of impacts to visual resources within the proposed withdrawal area. The contrast analysis method is applied from the perspective of chosen observation points, using the terms, concepts, and visual resource objectives applicable for each federal agency. The range of effects shown below in Table 4.9-1 is a generalized, simplified range, derived from those agency classes used in preparing the analysis. The duration of impacts and definitions for this analysis are given in Table 4.9-2. The analysis below will discuss duration of impacts in terms of being temporary, short term, or long term.

Table 4.9-1. Magnitude and Degrees of Effects on Visual Resources

Attribute of Effect	Description Relative to Visual Resources
Magnitude	
No Impact	Would not produce obvious changes in landscape contrasts.
Minor	Project-related visual impacts that would retain the existing character of the landscape, create a low level of change, and while visible, would not attract the attention of the casual viewer.
Moderate	Visual impacts that would partially retain the existing character of the landscape, and while attracting the attention of the casual viewer, would not dominate the view.
Major	Project-related impacts that would create a high degree of change within the existing landscape, would dominate the view, and would be a focus of viewer attention (this will be reduced upon completion of reclamation).

Table 4.9-2. Duration Definition of Effects on Visual Resources

Duration	
Temporary	Up to 1 year (periods of development and reclamation)
Short-term	1 to 5 years
Long-term	Greater than 5 years

The indicators for visual resource conditions are as follows:

- Consistency with and conformance to designated BLM VRM class objectives and Forest Service scenic quality management objectives;
- Visual contrast of anticipated activity from Key Observation Points in the proposed withdrawal area;
- Consistency with and conformance to Park visual objectives from Key Observation Points within Grand Canyon National Park.
- Visual contrast of anticipated activity from Grand Canyon National Park Key Observation Points;
- The extent to which the predicted change in regional haze attributable to mining activity is noticeable; and
- Qualitative analysis of the potential changes to the darkness of the night sky in the proposed withdrawal area and Grand Canyon National Park.

4.9.2 Impacts of Alternative A: No Action (No Withdrawal)

Changes to the Characteristic Landscape

The addition of approximately 728 uranium exploration projects, 30 uranium mines, 300,165 ore haul trips, and 22.4 miles of new roads and power lines, resulting in approximately 1,321 acres of disturbed landscape over 20 years, would cause visual changes to the existing landscape character. Current development within the existing landscape is limited to paved state highways, minor dirt roads, power line corridors, recreation facilities, grazing facilities, and ongoing and historic mining facilities. Mineral exploration and development components that would impact visual resources are the presence of exploration drilling rigs, mine facilities (building structures, towers, and equipment), vegetation clearing, roads, power lines, ore-haul traffic, dust, and night lighting. These facilities and landscape changes would introduce new elements of form, line, color, and texture into the landscape.

During the 20-year time frame, it is expected that there would be approximately 6 mines producing uranium ore under approved plans of operation at any one time in the entire withdrawal area. This differs from the current total of four mines with approved plans of operation (Arizona 1, Canyon Mine, Kanab North Mine, and Pinenut Mine) and only one (Arizona 1) producing uranium ore. Visual impacts depend on location and density of specific exploration and development operations and thus become project specific. Mines located in less visually sensitive areas and out of viewsheds of area visitors would have smaller impacts than mines placed in more prominent locations. Uranium mines would be located in the vicinity of uranium-bearing breccia pipe formations. This analysis discusses the typical visual impacts that could occur from exploration and development and the potential visual contrast that could be observed from Key Observation Points. It does not include specific breccia pipe locations or any speculation of potential mining locations.

The degree of impact would vary among the different stages of mining activities (mineral exploration, active mining, and mine reclamation). For example, mineral exploration generally would have a smaller visual impact than a full mining operation because of the smaller footprint size and shorter time frame. There would be more exploration projects than mines, and the total impact of all exploration projects could lead to greater visual impacts. In addition, the lands with different visual management designations have varying degrees of sensitivity to visual impacts. Mining activities that occur closer to Key Observation Points and/or in more restrictive visual management designations would have a greater visual impact than those occurring further away from the observation points and/or in less restrictive visual management designations.

Typical visual impacts that would occur from mineral exploration include vegetation disturbance of approximately 1.1 acres with a drill rig on-site for approximately 1 month. Road construction would be minimal, with use of existing roads and overland travel, and sites would be restored upon completion of the drilling project. Exploration projects out of sight of Key Observation Points and within less restrictive visual designations (VRM Classes III and IV, VQO Modification, and SMS Moderate and Low) would have a minor short-term impact. Exploration activities in the direct sight of Key Observation Points and within sensitive visual designations (VRM Class II, VQO Preservation, and SMS High) would have a moderate to major short-term impact. Major impacts could occur to persons in the direct vicinity of an exploration project during the short-term time frame if the persons are only in the area during the time at which exploration activities are occurring.

A typical breccia pipe underground mine operation would require clearing approximately 21 acres of land and re-contouring the site with berms surrounding the mine area. The mine would include various building structures for storage and personnel, containment areas created with landscape berms, heavy equipment, and a head-frame. The head-frame, constructed over the mine opening, is a steel frame structure that extends approximately 40 feet above the ground. Mining operations would represent a visual impact through changes in contrast with the characteristic landscapes form, line, color, and texture. Changes in form and line would result primarily from building structures and the head-frame structure, which stands approximately 40 feet above the ground and interrupts the natural horizon line and linear features of the landscape. This tall, vertical feature could be visible from distant viewing locations (depending on vegetation and angle of view) and become a dominant landscape feature. Vegetation removal and landscape berms would create contrast in landscape color, thus making the mine area potentially visible from distant observation points (depending on vegetation and angle of view).
The magnitude of mine operation visual impacts depends on the location of the mine relative to observation points and VRM designations. Visual impacts would be minor if the mine is located in less restrictive visual designations (VRM Classes III and IV, VQO Modification, and SMS Moderate and Low) and not in the viewshed of an observation point. Visual impacts would range from moderate to major for a mine located in a more restrictive visual designation (VRM Class II, VQO Preservation, and SMS High) and within the viewshed of an observation point. The observation points described in Chapter

3 (including points within Grand Canyon National Park) are analyzed for potential direct and indirect effects below in Table 4.9-4.

Other visual impacts associated with mineral exploration and mining would result from new road construction, power line construction, ore-haul trucking traffic, dust, and night lighting. All of these impacts would result in landscape contrast changes through altered form, line, color, and texture. New roads would result in color and line contrast changes. Power lines could bring form and line contrasts, with vertical lines potentially visible along horizon lines.

Under Alternative A, the expected changes in visual quality described above could lead to a moderate impact to visual resources in the proposed withdrawal area, based on the parameters presented in Table 4.9-1. The degree of impact will vary, depending on the location of mining operations. Some mines may have a major impact if located in sensitive viewsheds. Other mines located in less sensitive viewsheds may have a minor impact. Uranium mines are located at uranium-bearing breccia pipes; this analysis does not identify the locations of potential mine locations.

Conformance with Visual Resource Designation

Each parcel contains specific visual resource designations as discussed in Chapter 3. Each designation outlines visual management objectives required for management actions and are established through the agencies' (BLM's and Forest Service's) land use planning processes. The designations are used to determine the acceptable level of visual disturbance and project-specific mitigation requirements to minimize visual disturbance in order to meet the designations. The Mining Law allows for development of mining on public lands, and, typically, visual designations do not stop mining activities. However, mitigation of visual impacts from mining activities might be required to attempt to meet visual designation objectives.

Visual resource designations are established through a comprehensive visual data collection and analysis process and represent the visual importance and value of a particular landscape. Proposed project conformance or non-conformance with visual designations represents the general visual impact in a given area. The section below discusses each parcel's visual designation and the likelihood that each alternative's proposed management actions conform to the stated objectives.

The acreages and percentages of visual designations by alternative are presented in Table 4.9-3. This table illustrates how the range of visual designations is included in each alternative. Alternative B includes all proposed withdrawal lands and results in inclusion of 100%, or all, of the established visual resource designations. Alternative A withdraws no lands, and the acreage and percentage of visual resource designations is zero.

NORTH PARCEL

North Parcel BLM lands include VRM Classes I, II, III, and IV (see Figure 3.9-1, Table 3.9-4). The more restrictive VRM Class I lands, designated for preservation of the existing landscape, include the Kanab Creek Wilderness and portions of Hack Canyon area within the wilderness. The objective of VRM Class I is to provide very limited management activity, with minimal levels of change that do not attracting attention of the casual viewer. It is important to note that lands within Congressionally designated (henceforth 'designated') wilderness are already withdrawn from mineral location and entry, so no mining activities would occur. Persons accessing this Class I area typically travel through the North Parcel.

VRM Class II designated lands include the Moonshine Ridge, Johnson Spring, and Kanab Creek ACECs, the Dominguez-Escalante Historic Trail corridor, and the Kanab Creek corridor Hack Canyon Trailhead area (outside the Kanab Creek Wilderness). The objective of VRM Class II is to provide for management

activities that retain the existing character of the landscape. The level of change to the characteristic landscape should, therefore, be minimal. Typically, on-site evaluations and visual contrast ratings would be required prior to any mine development in Class II areas to determine appropriate mitigation measures. The probability that mine exploration and mine development occurring within Class II areas, approximately 10% of the total North Parcel, is high. Twenty-one randomly placed mines in the North Parcel could result in approximately two mines' (10% of the total) being developed in the Class II area. This level of development could meet the VRM Class II objectives of minimal landscape change. However, mining operation visual impacts (described in Section 4.9.2) in high use and visually sensitive areas could be difficult to mitigate to meet the Class II objectives.

Table 4.9-3. Acreage and Percentage of Visual Designation Withdrawn by Alternative

Visual Designation	Alternative A*	Alternative B (acres)	Alternative B (%)	Alternative C (acres)	Alternative C (%)	Alternative D (acres)	Alternative D (%)
North Parcel							
Class I†	0	4,156	100%	4,156	100%	4,156	100%
Class II	0	63,216	100%	53,702	85%	33,135	52%
Class III	0	505,449	100%	312,257	62%	65,758	13%
Class IV	0	23,422	100%	12,042	51%	2,553	11%
Preservation	0	3,069	100%	3,069	100%	3,069	100%
Modification	0	4,989	100%	4,989	100%	4,989	100%
East Parcel							
Class II	0	63,296	100%	62,615	99	24,541	49%
Class III	0	50,316	100%	8,479	17	8,452	17%
Class IV	0	86	100%	86	100%	76	88%
Partial Retention	0	818	100%	818	100%	818	100%
Modification	0	30,494	100%	23,498	77%	23,498	77%
South Parcel							
High	0	25,511	100%	20,478	80%	15,290	60%
Moderate	0	283,182	100%	177,765	63%	110,376	39%
Low	0	15,648	100%	9,829	63%	7,491	48%

* Alternative A does not withdraw any acreage.

† Class I areas are located with designated wilderness and already withdrawn from mineral location and entry.

The majority of the North Parcel is designated VRM Class III, with the objective of partially retaining the existing character of the landscape. A moderate level of change from management actions within these areas is acceptable but should not dominate the view of the casual observer. Mineral exploration, development, and accompanying activities do not conflict with this designation. However, all activities would require site-specific evaluations to reduce and mitigate potential visual impacts.

A power line corridor along the northern border of the North Parcel and a few mineral pits are designated VRM Class IV. This designation allows for major modifications to the landscape and therefore is consistent with mine exploration and development. However, efforts to minimize visual contrast are still undertaken in VRM Class IV areas.

The North Parcel contains a small portion of Forest Service lands designated VQO Preservation and Modification (see Figure 3.9-1, Table 3.9-4). The Preservation lands are in the Kanab Creek Wilderness. Preservation allows for ecological change only and management activities that are not noticeable to observers. Mineral exploration, development, and accompanying activities conflict with this management objective. However, since the area is designated wilderness, no mining would occur.

The lands designated Modification are in the Kanab Creek and Snake Gulch area but outside the Kanab Creek Wilderness. Modification allows for management activities that may dominate the characteristic landscape but that must use naturally established form, line, color, and texture. Mineral exploration, development, and accompanying activities wound not conflict with this designation with the application of project-specific visual resource mitigations.

Given the potential non-conformance with visual designation (Class II), impacts to visual resources could be moderate to major.

EAST PARCEL

East Parcel BLM lands include VRM Classes II, III and IV (see Figure 3.9-2, Table 3.9-5). The VRM Class II lands include the northern portion of House Rock Valley south of U.S. 89A and the Marble Canyon ACEC. The adjacent scenic Vermilion Cliffs contribute to the visual importance of this area. The objective of VRM Class II is to provide for management activities that retain the existing character of the landscape. The RFD scenario projects the development of two mines in the East Parcel. Nearly half of the parcel is designated VRM Class II, leading to a probability that half of the proposed mines—one—could be located in this area. This level of development could meet the VRM Class II objectives of minimal landscape change. However, mining operation visual impacts (described in Section 4.9.2) in high use and visually sensitive areas could be difficult to mitigate to meet the Class II objectives.

The VRM Class III area lies in the southern portion of House Rock Valley. Mineral exploration, development, and accompanying activities do not conflict with this designation. All activities would require site-specific evaluations to reduce and mitigate potential visual impacts.

A small portion (86 acres) of Class IV lands lies in the northeast portion of the parcel. This designation allows for major modifications to the landscape and therefore is consistent with mine exploration and development. Efforts to minimize visual contrast are undertaken in VRM Class IV areas.

The west side of the East Parcel contains Forest Service lands designated VQO Partial Retention and Modification (see Figure 3.9-2, Table 3.9-5). The Partial Retention lands are along the U.S. 89A highway corridor in the vicinity of the House Rock Valley Overlook. Partial Retention allows for management activities that may be evident to the observer but must remain subordinate to the characteristic landscape. Mineral exploration, development, and accompanying activities would likely conflict with this objective.

The lands designated Modification are on the western edge of House Rock Valley. Modification allows for management activities that may dominate the characteristic landscape but that must use naturally established form, line, color, and texture. Mineral exploration, development, and accompanying activities could meet the visual resource quality objective within this designation with the use of project-specific visual resource mitigation.

Given the potential non-conformance with visual designations (Class II, VQO Partial Retention), impacts to visual resources could be moderate to major.

SOUTH PARCEL

The South Parcel contains SMS designations of High, Moderate, and Low (see Figure 3.9-3, Table 3.9-6). High designations include Red Butte in the southern portion of the parcel and the Coconino Rim area in the northeastern portion of the parcel. High designation requires the landscape to appear unaltered and intact. Any deviations must blend so well with the existing landscape that they are not evident. Of the seven mines expected in the South Parcel, the probability of a randomly placed mine located in the area designated High (8% of total parcel) is low but possible. Mineral exploration and development impacts, as described in Section 4.9.2, would conflict with this designation, as it would not be possible to have

these activities go completely unnoticed by casual observers. However, mineral exploration is a short-term impact that, when reclaimed, would not present a visual impact. Any mines located in areas designated High would result in a major visual impact.

The majority of the parcel is designated Moderate. These landscapes appear slightly altered, and any noticeable changes should remain visually subordinate to the landscape character being viewed. With site-specific design mitigations, mineral exploration, development, and associated activities would not conflict with the objectives of this designation.

A few pockets of lands designated Low are located in the South Parcel. These lands typically appear moderately altered, and deviations may begin to dominate the landscape character. Mineral exploration, development, and associated activities would not conflict with the objectives of this designation.

Given the potential non-conformance with the visual designation (SMS High), impacts to visual resources could be moderate to major.

Observation Points Direct and Indirect Impacts

Analysis of views from Key Observation Points (described in Chapter 3) is presented in the table below (Table 4.9-4). This analysis uses the indicators described in Section 4.9.1. Direct and indirect visual impacts could result from mineral exploration, development, and associated activities. The degree of impact would vary among the different stages of mining activities (mineral exploration through reclamation) and the lands with different visual management designations.

Table 4.9-4. Alternative A Observation Point Impact Analysis

Observation Point	Direct and Indirect Impacts (as defined in Table 4.9-1)
North Parcel	
U.S. 89A	View of VRM Class III. Mine operation in foreground along roadway would result in a moderate long-term impact.
Swapp Trailhead	View of VRM Class III. Mine operation in foreground would result in a moderate long-term impact.
Hack Canyon Trailhead	View of VRM Class I and Class II. Mine operation in foreground and adjacent Class II areas would result in a major long-term impact. No mining would occur in Class I.
Toroweap Road Observation Point-within Antelope Canyon	View of VRM Class III. Mine operation in foreground of roadway would result in a moderate long-term impact. Mine operation at a distance not visible from the roadway and within VRM Class III would result in minor long-term impacts.
Big Springs Road	View of VRM Class III. Mine operation in foreground of roadway would result in a moderate long-term impact. Mine operation at a distance not visible from the roadway and within VRM Class III would result in minor long-term impacts.
SR 389	Limited views into the North Parcel. Views include VRM Class III and Class IV (power line corridor). No visual impacts would occur to views from this location.
East Parcel	
U.S. 89A	Views of VRM Class II. Mine operation in the foreground of the roadway corridor and in the Class II area would result in a major long-term impact.
U.S. 89A–Soap Creek Trailhead	Views of VRM Class II. Mine operation in the Class II area and in the foreground of the viewing location would result in a major long-term impact.
U.S. 89A–House Rock Valley Overlook	Views of VQO Partial Retention and Modification and VRM Class II. Mine operation in the foreground and background views from this location would result in a major long-term impact.
Rider Canyon Trailhead	Views of VRM Class II. Mine operation in the foreground views and the surrounding Class II area would result in a major long-term impact.
Bedrock Canyon Trailhead	Views of VRM Class III and VQO Modification. Mine operation in this area would result in a moderate long-term impact from this viewing location.

Table 4.9-4. Alternative A Observation Point Impact Analysis (Continued)

Observation Point	Direct and Indirect Impacts (as defined in Table 4.9-1)
South Parcel	
Red Butte–SR 64	The Red Butte viewpoint is elevated and allows for views of most of the South Parcel and provides views of SMS High and distant views of SMS Moderate and Low. Mine operation in the foreground and SMS High area would result in major long-term visual impacts.
Tusayan–SR 64	Views of SMS Moderate. Mine operation in this area would result in minor to moderate (depending on the distance from major travel corridors) long-term impacts.
Eastern SR 64	Views of SMS Moderate and background views of SMS High. Mine operation in the foreground area visible from the road would result in a moderate to major long-term impact; development in the SMS High area would result in a major long-term impact.
Forest Service Road 302	Views of SMS Moderate. Mine operation in this area would result in minor to moderate long-term impacts. The magnitude depends on distance from road.
Grand Canyon National Park and Other View Points	
Tuckup Canyon Trailhead	The GIS analysis illustrates limited views of a small portion of the North Parcel near the Park boundary, approximately 1 mile from the trailhead (Figure 4.9-1). Actual views of the North Parcel are unlikely. Views of the South Parcel at a distance of approximately 35 miles. Distant background views to this location are very limited, given vegetation and atmospheric obstructions. However, shiny or reflective objects at mine sites and on vehicles may be noticeable from this viewpoint. Possible distant views of night lighting. Impact magnitude is moderate.
Sowats Point	Views of the North Parcel at a distance ranging from approximately 7 to 20 miles (see Figure 4.9-1). Views consist of distant background locations. Shiny, reflective objects at mine sites and on vehicles may be noticeable from this viewpoint. Possible distant views of night lighting. Impact magnitude is minor.
Kanab Point	Views into the North Parcel are of pockets of landscape in the southern part of the parcel and an area between Grama Canyon and Kanab Creek (Figure 4.9-2). The visible area is VRM Class III. The distance is approximately 3 to 20 miles, with the visible area in the background view. Vegetative screening, distance, and landscape character would result in a minor impact to the casual observer from this location. However, shiny or reflective objects at mine sites and on vehicles may be noticeable from this viewpoint. Possible distant views of night lighting. Impact magnitude is minor.
Havasupai Point	Views of the South and North parcels (see Figure 4.9-2). Distance from viewpoint to visible area ranges from approximately 15 to 40 miles. This distant background view would provide the casual observer very minimal chances of noticing mining and associated activities. Vegetation would likely screen and obstruct views of the North Parcel. However, shiny or reflective objects at mine sites and on vehicles may be noticeable from this viewpoint. Possible distant views of night lighting. Impact magnitude is minor.
Cape Final	Views into House Rock Valley of the East Parcel and into the Coconino Rim area of the South Parcel (Figure 4.9-3). Distance to visible area in the South Parcel ranges from approximately 12 to 20 miles and in the East Parcel from approximately 28 to 40 miles. Impact to the casual observer, given vegetation, atmospheric obstruction, and distance, would be minimal. However, shiny or reflective objects at mine sites and on vehicles may be noticeable from this viewpoint. Possible distant views of night lighting. Impact magnitude is minor.
Cape Royal	Views into the South Parcel from across the Grand Canyon on the North Rim that include the Coconino Rim and Red Butte (see Figure 4.9-3). Distance of views range from 10 to 25 miles, with parcel views in distant background that include pockets South Parcel of the Coconino Rim. Impact to the casual observer, given vegetation, atmospheric obstruction, and distance, would be minor. However, shiny or reflective objects at mine sites and on vehicles may be noticeable from this viewpoint. Possible distant views of night lighting. Impact magnitude is minor.
Bright Angel Point	Views into the South Parcel from across the Grand Canyon that include Red Butte and the Coconino Rim area (Figure 4.9-4). Approximate distances of visible areas range from 10 to 25 miles. These represent background and distant views, and the likelihood of the casual observer noticing a 21-acre mine at that distance, given vegetation and atmospheric obstruction, is minimal. However, shiny or reflective objects at mine sites and on vehicles may be noticeable from this viewpoint. Possible distant views of night lighting. Impact magnitude is minor.
Point Imperial	Views of a major portion of the East Parcel and pockets of the South Parcel, including the Coconino Rim and Red Butte (see Figure 4.9-4). Viewing distances range from approximately 20 to 35 miles. These background and distant views may provide the casual observer viewing opportunities of mine operations. However, given the distance and possible vegetation obstruction, visibility of mining is unlikely. Shiny, reflective objects on mine sites and on vehicles may be noticeable from this viewpoint. Possible views of night lighting. Impact magnitude is moderate.

Table 4.9-4. Alternative A Observation Point Impact Analysis (Continued)

Observation Point	Direct and Indirect Impacts (as defined in Table 4.9-1)
Grand Canyon National Park and Other View Points, continued	
Desert View Watchtower	Views into the South Parcel of the Coconino Rim and Red Butte (Figure 4.9-5). Distances range from 5 to 20 miles. Shiny, reflective objects on mine sites and on vehicles may be noticeable from this viewpoint. Possible views of night lighting. Impact magnitude is moderate.
Grandview Point	Views into the South Parcel of the Coconino Rim area. Distances to the visible area ranges from approximately 3 to 15 miles from the viewpoint (see Figure 4.9-5). Impacts to casual observers from this viewpoint are possible, depending on vegetation obstruction. Shiny or reflective objects at mine sites and on vehicles may be noticeable from this viewpoint. Possible views of night lighting. Impact magnitude is moderate.
Trailview Overlook	Views of the northwestern portion of the South Parcel and Red Butte (Figure 4.9-6). Approximate distances of visible areas range from 3 to 15 miles. These represent background views. Possible views of mining operations by the casual observer. However, given vegetation obstruction and distance, they would be unlikely to notice mining operations. Shiny or reflective objects at mine sites and on vehicles may be noticeable from this viewpoint. Possible distant views of night lighting. Impact magnitude is moderate (see Figure 4.9-6).
Hopi Point	Views of the northwestern portion of the South Parcel and Red Butte (see Figure 4.9-6). Approximate distances of visible areas range from 3 to 15 miles. These represent background views. Possible views of mining operations by the casual observer. However, given vegetation obstruction and distance, they would be unlikely to notice mining operations. Shiny or reflective objects at mine sites and on vehicles may be noticeable from this viewpoint. Possible distant views of night lighting. Impact magnitude is moderate.

GRAND CANYON NATIONAL PARK

A viewshed analysis from Key Observation Points within Grand Canyon National Park was conducted to determine the “visible area” or “viewshed” from each viewpoint. Viewpoints analyzed include Tuckup Canyon and Sowats Point (see Figure 4.9-1), Kanab Point and Havasupai Point (see Figure 4.9-2), Cape Royal and Cape Final (see Figure 4.9-3), Bright Angel Point and Point Imperial (see Figure 4.9-4), Desert View Watchtower and Grandview Point (see Figure 4.9-5), and Trailview Overlook and Hopi Point (see Figure 4.9-6). The analysis, conducted with standard GIS viewshed methodology, uses a digital elevation model (DEM) to determine the visible area from viewpoints. Viewpoints were placed on a USGS 30-m grid DEM using locations identified on USGS 7.5-minute topographic maps and checked against known viewpoint elevations. The points were offset a minimum height of 4 m to account for potential placement error. Desert View Watchtower viewpoint was offset to meet the known land elevation and height of the tower. The GIS analysis uses algorithms to determine which grid cells can be seen from the viewpoint, based on grid cell elevation. The viewshed analysis provides information on the potential visible area from a particular location. However, it is a broad computer-generated analysis that has potential for error (viewpoint location, DEM accuracy, etc.). There could be visible areas that do not register in this analysis and areas that do show as visible do not account for any visual barriers such as vegetation, atmospheric conditions, and distance. Potential discrepancies will be noted. Site-specific analysis would be conducted for all mining proposals. Table 4.9-4 includes all of the Grand Canyon National Park viewpoints and any direct and indirect visual impacts. Impacts are determined using the criteria defined in Table 4.9-1.

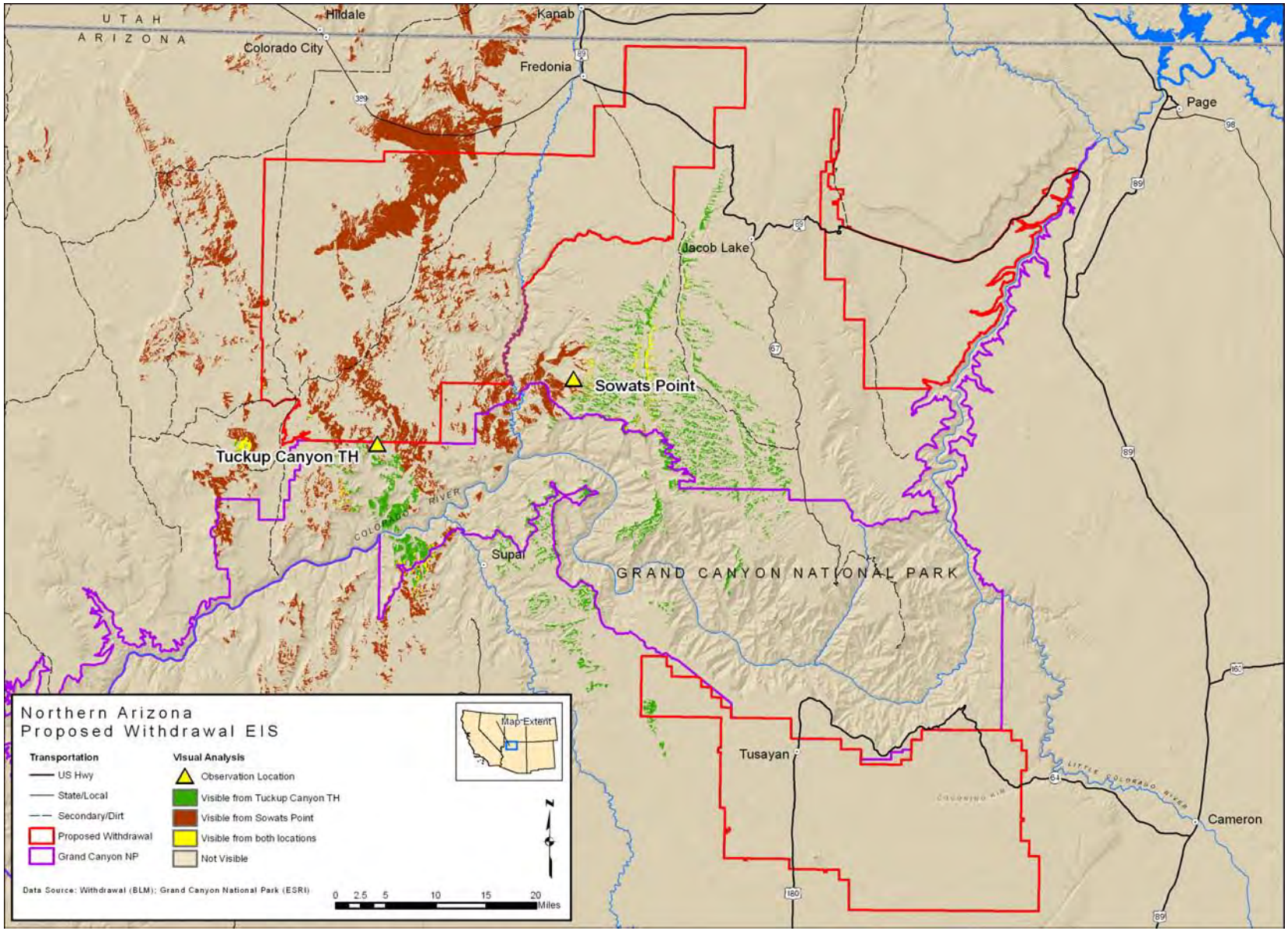

Figure 4.9-1. Viewshed analysis for Tuckup Canyon TH and Sowats Point.

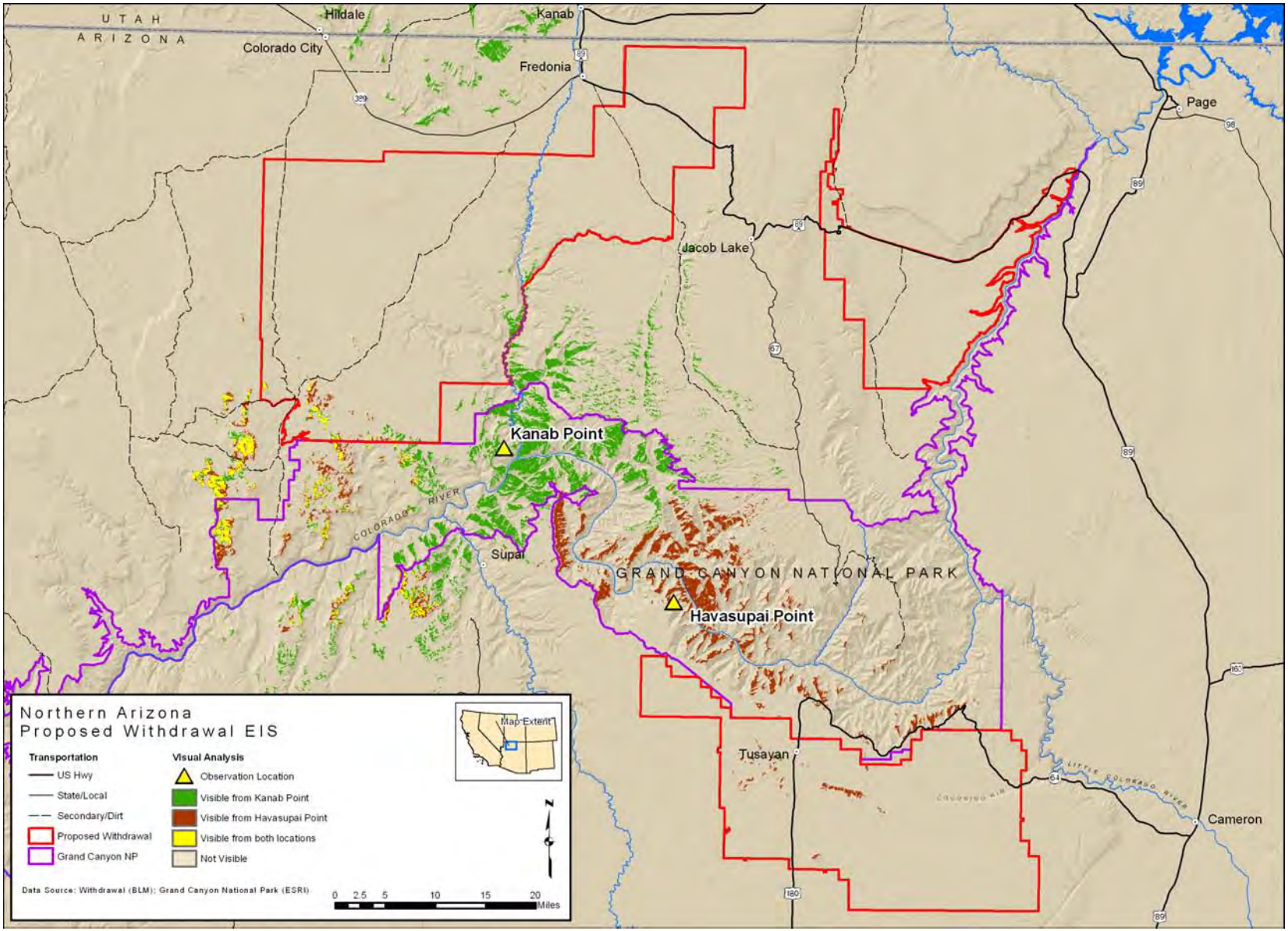

Figure 4.9-2. Viewshed analysis for Kanab Point and Havasupai Point.

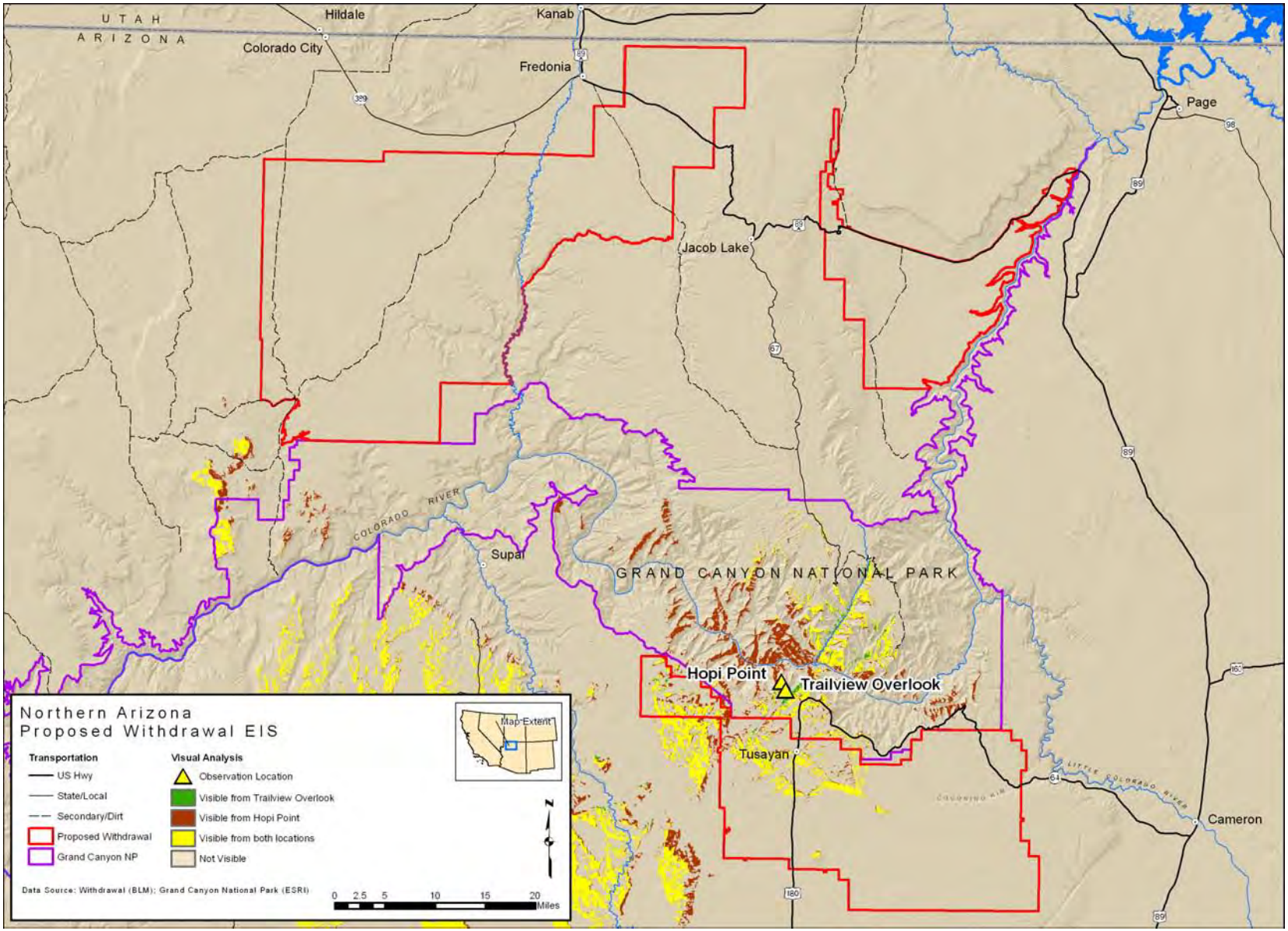

Figure 4.9-3. Viewshed analysis for Cape Final and Cape Royal.

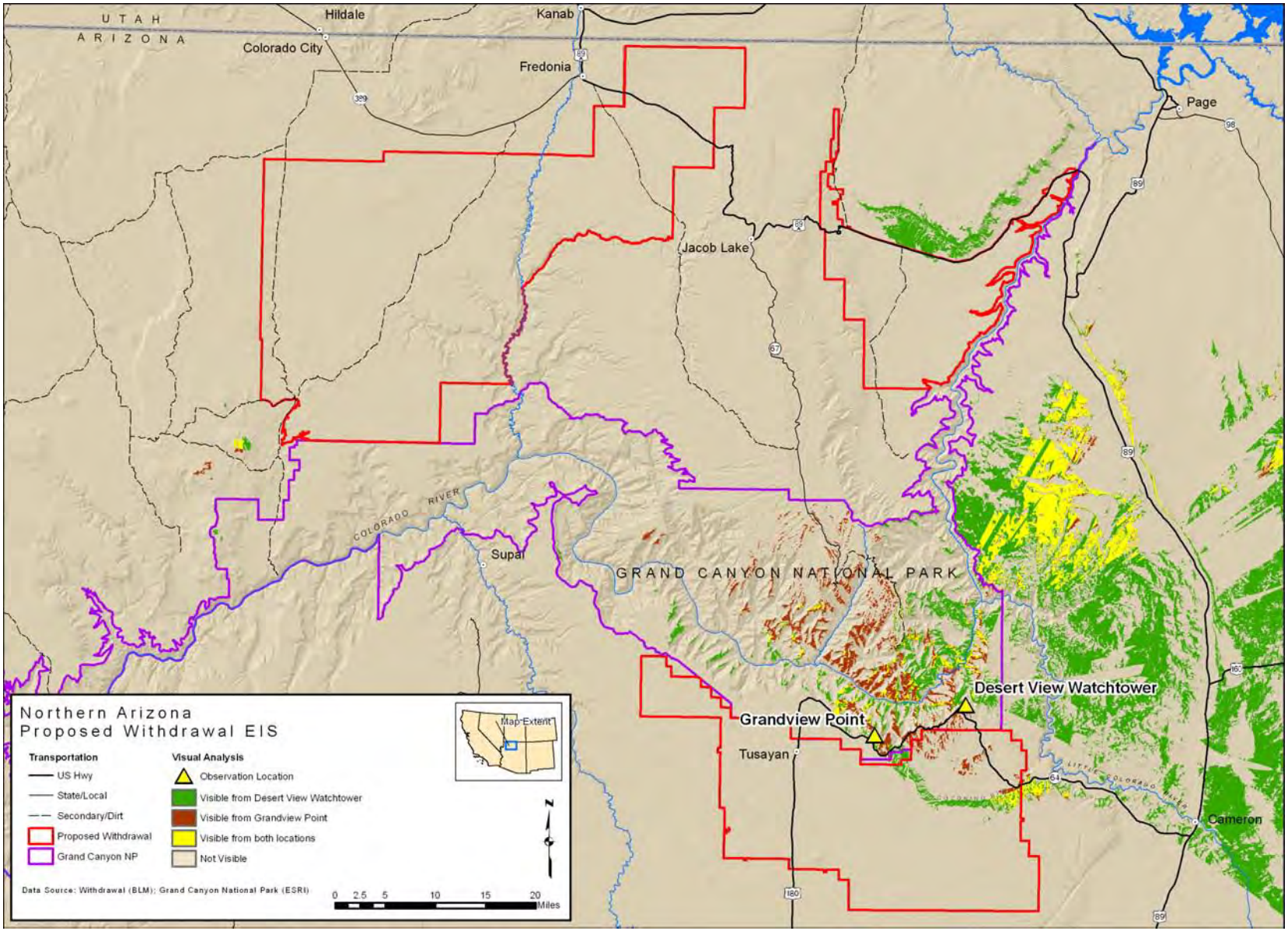

Figure 4.9-4. Viewshed analysis for Point Imperial and Bright Angel Point.

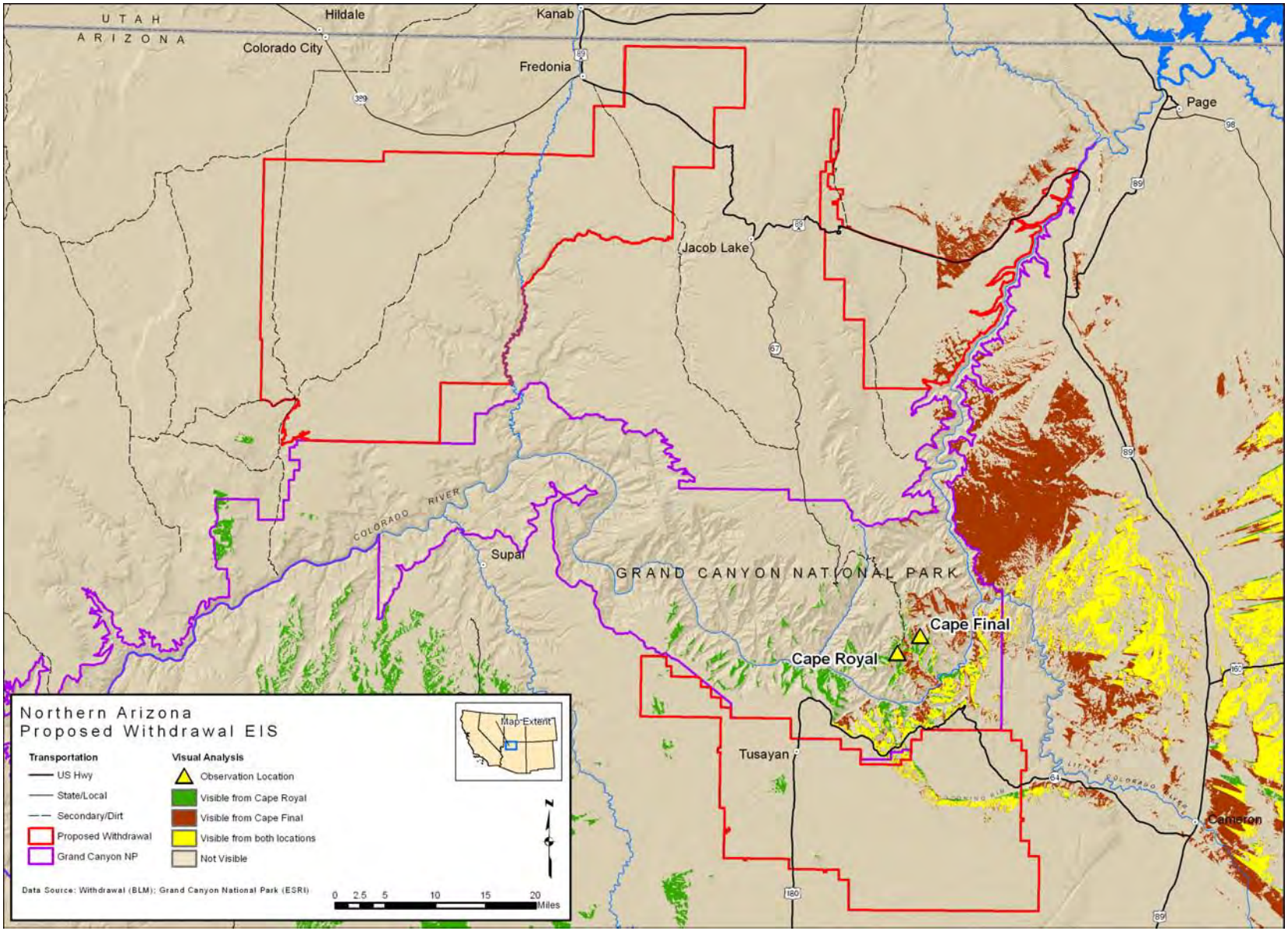

Figure 4.9-5. Viewshed analysis for Desert View Watchtower and Grandview Point.

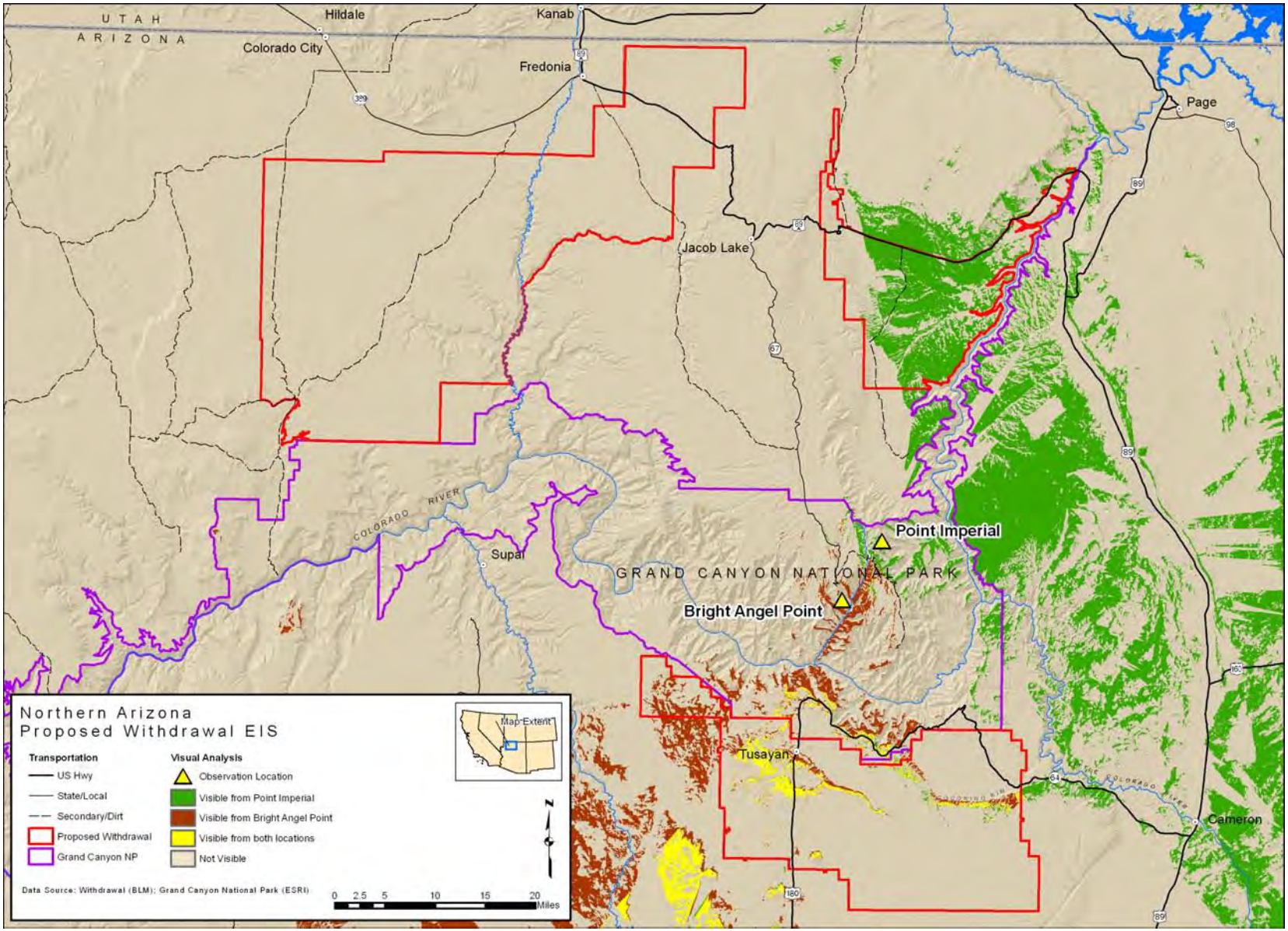

Figure 4.9-6. Viewshed analysis for Trailview Overlook and Hopi Pont.

Regional Haze and Dust

Uranium mining and associated activities would result in creation of fugitive dust. Visual impacts could result from dust emissions generated during the hauling of uranium ore to the processing facility located in Blanding, Utah. Visual impacts from truck-created dust would be localized to the unpaved roads on the haul routes. This impact depends on the frequency and density of traffic and vehicle speed and weight. Truck speed and weight directly correlate to the magnitude of dust created as slower, lighter trucks create less dust (Gillies et al. 2005). Frequent and dense truck traffic would result in visual impacts through an increase in fugitive dust. Dust impacts foreground views of persons in proximal locations. Background and long distance viewing from observation points could be impacted by an increase in dust. Localized fugitive dust generated from ore truck traffic on unpaved roads would have a visual impact on the casual observer in the vicinity of the truck traffic. Under Alternative A, these impacts would be moderate to major and short term. Some casual observers may not be impacted at all, but some observers may find themselves in the proximity of dust during their only trip to the area and may experience major impacts.

Grand Canyon National Park is designated a Class I airshed that is protected through federal regulations and is afforded special visibility protection designed to prevent plume visual impacts to observers within the Class I area. Regional air quality modeling, described in detail in Section 4.2, Air Quality, concluded that the mining projects are expected to comply with the criteria established by the EPA for maximum protection of Grand Canyon National Park.

Night Sky

The nighttime visual resources (e.g., “dark night skies”) are an important visual resource in northern Arizona and southern Utah, as described in Chapter 3. Uranium mining and associated activities could contribute to increased light pollution in the area through lighting on mining structures, construction equipment, ore trucks, and vehicles. Given the quality of the dark night skies in the area, minimal increases in night lighting could impact the area’s night skies. Mitigation of night lighting plays an important role in protecting night skies and would be determined on a specific mining project basis. These measures could include using low visibility spectrum lights and appliances (full cut-off fixtures that emit no light above the light’s horizontal line) on mine structures, minimizing night time mining activity, and limiting ore truck travel during night hours. With mitigation, impacts to the area’s night sky would be minimal. Impacts could occur to casual observers in the vicinity of the mines and exploration sites, persons traveling along area roads at night, and recreationists camping in the area. Under Alternative A, these impacts are classified as short-term and moderate.

Cumulative Effects

Cumulative effects on visual resources from Alternative A would result in relation to past, present, and future visual impacts on the landscape in the proposed withdrawal area. These cumulative visual impacts include regional light pollution from nearby communities, mechanical treatment of fire-prone vegetation (thinning, prescribed fire), noxious weed infestations, recreation amenities (trailheads, roads), livestock grazing, mining, power line corridors, unpaved roads, dust created from vehicular travel on gravel roads, and regional haze resulting from air quality impacts.

Continued population growth in large and small communities in the region of the proposed withdrawal area could erode the natural night sky conditions in the area. The night sky impacts listed above would not add to the regional light pollution and would result in no impact.

Continued treatment of fire-prone landscape vegetation through forest thinning and prescribed burning would add to the visual impacts in the proposed withdrawal area from smoke and changing the vegetative

character of the landscape. Visual impacts listed above for mining and associated activities would not add cumulatively to the impact from this vegetation treatment.

There are some existing noxious weed infestations in the proposed withdrawal area. This has the potential to change existing landscape form, texture, and color over large areas. Mining and associated activities could add a minor cumulative impact to the existing noxious weed problem.

Existing recreation areas include trailheads, trails, and roads. These areas are visible forms in the landscape. Mining operations and associated activities may lead to an increase in roads and public access to areas in the proposed withdrawal area. Increased access may increase visitation and creation of new trailheads. Visual cumulative impacts of this potential increase would be minor.

Existing livestock grazing activities present ongoing visual impacts in the proposed withdrawal parcels. Visual impacts from this activity include livestock, stock tanks, dust, and altered vegetation.

The addition of 22.4 miles of new power lines and roads could lead to a moderate to minor cumulative impact (see Table 4.9-1) to visual resources, depending on the location. If the new facilities are placed in a sensitive viewing area that does not contain these features, the impact would be major. If placed in a less sensitive viewing area that currently does contain these landscape features, the cumulative impact would be minor to moderate.

The addition of 300,165 ore hauling truck trips within the proposed withdrawal area would create a major cumulative impact to visual resources. Annual vehicle traffic data from the BLM shows 9,927 trips for the Toroweap Road and 5,616 for the Clayhole Road. The combined annual total traffic count of 15,543 for the North Parcel, combined with the projected annual ore truck traffic of 10,419 trips under Alternative A, would result in a 67% potential increase in annual traffic. This increase could have a major visual cumulative impact resulting from fugitive dust generated by truck traffic. Traffic data on the other parcels' unpaved roads is unavailable.

The cumulative impact would be classified as moderate under Alternative A.

4.9.3 Impacts of Alternative B: Proposed Action (~1 Million Acres, 20-Year Withdrawal)

Changes to the Characteristic Landscape

The addition of approximately 11 uranium exploration projects, 11 uranium mines, 88,885 ore haul trips, and 6.4 miles of new roads and power lines, resulting in approximately 152 acres of disturbed landscape, would cause visual changes to the existing landscape character.

This differs from Alternative A in mining and associated activities. It represents approximate decreases by 98% in exploratory drilling, 63% in mines, 70% in ore haul trips, 71% in new roads and power lines, and 88% in disturbed land.

Typical visual impacts to the characteristic landscape from mining and associated activities are described in detail under Alternative A. This reduction in mining operations and associated activities would result in reduced visual impacts with a magnitude of minor.

Conformance with Visual Resource Designation

Each parcel contains specific visual resource designations as discussed in Chapter 3. Each designation outlines visual management objectives required for management actions. The section below discusses each parcel's visual designation and the likelihood that the alternative's proposed management actions conform to the stated objectives. In general, conformance to visual objectives would be more likely to occur under Alternative B, given the reduction in mining and associated activities.

NORTH PARCEL

The descriptions of management designations and general determinations of conformance with visual designations remain the same as described in Alternative A; mining operations could conflict with VRM Class II management objectives. However, the substantial reduction in the number of projected mines (21 under Alternative A and 10 under Alternative B) would reduce the probability of mine operation occurrence in Class II areas by half. This leads to a probability of one mine occurring in the Class II area. Using site-specific design mitigation could make it possible to conform to the Class II designation on a case-by-case basis. One mine in the Class II area would likely result in a minor impact to visual resources.

EAST PARCEL

No mining exploration, operation, or associated activities are proposed for the East Parcel under Alternative B. This would result in conformance with all VRM objectives, as described under Alternative A. This conformance would result in no impact to visual resources.

SOUTH PARCEL

The visual resource designations and conformance details for the South Parcel are described under Alternative A in Section 4.9.2. Generally, the determinations of conformance with visual designations remain the same; mining operations conflict with SMS High management objectives. One mine is projected for the South Parcel under Alternative B. This mine is expected to be located in the existing Canyon Mine area, which is designated SMS Moderate. With applicable visual mitigation, this mine can conform to the SMS Moderate visual objectives. This likely conformance would result in minor impacts to visual resources.

Observation Points Direct and Indirect Impacts

Analysis of views from Key Observation Points (described in Chapter 3) is presented in the table below (Table 4.9-5). This analysis uses indicators described in Section 4.9.1. Direct and indirect visual impacts could result from mineral exploration, development, and associated activities. The degree of impact would vary among the different stages of mining activities (mineral exploration through reclamation) and the lands with different visual management designations.

Mining activity would be greatly reduced under Alternative B. However, the projected development of 10 mines in the North Parcel may result in similar impacts to views from the analyzed observation points if any mines are located in these viewsheds. With the reduced number of mines, it becomes less likely that mining would occur in these more visually sensitive areas. The one mine projected for the South Parcel is the Canyon Mine; visual impacts are analyzed using that mine location.

Table 4.9-5. Alternative B Observation Point Impact Analysis

Observation Point	Direct and Indirect Impacts (as defined in Table 4.9-1)
North Parcel	
U.S. 89A	View of VRM Class III (less visually sensitive). Reduced probability of mine operation in foreground along roadway, combined with visual sensitivity, would result in a minor long-term impact.
Swapp Trailhead	View of VRM Class III (less visually sensitive). Reduced probability of mine operation in foreground areas, combined with visual sensitivity, would result a minor long-term impact.
Hack Canyon Trailhead	View of VRM Class I and Class II (more visually sensitive). Reduced probability of mine operation in foreground and Class II areas, combined with visual sensitivity, would result in a moderate long-term impact. No mining would occur in Class I area.
Toroweap Road Observation Point– within Antelope Canyon	View of VRM Class III (less visually sensitive). Reduced probability of mine operation in foreground of roadway, combined with visual sensitivity, would result in a minor long-term impact. Mine operation at a distance not visible from the roadway and within VRM Class III would result in no impact.
Big Springs Road	View of VRM Class III (less visually sensitive). Reduced probability of mine operation in foreground of roadway, combined with visual sensitivity, would result in a minor long-term impact. Mine operation at a distance not visible from the roadway and within VRM Class III would result in no impact.
SR 389	Limited views into the North Parcel. Views include VRM Class III and Class IV (power line corridor). No visual impacts would occur to views from this location.
East Parcel	
U.S. 89A	No mining activity projected to occur in the East Parcel under Alternative B. No impact.
U.S. 89A–Soap Creek Trailhead	No mining activity projected to occur in the East Parcel under Alternative B. No impact.
U.S. 89A–House Rock Valley Overlook	No mining activity projected to occur in the East Parcel under Alternative B. No impact.
Rider Canyon Trailhead	No mining activity projected to occur in the East Parcel under Alternative B. No impact.
South Parcel	
Red Butte–SR 64	The Red Butte viewpoint is elevated and allows for views of most of the South Parcel and provides view of SMS High and distant views of SMS Moderate and Low. Operation of the Canyon Mine (the one projected mine in the South Parcel) would result in a moderate long-term visual impact.
Tusayan–SR 64	Views of SMS Moderate. The Canyon Mine is not visible from this viewing area; mine operation would result in no visual impact.
Eastern SR 64	Views of SMS Moderate and background views of SMS High. Mine operation of the Canyon Mine would result in no visual impact.
Grand Canyon National Park and Other Viewpoints	
Tuckup Canyon Trailhead	General views and typical visual impacts same as Alternative A (see Table 4.9-4). The entire viewshed within the proposed withdrawal area is withdrawn under this alternative (see Figure 4.9-1). However, reduction of mines and associated infrastructure under Alternative B would result in less visual impact than Alternative A. Impact ranges from no impact to a minor impact.
Sowats Point	General views and typical visual impacts same as Alternative A (see Table 4.9-4). The entire viewshed within the proposed withdrawal area is withdrawn under this alternative (see Figure 4.9-1). However, reduction of mines and associated infrastructure under Alternative B would result in less visual impact than Alternative A. Impact ranges from no impact to a minor impact.
Kanab Point	General views and typical visual impacts same as Alternative A (see Table 4.9-4). The entire viewshed within the proposed withdrawal area is withdrawn under this alternative (see Figure 4.9-2). However, reduction of mines and associated infrastructure under Alternative B would result in less visual impact than Alternative A. Impact ranges from no impact to a minor impact.
Havasupai Point	General views and typical visual impacts same as Alternative A (see Table 4.9-4). The entire viewshed within the proposed withdrawal area is withdrawn under this alternative (see Figure 4.9-2). However, reduction of mines and associated infrastructure under Alternative B would result in less visual impact than Alternative A. Impact ranges from no impact to a minor impact.

Table 4.9-5. Alternative B Observation Point Impact Analysis (Continued)

Observation Point	Direct and Indirect Impacts (as defined in Table 4.9-1)
Grand Canyon National Park and Other Viewpoints, continued	
Cape Final	General views and typical visual impacts same as Alternative A (see Table 4.9-4). The entire viewshed within the proposed withdrawal area is withdrawn under this alternative (see Figure 4.9-3). However, reduction of mines and associated infrastructure under Alternative B would result in less visual impact than Alternative A. Impact ranges from no impact to a minor impact.
Cape Royal	General views and typical visual impacts same as Alternative A (see Table 4.9-4). The entire viewshed within the proposed withdrawal area is withdrawn under this alternative (see Figure 4.9-3). However, reduction of mines and associated infrastructure under Alternative B would result in less visual impact than Alternative A. Impact ranges from no impact to a minor impact.
Bright Angel Point	General views and typical visual impacts same as Alternative A (see Table 4.9-4). The entire viewshed within the proposed withdrawal area is withdrawn under this alternative (see Figure 4.9-4). However, reduction of mines and associated infrastructure under Alternative B would result in less visual impact than Alternative A. Impact ranges from no impact to a minor impact.
Point Imperial	General views and typical visual impacts same as Alternative A (see Table 4.9-4). The entire viewshed within the proposed withdrawal area is withdrawn under this alternative (see Figure 4.9-4). However, reduction of mines and associated infrastructure under Alternative B would result in significantly less visual impact than Alternative A. Impact magnitude is minor.
Desert View Watchtower	General views and typical visual impacts same as Alternative A (see Table 4.9-4). The entire viewshed within the proposed withdrawal area is withdrawn under this alternative (see Figure 4.9-5). However, reduction of mines and associated infrastructure under Alternative B would result in less visual impact than Alternative A. Impact magnitude is minor.
Grandview Point	General views and typical visual impacts same as Alternative A (see Table 4.9-4). The entire viewshed within the proposed withdrawal area is withdrawn under this alternative (see Figure 4.9-5). However, reduction of mines and associated infrastructure under Alternative B would result in less visual impact than Alternative A. Impact magnitude is minor.
Trailview Overlook	General views and typical visual impacts same as Alternative A (see Table 4.9-4). The entire viewshed within the proposed withdrawal area is withdrawn under this alternative (see Figure 4.9-5). However, reduction of mines and associated infrastructure under Alternative B would result in less visual impact than Alternative A. Impact magnitude is minor.
Hopi Point	General views and typical visual impacts same as Alternative A (see Table 4.9-4). The entire viewshed within the proposed withdrawal area is withdrawn under this alternative (see Figure 4.9-5). However, reduction of mines and associated infrastructure under Alternative B would result in less visual impact than Alternative A. Impact magnitude is minor.

Regional Haze and Dust

Potential impacts to visual resources from regional haze and dust resulting from mining operations are described in detail under Alternative A in Section 4.9.2. Reduced mining and associated activities, particularly a 70% reduction in ore haul trips, projected for Alternative B would result in reduced visual impacts from regional haze and dust. Under Alternative B visual impacts would be minor and short term. Some casual observers may not be impacted at all, but some observers may find themselves in the proximity of dust during their only trip to the area may be experience major impacts.

Night Sky

Potential impacts to nighttime visual resources (e.g., “dark night skies”) are described in detail under Alternative A in Section 4.9.2. Reduction in projected mining and associated activities , compared with Alternative A, would result in decreased visual impacts to the night sky. Impact magnitude is minor and short term.

Cumulative Effects

Cumulative effects on the region's visual resources are described in detail under Alternative A in Section 4.9.2. Reduction in projected mining and associated activities, compared with Alternative A, would result in reduced cumulative impacts under Alternative B. Cumulative impacts would be classified as minor.

4.9.4 Impacts of Alternative C: Partial Withdrawal (~700,000 Acres)

Changes to the Characteristic Landscape

The addition of approximately 207 uranium exploration projects, 18 uranium mines, 166,725 ore haul trips, and 12.1 miles of new roads and power lines, resulting in approximately 508 acres of disturbed landscape, would cause visual changes to the existing landscape character.

The difference in mining and associated activities between Alternatives A and C represents approximate decreases by 71% in exploratory drilling, 40% in mines, 55% in ore haul trips, 45% in new roads and power lines, and 61% in disturbed land.

Typical visual impacts to the characteristic landscape from mining and associated activities are described in detail under Alternative A. Under Alternative C, all of the landscapes designated visually sensitive are included in the proposed withdrawal area and removed from most mining activity. Some mining would still occur in the proposed withdrawal area, as described in Alternative B, but the amount is limited. This reduction in mining operations and associated activities would result in reduced visual impacts with a magnitude of minor.

Conformance with Visual Resource Designation

Each parcel contains specific visual resource designations, as discussed in Chapter 3. Each designation outlines visual management objectives required for management actions. The section below discusses each parcel's visual designation and the likelihood for proposed management actions to conform to the stated objectives.

The acres and percentages of visual designations by alternative are presented in Table 4.9-3. This table illustrates how the range of visual designations is included in each alternative. Alternative C includes a high percentage of visually sensitive lands (Classes I and II, Preservation, and High) within the proposed withdrawal boundary and thus would result in less impact to visual resources than implementation of Alternative A. However, the Class I lands are designated wilderness and not open to mineral exploration and development.

For a detailed description of visual resource designations and conformance standards for each parcel, see Section 4.9.2 under Alternative A.

NORTH PARCEL

The descriptions of management designations and general determinations of conformance with visual designations remain the same as described in Alternative A; mining operations conflict with VRM Class II management objectives. However, Alternative C has substantially less mining, compared with Alternative A, and the proposed withdrawal area under Alternative C also includes all Preservation and most Class II and High designated lands (see Table 4.9-3). Given the reduced number of mines and the limited number expected in the Class II area, it would be possible for a mine to conform to the Class II

designation on a case-by-case basis. Inclusion of visually sensitive landscapes and the potential for conformance with management designation would result in a minor impact to visual resources.

EAST PARCEL

Nearly all visually sensitive areas in the East Parcel are included in the withdrawal area proposed under Alternative C (see Table 4.9-3). Ninety-nine percent of VRM Class II lands and all Partial Retention lands are included. The remaining area outside the proposed withdrawal area is less visually sensitive and designated VRM Classes III and IV and VQO Modification (see Table 4.9-2). Mineral exploration, development, and accompanying activities from one projected future mine would conform to the visual management objectives for the area outside Alternative C's withdrawal boundary. However, it is possible that development of one mine inside of the boundary (the more sensitive visual area) could not conform to the area's visual management objectives. This depends on the location of the mine and would have to be determined through site-specific analysis. This potential for one mine in the Class II area would result in a minor impact to visual resources.

SOUTH PARCEL

Almost all of the visually sensitive SMS High designated lands are included in the partial withdrawal under Alternative C (see Table 4.9-3). A small portion of the Coconino Rim area on the east side of the parcel and north of SR 64 is not included in the partial withdrawal. The remaining area is designated SMS Moderate and Low. The four projected future mine operations could be located within the area outside the withdrawal boundary and conform to existing visual management objectives and designations. Site-specific analysis on a case-by-case basis would determine ultimate compliance. Any mining located in the small portion of land designated SMS High that is out of the proposed withdrawal area would not conform to management objectives for this area. The potential for mining and associated activities occurring in visually sensitive landscapes is minimal and would result in a minor impact to visual resources.

Observation Points Direct and Indirect Impacts

Analysis of views from Key Observation Points (described in Chapter 3) is presented below in Table 4.9-6. This analysis uses the indicators described in Section 4.9.1. Direct and indirect visual impacts could result from mineral exploration, development, and associated activities. The degree of impact would vary among the different stages of mining activities (mineral exploration through reclamation) and the lands with different visual management designations.

The projected development of 18 mines may result in similar impacts to views from the analyzed observation points if any mines are located in these viewsheds. With the reduced number of mines, the probability of mines being developed in visually sensitive areas is reduced. Thus, mine development visual impacts fall between Alternatives A and B.

Regional Haze and Dust

Potential impacts to visual resources from regional haze and dust resulting from mining operations are described in detail under Alternative A in Section 4.9.2. Reduced mining and associated activities, particularly a 55% reduction in ore haul trips, projected for Alternative C would result in reduced visual impacts from regional haze and dust. Under Alternative C visual impacts would be minor to moderate and short-term. Some casual observers may not be impacted at all, but some observers may find themselves in the proximity of dust during their only trip to the area and may experience major impacts.

Table 4.9-6. Alternative C Observation Point Impact Analysis

Observation Point	Direct and Indirect Impacts (as defined in Table 4.9-1)
North Parcel	
U.S. 89A	View of VRM Class III (less visually sensitive). Foreground and background views not included in this withdrawal alternative increase the probability of mine operation in foreground along roadway. This, combined with visual sensitivity, would result in a moderate long-term impact.
Swapp Trailhead	View of VRM Class III (less visually sensitive). Point is included in this withdrawal alternative. It is also in the vicinity of the reclaimed Pigeon Mine. Reduced probability of mine operation in foreground areas, because of inclusion in withdrawal, and visual sensitivity would result a minor long-term impact.
Hack Canyon Trailhead	View of VRM Class I and Class II (more visually sensitive). Point is included in this withdrawal alternative. Reduced probability of mine operation in foreground and Class II areas, combined with visual sensitivity, would result in a moderate long-term impact. No mining would occur in Class I areas.
Toroweap Road Observation Point - within Antelope Canyon	View of VRM Class III (less visually sensitive). Entire road is included in this withdrawal alternative. Reduced probability of mine operation in foreground of roadway, combined with visual sensitivity, would result in a minor long-term impact. Mine operation at a distance not visible from the roadway and within VRM Class III would result in no impact.
Big Springs Road	View of VRM Class III (less visually sensitive). Majority of road not included in this withdrawal alternative increases probability of mine operation in foreground of roadway. This, combined with visual sensitivity, would result in a moderate long-term impact. Mine operation at a distance not visible from the roadway and within VRM Class III would result in no impact.
SR 389	Limited views into the North Parcel. Views include the less visually sensitive VRM Class III and Class IV (power line corridor). No visual impacts would occur to views from this location.
East Parcel	
U.S. 89A	Views of VRM Class II (more visually sensitive). Entire corridor included in this alternative. Reduced probability of mine operation in the foreground of the roadway corridor, combined with the area's visual sensitivity, would result in a moderate long-term impact.
U.S. 89A–Soap Creek Trailhead	Views of VRM Class II (more visually sensitive). Point included in this withdrawal alternative. Reduced probability of mine operation in the Class II area and in the foreground of the viewing location would result in a moderate long-term impact.
U.S. 89A–House Rock Valley Overlook	Views of VQO Partial Retention and Modification and VRM Class II. Point included in this withdrawal alternative. Reduced probability of mine operation in the foreground and background views from this location, combined with visual sensitivity, would result in a moderate long-term impact.
Rider Canyon Trailhead	Views of VRM Class II (more visually sensitive). Point included in this withdrawal alternative. Reduced probability of mine operation in the foreground views and the surrounding Class II area, combined with visual sensitivity, would result in a moderate long-term impact.
South Parcel	
Red Butte–SR 64	The Red Butte viewpoint is elevated and allows for views of most of the South Parcel and provides view of SMS High and distant views of SMS Moderate and Low. Point included in this withdrawal alternative. Reduced probability of mine operation in the foreground and SMS High area, combined with visual sensitivity, would result in moderate long-term visual impacts.
Tusayan–SR 64	Views of SMS Moderate (less visually sensitive). Entire corridor included in this withdrawal alternative. Reduced probability of mine operation in this area, combined with visual sensitivity, would result in minor long-term impacts.
Eastern SR 64	Views of SMS Moderate and background views of SMS High. Entire corridor included in this withdrawal alternative. Reduced probability of mine operation in the foreground area visible from the road, combined with visual sensitivity, would result in a moderate long-term impact.
Grand Canyon National Park and Other Viewpoints	
Tuckup Canyon Trailhead	General views and typical visual impacts same as Alternative A (see Table 4.9-4). Visible areas from this point are included in this withdrawal alternative, thus reducing the probability of a mine's being located in the viewshed (see Figure 4.9-1). Impact ranges from no impact to a minor impact.
Sowats Point	General views and typical visual impacts same as Alternative A (see Table 4.9-4). A majority of the visible areas from this point are included in this withdrawal alternative, thus reducing the probability of a mine's being located in the viewshed (see Figure 4.9-1). Impact ranges from no impact to a minor impact.

Table 4.9-6. Alternative C Observation Point Impact Analysis (Continued)

Observation Point	Direct and Indirect Impacts (as defined in Table 4.9-1)
Grand Canyon National Park and Other Viewpoints, continued	
Kanab Point	General views and typical visual impacts same as Alternative A (see Table 4.9-4). Visible areas from this point are included in this withdrawal alternative, thus reducing the probability of a mine's being located in the viewshed (see Figure 4.9-2). Impact ranges from no impact to a minor impact.
Havasupai Point	General views and typical visual impacts same as Alternative A (see Table 4.9-4). Visible areas from this point are included in this withdrawal alternative, thus reducing the probability of a mine's being located in the viewshed (see Figure 4.9-2). Impact ranges from no impact to a minor impact.
Cape Final	General views and typical visual impacts same as Alternative A (see Table 4.9-4). Most visible areas in the South Parcel are included in this withdrawal alternative. A small portion of the Coconino Rim area is not included. Nearly all visible area in the East Parcel is included (see Figure 4.9-3). This reduces the probability of mining in the viewshed and would result in impact ranges from no impact to a minor impact.
Cape Royal	General views and typical visual impacts same as Alternative A (see Table 4.9-4). Most visible areas in the South Parcel are included in this withdrawal alternative. A small portion of the Coconino Rim area is not included (see Figure 4.9-3). This reduces the probability of mining in the viewshed and would result in impact ranges from no impact to a minor impact.
Bright Angel Point	General views and typical visual impacts same as Alternative A (see Table 4.9-4). Most visible areas in the South Parcel are included in this withdrawal alternative. A small portion of the Coconino Rim area is not included (see Figure 4.9-4). This reduces the probability of mining in the viewshed and would result in impact ranges from no impact to a minor impact.
Point Imperial	General views and typical visual impacts same as Alternative A (see Table 4.9-4). Most visible areas in the South Parcel are included in this withdrawal alternative. A small portion of the Coconino Rim area is not included. Approximately half of the visible area in the East Parcel is included, with the south-central portion omitted. This reduces the probability of mining in the viewshed and would result in minor to a moderate impact.
Desert View Watchtower	General views and typical visual impacts same as Alternative A (see Table 4.9-4). Most visible areas in the South Parcel are included in this withdrawal alternative. A small portion of the Coconino Rim area is not included (see Figure 4.9-5). This reduces the probability of mining in the viewshed and would result in minor to a moderate impact.
Grandview Point	General views and typical visual impacts same as Alternative A (see Table 4.9-4). Most visible areas in the South Parcel are included in this withdrawal alternative. A small portion of the Coconino Rim area is not included (see Figure 4.9-5). This reduces the probability of mining in the viewshed and would result in minor to a moderate impact.
Trailview Overlook	General views and typical visual impacts same as Alternative A (see Table 4.9-4). Visible areas from this point are included in this withdrawal alternative, thus reducing the probability of a mine being located in the viewshed (see Figure 4.9-6). Impact ranges from no impact to a minor impact.
Hopi Point	General views and typical visual impacts same as Alternative A (see Table 4.9-4). Visible areas from this point are included in this withdrawal alternative, thus reducing the probability of a mine being located in the viewshed (see Figure 4.9-6). Impact ranges from no impact to a minor impact.

Night Sky

Potential impacts to nighttime visual resources (e.g., "dark night skies") are described in detail under Alternative A in Sections 4.9.2. Reduction in projected mining and associated activities as compared to Alternative A would result in decreased visual impacts to the night sky. Impact magnitude is minor and short-term.

Cumulative Effects

Cumulative effects to the regions visual resources are described in detail under Alternative A in Section 4.9.2. Reduction in projected mining and associated activities as compared to Alternative A would result in reduced cumulative impacts under Alternative C. Cumulative effects impacts would be classified as minor.

4.9.5 Impacts of Alternative D: Partial Withdrawal (~300,000 Acres)

Changes to the Characteristic Landscape

The addition of approximately 431 uranium exploration projects, 26 uranium mines, 255,685 ore haul trips, and 19.1 miles of new roads and power lines, resulting in approximately 914 acres of disturbed landscape, would cause visual changes to the existing landscape character.

The difference in mining and associated activities between Alternative A and Alternative D represents approximate decreases by 40% in exploratory drilling, 13% in mines, 14% in ore haul trips, 14% in new roads and power lines, and 30% in disturbed land.

Typical visual impacts to the characteristic landscape from mining and associated activities are described in detail under Alternative A. Under Alternative D, a portion of the landscapes designated visually sensitive are included in the proposed withdrawal area and removed from most mining activity. Some mining would still occur in the proposed withdrawal area as described in Alternative B, but the amount is limited. This increases the probability that mining operations and associated activities could be located in visually sensitive areas and would result in a moderate impact to visual resources.

Conformance with Visual Resource Designation

Each parcel contains specific visual resource designations as discussed in Chapter 3. Each designation outlines visual management objectives required for management actions. The section below discusses each parcel's visual designation and the likelihood that the alternative's proposed management actions conform to the stated objectives.

The acres and percentages of visual designations by alternative are presented in Table 4.9-3. This table illustrates how the range of visual designations is included in each alternative. Alternative D includes a portion of visually sensitive lands, but leaves some visually sensitive lands outside of the proposed withdrawal boundary. This, combined with the higher number of mines, increases the likelihood of mine development in a visually sensitive area and thus increases the potential for visual impacts.

For a detailed description of visual resource designations and conformance standards for each parcel see Section 4.9.2 under Alternative A.

NORTH PARCEL

The descriptions of management designation and determinations of conformance with visual designations remain the same as described in Alternative A; mining operations may conflict with VRM Class II management objectives.

Under Alternative D, all Preservation lands are included and 52% of Class II lands in the North Parcel are included in the proposed withdrawal (see Table 4.9-3). Exclusion of half of the Class II lands, combined with the high number of mines projected for this parcel (20) increases the probability that a mine would be developed in a visually sensitive area. This would result in a moderate impact to visual resources

EAST PARCEL

Almost half of Class II lands and all Partial Retention lands are included in the proposed withdrawal area under Alternative D. The Class II lands omitted from the proposed withdrawal represent a visually

sensitive area along the U.S. 89A corridor. Development of the one mine projected in this alternative on these lands would not conform to visual management objectives. The one mine projected for the East Parcel would conform to the management objectives for the Class III lands. Potential one mine developed on visually sensitive land would result in a minor impact to visual resources.

SOUTH PARCEL

Alternative D includes 60% of the visually sensitive SMS High designation in the proposed withdrawal. This increases the probability that a mine would be developed in this visually sensitive area and increases the potential visual impacts in the area. The area not included in the proposed withdrawal includes the Red Butte area and a portion of the Coconino Rim. Mine development in the area of this designation would not conform to the area's management objectives. This would result in a moderate impact to visual resources.

Observation Points Direct and Indirect Impacts

Analysis of views from key observation points (described in Chapter 3) is presented below in Table 4.9-7. This analysis uses the indicators described in Section 4.9.1. Direct and indirect visual impacts could result from mineral exploration, mining, and associated activities. The degree of impact would vary among the different stages of mining activities (mineral exploration through reclamation) and the lands with different visual management designations.

Mining activity is minimally reduced under Alternative D relative to Alternative A and a portion of visually sensitive landscapes are included in the proposed withdrawal area. The projected development of 26 mines would likely result in similar impacts to views from the analyzed observation points if any mines are located in these viewsheds. Given the omission of visually sensitive lands and the high number of mines the probability of mine development in visually sensitive areas is higher under this alternative than under Alternatives B or C.

Regional Haze and Dust

Potential impacts to visual resources from regional haze and dust resulting from mining operations are described in detail under Alternative A in Section 4.9.2. Reduction in mining and associated activities, particularly a 14% reduction in ore haul trips, projected for Alternative D would result in reduced visual impacts from regional haze and dust. Under Alternative D visual impacts would be moderate and short-term. Some casual observers may not be impacted at all, but some observers may find themselves in the proximity of dust during their only trip to the area may be experience major impacts.

Night Sky

Potential impacts to nighttime visual resources (e.g., "dark night skies") are described in detail under Alternative A in Sections 4.9.2. There is some reduction in projected mining and associated activities, compared with Alternative A, that would result in some decreased visual impacts to the night sky. Impact magnitude is moderate and short term.

Cumulative Effects

Cumulative effects on the region's visual resources are described in detail under Alternative A in Section 4.9.2. Some reduction in projected mining and associated activities, compared with Alternative A, would result in minor reduced cumulative impacts under Alternative B. Cumulative impacts would be classified as moderate.

Table 4.9-7. Alternative D Observation Point Impact Analysis

Observation Point	Direct and Indirect Impacts (as defined in Table 4.9-1)
North Parcel	
U.S. 89A	View of VRM Class III (less visually sensitive). Foreground and background views not included in this withdrawal alternative increase the probability of mine operation in foreground along roadway. This, combined with visual sensitivity, would result in moderate long-term impact
Swapp Trailhead	View of VRM Class III (less visually sensitive). Point not included in this withdrawal alternative. Increased probability of mine operation in foreground areas, combined with visual sensitivity, would result moderate long-term impact.
Hack Canyon Trailhead	View of VRM Class I and Class II (more visually sensitive). Point included in this withdrawal alternative. Reduced probability of mine operation in foreground and Class II areas, combined with visual sensitivity, would result in moderate long-term impact. No mining would occur in the Class I area.
Toroweap Road Observation Point - within Antelope Canyon	View of VRM Class III (less visually sensitive). Nearly the entire corridor is not included in this withdrawal alternative. Increase probability of mine operation in foreground of roadway, combined with visual sensitivity, would result in moderate long-term impact. Mine operation at a distance not visible from the roadway and within VRM Class III would result in no impact.
Big Springs Road	View of VRM Class III (less visually sensitive). Entire corridor not included in this withdrawal alternative. Increased probability of mine operation in foreground of roadway, combined with visual sensitivity, would result in moderate long-term impact. Mine operation at a distance not visible from the roadway and within VRM Class III would result in no impact.
SR 389	Limited views into the North Parcel. Views include VRM Class III and Class IV (power line corridor). No visual impacts would occur to views from this location.
East Parcel	
U.S. 89A	Views of VRM Class II (more visually sensitive). Over 50% of this corridor is not included in this withdrawal alternative. Increased probability of mine operation in the foreground of the roadway corridor and in the Class II area would result in a major long-term impact.
U.S. 89A–Soap Creek Trailhead	Views of VRM Class II (more visually sensitive). Point included in this withdrawal alternative. Reduced probability of mine operation in the Class II area and in the foreground of the viewing location would result in a moderate long-term impact.
U.S. 89A–House Rock Valley Overlook	Views of VQO Partial Retention and Modification and VRM Class II. Point included in this withdrawal alternative. Reduced probability of mine operation in the foreground and background views. However, views from this point include a large portion of the House Rock Valley that is not included in the withdrawal in this alternative. Any mining visible from this location would result in major long-term impact.
Rider Canyon Trailhead	Views of VRM Class II (more visually sensitive). Point included in this withdrawal alternative. Reduced probability of mine operation in the foreground views and the surrounding Class II area would result in moderate long-term impact.
South Parcel	
Red Butte–SR 64	The Red Butte viewpoint is elevated and allows for views of most of the South Parcel and provides view of SMS High and distant views of SMS Moderate and Low. Point not included in this withdrawal alternative. Increased probability of mine operation in the foreground and SMS High area would result in major long-term visual impacts.
Tusayan–SR 64	Views of SMS Moderate (less visually sensitive). Majority of corridor not included in this withdrawal alternative. Increased probability of mine operation in this area, combined with visual sensitivity, would result in minor to moderate long-term impacts.
Eastern SR 64	Views of SMS Moderate and background views of SMS High. Corridor included in this withdrawal alternative. Reduced probability of mine operation in the foreground area visible from the road would result in moderate long-term impact.

Table 4.9-7. Alternative D Observation Point Impact Analysis (Continued)

Observation Point	Direct and Indirect Impacts (as defined in Table 4.9-1)
Grand Canyon National Park and Other View Points	
Tuckup Canyon Trailhead	General views and typical visual impacts same as Alternative A (see Table 4.9-4). Visible areas from this point are included in this withdrawal alternative, thus reducing the probability of a mine being located in the viewshed (see Figure 4.9-1). Impact ranges from no impact to minor impact.
Sowats Point	General views and typical visual impacts same as Alternative A (see Table 4.9-4). A majority of the visible area visible area is not included in this withdrawal alternative; the visible area closest to the point is included. The probability of a mining in the excluded portions is increased. Impact magnitude is minor.
Kanab Point	General views and typical visual impacts same as Alternative A (see Table 4.9-4). Some visible areas from this point are included in this withdrawal alternative (Kanab Creek area). The visible area in the southern portion of the North Parcel is not included (see Figure 4.9-2). Impact magnitude is minor.
Havasupai Point	General views and typical visual impacts same as Alternative A (see Table 4.9-4). Visible areas in the South Parcel are included in this withdrawal alternative. Visible areas in the North Parcel are not included (see Figure 4.9-2). The probability of mining occurring is increased in the area not withdrawn. Impact magnitude is minor.
Cape Final	General views and typical visual impacts same as Alternative A (see Table 4.9-4). Most visible areas in the South Parcel are included in this withdrawal alternative. A small portion of the Coconino Rim area is not included. The northern visible area in the East Parcel is not included; the southern area is (see Figure 4.9-3). The probability of mining occurring is increased in the area not withdrawn. Impact magnitude is minor.
Cape Royal	General views and typical visual impacts same as Alternative A (see Table 4.9-4). Most visible areas in the South Parcel are included in this withdrawal alternative. A small portion of the Coconino Rim area is not included (see Figure 4.9-3). This reduces the probability of mining in the viewshed and would result in impact ranges from no impact to minor impact.
Bright Angel Point	General views and typical visual impacts same as Alternative A (see Table 4.9-4). Some visible areas in the South Parcel are included in this withdrawal alternative. Visible areas not included consist of Red Butte, the area near the eastern portion of Highway 64, and a small portion of the Coconino Rim area (see Figure 4.9-4). The probability of mining occurring is increased in the area not withdrawn. Impact magnitude is minor.
Point Imperial	General views and typical visual impacts same as Alternative A (see Table 4.9-4). Some visible areas in the South Parcel are included in this withdrawal alternative. Visible areas not included consist of Red Butte, the area near the eastern portion of Highway 64, and a small portion of the Coconino Rim area (see Figure 4.9-4). Approximately 25% of the visible area in the East Parcel (the eastern portion) is included. The probability of mining occurring is increased in the area not withdrawn. Impact magnitude is minor to moderate.
Desert View Watchtower	General views and typical visual impacts same as Alternative A (see Table 4.9-4). Most visible areas in the South Parcel are included in this withdrawal alternative. A small portion of the Coconino Rim area is not included (see Figure 4.9-5). This reduces the probability of mining in the viewshed and would result in minor to moderate impact.
Grandview Point	General views and typical visual impacts same as Alternative A (see Table 4.9-4). Most visible areas in the South Parcel are included in this withdrawal alternative. A small portion of the Coconino Rim area is not included (see Figure 4.9-5). This reduces the probability of mining in the viewshed and would result in minor to moderate impact.
Trailview Overlook	General views and typical visual impacts same as Alternative A (see Table 4.9-4). Some visible areas from this point are included in this withdrawal alternative. Areas omitted include Red Butte and the area near the eastern portion of Highway 64 (see Figure 4.9-6). The probability of mining occurring is increased in the area not withdrawn. Impact magnitude is minor to moderate.
Hopi Point	General views and typical visual impacts same as Alternative A (see Table 4.9-4). Some visible areas from this point are included in this withdrawal alternative. Areas omitted include Red Butte and the area near the eastern portion of Highway 64 (see Figure 4.9-6). The probability of mining occurring is increased in the area not withdrawn. Impact magnitude is minor to moderate.

4.10 SOUNDSCAPES

4.10.1 Introduction

This section describes the potential noise impacts associated with each alternative being evaluated for this EIS. The soundscape condition indicators that are evaluated in this analysis include the following:

1. Sound pressure levels produced by exploration and mining equipment and the distance from the source before noise levels are attenuated to background levels.
2. Areas in which the measured noise levels would exceed the ambient conditions because of noise associated with the proposed or alternative actions.
3. Analysis of the effects to the natural soundscape within Grand Canyon National Park as defined in Section 4.9 of the 2006 NPS Management Policies (NPS 2006b).
4. Comparison with the rules, policies, or orders established by the federal land managers and the EPA.

The EPA has published acoustical guidelines designed to protect the public health and welfare with an adequate margin of safety. The EPA has determined that an Ldn of 55 dBA protects the public from indoor and outdoor activity noise interference. An Ldn of 55 dBA is equivalent to a continuous noise level of 48.6 dBA.

Title 36, Parks, Forests, and Public Property, Part 2.12, Audio Disturbances, states that “operating motorized equipment or machinery that exceeds a noise level of 60 dBA at 50 feet or, if below that level, makes noise, which is unreasonable, considering the nature and purpose, location, time of day or night, purpose for which the area was established, impact on park users, and other factors that should govern the conduct of a reasonably prudent person under the circumstances” [36 CFR 2.12].

NPS Director’s Order 47, Soundscape Preservation and Noise Management, requires the natural soundscape to be protected, maintained, or restored to a condition unimpaired by inappropriate or excessive noise. In accordance with Section 4.9 of the NPS (2006b) Management Policies, “The Service will take action to prevent or minimize all noise that through frequency, magnitude, or duration adversely affects the natural soundscape or other park resources or values, or that exceeds levels that have been identified through monitoring as being acceptable to or appropriate for visitor uses at the sites being monitored.” Given the proximity of the proposed withdrawal area to the Park, consideration should be given to natural soundscapes, wildlife, cultural landscapes, wilderness character, and the visitor experience.

The 2003 Coconino County Comprehensive Plan stresses the desire for natural quiet as a community characteristic. While the plan sets no specific levels of acceptable noise, it does state that “noise should be considered when reviewing plans for new commercial and industrial developments especially those located close to residential, open space, or recreation areas.”

This assessment of noise impacts required the identification of project-related noise sources and the location of noise-sensitive receptors. Acoustical calculations were performed to estimate the noise levels as a result of exploration, development, and mine operation. Impacts were based on the project’s compliance with applicable noise safety requirements and in relation to Park values, including the ambient noise level (soundscapes), wildlife, cultural landscapes, wilderness character, and visitor experience.

As mentioned in Section 3.10, each of the proposed withdrawal parcels borders the Park. Natural ambient sound levels in non-tourist areas of the park are generally low level, ranging from 18.3 to 22.8 dBA, with a log mean sound level of 20.8 dBA (Ambrose 2010a). The ambient noise level used for natural soundscapes in this study is 20.8 dBA.

Ambient noise levels can be affected by the exploration, development, and operation of the projected mining projects. The magnitude and frequency of this noise may vary considerably over the course of the day, throughout the week, and across the varying seasons, in part as a result of the project schedule, the changing weather conditions, and the effects of seasonal vegetation cover.

Wind can further reduce the sound heard at a distance if the receptor is upwind of the sound. The action of the wind disperses the sound waves reducing the sound pressure levels upwind. While it is true that sound levels upwind of a noise source will be reduced, receptors downwind of a noise source will not realize an increase in sound level over that experienced at the same distance without a wind. This dispels the common belief that sound levels are increased downwind as a result of wind carrying noise.

The reflection, refraction, scattering, and absorption effects resulting from any obstruction (barriers, ground, vegetation, trees, hills, etc.) between a noise source and the receiver likely result in excess attenuation (Fang and Ling 2003). The Federal Highway Administration (1998:17) attributes approximately 1 to 3 dB of noise reduction for every 100 feet of vegetation that is “sufficiently dense to completely block the view along the sound propagation path.”

4.10.2 Incomplete or Unavailable Information

The on-the-ground sound study titled *Sound Levels of Equipment and Operations at the Arizona I Uranium Mine in Northern Arizona, March 20, 2010 to April 8, 2010* (Ambrose 2010b), dated June 21, 2010, provides data that can be used for modeling attenuation rates and audibility distances. However, refined modeling was not conducted for this EIS. Such modeling is required to estimate potential impacts to the natural soundscape of the Park.

A valid analysis of attenuation potential of any obstruction cannot be made without an exact description of factors characterizing the noise source, and receiver. Conditions such as the height, the placement of source (relative to any obstruction), the spectrum of the source and its duration (steady or transient), the size and density of vegetation, and the atmospheric conditions (temperature, wind gradient, relative humidity, and cloud cover). Without knowledge of the specific location of each noise source, these variables cannot be considered.

While there is a large body of peer-reviewed literature available regarding the effects of noise on wildlife, this EIS is framed as an overarching review for a very large area included in the three parcels, and no substantive evaluation of noise effects on wildlife can be generically applied. If a future mine were proposed, an independent EIS for that specific location would be performed at a level of detail appropriate for that site in a manner that ensures land use conditions that would be protective of the environment for that location.

Similarly, there have been numerous studies regarding the effects of aircraft noise on natural quiet conditions in the Park. However, without knowledge of the type and number of specific aircraft that would be used for aerial prospecting or the location and durations of such prospecting, an accurate estimate of impacts is difficult.

4.10.3 Impact Assessment Methodology and Assumptions

To assess the current value of the resource condition indicators, measurement of existing background noise levels in the specific area of any potential mine sites would be required. Once the background values are accurately established, screening level noise models could be run using either measured or manufacturer noise data from proposed mining equipment consistent with the proposed mining operations. The results of the model would allow for a mathematically sound estimate of possible noise effects of proposed mining operations at virtually any remote receiver of interest as agreed to by the concerned parties. Without specific knowledge of the location of potential mine sites, no realistic conclusions can be drawn with regard to the possible noise effects of their operation on the Park or any other nearby receiver of concern. Tables 4.10-1 and 4.10-2 provide definitions of impact magnitude and duration, respectively, as they relate to soundscapes.

Sound levels of mining equipment and operations were measured at the Arizona 1 Uranium Mine between March 20 and April 8, 2010. Monitors were placed approximately 492 feet west of the mine and approximately 466 feet from BLM Road 1058 (7,874 feet southwest of the mine sound monitor). The distance from each noise source was measured, and the sound levels at 50 feet were calculated.

The sound levels of common sources at Arizona 1 Mine and on BLM Road 1058 are presented in Table 4.10-3.

Table 4.10-1. Magnitude and Degrees of Effects on Soundscapes

Attribute of Effect	Description Relative to Soundscapes
Magnitude	
No Impact	Would not produce obvious changes in baseline condition of the resources.
Minor	Project-related impacts would occur, but resources would retain existing character and overall baseline conditions.
Moderate	Project-related impacts would occur, and resources would partially retain existing character. Some baseline conditions would remain unchanged.
Major	Project-related impacts that would create a high degree of change within the existing resource character and overall condition of resources.

Table 4.10-2. Duration Definition of Effects on Soundscapes

Duration	
Temporary	Up to 1 year (periods of development and reclamation)
Short-term	1 to 5 years
Long-term	Greater than 5 years

The noise levels in Table 4.10-3 were measured using the dBA scale to reflect the acuity of the human ear, which does not respond equally to all frequencies. The dBA scale specifically places a preference or “weighting” on sound frequencies that approximate the human ear’s response to low-level sound. Additionally, this weighting preference in the frequency range from approximately 1,000 to 5,000 hertz targets the frequencies most common for human speech and is therefore an indicator of possible impediments to communication.

Typically, the human ear’s minimum threshold of perception for changes in noise levels is considered to be 3 dBA. A change in noise level of 6 dBA is clearly noticeable to the human ear, while an increase of

10 dBA is perceived as a doubling of the noise level. A perceived doubling of the noise level would be the physical equivalent of halving the distance between the noise source and receiver. Based on the perception of sound, impacts from increased sound levels in the range of 3 to 6 dBA would be noticeable.

Table 4.10-3. Noise Levels (dBA) for equipment used at the Arizona 1 Mine (at 15 m)

Sound Source	dBA at known distance from source (measured)	Distance (feet) from source (measured)	dBA at 50 feet (calculated)
Vent Fan	60	400.	78
Trucks Traveling ~25 mph	59	466	77
Ore Dumping on Surface	58	551	76
Trucks Arriving to Site	55	551	73
Front-end Loader w/ Backup Horn	51	551	69
Ore Bucket (Vertical Shaft Movement)	36	551	54
Electric Transformer	27	394	45

Source: Ambrose (2010b).

It is important to remember the decibel scale is logarithmic. Therefore, the combined sound level of several sources is not derived by simply adding the decibels together. For example, 10 sources producing 70 dBA at 50 feet will have the combined sound pressure level of 80 dBA, not 700 dBA. The following formula is used to calculate the total sound pressure level of multiple sources:

$$\text{Total L} = 10 \times \log_{10}\left(\sum_{1}^{n} 10^{\frac{L_n}{10}}\right)$$

Where: Total L = Combined sound pressure level

L = Individual sound pressure level

n = number of sources

The application of this formula cannot account for the relative position of the sources.

A general roster of commonly used equipment during typical construction operations was used in this assessment. Denison provided a list of equipment used at the Arizona 1 Mine site that should be considered typical of equipment that would be used at other mines in the area (personal communication, Lorraine Christian, BLM 2010). The equipment in use at the Arizona 1 Mine site includes the following:

- 40-ton haul trucks (loaded with 25 tons of ore)
- Two front-end loaders with 2.5- to 3.5-yard buckets
- One water truck
- One forklift
- One vent fan
- One sorting screen
- One emergency generator

Table 4.10-4 presents the typical noise emissions levels at 50 feet for the noise-producing equipment that would potentially be used during exploration and development activities. Predicting the Sound Level at Distances Greater than 100 Meters for Outdoors Sound Propagation, Version 1.1, from Associates in Acoustics, Inc., was used to estimate the distance from the source to achieve attenuation to 20.8 dBA.

Table 4.10-4. Noise from Typical Mining Equipment Activities during Exploration, Development, and Reclamation/Closure

Primary Equipment	Estimated Maximum Sound Pressure Level (L_{max}) at 50 feet*	Number of Devices	Estimated Combined Noise Level (dBA) at the Specified Distance of 50 feet†	Estimated Distance from the Source to achieve attenuation to 20.8 dBA‡ (feet)
Exploratory Activity (per site)				
Truck, Pick-Up	75	4	81	7,740
Water Truck	83	1	83	8,730
Drill Rig (Travel)	79	1	79	6,860
Drill Rig (Drilling)	86	1	86	10,400
Mine Development (per mine site)				
Truck, Pick-Up	75	10	85	9,810
Back Hoe, w/Bucket	78	1	78	6,430
Crane, Hydraulic, 25–35 Ton	83	1	83	8,730
Loader, Front End, w/ Bucket	80	1	80	7,300
Road Grader	85	1	85	9,810
Truck, Dump, 10 Ton	76	1	76	5,680
Truck, Flatbed, 2 Ton	74	2	77	6,040
Water Truck	83	1	83	8,730
Generator	81	1	81	7,740
Truck, Semi, Tractor	86	2	89	12,240
Mine Development (per mile of new access road)				
Backhoe / Front Loader	80	1	80	7,300
Road Grader	85	1	85	9,810
Scraper	84	1	84	9,280
Dozer	82	1	82	8,230
Truck, Pick-Up	75	5	78	6,430
Truck, Semi, Tractor	86	2	89	12,240
Water Truck	83	1	83	8,730
Mine Development (per mile of new power line)				
Truck, Pick-Up	75	5	82	8,230
Back Hoe, w/Bucket	78	1	78	6,430
Digger, Distribution, Truck Mount	85	1	85	9,810
Crane, Hydraulic, 25–35 Ton	81	2	84	9,280
Backhoe / Front Loader	76	1	76	5,680
Forklift, 5 Ton	73	1	73	4,630
Truck, Flatbed, w/ Bucket, 5 Ton	74	2	77	6,040
Truck, Dump, 10 Ton	76	1	76	5,680
Truck, Wire Puller, 3-Drum	84	1	84	9,280
Roller/Compactor	80	1	80	7,300
Water Truck	83	1	83	8,730
Truck, Semi, Tractor	86	2	89	12,240

Table 4.10-4. Noise from Typical Mining Equipment Activities during Exploration, Development, and Reclamation/Closure (Continued)

Primary Equipment	Estimated Maximum Sound Pressure Level (L_{max}) at 50 feet*	Number of Devices	Estimated Combined Noise Level (dBA) at the Specified Distance of 50 feet†	Estimated Distance from the Source to achieve attenuation to 20.8 dBA‡ (feet)
Mine Closure and Reclamation (per site)				
Road Grader	85	1	85	9,810
Truck, Pick-Up	75	5	82	8,230
Water Truck	83	1	83	8,730
Truck, Semi, Tractor	86	2	89	12,240

Source: Federal Highway Administration (2006).

* Sound levels for construction equipment were obtained from Federal Highway Administration (2006) and equipment manufacturer specifications.

† Derived by adding the sound pressure levels logarithmically using the formula $Leq_{total} = 10 \log(\Sigma Leq/10)$.

‡ Estimated distance from the source to achieve attenuation to 20.8 dBA was calculated using Associates in Acoustics, Inc. (2002).

The maximum sound pressure levels (L_{max}) levels listed on this table should not be compared directly with the recommended L_{dn}. Day-night average levels are only valid for a 24-hour period and are computed as a 24-hour time weighted average with specific stipulations regarding the hours between 10:00 pm and 7:00 am. The concept is based on the premise that people are more annoyed by a given level of noise during typical sleeping hours.

While the operation of multiple mine sites within a single parcel would have additive effects on the noise levels at certain receptors, the distances between the operations, alignment of the activities relative to the receptor of concern, and the specific equipment used for each operation would need to be considered prior to attempting to model potential noise levels. Should future mining operations be proposed, the noise affects of the individual operations would be considered, and all subsequent proposed operations would be evaluated for the specific site's potential additive effects to the local soundscapes.

Noise levels from exploration, mine development, and reclamation/closure activities may occur near an NSA. A portion of each proposed withdrawal area borders the Park. Therefore, there is the potential for sounds from the mine exploration, development, and reclamation/closure activities to be audible within the Park.

Operation of the underground mines could increase the ambient noise levels in the immediate vicinity of the mine sites and haul roads. The primary noise sources at a typical underground mine site include operation of heavy-duty diesel equipment (e.g., drill rigs, water trucks, graders, dump trucks, front-end loaders, ore haul trucks, etc.) and stationary mining equipment (e.g., mine shaft vent fans and sorting screens). The overall noise level generated by the equipment depends on where the equipment is being used, the number of individual equipment units, and the mitigation measures employed. Table 4.10-5 presents the typical noise emissions levels at 50 feet for the noise-producing equipment that would be used during operation of the mine. Additionally, the table provides the estimated distance from the source to achieve attenuation to 20.8 dBA is provided.

Each of the proposed withdrawal parcels borders the Park. Table 4.10-6 presents the potentially impacted area of the Park, the percentage of the area of the Park, and the approximate dBA range of mining operation noise levels for three varying distances from the withdrawal parcels for all of the Park area and for the area above the Grand Canyon rim. The noise levels included in the table below are provided for illustration; each proposed mine operation would require individual analysis to estimate the possible effects of noise from that specific location, relative to the location of receptors of concern.

Table 4.10-5. Noise from Typical Mining Equipment Activities during Operation

Primary Equipment	Estimated Maximum Sound Pressure Level (L_{max}) 50 feet*	Number of Devices	Estimated Combined Noise Level (dBA) at the Specified Distance of 50 feet†	Estimated Distance from the Source to achieve attenuation to 20.8 dBA‡ (feet)
Mine Operation (per site)				
Truck, Pick-Up	73	5	76	5,680
Backhoe / Front Loader	69	2	72	4,330
Ore Dumping	76	12	79	6,860
Mineshaft Vent Fan	78	2	81	7,740
Transformer	45	1	45	2,200
Haul Trucks				
Trucks Traveling ~25 mph	77	1	77	7,280

Source: Federal Highway Administration (2006).

* Sound levels for construction equipment were obtained from Ambrose (2010b), Federal Highway Administration (2006), and equipment manufacturer specifications.

† Derived by adding the sound pressure levels logarithmically using the formula $Leq_{total} = 10 \log(\Sigma Leq/10)$.

‡ Estimated distance from the source to achieve attenuation to 20.8 dBA was calculated using Associates in Acoustics, Inc. (2002).

Table 4.10-6. Percentage of Grand Canyon National Park Mean Mining Operation Sound Levels from Various Distances from Withdrawal Area*

Distance from Withdrawal Area	Number of Acres	Percentage of Grand Canyon National Park	Mining Operations Mean dBA, Range
All of Park Areas			
Within 7.5 km	219,940	18%	87.3–33.3
Within 15 km	469,566	39%	33.3–27.3
Within 30 km	867,398	72%	27.3–21.3
Above the Canyon Rim			
Within 7.5 km	106,998	9%	87.3–33.3
Within 15 km	139,082	12%	33.3–27.3
Within 30 km	249,637	21%	27.3–21.3

Source: Ambrose (2010a).

* Natural ambient sound levels in non-tourist areas of the Park have been measured to range from 18.3 to 22.8 dBA, with a log mean sound level of 20.8 dBA (Ambrose 2010a).

Noise levels from mining equipment operation could contribute noise within the area of the mine site. Under ideal meteorological, geographic, and terrestrial conditions, the noise impacts could extend a considerable distance from the source. Therefore, the large increase in operational noise within the immediate vicinity of the mine operations represents a change to the ambient environment and has the potential to add sound energy to the local environment. Furthermore, since the proposed withdrawal parcels border the Park, it is possible that sounds from the mine operation activities could be audible within the Park. However, this is relative to the location of the actual source within the parcel and must be determined for each source location.

Outside the boundaries of the proposed withdrawal area, ore haul trucks could have localized, short-term, transient impacts on residences and communities adjacent to the paved highways used by the haul trucks traveling from the mine sites to the ore processing facility in Blanding, Utah. Traffic volume, speed, and vehicle type all affect noise levels. One truck traveling at 55 mph will sound as loud as 28 cars moving at

the same speed (Federal Highway Administration 2010). Typical noise levels for heavy trucks (e.g., log-haul tractor-trailers (semi-trucks), large tow trucks, dump trucks, cement mixers, large transit buses, motor homes with exhaust located at top of vehicle, and other vehicles with the exhaust located above the vehicle) are expected to range from 84 to 86 dBA at 55 mph at 50 feet from the source (Minor 2005). For comparison, typical noise levels for passenger vehicles (e.g., normal passenger vehicles, small and regular pickup trucks, small to mid-sized sport utility vehicles, etc.) are expected to range from 72 to 74 dBA at 55 mph at a distance of 50 feet from the source.

Based on information obtained from Research and Innovation Technology Administration Bureau of Transportation Statistics (2010) there were 135.9 million passenger vehicles and 6.8 million single-unit two-axle six-tire or more trucks registered in the United States in 2007. Therefore, without performing a project-specific traffic study, it is anticipated that ore haul truck traffic would make up a rather small percentage of the normal highway traffic. Note the “typical” 300-tpd uranium mine will require 12 to 16 25-ton ore haul truck trips per day.

4.10.4 Impacts Common to All Alternatives

Under Alternatives A through D, mine noises are estimated to be greater than the natural ambient sound levels of the non-tourist areas of the Park (18.3–22.8 dBA) at distances within 2,360 m or 2.3 km (7,740 feet, or 1.5 miles) from a mine site and 2,220 m or 2.2 km (7,280 feet, or 1.4 miles) from ore haul trucks. However, some attenuation would occur as a result of the vegetation and distance’s acting in unison.

Based on the report titled *Mining Adjacent to Grand Canyon National Park: Potential Impacts to the Natural Soundscape of the Park* (Ambrose 2010a), the noise from operation of an underground uranium mine, depending on the location, could be audible in some areas of the Park. It is likely the Grand Canyon rim will block some of the noise generated by the mining exploration and develoment from reaching lower areas of the Grand Canyon. Likewise, vegetative cover above the rim will disrupt noise transmission. In addition, the prevailing wind could affect the attenuation.

Development and operation of proposed underground uranium mines under each alternative as well as currently operating mines (Arizona 1 Mine), and reasonably foreseeable future projects (e.g., VANE claims, EZ-1/EZ-2/Canyon Mine) identified in Appendix B, would involve the use of heavy equipment that would produce noise that could affect ambient soundscapes.

Under Alternatives A through D, exploration and development of a proposed mine sites would cause temporary increases in ambient noise levels in the immediate vicinity of the exploration and development areas. The primary noise sources at a typical underground mine exploration/development sites include operation of heavy-duty diesel equipment (e.g., drill rigs, water trucks, graders, dump trucks, front-end loaders, etc.). The overall noise level generated by the heavy equipment use depends on where the equipment is being used, the number of individual equipment units, and the mitigation measures employed.

The extent of the impact is dependent on the proximity of the mining activity to the Park boundary, the type of equipment used, the topography of the area, direction of the prevailing wind, and hours of equipment operation. Areas of the Park that are closer to mining operations would be impacted more than areas that are farther away, and areas above the rim would likely be impacted more than areas below the rim. The rim of the Grand Canyon will block some of the sounds generated by the mining activities; however, the extent to which sound travels below the rim will vary, based on the meteorological conditions.

New technologies such as low-level aerial surveys may be conducted during “prospecting” or exploration activities. Any aerial surveys would be subject to those provisions of the National Parks Overflight Act of

1987 [PL 100-91]. These activities would be short term and transient in nature. The mobility of prospecting operations makes the noise contribution at various receptors temporary and variable. Additional modeling would be required to estimate the noise contribution associated with aerial prospecting.

Compliance with Environmental Regulations and Permitting

Based on good management practices the following measures should be implemented to ensure compliance with environmental regulations and permitting requirements.

- Where possible, the exploration and development activities would be limited to daytime hours (10-hour shifts and a 5-day work week), thus limiting noise on nights and weekends.
- All equipment would be carefully maintained to achieve the lowest practical noise levels (e.g., required to have manufacturer recommended mufflers, tightening loose parts, etc.).
- To the extent feasible, configure the construction site in a manner that keeps noisier equipment and activities as far as possible from NSAs.
- To the extent feasible, mining equipment producing the most noise should be constructed in areas where the topography provides a natural buffer (i.e., locate nosier components in depressions and off of hill crests).

4.10.5 Impacts of Alternative A: No Action (No Withdrawal)

Table 4.10-7 summarizes the activities associated with Alternative A.

Table 4.10-7. Summary of Activity Associated with Alternative A

Activity	North Parcel	East Parcel	South Parcel
Total Number of Mines	21	2	7
Number of Exploration Projects	504	56	168
Miles of New Road	16.4	2.4	3.6
Number of Haul Trips	208,385	22,240	69,540
Miles of New Power line	16.4	2.4	3.6

Direct Impacts

Under Alternative A, exploration and development of a proposed mine site would cause temporary increases in ambient noise levels in the immediate vicinity of the exploration and development sites. The primary noise sources at a typical underground mine exploration/development site include operation of heavy-duty diesel equipment (e.g., drill rigs, water trucks, graders, dump trucks, front-end loaders, etc.). The overall noise level generated by the heavy equipment use depends on where the equipment is being used, the number of individual equipment units, and the mitigation measures employed.

Under Alternative A, areas with potential mining activity are in relatively remote areas currently devoid of residential or industrial activity. Therefore, the increase in operational noise within the immediate vicinity of the mine operations represents a change to the ambient environment. Furthermore, since portions of the proposed withdrawal area border the Park, it is possible that sounds from mining operations could be audible within these areas. However, quantifying the number of Park visitors whose

experience could be disrupted or the impact to wildlife populations would require additional study, specific to individual mines in each parcel.

4.10.6 Impacts of Alternative B: Proposed Action (~1 Million Acres, 20-Year Withdrawal)

Under Alternative B, the withdrawal would occur for a period of 20 years. No new mining claims could be located within the withdrawal area, nor could further exploration or development occur on existing mining claims within the withdrawal area unless valid existing rights were established. Mineral exploration and development on any claims with valid existing rights would continue under the applicable BLM or Forest Service surface management regulations. After the expiration of the segregation period, the potential withdrawal under Alternative B would restrict the location of new mining claims within the segregation area from exploration, development, and underground uranium mining activities.

Reasonably foreseeable uranium mining exploration activities would occur at 11 exploration sites, leading to the development of 11 mine sites (including Pinenut, Kanab North, Arizona 1, and Canyon Mines) and 6.4 miles of new access roads and power lines. Table 4.10-8 summarizes the activities associated with Alternative B.

Table 4.10-8. Summary of Activity Associated with Alternative B

Activity	North Parcel	East Parcel	South Parcel
Total Number of Mines	10	0	1
Number of Exploration Projects	10	0	1
Miles of New Road	6.4	0	0
Number of Haul Trips	86,065	0	2,820
Miles of New Power line	6.4	0	0

4.10.7 Impacts of Alternative C: Partial Withdrawal (~700,000 Acres)

The withdrawal under Alternative C would apply to 695,774 acres of federal lands, compared with approximately 1 million acres under Alternative B. The Alternative C withdrawal would occur for a period of 20 years. No new mining claims could be located within the withdrawal area, nor could further exploration or development occur on existing mining claims within the withdrawal area unless valid existing rights were established. Mineral exploration and development on any claims with valid existing rights would continue under the applicable BLM or Forest Service surface management regulations. After the expiration of the segregation period, the potential withdrawal under this alternative would restrict the location of new mining claims within the withdrawal area from exploration, development, and underground uranium mining activities similar to that for Alternative B, but would apply to a smaller area.

Under Alternative C, reasonably foreseeable uranium mining exploration activities would occur at 207 exploration sites, leading to the development of 18 mine sites (including Pinenut, Kanab North, Arizona 1, and Canyon Mine) and 12.1 miles of new access roads and power lines. Table 4.10-9 summarizes the activities associated with this alternative.

Table 4.10-9. Summary of Activity Associated with Alternative C

Activity	North Parcel	East Parcel	South Parcel
Total Number of Mines	13	1	4
Number of Exploration Projects	94	28	85
Miles of New Road	9.1	1.2	1.8
Number of Haul Trips	119,425	11,120	36,180
Miles of New Power Line	9.1	1.2	1.8

4.10.8 Impacts of Alternative D: Partial Withdrawal (~300,000 Acres)

Under Alternative D, a withdrawal would apply to approximately 306,015 acres of federal lands and the withdrawal would occur for a period of 20 years. No new mining claims could be located within the withdrawal area, nor could further exploration or development occur on existing mining claims within the withdrawal area unless valid rights were first established. Mineral exploration and development on mining claims with valid existing rights would continue under the respective BLM or Forest Service surface management regulations.

Under this alternative, reasonably foreseeable uranium mining exploration activities would occur at 431 exploration sites, leading to the development of 26 mine sites (including Pinenut, Kanab North, Arizona I, and Canyon Mines) and 19.1 miles of new access roads and power lines. Table 4.10-10 summarizes the activities associated with Alternative D.

Table 4.10-10. Summary of Activity Associated with Alternative D

Activity	North Parcel	East Parcel	South Parcel
Total Number of Mines	20	1	5
Number of Exploration Projects	290	28	113
Miles of New Road	15.5	1.2	2.4
Number of Haul Trips	197,265	11,120	47,300
Miles of New Power Line	15.5	1.2	2.4

4.10.9 Cumulative Impacts

Based on the RFD and normal operating scenarios, the noise generating equipment identified in this section would not operate simultaneously. Moreover, the number of activities is limited by the alternatives, and not all mines would be developed concurrently.

It is anticipated that a maximum of two mines would operate simultaneously in the North Parcel and that no more than one mine each would operate within the East and South parcels. The majority (approximately 77%) of the mining development and operations would take place on the North Parcel. However, cumulative impacts to soundscapes are a function of the specific noise sources and their specific location to the NSA. Without this knowledge, noise modeling, which considers conditions such as the height and placement of the source (relative to any obstruction), the spectrum of the source and its duration (steady or transient), the size and density of vegetation, and the atmospheric conditions, cannot be conducted.

It is recognized there would be other noise-generating activities within the proposed withdrawal parcels such as recreational vehicles, OHV use, aerial tours, etc. While these activities could contribute to cumulative impacts, the nature of the noise caused by these sources is completely dependent on the number and location of their operation and is by nature transient. Future projects will be required to undergo NEPA analysis based on individual proposed actions. The NEPA process will require a determination of direct, indirect, and cumulative impacts specific to each mine location. Without specific information regarding the location and duration of the operation of these sources, no substantive estimates of the addition of cumulative noise can be presented in this level of evaluation.

4.11 CULTURAL RESOURCES

4.11.1 Impact Assessment Methodology and Assumptions

For the purposes of this analysis, cultural resources are defined as prehistoric and Historic period archaeological sites and historic buildings or structures. Cultural resources that are primarily valued for their importance to American Indian tribes, such as TCPs, cultural landscapes, and sacred sites, are addressed separately in Section 4.12, American Indian Resources. As American Indian tribes also ascribe importance to places and archaeological sites connected to their ancestors and oral histories, many archaeological sites may also be places of traditional religious or cultural importance.

Effects include both direct and indirect effects. Direct effects are those that occur during the action and in the location of the action; indirect effects are those that occur either removed in time or space from the action. Adverse effects are generally evaluated in regard to the specific criteria that make a property eligible for inclusion in the NRHP (see Section 3.11.1). Adverse impacts on cultural resources result from physical destruction, damage, or alteration of all or part of the property, or from alterations to the site's setting when the character of setting contributes to its eligibility. Such alterations could include visual, audible, or atmospheric elements that are out of character with the setting. A project may also result in no adverse effects; in those cases, an action does have an impact to a resource, but the impact either does not harm the resource or the harm to the resource can be successfully mitigated.

Direct adverse impacts from mining activities could include disturbance resulting from exploration, construction, mine operation, road construction and use, and reclamation. Direct or indirect impacts could result from effects on one or more aspects of integrity (location, design, setting, materials, workmanship, feeling, and association), which would disturb the character of the setting. Indirect impacts could include loss of opportunities for interpretive development or educational uses as a result of loss of integrity or diminished qualities of setting.

The nature and magnitude of the impacts would depend on the specific location and scope of the proposed exploration or development activities. Tables 4.11-1 and 4.11-2 provide definitions of impact magnitude and duration, respectively, as they relate to cultural resources.

Because cultural resources are location specific and the actual locations of the possible mining activities are unknown at this time, this analysis assumes that all future mining-related activities have the potential to affect any of the resources, except where noted. The primary indicator of impacts to cultural resource sites is disturbance. Cultural resources are irreplaceable once disturbed or damaged and cannot be reclaimed, so that any disturbance to a site can be considered a major impact. However, existing mining regulations do address cultural resource disturbance through mitigation (see below). Conversely, it is possible that a given mining project would not adversely affect cultural resources if no resources will be disturbed.

Table 4.11-1. Magnitude and Degrees of Effects on Cultural Resources

Attribute of Effect	Description Relative to Cultural Resources
Magnitude	
No Impact	Would avoid resource.
Minor	Project-related impacts would occur but resources would retain existing characteristics that make it eligible for the NRHP.
Moderate	Project-related impacts would occur, and resources would partially retain existing characteristics that make it eligible for the NRHP; however, resource's eligibility would need to be re-evaluated.
Major	Project-related impacts that would result in loss of the NRHP eligibility of the resource.

Table 4.11-2. Duration Definition of Effects on Cultural Resources

Duration	
Temporary	Up to 1 year (periods of development and reclamation) (auditory and visual only)
Short-term	1 to 5 years (auditory and visual only)
Long-term	Greater than 5 years (all impacts caused by ground disturbance are long-term)

In the following impact analysis, cultural resource sites were classified into four categories based on documented NRHP determinations and evaluations: 1) listed in the NRHP, 2) eligible for listing in the NRHP, 3) not eligible for listing in the NRHP, and 4) unevaluated with respect to status for listing in the NRHP. Sites currently classified as unevaluated are still considered in this analysis because unevaluated sites are treated as eligible by the BLM and Forest Service until they are determined ineligible for the NRHP. The following analysis of potential impacts takes into account the RFD scenarios for the predicted numbers and areal extent of exploration and development activities under each alternative. It is assumed that the majority of development would occur in the North Parcel, with less on the South Parcel and very little in the East Parcel; however, the RFD scenarios cannot predict precisely where the potential mines could be developed.

For each parcel proposed for withdrawal, a Class I cultural resources inventory of existing records and databases was completed in order to identify known cultural resources. The majority of the areas within each parcel have not been subjected to on-the-ground archaeological surveys. Survey coverage varies from less than 10% of the North and East parcels to less than 25% of the South Parcel. Therefore, the exact number of cultural resources on each parcel is unknown. Site density per acre surveyed varies across the three parcels. The North Parcel has a site density of 0.03 site per surveyed acre, the East Parcel has a site density of 0.05 site per surveyed acre, and the South Parcel has a site density of 0.02 site per surveyed acre. These numbers do not take into account differences in environment or terrain that may affect site density.

4.11.2 Compliance with Environmental Regulations and Permitting

The implementation of mitigation measures according to current mining regulations would reduce adverse impacts to cultural resources. The primary mitigation measure would be avoidance. Under all the alternatives, areas proposed for mine development would be subjected to intensive archaeological surveys to identify and evaluate cultural resources that could be affected. Impacts to cultural resources would be considered and addressed through the NEPA and Section 106 processes, with efforts made to identify, avoid, mitigate, or otherwise resolve any adverse effects.

It is assumed that the majority of archaeological sites determined eligible for the NRHP would be valued for their potential to yield important information. Therefore, one of the mitigation measures would be the implementation of agency-approved plans for scientific data recovery. Data recovery procedures could include excavations, mapping, collection of artifacts and other archaeological materials, archival research, or oral histories. Final reports would be required to document the results of analysis, with collections and data preserved for long-term research in a museum or other federally approved repository. American Indian tribes would be consulted in developing related research designs, plans, and procedures. The agencies would comply with the provisions of the Native American Graves Protection and Repatriation Act to address any discoveries of materials protected under that law.

Other potential mitigation measures include avoidance of impacts through the design or relocation of activities or facilities; required education of workers to ensure that they understand and comply with cultural resource protection measures; and implementation of discovery plans to address any unexpected finds during exploration, construction, or operation. Mitigation measures near access roads could include implementation of site monitoring plans to detect violations and support enforcement of the Archaeological Resources Protection Act.

Visual intrusions could be mitigated through measures designed to reduce visual impacts by lowering the contrast of mining-related facilities with the surrounding terrain and viewshed. Auditory intrusions could be mitigated through scheduling of mining activities to avoid sensitive times of the year. Reclamation could restore aspects of the setting after mining activities conclude. However, it may not be possible to reduce all such adverse effects in the long term, especially impacts to the character, association, and feeling of the setting.

4.11.3 Incomplete or Unavailable Information

As described above, survey coverage of the proposed withdrawal parcels ranges from less than 10% to 24%. There are more than 2,000 known sites, indicating that the parcels include several thousand cultural resource sites yet unrecorded, many of which are likely to be eligible for the NRHP and could be affected by mining activities; however, sufficient information is available to analyze potential effects on cultural resources types. Although the specific locations of potential mining activities are not defined, the RFD scenarios provide sufficient information to support the alternatives impact analysis.

4.11.4 Alternative A: No Action (No Withdrawal)

Under Alternative A, each parcel would be open for the entry and location of new mining claims once the segregation order was lifted or expired. The RFD scenario estimates that 26 new mines would be developed, in addition to the four mines that are currently in operation or in interim management mode. The 30 mines would also involve 728 exploratory projects.

Direct and Indirect Impacts

In the North Parcel, the RFD scenario estimates that 18 new mines would be developed over the next 20 years, in addition to the three existing mines, involving 504 exploration projects. Exploration drilling involves drilling several holes to confirm the presence of a breccia pipe, its boundaries, and presence of mineralization. In some cases, a shaft may be sunk to intercept the ore. Exploration sites are routinely moved to avoid sensitive resources, including cultural resources. Including new roads, the projection is a total of 945 acres disturbed. Depending on the location of the mining activities, cultural resources could be directly impacted by the disturbance of 945 acres. There are 743 known cultural resource sites, as well as sites yet to be discovered, in this parcel (Table 4.11-3). One area of concern is the Kanab Creek

watershed, the location of the current uranium mines. The Kanab Creek area is known to contain a high density of significant cultural resources, likely associated with the presence of water sources and springs.

In the East Parcel, the RFD scenario estimates that two new mines would be developed over the next 20 years, involving 56 exploration projects. Including new roads, the projection is a total of 107 acres disturbed, which could directly impact cultural resources. There are 171 known cultural resource sites in this parcel (see Table 4.11-3). Areas of concern, which contain significant known sites, border the Vermilion Cliffs, Colorado River, and the western margin of the parcel at the base of the Kaibab Plateau.

Table 4.11-3. National Register of Historic Places status of Known Sites by Parcel for Alternative A

	North	East	South	Total
Listed	–	1	11	**12**
Eligible	133	60	268	**461**
Ineligible	102	7	92	**201**
Unevaluated	508	103	1,370	**1,981**
Total	**743**	**171**	**1,741**	**2,655**

In the South Parcel, the RFD scenario estimates that six new mines would be developed over the next 20 years, involving 168 exploration projects. Including new roads, the projection is a total of 312 acres disturbed, which could directly impact cultural resources. This parcel includes 1,741 known cultural resource sites (see Table 4.11-3). Information from past surveys indicates a high density of cultural resources throughout the parcel.

Cultural resources near mining activities or facilities could be indirectly affected by adverse impacts to aspects of setting by construction of new roads. There would be 16.4 miles of new roads in the North Parcel, 2.4 miles in the East Parcel, and 3.6 miles in the South Parcel.

Cumulative Impacts

Cumulative impacts are defined as “the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (federal or non-federal) or person undertakes such other activities” [40 CFR 1508.7]. For cultural resources, the loss of resources over time and space may result in an alteration to the historic (including prehistoric) character and integrity of a place. Past actions such as livestock grazing allotments on Forest Service land have contributed in a minor way to disturbance and erosion of cultural resources; however, this disturbance is not considered significant overall. Site condition data for cultural resources on BLM land were not available; however, similar amounts of disturbance can reasonably be assumed for the portions of the proposed withdrawal area on BLM lands. Examples of past, present, and future projects include, but are not limited to, the Grand Canyon National Park Airport Fuels Reduction Project, the Arizona Strip ROD/RMP, the Designation of Energy Corridors on Federal Land in the 11 Western States EIS, the Orphan Mine, the Arizona 1 Mine, the EZ1 and EZ2 Mines, the What Mine, the VANE Minerals Uranium Exploratory Drilling Project EIS, the Four Forest Restoration Initiative, the Kaibab National Forest Travel Management EAs, and the Plateau Facility Fire Protection Project EA. For all of these projects, the amount and type of disturbance to sites would be the primary impact indicator; however, existing regulations stipulate that all past, present, and future projects, including mining applications, construction of utility lines, fire management, etc., on federal lands are subject first to cultural resources inventory. If sites are found during this inventory, disturbance to those sites must be mitigated. Since avoidance is the primary mitigation measure for any project, it can be assumed that the total number of cultural resources that would need to be mitigated further through data recovery or other

means for these projects is minimal and would not significantly change the historic or prehistoric character of the parcels; therefore, no cumulative impacts to cultural resources are anticipated under Alternative A.

4.11.5 Impacts of Alternative B: Proposed Action (~1 Million Acres, 20-Year Withdrawal)

Because all three parcels, approximately 1,000,000 acres, would be withdrawn and no new exploration or claims would be allowed for 20 years, mining activities would be focused on the exploration and development of valid existing claims. The RFD scenario estimates that 11 mines would be developed during the 20-year period.

Direct and Indirect Impacts

In the North Parcel, the RFD scenario estimates that 10 mines would be developed over the next 20 years, involving 10 associated exploration projects. Including new roads, the projection is a total of 163 acres disturbed, which could directly impact cultural resources. There are 743 cultural resource sites within the North Parcel. Mining-related impacts to cultural resources would be limited to the mine development areas. Throughout the rest of the parcel, cultural resources would not be affected by new mining activities.

In the East Parcel, no new mines would be developed, and there would be no exploration projects. The entire area would be excluded from impacts associated with mining.

In the South Parcel, the RFD scenario estimates that one existing mine would be further developed, with one exploration project and no new roads. Disturbance from the exploration project would be approximately 1 acre. Any cultural resource sites at or near the mine development could be impacted by mining activities. In the rest of the parcel, cultural resources would not be affected by new mining activities.

Cultural resources near mining activities or facilities could be indirectly affected by adverse impacts to aspects of setting through construction of 6.4 miles of new roads in the North Parcel.

Cumulative Impacts

For the same reasons as identified for Alternative A, no cumulative impacts to cultural resources are anticipated under Alternative B.

4.11.6 Impacts of Alternative C: Partial Withdrawal (~700,000 Acres)

Under Alternative C, approximately two-thirds of the area proposed for withdrawal under Alternative B, or approximately 700,000 acres, would be withdrawn from mineral entry for 20 years. The RFD scenario anticipates the development of 18 new mines.

Direct and Indirect Impacts

In the North Parcel, 290,232 acres would be withdrawn, focused on the Kanab Creek watershed, ACECs, and other areas containing sensitive cultural resource values. The RFD scenario estimates that 13 mines would be developed, involving 94 exploration projects. Including new roads and exploratory projects, the

projection is a total of 320 acres disturbed, which could directly impact cultural resources. There are 82 known cultural resource sites in areas excluded from withdrawal. For the 661 known sites in the area proposed for withdrawal, impacts from new mining activities would be limited to those associated with the development of valid existing claims (Tables 4.11-4 and 4.11-5).

Table 4.11-4. National Register of Historic Places Status of Sites within Alternative C Withdrawal Boundaries, By Parcel

	North Parcel	East Parcel	South Parcel	Total
Listed	–	–	9	**9**
Eligible	127	13	223	**363**
Ineligible	93	7	66	**166**
Unevaluated	441	71	968	**1,480**
Total	**661**	**91**	**1,266**	**2,018**

Table 4.11-5. National Register of Historic Places Status of Sites in Areas Excluded from Withdrawal under Alternative C, By Parcel

	North Parcel	East Parcel	South Parcel	Total
Listed	–	1	2	**3**
Eligible	6	47	45	**98**
Ineligible	9	–	26	**35**
Unevaluated	67	32	402	**501**
Total	**82**	**80**	**475**	**637**

In the East Parcel, 96,199 acres would be withdrawn, focused on areas containing sensitive cultural resource values. The RFD scenario estimates that one new mine would be developed, involving 28 exploration projects. Including new roads and exploratory projects, the projection is a total of 54 acres disturbed, which could directly impact cultural resources. There are 80 known cultural resource sites in areas excluded from withdrawal. The 91 known sites in the area proposed for withdrawal would avoid direct impacts associated with mining (see Tables 4.11-4 and 4.11-5).

In the South Parcel, 209,313 acres would be withdrawn, focused on Red Butte, zones adjacent to Grand Canyon National Park, and other areas containing sensitive cultural resource values. The RFD scenario estimates that four mines would be developed, involving 85 exploration projects. Including new roads and exploratory projects, the projection is a total of 158 acres disturbed, which could directly impact cultural resources. There are 475 known cultural resource sites in areas excluded from withdrawal. For the 1,266 known sites in the area proposed for withdrawal, impacts from new mining activities would be limited to those associated with the development of valid existing claims (see Tables 4.11-4 and 4.11-5).

Cultural resources near mining activities or facilities could be indirectly affected by adverse impacts to aspects of setting through construction of 9.1 miles of new roads in the North Parcel, 1.2 miles in the East Parcel, and 1.8 miles in the South Parcel.

Cumulative Impacts

For the same reasons as identified for Alternative A, no cumulative impacts to cultural resources are anticipated under Alternative C.

4.11.7 Impacts of Alternative D: Partial Withdrawal (~300,000 Acres)

Under Alternative D, approximately one-third of the area proposed for withdrawal under Alternative B, approximately 300,000 acres, would be withdrawn from mineral entry for 20 years. The RFD scenario anticipates the development of 26 new mines.

Direct and Indirect Impacts

In the North Parcel, 113,664 acres would be withdrawn, focused on areas containing multiple sensitive resource values. The RFD scenario estimates that 17 new mines, in addition to the three existing mines, would be developed, involving 290 exploration projects. Including new roads and exploratory projects, the projection is a total of 688 acres disturbed, which could directly impact cultural resources. There are 403 known cultural resource sites in areas excluded from withdrawal. For the 340 known sites in the area approved for withdrawal, impacts from new mining activities would be limited to those associated with the development of valid existing claims (Tables 4.11-6 and 4.11-7).

Table 4.11-6. National Register of Historic Places Status of Sites within Alternative D Withdrawal Boundaries, By Parcel

	North Parcel	East Parcel	South Parcel	Total
Listed	–	–	8	**8**
Eligible	59	9	170	**238**
Ineligible	40	5	46	**91**
Unevaluated	241	61	591	**893**
Total	**340**	**75**	**815**	**1,230**

Table 4.11-7. National Register of Historic Places Status of Sites in Areas Excluded from Withdrawal under Alternative D, By Parcel

	North Parcel	East Parcel	South Parcel	Total
Listed	–	1	3	**4**
Eligible	74	51	98	**223**
Ineligible	62	2	46	**110**
Unevaluated	267	42	779	**1,088**
Total	**403**	**96**	**926**	**1,425**

In the East Parcel, 58,087 acres would be withdrawn, focused on areas containing multiple sensitive resource values. The RFD scenario estimates that one new mine would be developed, involving 28 exploration projects. Including new roads and exploratory projects, the projection is a total of 54 acres disturbed, which could directly impact cultural resources. There are 96 known cultural resource sites in areas excluded from withdrawal. The 75 known sites in the area proposed for withdrawal would avoid direct impacts associated with mining (see Tables 4.11-6 and 4.11-7).

In the South Parcel, 134,264 acres would be withdrawn, focused on areas containing multiple sensitive resource values. The RFD scenario estimates that four new mines would be developed, involving 113 exploration projects. Including new roads and exploratory projects, the projection is a total of 209 acres disturbed, which could directly impact cultural resources. There are 939 known cultural resource sites in areas excluded from withdrawal. For the 815 known sites in the area proposed for withdrawal,

impacts from new mining activities would be limited to those associated with the development of valid existing claims (see Tables 4.11-6 and 4.11-7).

Cultural resources near mining activities or facilities could be indirectly affected by adverse impacts to aspects of setting through construction of 15.5 miles of new roads in the North Parcel, 1.2 miles in the East Parcel, and 2.4 miles in the South Parcel.

Cumulative Impacts

For the same reasons as identified for Alternative A, no cumulative impacts to cultural resources are anticipated under Alternative D.

4.12 AMERICAN INDIAN RESOURCES

4.12.1 Impact Assessment Methodology and Assumptions

American Indian resources consist of many types of places and landscapes, including tribal homelands, places of traditional importance, traditional use areas, cultural landscapes, trails, springs and waterways, and sacred sites. Each of these places is associated with values that contribute to sustaining the culture; these values are associated with cultural heritage, respect for ancestors, spirituality, education, economics, and social relationships. Some of these places and landscapes may be recognized as TCPs by the federal government; however, many are not. Although these places and landscapes have not been through the formal nomination process as TCPs, they are no less important to American Indians and their cultures and must be considered when evaluating the impacts of an undertaking. TCPs may also be associated with non–American Indian groups; however, there are no non–American Indian TCPs in the proposed withdrawal area.

For American Indian resources, adverse impacts are varied and sometimes difficult to measure. In many cases, American Indian perception of adverse impacts is as important as any physical and measurable impact. Possible adverse impacts could include the following:

- direct damage, disturbance or destruction of places or landscapes, resulting from exploration, construction, operation, transportation, and reclamation activities;
- any “wounding” of the earth through drilling or mining;
- disturbance of graves, human remains, or other materials protected under the Native American Graves Protection and Repatriation Act;
- visual, audible, or atmospheric elements that adversely affect the integrity and values of resources;
- impediments to traditional practices or land uses;
- restricted access to traditional use areas or sacred sites;
- disruption in feeling or association of places or landscapes from visual or auditory impacts;
- loss of springs or declines in quantity or quality of important water sources;
- social impacts such as distress or anxiety caused by effects on cultural values and sense of place, or fears of loss, illness, or resource contamination.

Some of these impacts can be mitigated, while others cannot. Mitigation may be difficult or impossible in many cases, as alterations or damage to the values of significant, connected places may be irreversible

and irreparable, regardless of reclamation; however, some potential mitigation measures include the following:

- avoidance or reduction of impacts through relocation or redesign of activities or facilities;
- measures implemented to reduce visual impacts, air quality impacts, and noise.
- access routes provided or kept open to traditional use areas and sacred sites.
- reclamation to restore aspects of setting.

Areas of potential traditional religious or cultural importance within the proposed withdrawal area were identified through a search of published literature and consultation with American Indian tribes (Hedquist and Ferguson 2010). In order to determine potential impacts, locations of traditional cultural importance, including sacred places, were compared against possible mine site locations. Although acreage of possible disturbance was taken into consideration in the analysis**,** any disturbances or damage to places of cultural importance to tribes are likely to be perceived as significant. Tables 4.12-1 and 4.12-2 provide definitions of impact magnitude and duration, respectively, as they relate to American Indian resources.

Table 4.12-1. Magnitude and Degrees of Effects on American Indian Resources

Attribute of Effect	Description Relative to Cultural Resources
Magnitude	
No Impact	Would avoid resource.
Minor	Project-related impacts would occur but resources would retain existing characteristics vital to their cultural functions and uses by American Indians.
Moderate	Project-related impacts would occur, and resources would partially retain existing characteristics vital to their cultural functions and uses by American Indians. Some functionality of resource may be lost.
Major	Project-related impacts that would result in loss of resource and/or functional use of resource.

Table 4.12-2. Duration Definition of Effects on American Indian Resources

Duration	
Temporary	Up to 1 year (periods of development and reclamation) (auditory and visual only)
Short-term	1 to 5 years (auditory and visual only)
Long-term	Greater than 5 years (all impacts caused by ground disturbance are long-term)

In order to determine potential impacts for each alternative, the analysis evaluated the presence of documented ethnographic resources that could be affected by mineral exploration and development. Any disturbance or damage to these places, regardless of size, may be perceived by American Indians as significant because it may disrupt the function of these particular places.

The information provided in the ethnographic report should not be considered comprehensive. Many places important to tribes are not identified in the report because many tribes feel that they should not share sacred and tribal knowledge with outsiders; the resources mentioned here likely represent a fraction of the total number of American Indian resources within the proposed withdrawal area. Any mining activity has the potential to affect yet-unidentified resources within the proposed withdrawal area.

The RFD scenarios estimate the likely number of mines for each parcel; however, they cannot precisely predict the locations of the mines. For the purposes of this analysis, it will be assumed that the majority of development would occur in the North Parcel, substantially less in the South Parcel, and little if any in the East Parcel; however, given the limited data, it is extremely difficult to predict within an individual parcel where any mines might eventually be developed. Because the actual locations of the possible mines are

unknown, this analysis assumes that each mine has the potential to affect any of the resources, except where noted. The cumulative impact analysis area was confined to the boundaries of the proposed withdrawal area.

It is important to note that many American Indians view exploratory drilling and mining as wounding the earth. Past mining activities that are visible on the surface are seen as wounds that cannot scab over or heal (Nuvamsa 2008). Any drilling into the earth, regardless of size, is considered a wound to the earth. In commenting on other projects in the withdrawal area, the Hopi have repeatedly stated that the earth is sacred and should not be dug up for commercial reasons (Forest Service 1986a). Other tribes believe that repeated wounding of the earth can kill their deities and by extension a sacred site. In their lawsuit against the U.S. government over the Canyon Uranium Mine, the Havasupai stated that "the Canyon Mine site is sacred and any mining will interfere with their religious practices at and near the mine, and will kill their deities, and destroy their religion" (Havasupai Tribe *v.* United States 1992).

4.12.2 Compliance with Environmental Regulations and Permitting

Since damage to traditional cultural and sacred places is irreversible, the preferred mitigation measure is avoidance. The BLM and Forest Service are required to consult with interested tribes on a government-to-government basis and attempt to address their concerns (BLM 2010i). The consultation process consists of informative letters, phone calls, emails, and formal meetings with tribal members. Meetings are held either near or on the various reservations and allow for tribal members to ask questions and offer their opinions about the proposed withdrawal. Draft versions of relevant documents such as archaeological and ethnographic studies and draft EAs and EISs are provided for review by tribal members. Concerns expressed by tribal members are then incorporated into the final versions of these documents, as long as those concerns are not deemed confidential by tribal members. Confidential issues are addressed without releasing information to the public (BLM 2010i). If a conflict arises, mine operators would then attempt to relocate drill or mining locations that are particularly sensitive to the interested tribes; however, since any drilling or excavation into the earth is considered wounding the earth, it may not be possible to mitigate all impacts by moving locations.

4.12.3 Incomplete or Unavailable Information

As of September 2010, the final ethnographic report by the NPS has been completed (Hedquist and Ferguson 2010); however, tribal consultation is ongoing. Further information may be added to the Final EIS based on the results of these investigations; however, sufficient information is in the interim report and existing literature to demonstrate the breadth of available information and its limitations.

4.12.4 Impacts of Alternative A: No Action (No Withdrawal)

Under Alternative A, the proposed withdrawal area would be open for the location and entry of new mining claims once the segregation order is lifted or expires.

Direct and Indirect Impacts

In the North Parcel, the RFD scenario estimates that over the next 20 years, 18 new mines would be developed, in addition to the three existing mines, which would result in 945 acres of total new disturbance. In addition, 504 exploratory projects would occur. This new disturbance includes new roads and power lines, in addition to the actual exploration and mine disturbance; however, the exact location of

this disturbance is unknown. The 945 acres of new disturbance would disturb a portion of the Grand Canyon Regional Landscape of the Southern Paiute, which encompasses the North and East parcels. Although the amount of disturbance of the landscape would be on a small scale, the landscape is seen by the Southern Paiute as an interconnected series of places, and it is possible that the disturbance could be significant if an especially important place within the landscape were damaged.

The three current mines on the North Parcel—Pinenut, Kanab North, and Arizona 1—are all located within the Kanab Creek Ecoscape of the Southern Paiute, as are two of the three previously reclaimed mines on the parcel; therefore, it is reasonable to assume that the Kanab Creek Ecoscape would be disturbed in a higher proportion to the rest of the parcel under Alternative A. In addition, the exploratory drilling and the mines predicted for the North Parcel could disturb, or be perceived by American Indian groups to disturb, a ceremonial site and the portion of the Kanab Creek and the Kanab Creek trail not located within the Kanab Creek Wilderness by disrupting the cultural function of these places. Other resources whose traditional use may be disrupted under Alternative A in the North Parcel include Moonshine Spring, Yellowstone Spring, and Antelope Spring, the Kaibab band and Uinkaret band territories, trails and access route to sacred places south of the parcel, and three resource procurement areas on the parcel.

In the East Parcel, the RFD scenario under Alternative A estimates that two new mines would be developed, with a total of 107 acres of disturbance, as well as 56 exploratory projects. The Aesak Cultural Landscape of the Southern Paiute encompasses the entire House Rock Valley, which includes the East Parcel; therefore, the 107 estimated acres of disturbance would disturb the Aesak Cultural Landscape. It is possible that some areas of the landscape may be more sensitive to damage than others; this would need to be established through tribal consultation.

The two springs at Kane Ranch, the trails crossing the valley, and the four resource procurement areas could be disturbed by future mining activity; any disturbance to these resources would be considered significant in that it would disrupt the function and cultural association of the resources.

In the South Parcel, the RFD scenario under Alternative A estimates that over the next 20 years, 168 exploratory projects would occur, as well as the development of seven mines, which would result in 312 acres of total new disturbance. Currently, there are slightly more mining claims in the southern portion of the parcel near Red Butte, which indicates that Red Butte has a greater risk of being disturbed by new mines. Red Butte (TCP determination of eligibility in process) is an important ceremonial site for several tribes and is particularly sensitive to ground, visual, and noise disturbances. Any activities associated with mining have the potential to disrupt ceremonial activities at and near Red Butte, as well along the travel corridor from Red Butte to the Grand Canyon and along several trails leading to and from Red Butte. Although mining activities may only take place for a few years per mine, any disruption in ceremonial activities would be considered detrimental to American Indian culture.

The Navajo Cultural Landscape, which encompasses the entire Coconino Plateau, a Navajo traditional use area, a Hopi traditional use area, and the Havasupai traditional range are also all at high risk for disturbance since they encompass large amounts or even all of the South Parcel. In addition, several American Indian trails, a Navajo ceremonial site, two Havasupai seasonal camps, and a Southern Paiute deer hunting location are also at risk of disturbance.

Under Alternative A, indirect impacts to American Indian traditional sacred and cultural places would consist of increased traffic, which could increase the likelihood of vandalism of places and landscapes. Increased traffic would also contribute to higher noise levels.

Other indirect impacts to traditional cultural or sacred places include possible visual or skyline impairment during operation. It is estimated that approximately 20 acres would be disturbed by each mine

site which could be within the viewshed of a traditional cultural or sacred place. Any new power lines may also disrupt the skylines seen from a traditional cultural or sacred place. In addition, the increased noise from operations and haul trucks may disrupt ceremonial activity near sacred places within the Kanab Ecoscape and at the three springs. Both visual and noise impacts may also be considered direct impacts, depending on how far away the disturbance is from a particular traditional cultural or sacred place.

Cumulative Impacts

The implementation of NEPA requires the consideration of cumulative impacts, which are defined as "the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other activities" [40 CFR 1508.7]. For American Indian resources, the disturbance of traditional cultural and sacred places over time and space can result in the loss of function and sacredness of these places. Past, present, and future projects that result in ground disturbance or visual impacts, such as construction within energy corridors and any other type of mining, could result in disturbance to American Indian traditional cultural and sacred places over time and space. This disturbance, combined with that predicted for Alternative A, could desecrate traditional cultural and sacred places. Examples of past, present, and future projects include the Grand Canyon National Park Airport Fuels Reduction Project, the Arizona Strip ROD/RMP, the Designation of Energy Corridors on Federal Land in the 11 Western States EIS, the Orphan Mine, the Arizona 1 Mine, the EZ1 and EZ2 Mines, the What Mine, the VANE Minerals Uranium Exploratory Drilling Project EIS, the Four Forest Restoration Initiative, the Kaibab National Forest Travel Management EAs, and the Plateau Facility Fire Protection Project EA. The addition of exploratory drilling or mining to other ground-disturbing projects can harm or even "kill" sacred sites in or near the place of disturbance. In addition, Indian Trust Resources outside the proposed withdrawal area could be damaged from the combination of mining activities. One place of concern is Havasupai Springs, which may suffer from contamination from the mining activity as well as from effects of other activities (see Section 4.4, Water Resources).

4.12.5 Impacts of Alternative B: Proposed Action (~1 Million Acres, 20-Year Withdrawal)

Under Alternative B, approximately 1,010,776 acres of BLM and Forest Service lands would be withdrawn from mineral location and claims entry for 20 years. In addition, exploration or development of mines without a valid existing claim as of July 21, 2009, would not be allowed.

Direct and Indirect Impacts

Under Alternative B, in addition to the three existing mines in the North Parcel, seven additional known mineralized breccia pipes would likely be developed, for a total of 10 mines and 10 exploratory projects. These 10 mines would result in 163 acres of disturbance from exploration, new power lines, and new roads. As these known mineralized breccia pipes are located along the Kanab Creek Ecoscape, the impacts would be the same as Alternative A, with a few exceptions. The total acreage of possible disturbance would be less, meaning that a smaller percentage of the Kanab Creek Ecoscape and possibly portions of the Kanab Creek trail not within the Kanab Creek Wilderness would be affected. With the reduced number of mines and exploratory projects, there is less potential for disturbance to the Kaibab band and Uinkaret band territories. None of the springs would be directly disturbed by the mining activity since they are not located near the breccia pipes; however, mining activities areas away from springs could affect the springs through groundwater contamination (see Section 4.4, Water Resources). In

addition, there would be a great reduction in the number of exploratory projects from 504 to 10 decreasing, the potential for "wounding" of the earth through drilling.

Under this alternative, no mines would be developed in the East Parcel; therefore, there would be no impacts to any traditional cultural or sacred places.

Under this alternative, only the Canyon Mine would operate in the South Parcel, and only 1 additional acre would be disturbed as a result of exploration. In addition, one exploratory project would occur. This additional acre and single exploratory project are unlikely to significantly disturb a traditional cultural or sacred place; therefore, there would likely be very little to impact American Indian resources in the South Parcel of this alternative. However, both the single acre and the exploratory project may be considered wounding of the earth, as discussed above.

The indirect impacts for Alternative B for the North Parcel would be similar to those under Alternative A, but to a lesser degree, since fewer mines would potentially be developed near American Indian resources. Since there are no mines anticipated for the East Parcel, there would be no indirect impacts for the East Parcel; since only an additional 1 acre for exploration for the existing Canyon Mine is anticipated for future development, any indirect impacts for the South Parcel would be unlikely.

Cumulative Impacts

Although fewer mines would be developed under Alternative B, the potential for disturbance and desecration of places of cultural importance to American Indians within the North Parcel is very high. Depending on the location of the mining activities, the cumulative impacts under Alternative B could be similar to those under Alternative A for the North Parcel. Since no mines would be developed in the East Parcel, there would be no cumulative impacts for the East Parcel. The cumulative impacts for the South Parcel would be less than Alternative A; however, because any disturbance to American Indian resources or the earth may be seen as significant to American Indians, the cumulative impacts from mine activities and other projects may be enough to threaten important places and sacred sites.

4.12.6 Impacts of Alternative C: Partial Withdrawal (~700,000 Acres)

Under Alternative C, approximately 652,986 acres of federal lands in the three parcels would be withdrawn.

Direct and Indirect Impacts

In the North Parcel, 290,232 acres would be withdrawn, which would include areas with sensitive resources values. Antelope Spring, portions of the Kaibab and Uinkaret band territories, and part of a resource procurement area are outside the proposed withdrawal boundaries for this alternative. The RFD scenario estimates that in addition to the three existing mines, seven new mines would be developed within the proposed withdrawal area and three in the area excluded from withdrawal, resulting in a total of 320 acres of disturbance. Ten exploratory projects within the proposed withdrawal area and three in the area excluded from withdrawal would also occur. Much of the Kanab Creek Ecoscape would be included within the proposed withdrawal boundaries of Alternative C. The direct impacts of Alternative C for traditional cultural or sacred places would be the same as for Alternative B, except that the likelihood of disturbance to Antelope Spring, the Kaibab band and Uinkaret band territories, and the resource procurement area by one or more of the three mines outside the boundary would be greater.

In the East Parcel, 96,199 acres would be withdrawn; one exploratory project and one new mine with 54 acres of disturbance would be developed in the area excluded from withdrawal. The withdrawal area for Alternative C would not include the southern portion of the Aesak Cultural Landscape, the two springs at Kane Ranch, and a Southern Paiute hunting area, so the new mine could disturb any of these resources.

In the South Parcel, 209,313 acres would be withdrawn, which would include several sensitive areas. One subsistence locale, portions of the Hopi trails, portions of the Hopi and Navajo traditional use areas, a portion of the Havasupai traditional range, and the Navajo Cultural Landscape would not be included within the withdrawal boundaries under Alternative C. One exploratory project is estimated for the proposed withdrawal area and three within the area excluded from withdrawal in the South Parcel. One existing mine and three new mines are estimated for the area excluded from withdrawal over the next 20 years. The direct impacts of Alternative C for traditional cultural or sacred places would be the same as for Alternative B, except that the likelihood of disturbance to the Hopi Trails and the southern portion of the Navajo Cultural Landscape would be greater.

For all three parcels, since fewer mines would be developed than under Alternative A, indirect impacts under Alternative C would be similar but lesser in intensity than under Alternative A. However, they would be greater than under Alternative B since more mines would be developed.

Cumulative Impacts

The cumulative impacts of Alternative C would be identical to those under Alternative A.

4.12.7 Impacts of Alternative D: Partial Withdrawal (~300,000 Acres)

Under Alternative D, 300,681 acres of federal lands would be withdrawn.

Direct and Indirect Impacts

In the North Parcel, 113,664 acres would be withdrawn, which would allow 10 exploratory projects within the withdrawal boundaries and 10 exploratory projects in the area excluded from withdrawal. Seventeen new mines would be developed in the area excluded from withdrawal along with the three currently existing mines within the Alternative D boundaries. Yellowstone Spring, Antelope Spring, Moonshine Spring, the trail from Moonshine Spring, two resource procurement areas, portions of the Kaibab band and Uinkaret band territories, and portions of the Kanab Creek Ecoscape and Kanab Creek trail would all be outside the proposed withdrawal borders. The impacts of Alternative D would be greater than that of Alternatives B and C since the potential for disturbance to traditional cultural and sacred places outside the Alternative D boundary would increase. As important water sources and place of increased cultural use, Moonshine Spring, Yellowstone Spring, and Antelope Spring are most at risk.

In the East Parcel, 58,087 acres would be withdrawn; one exploratory project and one new mine are estimated to be developed in the area excluded from withdrawal. Only areas along the eastern and western boundaries of the Alternative B proposed withdrawal would be withdrawn under Alternative D, leaving the central portion of the Aesak Cultural Landscape, the springs at Kane Ranch, and three resource procurement areas all outside the proposed withdrawal boundaries. The potential for disturbance to traditional cultural places for the East Parcel is similar to that of Alternative A.

In the South Parcel, 134,264 acres in the northern portion of the parcel would be withdrawn. Over the 20-year time span, five mines with 209 acres of disturbance are estimated for development in the area

excluded from withdrawal. In addition, one exploratory project would occur within the Alternative D boundaries and four would occur in the area excluded from withdrawal. Under Alternative D, Red Butte, one subsistence locale, portions of the Hopi trails, portions of the Hopi and Navajo traditional use areas, and a portion of the Havasupai traditional range would be all be within the area excluded from withdrawal. The impacts of Alternative D would be similar to those under Alternative A. Red Butte and the associated travel corridor to the Grand Canyon, identified by many tribes as important cultural areas, would be outside the proposed withdrawal boundaries. Since this area of the South Parcel has been a focus of prior exploration activities, there would be a high potential for disturbance of these resources.

For all three parcels, indirect impacts under Alternative D would be similar but less than under Alternative A, and greater than those anticipated under Alternatives B and C. Fewer mines would be developed under Alternative D than under Alternative A, but it would be more than under Alternative B or C.

Cumulative Impacts

The cumulative impacts of Alternative D would be identical to those under Alternative A.

4.13 WILDERNESS

4.13.1 Introduction

The wilderness impact analysis is an assessment of potential impacts on three designated wilderness areas and one proposed wilderness area that could result from exploration and development activities as described for each alternative in Chapter 2.

As stated in Section 3.13.7, there is one designated wilderness area adjacent to the North Parcel: Kanab Creek. There are two designated wilderness areas adjacent to the East Parcel: Paria Canyon–Vermilion Cliffs and Saddle Mountain. There are no designated wilderness areas adjacent to the South Parcel.

There is one area of land managed to maintain wilderness characteristics in the North Parcel adjacent to Kanab Creek Wilderness.

A wilderness proposal was prepared for Grand Canyon National Park in 1980 and sent to the Secretary of the Interior; it was updated in 1993 and awaits further action. The wilderness proposal proposed wilderness designation for 1,109,257 acres and identified an additional 29,820 acres of potential wilderness within Grand Canyon National Park.

4.13.2 Impact Assessment Methodology and Assumptions

As discussed in Chapter 3, the Wilderness Act of 1964 [PL 88-577; 16 USC 1131–1136] dictates that wilderness areas are managed to protect and preserve their “wilderness character.” Analysis of impacts to designated and proposed wilderness areas involves determining whether the potential impacts of the proposed mineral withdrawal would change any of the four tangible qualities of wilderness that make up the description of wilderness character relevant and practical to wilderness stewardship:

- **Untrammeled**: The Wilderness Act states that wilderness is “an area where the earth and its community of life are untrammeled by man” and “generally appears to have been affected primarily by the forces of nature.”

- **Natural**: The Wilderness Act states that wilderness is "protected and managed so as to preserve its natural conditions." Wilderness ecological systems are substantially free from the effects of modern civilization.
- **Undeveloped**: The Wilderness Act states that wilderness is an area of undeveloped Federal land retaining its primeval character and influence, without permanent improvements or human habitation, "where man himself is a visitor who does not remain" and "with the imprint of man's work substantially unnoticeable."
- **Solitude or a primitive and unconfined type of recreation**: The Wilderness Act states that wilderness has "outstanding opportunities for solitude or a primitive and unconfined type of recreation."

To analyze potential impacts to wilderness characteristics, RFD scenarios of uranium mining activities provide the basis for determining what level of development scenarios would occur under each alternative (see Appendix B).

Effects are quantified where possible. In the absence of quantitative data, the best professional judgment was used. Impacts are sometimes described using ranges of potential impacts or in qualitative terms, if appropriate. Tables 4.13-1 and 4.13-2 provide thresholds and descriptions used during analysis for wilderness impacts.

Table 4.13-1. Magnitude and Degrees of Effects on Wilderness Resources

Attribute of Effect	Description Relative to Wilderness Characteristics
No Impact	Impacts would have no discernible effect on wilderness character. Natural conditions would prevail. There would be no permanent visual improvements or human occupation. There would be outstanding opportunities for solitude or a primitive and unconfined type of recreation.
Minor	Impacts would be slightly detectable within limited areas of the wilderness. Natural conditions would predominate. There would be no permanent visual improvements or human occupation. While there might be short-term impacts within the wilderness, over the long term, outstanding opportunities for solitude or a primitive and unconfined type of recreation would prevail, but may vary by season.
Moderate	Impacts would be readily apparent within limited areas of the wilderness. It would be apparent that man has altered natural conditions within such areas. There would be no permanent visual improvements or human occupation. Outstanding opportunities for solitude or a primitive and unconfined type of recreation would be restricted in limited areas and during limited times of the year.
Major	Impacts would substantially alter the wilderness resource throughout the wilderness area. Natural conditions would have been substantially altered by man. Improvements made by man, while not permanent, would be long term and become part of the landscape. Outstanding opportunities for solitude or a primitive and unconfined type of recreation would be restricted throughout the wilderness.

Table 4.13-2. Duration Definition of Effects on Wilderness Resources

Duration	
Temporary	Up to 1 year
Short-term	1 to 5 years
Long-term	Greater than 5 years

4.13.3 Impacts of Alternative A: No Action (No Withdrawal)

Direct and Indirect Impacts

The addition of approximately 728 uranium exploration projects, 30 uranium mines, 300,165 ore haul trips, and 22.4 miles of new roads and power lines, resulting in approximately 1,321 acres of disturbed

landscape over 20 years, would not result in any direct impacts to designated and proposed wilderness areas; however, these activities could result in indirect impacts to the land's wilderness characteristics: untrammeled, natural, undeveloped, and opportunities for solitude or a primitive and unconfined type of recreation.

Under Alternative A, opportunities for solitude and the ability for users to avoid the sights, sounds, and evidence of other people would be disrupted during the life of the mine. Construction and operation adjacent to the designated and proposed wilderness could also include an increase in dust and noise levels within these areas during the life of the mine. This disturbance could last approximately 5 years per mine.

Impacts to the untrammeled character of designated or proposed wilderness could occur if management activities manipulate the components or processes of ecological systems inside the wilderness. This could occur through indirect impacts to vegetation, wildlife, and water resources within the wilderness. Indirect impacts to vegetation, wildlife, and water resources are described in further detail in Sections 4.4, 4.6, and 4.7.

The soundscape analysis discussed in Section 4.10 indicates that operation associated with mining activity would cause increases in ambient noise levels in the immediate vicinity of the mine sites and haul roads; this has the potential to impact natural and undeveloped characteristics of the wilderness area. In addition, mining activities within the viewshed of a designated or proposed wilderness area would have an impact on the natural and undeveloped characteristics of the wilderness area. The presence of mineral exploration and development components adjacent or within close proximity to designated or proposed wilderness that could impact the undeveloped and natural characteristics include exploration drilling rigs, mine facilities (building structures, towers, and equipment), roads, power lines, ore-haul traffic, and dust. These components would be inconsistent with the requirement to retain the primeval character of the wilderness.

The recreation analysis discussed in Section 4.14 indicates that operation associated with mining activity would potentially alter the existing recreation setting and opportunity as a result of the presence of new roads in previously non-roaded areas (note that no new roads will be located within the designated or proposed wilderness areas), heavy-haul trucks, and mining facilities. This has the potential to impact solitude or primitive and unconfined recreation within a designated or proposed wilderness located adjacent to or within close proximity of mining activity.

Potential impacts to designated and proposed wilderness depend on placement and density of specific exploration and mining operations and thus become project specific. Mining activities that occur closer to designated or proposed wilderness would have a greater potential impact than those occurring farther away. Portions of the proposed withdrawal area are adjacent to wilderness boundaries; therefore, it is possible that mine exploration, development, and reclamation/closure activities could indirectly impact the wilderness characteristics of designated and proposed wilderness areas that are in the immediate vicinity of the proposed withdrawal parcels.

Mining activities that are far from designated or proposed wilderness would have a minor short-term impact to wilderness characteristics. Mining activities in close proximity to designated or proposed wilderness boundaries would have a moderate short-term impact to the wilderness characteristics of naturalness, opportunities for solitude, and opportunities for primitive and unconfined recreation.

Cumulative Impacts

The cumulative effects analysis area for Alternative A includes the proposed withdrawal area, the proposed wilderness area, and the three designated wilderness areas. Past, present, and reasonably foreseeable future projects may contribute to the indirect impacts to the land's wilderness characteristics:

untrammeled, natural, undeveloped, and opportunities for solitude or a primitive and unconfined type of recreation. Wilderness impacts, when viewed incrementally with the past, present and reasonably foreseeable future cumulative actions in the cumulative effects analysis area would result in minor indirect impacts.

Past projects include the following: fuels reduction around the Tusayan airport; wildlife waters development on all three parcels; issuance of special recreation permits for jeep and biking tours on the North and East parcels; livestock grazing; small mineral materials pits on the North Parcel; and vegetation restoration. In addition to these site-specific projects, other past actions and events include homesteading and community settlement in the early 1900s–1930s; trail and road/highway construction; the creation of the specially designated national park and national monuments and the subsequent tourism that increased visitation to the area; drought and wildfires; and mineral exploration and extraction.

Existing projects and events that are present in the proposed withdrawal area include special recreation permits for OHV use; dispersed recreation; and mineral development.

Reasonably foreseeable future projects and events for the proposed withdrawal areas include the continuance of regional and community population growth; continuance of livestock grazing; land tenure adjustments by the BLM and Forest Service; recreation, particularly OHV use increases; the Kaibab National Forest Plan Revision and Travel Management Plan; and vegetation and wildlife restoration projects.

4.13.4 Impacts of Alternative B: Proposed Action (~1 Million Acres, 20-Year Withdrawal)

Direct and Indirect Impacts

The addition of approximately 11 uranium exploration projects, 11 uranium mines, 88,885 ore haul trips, and 6.4 miles of new roads and power lines, resulting in approximately 164 acres of disturbed landscape, would not result in any direct impacts to designated and proposed wilderness areas; however, these activities could result in indirect impacts to the land's wilderness characteristics: untrammeled, natural, undeveloped, and opportunities for solitude or a primitive and unconfined type of recreation.

Alternative B's potential to impact the wilderness characteristics of the proposed and designated wilderness areas adjacent to the proposed withdrawal area would be similar to those under Alternative A. However, less mineral activity than Alternative A is estimated under Alternative B; therefore, fewer mining activities would occur simultaneously, thus potentially reducing the magnitude of impacts to wilderness characteristics.

Cumulative Impacts

The GA identified for analysis of Alternative B's cumulative impacts to wilderness characteristics is the same as described for Alternative A.

Cumulative impacts under Alternative B would be similar in magnitude to Alternative A. For this analysis, although there is a measurable difference in anticipated mining activity under the proposed RFD scenario, cumulative impacts would not be substantially different to warrant a separate discussion here for Alternative B.

4.13.5 Impacts of Alternative C: Partial Withdrawal (~700,000 Acres)

Direct and Indirect Impacts

The addition of approximately 207 uranium exploration projects, 18 uranium mines, 166,725 ore haul trips, and 12.1 miles of new roads and power lines, resulting in approximately 532 acres of disturbed landscape, would not result in any direct impacts to designated and proposed wilderness areas; however, these activities could result in indirect impacts to the land's wilderness characteristics: untrammeled, natural, undeveloped, and opportunities for solitude or a primitive and unconfined type of recreation.

Alternative C's potential to impact the wilderness characteristics of the proposed and designated wilderness areas adjacent to the proposed withdrawal area would be similar to those under Alternative A. However, less mineral activity than Alternative A is estimated under Alternative C; therefore, fewer mining activities would occur simultaneously, thus potentially reducing the magnitude of impacts to wilderness characteristics.

Cumulative Impacts

The GA identified for analysis of Alternative C's cumulative impacts to wilderness characteristics is the same as described for Alternative A.

Cumulative impacts under Alternative C would be similar in magnitude to Alternative A. For this analysis, although there is a measurable difference in anticipated mining activity under the proposed RFD scenario, cumulative impacts would not be substantially different to warrant a separate discussion here for Alternative C.

4.13.6 Impacts of Alternative D: Partial Withdrawal (~300,000 Acres)

Direct and Indirect Impacts

The addition of approximately 431 uranium exploration projects, 26 uranium mines, 255,685 ore haul trips, and 19.1 miles of new roads and power lines, resulting in approximately 951 acres of disturbed landscape, would not result in any direct impacts to designated and proposed wilderness areas; however, these activities could result in indirect impacts to the land's wilderness characteristics: untrammeled, natural, undeveloped, and opportunities for solitude or a primitive and unconfined type of recreation.

Alternative D's potential to impact the wilderness characteristics of the proposed and designated wilderness areas adjacent to the proposed withdrawal area would be similar to those under Alternative A. However, less mineral activity than Alternative A is estimated under Alternative D; therefore, fewer mining activities would occur simultaneously, thus potentially reducing the magnitude of impacts to wilderness characteristics.

Cumulative Impacts

The GA identified for analysis of Alternative D's cumulative impacts to wilderness characteristics is the same as described for Alternative A.

Cumulative impacts under Alternative D would be similar in magnitude to Alternative A. For this analysis, although there is a measurable difference in anticipated mining activity under the proposed RFD scenario, cumulative impacts would not be substantially different to warrant a separate discussion here for Alternative D.

4.14 RECREATION RESOURCES

This section presents potential impacts of the proposed withdrawal and alternatives on recreation resources. The impacts are determined through potential changes in the recreation resource impact indicators identified in Chapter 3. Recreation activities are interrelated and connected to other natural resources and resources uses and wilderness character; therefore, changes in allowable uses and restrictions on other resources can have influences on recreation. Recreation resource impact indicators are evaluated based on the following parameters, which could change if the proposed withdrawal were implemented:

- visitor use by activity;
- acres within the ROS settings and proposed wilderness,
- desired semi-primitive and primitive recreation experiences; and
- miles or number of roads that provide access to recreation sites that are currently designated in the proposed withdrawal areas.

Recreational experiences and the potential attainment of a variety of beneficial outcomes are vulnerable to any management action that would alter the settings and opportunities in a particular area. The recreation settings are based on a wide variety of attributes, including remoteness, the degree of human modification to the natural environment, evidence of other users, restrictions and controls on surface-disturbing activities, and level of motorized vehicle use. Actions that alter such features within a particular portion of the proposed withdrawal area could affect the capacity of that landscape to provide appropriate recreation opportunities and beneficial outcomes.

As explained in Chapter 3, the analysis area is essentially the entire proposed withdrawal area, where sights and sounds related to mineral development would be experienced by the visitor. To assess changes to recreation opportunities and settings resulting from the implementation of the proposed withdrawal, this analysis uses information from other resources analyzed in this EIS, such as noise and visual resources.

The analysis considers the projected increase in sound at select noise-sensitive receptors within and surrounding the area. It assumes that the greater the distance the recreationist has to travel to get away from the sound, the greater the impact to the recreational experience.

Visual simulations in conjunction with the visual resource contrast analysis are used to estimate changes to the viewshed from select Key Observation Points throughout the analysis area. It is assumed for this analysis that the greater the degree of contrast, the more visible a mining development/activity will be on the landscape, and the greater the impact to the recreational activities, settings, and experiences. See Sections 4.10, Soundscapes, and 4.9, Visual Resources, for more detailed information on visual resources and noise analysis methodologies and results.

Further, this analysis assumes that indirect impacts could occur in the areas outside the proposed withdrawal, such as Grand Canyon National Park, Vermilion Cliffs National Monument, and designated and proposed wilderness areas. These impacts would be minor and limited to visual resources, soundscapes, existence and use values, and temporal bounds.

Indirect impacts to recreation may occur outside the withdrawal area due to the major tourism and visitation (5 million plus per year in Grand Canyon National Park alone) experienced in the region. The region is known for its scenic beauty, which could be affected if uranium mining occurred in areas near or within the same viewshed as the above mentioned specially designated areas, monuments, and wilderness areas. The visual intrusions and associated mining traffic could impact recreation in varying degrees, depending on recreation activity, distance, topography, and preferences of individual visitors (refer to Section 4.9 for visual impacts). Further, it is recognized that while primitive recreation ROS settings may not exist within the proposed withdrawal area, there are adjacent areas that include a primitive setting or undeveloped setting.

4.14.1 Impact Assessment Methodology and Assumptions

The analysis to determine potential impacts to recreation is based in part on visitor use reporting statistics from the Arizona Strip District Office and RMIS; the Kaibab National Forest's Tusayan Ranger District NVUM; and Grand Canyon National Park backcountry visitation data. In addition to the visitation tracking numbers, spatial/GIS information was also used in this analysis and includes wilderness characteristics boundaries, special designations, transportation inventory, ROS settings, historic and recreational trails, and known cultural sites. As outlined in Chapter 3, the changes (based on a reasonably foreseeable development scenario) to the resource condition indicators provide the basis for assessing impacts to recreation. The impact analysis is also based on review of existing literature and information provided by resource team experts in the BLM, NPS, Forest Service, and other agencies.

To analyze potential impacts to recreation resources, RFD scenarios of uranium mining activities provide the basis for determining what level of development scenarios would occur under each alternative in Appendix B.

Effects are quantified where possible. In the absence of quantitative data, the best professional judgment was used. Impacts are sometimes described using ranges of potential impacts or in qualitative terms, if appropriate. Tables 4.14-1 and 4.14-2 below describe qualitative impact terms used to determine recreation impacts.

The following assumptions are included when analyzing the environmental consequences the proposed withdrawal alternatives would have on recreation resources:

- Recreation opportunities in adjacent primitive ROS settings and adjacent undeveloped areas could be impacted by uranium activities that are visible from a particular viewshed.

Table 4.14-1. Magnitude and Degrees of Effects on Recreation Resources

Attribute of Effect	Description Relative to Recreation Resources
No Impact	The action would not produce obvious changes to the recreation setting, opportunity or desired experiences.
Minor	Project-related impacts that would retain the existing character of the recreation setting and create a low level of change in the recreation opportunity or desired experiences.
Moderate	Recreation impacts that would partially retain the existing character of the recreation setting, and would not dominate the recreation opportunity by eliminating the desired recreation experiences.
Major	Project-related impacts that would create a high degree of change in the recreation setting and would dominate the recreation opportunity by eliminating the desired recreation experiences.

Table 4.14-2. Duration Definition of Effects on Recreation Resources

Duration	
Temporary	Up to 1 year (periods of development and reclamation)
Short-term	1 to 5 years
Long-term	Greater than 5 years

4.14.2 Incomplete or Unavailable Information

As stated in Table 3.14-3, some recreation sites analyzed in this EIS do not report visitation data. Coordination with BLM Recreation Planners, Forest Service Recreation Specialists, and NPS Outdoor Recreation Planners was conducted if information was incomplete or unavailable. Regional expertise from those familiar with the recreation sites and trends also assisted in providing information for qualitative analysis.

4.14.3 Impacts of Alternative A: No Action (No Withdrawal)

Direct and Indirect Impacts

The landscape and existing roads and trails within the study area could be altered once the segregation is lifted, and there could be continuing changes to the visual character or levels of noise. Existing BLM and Forest Service surface management regulations would provide the standards with which mining activities must comply. These standards would not preclude impacts to recreation, however. The presence of mining activities in itself can impact recreation. New roads may be created (which could benefit some forms of recreation opportunity, as discussed below), and mining activities could occur on lands that were previously undeveloped if the No Action Alternative were implemented.

Impacts to Visitor Use

Alternative A's potential to impact recreation visitor use on the public lands within the proposed withdrawal area would likely be minor. The potential for mineral development to create new roads could attract more users to explore areas that were previously inaccessible to vehicles. This may increase the amount of visitors to all three withdrawal parcels, particularly to the North and South parcels, as these two parcels include greater potential for uranium presence than the East Parcel (USGS 2010b); therefore, the possibility of new roads would be greater in the North and South parcels. These new roads, if constructed, would only exist for the life of the mine, typically 3 to 5 years, at which point the roads would be closed and reclaimed. Therefore, the creation of new roads would not be a long-term impact to recreation.

Because of the proposed withdrawal area's remote and relatively undeveloped character, many users seek out and expect solitude and semi-primitive recreation experiences when visiting the Grand Canyon region. The likelihood of impacts to these types of recreation opportunities could increase if Alternative A is implemented, as the presence of new roads in previously non-roaded areas, heavy-haul trucks, and mining facilities could increase. The impacts to recreation could be adverse as a result of the mining activities' potential to alter the existing recreation setting and opportunity. Although Alternative A could increase the existing mineral activity, the mines themselves would be relatively spaced out and separated, compared with the overall acreage of the available BLM and Forest Service lands; therefore, the impact to visitor use would be classified as minor.

Because of the high number of visitors that travel to Grand Canyon National Park (up to 5 million per year), impacts of uranium exploration and development to visitor use are not eliminated. This is the result of the presence of uranium mining activities such as heavy-haul trucks, noise, and visual intrusion and their contrast to typical recreation and visitor use of the Grand Canyon region. Impacts to visitor use on certain sites may be moderate, depending on the mining activity's proximity to highly used areas. The overall impact to visitor use would be minor since each uranium exploration would only affect 1.1 acres and each uranium development would affect only approximately 20 total acres in the proposed withdrawal area. Further, the majority of the 5 million visitors to Grand Canyon National Park visit the South Rim, in the developed Grand Canyon Village, where the impacts of mining-associated activity would be minor. Impacts from mining haul trucks to Grand Canyon visitor traffic along SR 64 would result in minor impacts and interactions but could be long term since the duration of the mines are estimated at 7 years.

Impacts to Recreation Opportunity

Alternative A forecasts up to 728 exploration projects could occur, and of these explorations, 30 mines could be developed (including existing and new mines). The overall ground disturbance expected under the Alternative A, in terms of acreage, is small, compared with the recreation opportunity acreage in the region as a whole. The nexus for recreation impacts from uranium mining activity lies not in ground disturbance acreages but in terms of new road creation and the mining presence. In the long term, the impacts associated with new road creation would be eliminated once the roads are closed and reclaimed back to their natural condition.

As Chapter 3 describes, driving for pleasure and sightseeing are among the most popular recreational activities in the proposed withdrawal parcels. Alternative A would require up to 22.4 miles of temporary new roads to support mine operations, if the mines were constructed. This increase in roads, if made available to the public, could increase the recreational setting available for those types of recreational experiences that center on road travel, such as sightseeing, driving for pleasure, and casual OHV use in the short term; once the mines are closed, these roads would be reclaimed. Conversely, with the new roads would come increased heavy-haul trucks in both amount and frequency. The increase in activity associated with the 30 new mines, increase in heavy-haul trucks, increase in noise, and 22.4 miles of new roads could affect the recreational experiences, although the impact would be minor. However, it is important to note that the RFD scenario would occur over a 20-year time frame; therefore, the new mines, roads, and increase in haul trips would not occur simultaneously. Table 4.14-3 lists recreational sites that occur within roaded-natural, semi-primitive motorized, and semi-primitive non-motorized settings within the proposed withdrawal area. Impacts to recreation sites outside the withdrawal area (those sites requiring access from the withdrawal area, as identified in Table 3.14-2) would be indirect. Up to 19 recreational sites in Alternative A's proposed withdrawal area may be impacted.

Grand Canyon National Park specifically manages areas such as the southern portion of Kanab Plateau and Marble Platform (both adjacent to the proposed withdrawal area) to maintain undeveloped character; similar to ROS primitive settings used by BLM and Forest Service (see Appendix I). NPS zoning management areas do not apply to activities on adjacent land. However, users of NPS's backcountry management zones may experience minor impacts to the recreation opportunity under Alternative A if the mineral exploration and development occur in visible or nearby areas to backcountry management zones. This impact would be similar for all alternatives discussed below.

Table 4.14-3. Recreation Sites Occurring in ROS Settings

Withdrawal Area	Recreation Site	ROS Setting	Alternative A	Alternative B	Alternative C	Alternative D
East Parcel	House Rock Valley Overlook/Interpretive Site	RN	×	×	×	×
East Parcel	Navajo Trail	SPM	×	×		
East Parcel	Soap Creek	SPNM	×	×	×	×
East Parcel	Rider Canyon	SPNM	×	×	×	×
East Parcel	North Canyon Creek	SPM	×	×		
East Parcel	Badger Creek	RN	×	×	×	×
East Parcel	Dominquez-Escalante Interpretive Site	RN	×	×		
East Parcel	Condor Interpretive Site	RN	×	×		
North Parcel	Hack Canyon	RN	×	×	×	×
North Parcel	Swapp Trail	RN	×	×	×	
North Parcel	Gunsight Point	RN	×	×	×	×
North Parcel	Hatch Cabin	SPNM	×	×	×	×
North Parcel	Rock Canyon	SPM	×	×		
South Parcel	Ten-X Family Campground	RN	×	×	×	
South Parcel	Charlie Tank Group Camp Ground	RN	×	×		
South Parcel	Tusayan Bike Trails	RN	×	×	×	×
South Parcel	Arizona Trail	RN	×	×	×	
South Parcel	Red Butte	SPNM	×	×	×	
South Parcel	Russell Tank Fishing Parking Area	RN	×	×		
Totals			**19**	**19**	**13**	**8**

Sources: BLM and Forest Service ROS settings with a GIS recreation data overlay.

Notes: RN = Roaded Natural; SPM = Semi-primitive Motorized; SPNM = Semi-primitive non-motorized.

Impacts to Recreation Settings and Experiences

There are 19 recreation sites within the proposed withdrawal area. The management of these sites is dependent on who manages the land. The majority of the 19 recreation sites are managed by the BLM (refer to Table 3.14-2 for recreation sites overview), but the Forest Service and NPS also manage recreational sites and settings. (Note that NPS does not manage recreation sites within the proposed withdrawal area, but many recreation experiences on NPS land listed in Table 3.14-3 require access via the proposed withdrawal areas.) It is important to note that desired recreation experiences of users would be commensurate with the multiple-use mandates of the land and their respective recreation opportunity settings, i.e., users of roaded natural areas expect modifications to the landscapes, and users of semi-primitive areas expect little to no modifications to the landscape.

As Figure 3.14-1 illustrates, particularly in the North Parcel, those recreation sites that occur within the proposed withdrawal boundary tend to be concentrated in areas at canyon entrances or canyon overlooks, where the desired recreation setting and experience would be remoteness with high scenic quality (refer to Section 4.9, Visual Resources, for impacts to scenic quality). Under Alternative A, there could be a high possibility of mineral development in these areas. Recreation settings and experiences could be impacted at individual sites.

The East Parcel has the fewest mining claims of all the three proposed withdrawal parcels. The Colorado River is relatively easy to access, compared with other reaches within the Park, and House Rock Valley serves as a gateway to other North Rim and Arizona Strip attractions such as Jacob Lake, Vermilion Cliffs National Monument, and the Kaibab Plateau, meaning that public users will pass through House Rock Valley en route to other destinations, primarily on paved U.S. 89A (BLM 2009d). Therefore, even a small mineral development presence may impact recreation settings and experiences in the East Parcel, particularly for users who venture off U.S. 89A; however, these impacts would be minimal. This is because of the fact that the impacts associated with mining- haul traffic, visual and noise intrusions, and increased roads would be compatible with the current roaded-natural and semi-primitive settings. Impacts to recreation settings in semi-primitive non-motorized areas (canyon entrances such as Soap Creek, Rider, North and Badger) from uranium mining would be moderate.

Figure 3.14-1 shows the concentration of recreation sites on the South Parcel along the SR 64 corridor. The impacts to recreation would be moderate in the South Parcel since mineral development would preclude mineral exploration and development in areas near campgrounds and population centers such as the town of Tusayan. Mineral development within the South Parcel could still have impacts to recreation, particularly to activities that take place on the rolling terrain dominated by juniper trees such as hunting, hiking, mountain biking, and nature study. This same terrain would also serve as sound and visual barriers to the contrast of mineral exploration and development, decreasing the impact to the settings and experiences.

Section 4.9.2 of the EIS discusses Alternative A’s impacts from mining-associated activity to the visual character, indicating there would be changes to the existing visual character if Alternative A were implemented. Therefore, recreation settings and experiences that center on scenic viewing or overlooks would be impacted. The degree of impact would vary among the different stages of mining activities (mineral exploration through reclamation). In addition, the lands with different visual management designations have varying degrees of limits for visual impacts. For example, mineral exploration generally would have a much smaller visual impact than a full mining operation because of the smaller footprint size and shorter time frame. Mining activities that occur closer to observation points and/or in more restrictive visual management designations would have a greater recreation impact than those occurring further away from observation points and/or in less restrictive visual management designations.

The soundscape analysis discussed in Section 4.10.1 indicates that mining-associated activity would cause increases in ambient noise levels in the immediate vicinity of the mine sites and haul roads. Noise levels from exploration, mine development, and reclamation/closure activities would be limited to short durations over a period of a couple months at any one location. However, portions of the proposed withdrawal border Grand Canyon National Park; therefore, it is possible that sounds from the mine exploration, development, and reclamation/closure activities could be audible within the Park, impacting recreation settings and experiences.

Indirect impacts to adjacent NPS backcountry management zones may occur if the mining activity occurs near or within sight of the backcountry management zone.

Cumulative Impacts

The GA identified for analysis of Alternative A’s cumulative impacts to recreation resources includes the proposed withdrawal area and the adjacent special designations of Vermilion Cliffs National Monument, Grand Canyon–Parashant National Monument, and Grand Canyon National Park.

Past projects include the following: fuels reduction around the Tusayan airport; wildlife waters development on all three parcels; issuance of special recreation permits for jeep and biking tours on the North and East parcels; livestock grazing; small mineral materials pits on the North Parcel; and vegetation

restoration. In addition to these site-specific projects, other past actions and events include homesteading and community settlement in the early 1900s–1930s; trail and road/highway construction; the creation of the specially designated national park and national monuments and the subsequent tourism that increased visitation to the area; drought and wildfires; and mineral exploration and extraction.

Existing projects and events that are present in the proposed withdrawal area include special recreation permits for OHV use; dispersed recreation; and mineral development.

Reasonably foreseeable future projects and events for the proposed withdrawal areas include the continuance of regional and community population growth; continuance of livestock grazing; land tenure adjustments by the BLM and the Forest Service; recreation, particularly OHV use increases; the Kaibab National Forest Plan Revision and Travel Management Plan; and vegetation and wildlife restoration projects.

Although all these other activities have occurred or will occur, no cumulative impacts to recreation resources are anticipated beyond those already described above as direct and indirect impacts. Recreation impacts, when viewed incrementally with the past, present, and reasonably foreseeable future cumulative actions in the proposed withdrawal area, would mostly result in indirect impacts.

Based on the impacts described, Alternative A, if implemented, would result in an overall moderate impact to visitor use, recreation opportunity, and recreation settings and experiences.

4.14.4 Impacts of Alternative B: Proposed Action (~1 Million Acres, 20-Year Withdrawal)

Direct and Indirect Impacts: Impacts to Visitor Use

Alternative B's potential to impact recreation visitor use of the public lands within the proposed withdrawal area would be minor. Over the long term (5+ years) of the proposed withdrawal, Alternative B could result in increased visitor use as a result of the possibility of new roads' being constructed.

There is some potential for mineral development to create new temporary roads (6.4 miles over 20 years), which could allow greater access to more areas and may increase visitor use of these areas in the short term. Mineral development would occur over a 20-year time frame; therefore, the roads would not be built simultaneously, decreasing the impact to visitor use.

Impacts to Recreation Opportunity

Alternative B forecasts that up to 11 explorations could occur, and of these explorations, 11 mines could be developed (including existing and new mines). The overall ground disturbance that would be expected, in terms of acreage, is small, compared with the existing recreation opportunity acreage as a whole. Recreation opportunities that require little to no development, unaltered landscapes, and remoteness would not be affected if Alternative B were implemented.

This is because of the fact that some users would have a greater value for the landscape if the land precluded mineral development, seen as an impact to recreation since mineral activity is typically not compatible with dispersed recreational activity. An exception is the increase in new roads that mineral development may include, which is compatible with developed recreational opportunities and activities such as scenic driving, as well as access to areas that previously may have been inaccessible by vehicle. However, the new roads would not occur simultaneously and in many cases may be reclaimed in 5 to 7 years; therefore, the long-term impact would be minimal. It is important to note that desired recreation

experiences of users would be commensurate with the multiple-use mandates of the land and their respective recreation opportunity settings, i.e., users of roaded-natural areas expect modifications to the landscapes, and users of semi-primitive areas expect little to no modifications to the landscape.

Alternative B would require up to 6.4 miles of new roads to support exploration and development and valid existing rights. This increase in roads would be less than Alternative A. With the new roads would come increased heavy-haul trucks in both amount and frequency. The increase in uranium activity presence and noise that may impact individual sites or areas that would come with the 11 mines, the increase in heavy-haul trucks with 88,885 trips, and 6.4 miles of new roads could impact the recreational opportunities and setting. However, it is important to note that the RFD scenario would occur over a 20-year time frame; therefore, the new mines, roads, and increase in haul trips would not occur simultaneously. Table 4.14-3 lists recreational sites that occur within roaded-natural, semi-primitive motorized, and semi-primitive non-motorized within the proposed withdrawal area under Alternative B. Up to 19 recreational sites may avoid impacts from mineral exploration and development if Alternative B is implemented, subject to valid existing rights.

Impacts to Recreation Settings and Experiences

Alternative B would result in minor impacts to recreation settings and experiences. This is because the scenario would include less disturbed acreage (782 acres less than Alternative A), fewer acres of new roads (17 acres less than Alternative A), and fewer heavy-haul trips (122,320 fewer haul trips than Alternative A). Alternative B would have up to 10 mines in the North Parcel. Impacts that may result from exploration and development of valid existing rights would still be possible under Alternative B and are discussed above under Impacts to Recreation Opportunity.

Alternative B for the East Parcel would include no mines. Therefore, Alternative B would have no impacts to recreation resources on the East Parcel since no ground disturbance, new roads, or haul trips would occur.

Alternative B for the South Parcel would include one mine that is an existing mine. One mine would have a minimal effect on the recreation settings and experiences in the South Parcel. If the mine is located within the viewshed of Red Butte, or near the SR 64 corridor, the impact would be greater than if the mine were located on the eastern portions of the South Parcel, outside the Red Butte viewshed and far from the popular recreation settings along the SR 64 corridor. This is because of Red Butte's visual and cultural resource value as the prominent view of the Coconino Plateau and the higher density of public recreational use on Forest Service lands adjacent to SR 64.

Impacts to recreation settings and experiences related to visual resources would be similar to the moderate impacts discussed under Alternative A. However, the magnitude of impact would be minor as a result of the decrease in amount of allowable mineral development (30 mines versus 11 mines, respectively).

Impacts to recreation settings and experiences related to soundscapes would be similar to the moderate impacts discussed under Alternative A. However, the magnitude of impact would be minor due to the decrease in amount of allowable mineral development (30 mines versus 11 mines, respectively).

Indirect impacts to adjacent NPS backcountry management zones may occur if the mining associated activity occurs nearby or within sight of the backcountry management zone.

Cumulative Impacts

The GA identified for analysis of Alternative B's cumulative impacts to recreation resources is the same as described for Alternative A.

Although the activities described under Alternative A have occurred or will occur, no cumulative impacts to recreation resources are anticipated beyond those already described above as direct and indirect impacts. Recreation impacts, when viewed incrementally with the past, present, and reasonably foreseeable future cumulative actions in the proposed withdrawal area, would mostly result in indirect impacts.

Based on the indirect, direct, and cumulative impacts described, Alternative B, if implemented, would result in an overall minor impact to visitor use, recreation opportunity, and recreation settings and experiences.

4.14.5 Impacts of Alternative C: Partial Withdrawal (~700,000 Acres)

Direct and Indirect Impacts: Impacts to Visitor Use

Alternative C's potential to impact recreation visitor use of the public lands within the proposed withdrawal area would be minimal; however, the potential for impacts to recreation is greater than Alternative B because of the smaller overall acreage of the partial withdrawal included in this alternative. Areas with higher concentrations of recreational sites would be included in the partial withdrawal, as Figure 2.4-1 illustrates. Dispersed recreation does occur on lands outside Alternative C's partial withdrawal; however, the recreation opportunities and settings in these areas are not considered high visitor-use areas (BLM 2009b). Visitor-use of U.S. 89A and BLM Road 5 (see Figure 3.14-2) could be impacted by the presence of mineral exploration and development if these facilities presented a contrast to the landscape that can be viewed from these routes.

Impacts to Recreation Opportunity

Alternative C forecasts that up to 207 explorations could occur, and of these explorations, 18 new mines could be developed. The acreage totals of the Alternative C withdrawal parcels are reduced from Alternative B acreage totals. The overall ground disturbance that would be expected with valid existing rights under the Alternative C, in terms of acreage, is small, compared with the existing recreation opportunity acreage as a whole.

Recreation opportunities that require little to no development, unaltered landscapes, and remoteness may actually improve if Alternative C were implemented, compared with Alternative A. This is because of the fact that many users would have a greater value for the landscape if the land precluded mineral development, seen as an impact to many recreation opportunities since mineral activity is typically not compatible with dispersed recreational activity. An exception is the increase in new roads that mineral development may include, which is compatible with developed recreational opportunities and activities such as scenic driving, as well as access to areas that previously may have been inaccessible by vehicle.

Alternative C would develop up to 12.1 miles of new roads. This increase in roads would be slightly greater than Alternative B. The slight increase in roads available to the public could increase the recreational setting available for those types of recreational pursuits that center on road travel, such as sightseeing, driving for pleasure, and casual OHV use. The RFD scenario would occur over a 20-year time frame; therefore, the new roads would not occur simultaneously and would be reclaimed once mining activities cease.

Conversely, with the new roads would come increased heavy-haul trucks in both amount and frequency. The increase in activity associated with the 18 mines and 166,725 trips and 12.1 miles of new roads could have a minor impact as a result of the decrease in the semi-primitive recreational opportunities and

settings available to the public. However, it is important to note that the RFD scenario would occur over a 20-year time frame; therefore, the new mines, roads and increase in haul trips would not occur simultaneously. Table 4.14-3 lists recreational sites that occur within roaded-natural, semi-primitive motorized, and semi-primitive non-motorized, within the proposed withdrawal area under Alternative C. Up to 16 recreational sites may avoid impacts from mineral exploration and development if Alternative C were implemented, subject to valid existing rights.

Impacts to Recreation Settings and Experiences

Alternative C would reduce impacts to recreation resources in the proposed withdrawal area. In the North Parcel, recreation resources are concentrated in areas that have multiple resource values, such as unique topography, cultural significance, and high ecological value. The Toroweap Road (BLM Road 109) would also be included in Alternative C's withdrawal area. This road is used by many users heading to the Toroweap Campground and overlook in Grand Canyon National Park. Alternative C would result in fewer impacts to recreation experiences than Alternatives A and D. This is because the scenario is similar to Alternative B but on a smaller acreage. Alternative C would have up to 13 mines in the North Parcel. It is important to note that mineral development would occur over a 20-year time frame; therefore, the new mines, roads, and increase in haul trips would not occur simultaneously and would be reclaimed once mining activities cease. Impacts that may result from exploration and development of valid existing rights would still be possible under Alternative C and are discussed above under Impacts to Recreation Opportunity.

Alternative C for the East Parcel would include one mine. Up to 28 explorations could occur. Recreation settings and experiences in the East Parcel are evenly distributed among dispersed and developed recreation. The settings are largely based on the views and available access to the Colorado River via multiple side canyons. The partial withdrawal would lessen the impacts to scenic driving and hiking to the Colorado River in many of the highly used areas. Up to 1.2 new miles of road could create more access for developed recreational experiences.

Alternative C for the South Parcel would include four mines. The partial withdrawal would include areas of the South Parcel that contain well-used recreation settings and experiences, such as camping, hiking, and scenic driving. These settings are popular because of their proximity to SR 64 and the Grand Canyon National Park. The overall surface disturbance of 158 acres expected under Alternative C would likely have little to no impact to recreation.

Under Alternative C, all of the landscapes designated visually sensitive are included in the proposed withdrawal area and removed from most mining activity. Some mining would still occur in the withdrawal area, as described in Alternative B, but the amount is limited. Therefore, Alternative C's visual impacts from mining-associated activity to recreation settings and experiences would be minor.

Impacts to recreation settings and experiences related to soundscapes would be similar to impacts discussed under Alternative B. The decreased overall acreage of Alternative C's proposed withdrawal area may increase the likelihood of impacts, but the impact to recreation settings and experiences would be minor.

Indirect impacts to adjacent NPS backcountry management zones may occur if the mining associated activity occurs near or within sight of the backcountry management zone.

Cumulative Impacts

The GA identified for analysis of Alternative C's cumulative impacts to recreation resources is the same as described for Alternative A.

Although the activities described under Alternative A have occurred or will occur, no cumulative impacts to recreation resources are anticipated beyond those already described above as direct and indirect impacts. Recreation impacts, when viewed incrementally with the past, present, and reasonably foreseeable future cumulative actions in the proposed withdrawal area, would mostly result in indirect impacts.

Based on the impacts described, Alternative C, if implemented, would result in an overall minor impact to visitor use, recreation opportunity, and recreation settings and experiences.

4.14.6 Impacts of Alternative D: Partial Withdrawal (~300,000 Acres)

Direct and Indirect Impacts: Impacts to Visitor Use

Alternative D's potential to impact recreation visitor use of the public lands within the proposed withdrawal area would be minimal and similar to Alternative C; however, the potential for impacts to recreation is greater than Alternative C because of the smaller overall acreage of the withdrawal included in Alternative D. Areas with higher concentrations of recreational sites would be included in the partial withdrawal, as Figure 2.4-4 illustrates. A key difference and between Alternatives C and D, in terms of a greater impact to recreation resources, is that the Toroweap Road is not included in Alternative D's partial withdrawal. Chapter 3 describes the importance of the Toroweap Road; it is the primary route users take when visiting the Toroweap Point campground and overlook, as well as other scenic overlooks and trailheads in Grand Canyon National Park. The presence of mineral exploration and development, if visible from Toroweap Road, could impact the recreation opportunities and settings. Similarly, local and visitor use of U.S. 89A, SR 64, the east entrance to Grand Canyon National Park, and BLM Road 5 (see Figure 3.14-2) could be impacted, although minimally, by the presence of mineral exploration and development if these facilities presented a contrast to the landscape that is visible from these routes.

Impacts to Recreation Opportunity

Under Alternative D, up to 431 explorations could occur, and 26 mines could be developed. The acreage totals of the Alternative D withdrawal areas are reduced from Alternative B and C acreage totals. The overall ground disturbance that would be expected with valid existing rights under the Alternative D, in terms of acreage, is small, compared with the existing recreation opportunity acreage as a whole. Alternative D's withdrawal (see Figures 2.4-5 through 2.4-7) would withdraw from mining exploration and development areas that have high scenic, cultural, and biological value. These withdrawal areas are also commonly used recreational destinations such as hiking trailheads, historic trails, and interpretive sites.

Recreation opportunities that require little to no development, unaltered landscapes, and remoteness could be impacted if Alternative D were implemented. This is because of the fact that some users would have a greater value for the landscape if the land precluded mineral development, seen as an impact to recreation since mineral activity is typically not compatible with dispersed recreational activity. An exception is the increase in new roads that mineral development may include, which is compatible with developed recreational opportunities and activities such as scenic driving, as well as access to areas that previously may have been inaccessible by vehicle. However, the new roads would not occur simultaneously and would be reclaimed once mining activities cease; therefore, the impact would be minimal.

The recreational opportunity on Toroweap Road could be impacted if Alternative D were implemented. As Figure 3.14-3 illustrates, Toroweap Road is rated as roaded-natural. The presence of mining activity, if visible from the road, would have a minimal impact to recreation opportunity. If mining activities are

sited in areas that would not be visible from Toroweap Road, the potential to impact recreational opportunity would be reduced. It is important to note that desired recreation experiences of users would be commensurate with the multiple-use mandates of the land and their respective recreation opportunity settings, i.e., users of roaded-natural areas expect modifications to the landscapes, and users of semi-primitive areas expect little to no modifications to the landscape.

Alternative D would develop up to 19.1 miles of new roads to support exploration and development and valid existing rights. This increase in roads would be the greatest of all the action alternatives. This increase in roads available to the public could increase the recreational setting available for those types of recreational pursuits that center on road travel, such as sightseeing, driving for pleasure, and casual OHV use.

However, with the new roads would come increased heavy-haul trucks in both amount and frequency. The increased activity associated with the 26 mines and 255,685 trips, and 19.1 miles of new roads could have a minor impact as a result of the small decrease in the semi-primitive recreational settings. However, it is important to note that the RFD scenario would occur over a 20-year time frame; therefore, the mines, roads, and increase in haul trips would not occur simultaneously.

Table 4.14-3 lists recreational sites that occur within roaded-natural, semi-primitive motorized, and semi-primitive non-motorized within the proposed withdrawal area under Alternative D. Up to 10 recreational sites may avoid impacts from mineral exploration and development if Alternative D were implemented, subject to valid existing rights.

Impacts to Recreation Settings and Experiences

Alternative D would have similar impacts to recreation settings and experiences as Alternative C. However, because of the smaller total acreage of the proposed withdrawal under this alternative, the impacts to the recreation settings and experiences would be slightly increased, compared with Alternatives B and C.

Cumulative Impacts

The GA identified for analysis of Alternative D’s cumulative impacts to recreation resources is the same as described for Alternative A.

Although the activities described under Alternative A have occurred or will occur, no cumulative impacts to recreation resources are anticipated beyond those already described above as direct and indirect impacts. Recreation impacts, when viewed incrementally with the past, present, and reasonably foreseeable future cumulative actions in the proposed withdrawal area, would mostly result in indirect impacts.

Based on the impacts described, Alternative D, if implemented, would result in an overall minor impact to visitor use, recreation opportunity, and recreation settings and experiences.

4.15 SOCIAL CONDITIONS

4.15.1 Impact Assessment Methodology and Assumptions

The impacts analysis for social conditions evaluates how social condition effects of the project would be distributed among the communities and counties in the study area. Impacts to Coconino and Mohave

counties in Arizona; Kane, San Juan, and Washington counties in Utah; and minority and/or low-income communities will be considered for this analysis. Effects on groups and individuals outside the study area will be addressed under stakeholder values.

Impacts are sometimes described using ranges of potential impacts or in qualitative terms, if appropriate (Tables 4.15-1 and 4.15-2).

Table 4.15-1. Magnitude and Degrees of Effects on Social Conditions

Attribute of Effect	Description Relative to Social Conditions
Magnitude	
No Impact	Would not produce obvious changes in demographics; stakeholder values; public health and safety; or environmental justice populations.
Minor	Project-related impacts on social conditions that would retain the existing character of the demographics; stakeholder values; public health and safety; or environmental justice populations but create a low level of change which would not alter the perception of the Grand Canyon region for stakeholders (either residents or visitors).
Moderate	Impacts on social conditions that would adversely affect stakeholders but can be mitigated.
Major	Project-related impacts that would create a high degree of change within the existing population, permanently damage or drastically improve the perception and use of the area by stakeholders, cause harm to public health and safety or improve existing conditions, and adversely affect the environmental justice populations in the long term.

Table 4.15-2. Duration Definition of Effects on Social Conditions

Duration	
Temporary	Transient (period of project right-of-way construction and de-construction)
Short-term	Less than 5 years
Long-term	Greater than 5 years

Impacts to social conditions from implementation of alternatives would be considered significant if one or more of the following occurs:

- Substantial gains or losses in population that would affect and possibly burden resources in the study area in the long term.
- Activities or operations that substantially alter stakeholder values, specifically quality of life. As discussed in Section 3.15, stakeholders can include locals and non-locals.
- Disproportionately high and adverse environmental or human health impacts to an identified minority or low-income population that appreciably exceed those to the general population around the project area.

The assessment of demographics would be attributed to anticipated changes in population levels associated with each alternative. Current population may be altered with the influx of employees and their families to the counties and communities in the study area. This influx is compared with populations in all five counties to determine whether population growth resulting from the alternatives would be substantial.

The following analysis of stakeholder values is based on the assumption that alternatives seeking additional protection of the Grand Canyon watershed and limiting uranium mining activity would increase protection of the study area as a social amenity and component of area quality of life. Stakeholder values are difficult to quantify, particularly in the absence of data (i.e., interviews and studies that survey people's willingness to pay for some resource, protection, etc.). As discussed in Section

3.15.2, stakeholder values could be affected by changes in land management related to the proposed withdrawal areas; impacts could result if local or non-local individual's or community's values and beliefs are compromised, or if their values are not fulfilled. Further, as discussed in Section 3.15.1, stakeholder values are assessed using two basic perspectives—mineral activity support, or withdrawal support. Many different stakeholders have expressed an interest in the proposed mineral withdrawal because they support the withdrawal, they do not support the withdrawal, or they fall somewhere along a spectrum between the two attitudes. Accordingly, impacts to stakeholder values are assessed qualitatively.

Stakeholders include American Indian tribes, local governments, unincorporated area communities, mining companies, recreationists, and environmental and preservation groups, to name a few. It is important to note that stakeholders can include locals and non-locals, and/or individuals or groups inside and outside the study area. No specific survey of these groups was conducted for the analysis; thus, the following discussion is based on comments received during scoping and input from tribal consultation and cooperating agencies.

The analysis of public health effects will evaluate the potential for impact from activity at the mines and from the transportation of uranium ore between mines and the White Mesa Uranium Mill in Blanding, Utah.

The assessment of potential environmental justice impacts evaluates whether a disproportionate and adverse impact on a minority or low-income population would occur. As shown in Section 3.15, 11 communities meet the criteria for identification as an "Environmental Justice community." These communities include Kayenta, Tuba City, Bitter Springs, Tusayan, Williams, Kaibab CDP, Big Water, Orderville, Navajo Mountain, Hildale, and St. George. Tribes that meet these criteria are the Havasupai Indian Reservation, Hopi Tribe, Navajo Nation, Kaibab Reservation (Kaibab Band of Paiutes), and Hualapai Tribe.

4.15.2 Impacts of Alternative A: No Action (No Withdrawal)

Direct and Indirect Impacts

AREA COMMUNITIES

Impacts to area communities are described in terms of potential changes to the demographic profile of the area, or changes in land management that may affect stakeholder values. As a result, impacts to area communities are discussed below in the Demographics and the Stakeholder Values sections. This will be true for all alternatives.

DEMOGRAPHICS

In general, workers from the study area would be expected to continue residing in their existing homes. Potential employees from outside of the study area with highly specialized skills would have higher pay and could potentially expand and contribute to the tax base. It is likely that they would also bring additional family members, adding to the total population of any of the five counties in the study area. Because the mine locations are not known at this time, it is difficult to speculate where potential employees would reside. However, given that most of the mines would be located in the North Parcel, it is likely that any workers from outside the area would move into smaller communities located nearby, such as Kanab, Utah, and Fredonia, Arizona.

Estimated direct employment for each mine is 75 employees; total direct employment over the 20-year period under Alternative A would be 2,250 employees, or an annual average of 112.5 (see Section 4.16,

Employment). For different phases of the mine, a maximum of 50% of highly specialized workers would likely be from outside the area. Assuming that 50% of the workforce per mine would be from outside the area, there could be a direct impact of 57 additional individuals along with their families moving to the area per year, per mine.

If an estimated 57 individuals relocated to the area per year, specifically Kanab, this would represent a 1.58% increase over 2000 population (no data available for 2008). Alternatively, if all 57 workers moved to Fredonia, it would represent a 5.43% increase over 2000 population. While these potential changes are not significant in terms of a percent increase, it could result in a relatively large increase in population for these smaller communities, particularly if the workers bring their families with them.
No direct changes to employment or population in Blanding (where the White Mesa Uranium Mill is located) are anticipated. The mill currently operates at a level to accommodate estimated ore recovery (see Appendix B).

Indirect and induced employment are a result of money spent by the mines and mining employees; the cycle of spending is recirculated in the economy as employees use their salaries and wages to purchase goods and services from other businesses. In turn, businesses make their own purchases and hire employees, who also spend their salaries and wages throughout the local, regional, and state economies. As discussed in Chapter 4.16 (see Table 4.16-5), indirect and induced employment are expected to result in an additional 4,398 jobs in the five-county study area under Alternative A. This would result in a total indirect increase of 4,398 individuals under Alternative A over the 20-year period, or an annual average of 219.9 individuals into the five-county study area. It is important to note that the indirect employment effects would not be as localized as direct employment (i.e., into Fredonia or Kanab) but would be spread throughout the five-county area.

Mining activity is not expected to increase the burden on area infrastructure. An estimated 57 employees relocating to area communities each year is not expected to result in increased demand for public services. Current police, fire, medical, and educational facilities should be sufficient to handle direct employment and population changes. Indirect employment and population changes, as previously discussed, would not be localized but would be spread throughout the five-county study area.

Thus, communities to which workers relocate could experience minor, long-term, direct and indirect effects on the demographic composition of the region under Alternative A. While proposed withdrawal–related impacts on demographics would change demographic composition, the change is not expected to result in wide-scale changes to community character, nor to alter the perception of the Grand Canyon region to either a resident or a visitor.

STAKEHOLDER VALUES

As stated in Section 3.15.1, there are two basic perspectives on mineral activity in the study area; people who embrace mining activity for the potential economic benefits and those who view uranium mining negatively and prefer to see study area lands closed to mining.

Mineral Activity Support

Residents of area communities and their governments benefit from the economic activity, such as employment, the multiplier effect of industry activity on other business sectors, and tax revenues, associated with mineral activity. Although mineral activity contributes a small portion of overall employment and industrial output (see Section 4.16), these benefits can influence local and state government support of mineral activity. Although not necessarily all residents of area communities or local governments support mineral activity, many do support the activity because of the economic benefits.

If local economic gains are realized as a result of continued and/or increasing mineral activity, Alternative A could result in direct and indirect impacts to local and state governments as potential economic gains (employment, compensation, and output) could result in an increase in social well-being for affected business owners, employees, and their families, overall economic health of area communities, and overall increase in business activity. Although mining sector jobs account for 1.64% of study area employment (see Section 3.16), which is a relatively small contribution, mining jobs tend to be higher paying than tourism and other service-sector jobs. Jobs with higher paying wages could result in increased well-being for individuals employed in mining jobs.

Estimated mineral activity scenarios under Alternative A would result in the greatest amount of activity of all alternatives considered in this analysis and would therefore result in the greatest amount of economic gains for area residents, communities, and local and state governments that benefit from mineral activity and support continued mining.

As Alternative A would not result in mineral activity withdrawal, a minor long-term beneficial impact to individuals and groups who support mineral activity would result.

Withdrawal Support

As previously stated, individuals and groups who would prefer to see the proposed withdrawal lands removed from mineral activity feel that way because of a variety of factors, whether they treasure the solitude and isolation of area lands, have a cultural and spiritual connection to area lands, or benefit economically from tourist destinations in the study area. Residents of area communities and their governments benefit from the economic activity associated with tourism spending (see Chapters 3.16 and 4.16 for a discussion of the economic impact of tourist activity). American Indian groups in particular have expressed deep concern about mineral activity near the Grand Canyon (Congressional Field Testimony 2007) based on prior tribal impacts and memories of those impacts from poor mining practices on their lands in the past.

Haul traffic on highways and state routes from proposed withdrawal parcels to the processing mill in Blanding, Utah, could also impact area quality of life for individuals and groups in the study area, particularly tourists who use these roads to access area destinations. Daily traffic on less traveled routes like U.S. 191 and U.S. 160 could increase 0.012% (estimated 5 to 6 trips per mine, annual average number of mines would be two).

Estimated mineral activity scenarios under Alternative A would result in the greatest amount of activity of all alternatives considered in this analysis. Thus, Alternative A would result in the most considerable adverse direct and indirect impacts to individuals and groups who would like to see mineral activity prohibited in the project area. Stakeholder and quality of life values associated with withdrawal support (as described in Section 3.15.1) could be compromised because their values would not be fulfilled. Each person with some attachment to the proposed withdrawal area has a different reason for his or her opinions and feelings regarding area lands and mineral activity on these lands. However, in general, stakeholders who fall on the “withdrawal support” end of the spectrum would prefer to see less mineral activity. Therefore, a moderate long-term adverse impact to individuals and groups who support mineral withdrawal would result.

PUBLIC HEALTH AND SAFETY

As described in Section 3.15.1, all proposed mine operations would be required to comply with stringent safety and health standards administered by MSHA through federal regulations at 30 CFR Parts 1 through 199 and, in particular, Part 57. MSHA regulations include requirements for ground support systems, mine ventilation, electrical systems, combustible fluid storage, underground shops, equipment specifications

and maintenance, explosives storage and handling, dust control, monitoring and reporting requirements, alarm systems, worker personal safety equipment, and restrictions for public access. To comply with MSHA standards, all proposed mining activity would require the necessary MSHA mine permit and an MSHA-approved miner training plan, escape and evacuation plan, and ventilation plan.

Health Safety Risks

Cancer

As described in Section 3.15.1, although there is a chance of getting cancer from any radioactive material like uranium, scientists have not detected harmful radiation effects from low levels of natural uranium, although some may be possible (Craft et al. 2004). No human cancer has been documented as a result of exposure to natural or depleted uranium; thus, it is unlikely that exposure to uranium at the proposed withdrawal parcels and roads would cause harmful effects related to cancer (Lantz 2010).

BEIR IV reported that eating food or drinking water that has normal amounts of uranium will most likely not cause cancer or other health problems in most people. BEIR IV used data from animal studies to estimate that a small number of people who steadily eat food or drink water that has larger-than-normal quantities of uranium in it could get a kind of bone cancer called a sarcoma. BEIR IV reported calculations that showed that if people steadily eat food or drink water containing about 1 pCi of uranium every day of their lives, bone cancer (sarcomas) would be expected to occur in about 1 to 2 of every million people after 70 years, based on the radiation dose alone. However, this is not certain because people normally ingest only slightly more than this amount each day, and people who have been exposed to larger amounts have not been found to develop cancer.

Two studies have examined the potential adverse health outcomes from living near uranium mine tailings and waste sites; one study examined the incidence of deaths due to cancers, comparing an exposed population to one that would not have been exposed to the mine tailings (Boice et al. 2003). There were no differences in cancer-related deaths between the populations living near the mine waste, compared with a control population. However, Au et al. (1998) found that individuals living near uranium mine waste did have defective repair of DNA damage, which suggests that they would be more susceptible to DNA trauma. The ability of uranium to cause DNA damage, increase in DNA mutations and transform cells into tumorigenic (tending to produce tumors) forms has been reported. These changes were seen at high uranium levels (at least 10 to 1,000 times above the EPA or National Institute for Occupational Safety and Health standards) (Stearns et al. 2005; Xie et al. 2010).

Ionizing Radiation

As previously stated, the risk of developing cancer is related to the dose of the radiation. Because depleted uranium is only weakly radioactive, an individual would have to inhale very large amounts of dust (on the order of grams) for the additional risk of lung cancer to be detectable in an exposed group.

Kidney Disease

Kidney disease is the most common adverse health effect from chemical exposure to uranium (see Section 3.15.1); however, it is important to note that studies of factors affecting the health of uranium miners and mill workers have not demonstrated unusual rates of kidney disease. A recent comparison of kidney tissue obtained from seven uranium workers and six referents with no known exposure to uranium showed that the groups were indistinguishable by pathologists experienced in uranium-induced kidney disease. It is interesting to note that that despite exposure to high levels of dusts of both soluble and insoluble uranium compounds, there were no measurable renal injuries among uranium miners and mill workers tested.

Lung Toxicity

As described in Section 3.15.1, respiratory diseases have been associated with human exposure to the atmosphere in uranium mines. Respiratory diseases in uranium miners (fatal in some cases) have been linked to exposure to silica dust, oxide dusts, diesel fumes, and radon[15] and its daughters, in conjunction with cigarette smoking. In several of these studies, the investigators concluded that, although uranium mining clearly elevates the risk for respiratory disease, uranium contributes minimally, if at all, to this risk. The mine air also contained radon and its daughters, and cigarette smoke, which are proven carcinogens. As in human studies, several animal studies in which uranium-containing dusts, such as carnotite uranium dust, were used reported the occurrence of respiratory diseases.

Studies among workers who had been exposed to uranium aerosols in strip and underground mines, mills, and processing facilities found more than the expected number of lung cancers only among underground miners and especially among miners who were cigarette smokers. No significant difference in the incidence rate of lung cancer was found between other workers who had been occupationally exposed to uranium and control populations. In addition to uranium dust, the mine air contained many other noxious aerosols (including silica, oxides of nickel, cobalt, and vanadium), radon and its daughters, diesel fumes, and cigarette smoke. Excess cancers were found among those underground miners whose radon daughter exposure exceeded 120 working level months. The rate of cancer incidence increased with increasing exposure to radon daughters.

No significant difference in cancer (of the lungs) was found between workers who are occupationally exposed to uranium and control populations. Other detailed studies conducted between 1950 and 1967 on the association between uranium mining and an increased incidence of cancer found lung cancer in the miners more than six times the rate expected. However, some of the miners were exposed to other potentially cancer-causing substances such as radon and its progeny, tobacco smoke, diesel smoke, and solvents (carbon tetrachloride and trichloroethylene). These studies and a review of 11 uranium miner studies attributed the increased incidence of lung cancer to radon and its progeny and not to uranium. Thus, although uranium mining clearly elevates the risk for respiratory disease, uranium alone contributes minimally, if at all, to this risk (Craft et al. 2004).

Other Toxicities

Although very high doses of uranium (30 mg or higher) have caused reproductive problems, it is not believed that exposure to and the consumption of uranium related to this project would affect reproductive effects in workers and visitors to the proposed withdrawal areas (Craft et al. 2004).

Radon

As previously stated (see Section 3.15.1), radon is known to lead to an elevated risk of lung cancer in humans. Risk for developing lung cancer associated with radon exposure varies, depending on how much radon is in the indoor environment, the amount of time spent in that indoor environment, and whether the person smokes or has ever smoked (Lantz 2010). The only way to know whether you are being exposed to elevated radon levels is to test the indoor environment (National Research Council's Commission on Life Sciences 1999). As previously stated, all mines would comply with MSHA standards, including a ventilation plan and monitoring of radon levels.

[15] See a discussion in the following section about radon exposure.

Ingestion of Wildlife Exposed to Uranium

As discussed in Chapter 3.15, human health risks associated with the human consumption of wildlife exposed to uranium would be similar to the risks described above for ingestion of uranium. See previous discussions on human health risks associated with ingesting uranium for details on possible health risks.

Because Alternative A includes the highest estimated mineral activity, this alternative could result in the most human health risks in terms of cancer, kidney disease, lung toxicity, other toxicities, radon, and ingestion of contaminated wildlife. MSHA safety standards, which are required to be implemented at each mine, would minimize many of the above discussed risks by preventing workers from smoking in the mine, monitoring radon exposure, and requiring implementation of other required safety plans and measures. However, it is important to note that these risks are not expected to elevate above current conditions for mineral activity. Thus, impacts to Human Health are expected to be long term and minor.

Human Safety Risks

As previously noted in Section 3.15.1, potential safety risks associated with the mining operations could affect area recreationists and visitors; however, these risks would be mitigated by safety mechanisms mandated by the land managing agencies such as the BLM and Forest Service, as well as MSHA. For instance, secured gates at mine operations are required. Thus, no impacts to Human Safety under Alternative A are expected.

Transportation Conflicts

Under Alternative A, there would be 300,165 haul trips over a 20-year period of heavy haul trucks carrying ore (see RFD, Appendix B), resulting in an annual average of 15,000 haul trips (estimated annual average of 24–30 trips per week, or 5–6 trips per day per mine). This could impact roadways traveled by employees and visitors in the proposed withdrawal parcels should accidents occur as a result of increased traffic. However, with implementation of speed restrictions by the mining company (i.e., maximum speeds of 25 mph on unpaved roads), the potential for impacts would be mitigated and minimized.

Under Alternative A, given the estimated number of ore haul trips at 15,000 annually; indirect impacts on human safety may arise from the transport of ore materials from the proposed withdrawal parcels to the White Mesa Uranium Mill in Blanding, Utah, on roadways traveled by the public. In the event of an accident, hazardous contaminants may be released; however, exposure to uranium would be unlikely to affect the health of individuals within the vicinity. According to Denison, when accidents occur, drums transporting yellowcake are unlikely to be breached. If they are, the material usually stays inside the drums or remains within the damaged vehicle or in close proximity (Denison 2010a).

Between 1980 and 1991, uranium mines hauled more than 1,337,362 tons for 200 miles to the White Mesa Uranium Mill using a total of 16,048 truckloads (personal communication, M.M. Singh, June 29, 2010). During this time period, there was a total of five spills, or roughly one spill for every 3.2 million haul miles (personal communication, M.M. Singh, June 29, 2010). Data presented from 1980–1991 represent the most comprehensive information for haul trips to the mill; data for this period are especially relevant because it was a period of relatively high mining activity in the region. Since 1980–1991, conditions on these roadways have also changed. There has likely been an increase in traffic volumes and possible changes in speed limits since 1991.

Although accidents were rare for the roughly 10-year period (1980–1991), subsequent changes in speed limits and increases in traffic, along with haul traffic, could result in an increased likelihood for accidents on the road from drivers attempting to pass the heavy-haul trucks, thus compromising the safety of all drivers using the same roads.

Impacts to Human Safety in terms of transportation conflicts under Alternative A are expected to be long term and moderate. Transportation containers and methods as well as area speed limits are expected to mitigate potential risks.

ENVIRONMENTAL JUSTICE

As discussed in Section 3.15.1, there are nine communities in the study area that meet the criteria for an environmental justice community–Bitter Springs, Tusayan, Williams, Kaibab CDP, Big Water, Orderville, Navajo Mountain, Hildale, and St. George. Tribes in the study area that meet these criteria are the Havasupai Indian Reservation, Hopi Tribe, and Navajo Nation Kaibab Reservation (Kaibab Band of Paiutes), and Hualapai Tribe. The location of these communities in relation to the proposed withdrawal parcels can be seen on Figure 3.15-1.

Potential health risks associated with mineral activity as described above under Public Health and Safety could affect environmental justice communities. However, there are numerous other non–environmental justice communities within the study area that could be exposed to the same health risks; therefore, these effects are not expected to be disproportionate.

In particular, tribal environmental justice communities in the study area (Havasupai Indian Reservation, Hopi Tribe, and Navajo Nation Kaibab Reservation [Kaibab Band of Paiutes], and Hualapai Tribe) have an intimate relationship with the landscape, especially that of the Grand Canyon area (see Section 3.12) and have expressed concerns about mineral activity in the region (see also Section 3.15.1). Numerous other non-tribal individuals and groups have expressed concern regarding mineral activity. Therefore, as with potential health risks described above, these effects are not expected to be disproportionate to tribal environmental justice communities.

As a result, Alternative A could result in a minor, long-term impact to low-income and minority populations in terms of potential health risks.

Cumulative Impacts

The cumulative effects analysis area for Alternative A includes Coconino and Mohave counties in Arizona and Kane, San Juan, and Washington counties in Utah. All data on demographics, stakeholder values, public health and safety, and environmental justice apply to the cumulative effects analysis area analysis. The past and present land uses in the CEAA have had a direct effect on social conditions of the cumulative effects analysis area through changes to population (both types and amount). Past and present actions have resulted in the current social conditions in the cumulative effects analysis area, as described in Section 3.15 in Chapter 3.

Because of the presence of the Grand Canyon, the Kaibab National Forest, and the Arizona Strip, there are vast opportunities for recreation, solitude, and an overall perception of a higher quality of life. With projects that would enhance regional transportation systems and recreational areas such as the Four Forest Restoration Initiative, Tusayan’s and the North Kaibab Travel Management Projects, and the Greenway Trail and Parking Lot, there is the potential for more visitors to visit the region, which would increase employment opportunities and subsequently allow for slight increases in population.

From a lifestyle perspective, further development within the cumulative effects analysis area would change the landscape characteristics, existing conditions on area transportation systems, and existing landforms, which would contribute to an overall change in the sense of place for members of these counties. With the exception of the urban developed areas, the cumulative effects analysis area has a largely dispersed, rural, sparsely developed landscape.

4.15.3 Impacts of Alternative B: Proposed Action (~1 Million Acres, 20-Year Withdrawal)

Direct and Indirect Impacts

DEMOGRAPHICS

Under Alternative B, it is anticipated that over a 20-year period, a total of 11 mines could be mined for uranium, a decrease of 63.3% from Alternative A (an average of 1 mine would be developed every other year for 20 years). Direct employment associated with Alternative B would be 825 employees, or an annual average of 41.25 individuals. Assuming that an estimated 50% of these individuals relocate to the area, this would result in approximately 21 individuals relocating to areas such as Fredonia and Kanab each year. Although there would be fewer employment opportunities, in the case of Alternative B, a decrease in population as a result of a reduction in employment opportunities is unlikely. Impacts to employment and unemployment are discussed in Section 4.16.

Under Alternative B, no indirect impacts to population near White Mesa Uranium Mill in Blanding, Utah, are anticipated. According to Denison, current employment at the mine would not change if ore is reduced; a certain number of staff are required to run the mill regardless of ore volume delivered or processed there (personal communication, C. Woodward, March 2, 2010).

Indirect and induced employment associated with Alternative B would be 1,613 employees, or an annual average of 80.65 individuals. As under Alternative A, indirect employment effects would not be as localized as direct employment (i.e., into Fredonia or Kanab), but would be spread throughout the five-county area.

Mineral exploration and development is not expected to increase the burden on area infrastructure. An estimated 21 employees relocating to area communities each year is not expected to result in increased demand for public services. Current police, fire, medical, and educational facilities should be sufficient to handle direct employment and population changes. Indirect employment and population changes, as previously discussed, would not be localized but would be spread throughout the five-county study area.

The employment estimates under Alternative B would be a reduction from current conditions. However, as noted, decreases in direct and indirect employment opportunities are not expected to result in changes in population. As a result, no direct or indirect impacts to demographics are expected under Alternative B.

STAKEHOLDER VALUES

Impacts discussed under Alternative A would be similar under all action alternatives, including Alternative B; the difference between types of impacts is a matter of degree. Alternative B includes some mineral activity (primarily in the North Parcel) but less estimated activity than under Alternative A. Because mineral activity would still occur to some degree, the same groups and individuals who support mineral activity or support mineral withdrawal are likely to be affected. However, individuals and groups who support mineral activity would be more adversely directly and indirectly impacted, while individuals and groups who support mineral withdrawal would also be more (beneficially) impacted. Thus, Alternative B would result in a moderate long-term impact to stakeholder values.

PUBLIC HEALTH AND SAFETY

Health Risks

As with Stakeholder Values, impacts to public health and safety, specifically health risks (cancer, kidney disease, lung toxicity, other toxicities, and radon), would be similar under all action alternatives, including Alternative B; the difference between types of impacts is a matter of degree. Less mineral activity is estimated under Alternative B; therefore, less risk of human health impacts is anticipated. Based on the attributes of effect described at the beginning of Section 4.15, no impact to health is anticipated.

Human Safety Risks

Under Alternative B, direct impacts to public health and safety would be similar to Alternative A. There would, however, be fewer heavy-haul trips, which would average approximately 4,442 trips annually, 70.4% less than Alternative A. This reduction would minimize the potential for impacts on traffic safety in the proposed withdrawal parcels.

Under Alternative B, indirect impacts to public health and safety would be similar to Alternative A. However, with the reduction of heavy-haul trips, there is less potential for impact on traffic safety for drivers traveling on the same roads from the proposed withdrawal parcels to Blanding, Utah, than Alternative A.

Less mineral activity is estimated under Alternative B; therefore, less risk of human safety impacts is anticipated. Based on the attributes of effect described at the beginning of Section 4.15, no impact to Human Safety is anticipated.

ENVIRONMENTAL JUSTICE

The environmental justice study area for Alternative B does not change from that identified for Alternative A. Therefore, the same communities discussed under Alternative A are also considered for all action alternatives, including Alternative B.

Potential health risks associated with mineral activity as described above under Public Health and Safety would pose less of a risk to the nine environmental justice communities. However, although there are some health risks associated with mineral activity in general, there are numerous other non–environmental justice communities within the study area; therefore, these effects are not expected to be disproportionate.

As with potential health risks associated with mineral activity, impacts to quality of life for tribal environmental justice communities in the study area would be less than impacts experienced under Alternative A. However, as with Alternative A, numerous other non-tribal individuals and groups have expressed concern regarding mineral activity. Therefore, these effects are not expected to be disproportionate to tribal environmental justice communities.

As a result, Alternative A could result in a minor long-term impact to low-income and minority populations in terms of potential health risks.

Cumulative Impacts

Cumulative impacts under Alternative B would be similar in magnitude to Alternative A, although there would be fewer employment opportunities and subsequently less revenue that would be generated as a

result of the reduced number of mines available for development and production. This could impact the perceived quality of life, depending on the perspective one has of the Grand Canyon region. For this analysis, although there is a measurable difference in anticipated mineral exploration and development under the RFD scenarios (see Appendix B), cumulative impacts would not be substantially different to warrant a separate discussion here for Alternative B.

4.15.4 Impacts of Alternative C: Partial Withdrawal (~700,000 Acres)

Direct and Indirect Impacts

DEMOGRAPHICS

Under Alternative C, it is anticipated that over a 20-year period, a total of 18 mines could be mined for uranium, 40% less than Alternative A. Direct employment associated with Alternative C would be 1,350 employees, or an annual average of 67.5 individuals. Assuming that an estimated 50% of these individuals relocate to the area, this would result in approximately 34 individuals relocating to areas such as Fredonia and Kanab each year. Although there would be fewer employment opportunities, a decrease in population as a result of a reduction in employment opportunities is unlikely. Impacts to employment and unemployment are discussed in Section 4.16.

As with the other action alternatives, under Alternative C, no indirect impacts to population near White Mesa Uranium Mill in Blanding, Utah, are anticipated. According to Denison, current employment at the mine would not change if ore is reduced; a certain number of staff are required to run the mill regardless of ore volume delivered or processed there (personal communication, C. Woodward, March 2, 2010).

Indirect and induced employment associated with Alternative C would be 2,639 employees, or an annual average of 131.95 individuals. As under Alternatives A and B, indirect employment effects would not be as localized as direct employment (i.e., into Fredonia or Kanab) but would be spread throughout the five-county area.

Mineral exploration and development is not expected to increase the burden on area infrastructure. An estimated 34 employees relocating to area communities each year is not expected to result in increased demand for public services. Current police, fire, medical, and educational facilities should be sufficient to handle direct employment and population changes. Indirect employment and population changes, as previously discussed, would not be localized but would be spread throughout the five-county study area.

The employment estimates under Alternative C would be a reduction from current conditions (40%, as stated above). However, as noted, decreases in direct and indirect employment opportunities are not expected to result in changes in population. As a result, no direct or indirect impacts to demographics are expected under Alternative C.

Stakeholder Values

Impacts discussed under Alternative B would be similar to this discussion of Alternative C. Alternative C includes some mineral activity (concentrated in the North Parcel) but less estimated activity than Alternative A. Because mineral activity would still occur to some degree, the same groups and individuals who support mineral activity or support mineral withdrawal are likely to be affected. However, individuals and groups who support mineral activity would be more directly and indirectly adversely impacted, while individuals and groups who support mineral withdrawal would also be more (beneficially) impacted.

Thus, Alternative C would result in a moderate long-term impact to stakeholder values.

PUBLIC HEALTH AND SAFETY

Health Risks

Impacts discussed under Alternative B would be similar to this discussion of Alternative C. Less mineral activity is estimated under Alternative C than under Alternative A; therefore, less risk of human health impacts is anticipated. Based on the attributes of effect described at the beginning of Section 4.15, no impact to Health Safety is anticipated.

Human Safety Risks

Under Alternative C, direct impacts to public safety would be similar to Alternative A. However, annual heavy-haul trips would be reduced by 44.4%, and the potential for impact on traffic safety within the proposed withdrawal areas would be lower than for Alternative A. This reduction would minimize the potential for impacts on traffic safety in the proposed withdrawal parcels.

Under Alternative C, indirect impacts to public safety would be similar to Alternative A. However, with the reduction of heavy haul trips, there is less potential for impact on traffic safety for drivers traveling on the same roads from the proposed withdrawal parcels to Blanding, Utah, than Alternative A.

ENVIRONMENTAL JUSTICE

Direct and indirect impacts to Environmental Justice are very similar between Alternatives B and C. Potential health risks associated with mineral activity as described above under Public Health and Safety would pose less of a risk to the nine environmental justice communities than those discussed under Alternative A. However, although there are some health risks associated with mineral activity in general, there are numerous other non–environmental justice communities within the study area; therefore, these effects are not expected to be disproportionate.

As with potential health risks associated with mineral activity, impacts to quality of life for tribal environmental justice communities in the study area would be less than impacts experienced under Alternative A. Numerous other non-tribal individuals and groups have expressed concern regarding mineral activity; therefore, these effects are not expected to be disproportionate to tribal environmental justice communities.

Cumulative Impacts

Cumulative impacts under Alternative C would be similar in magnitude to Alternative A. For this analysis, there is not enough of a measurable difference in anticipated mineral exploration and development under the RFD scenarios (see Appendix B) to indicate that cumulative impacts would be substantially different to warrant a separate discussion for Alternative C.

4.15.5 Impacts of Alternative D: Partial Withdrawal (~300,000 Acres)

Direct and Indirect Impacts

DEMOGRAPHICS

Similar to Alternative A, over a 20-year period, a total of 26 mines could be mined for uranium under Alternative D. An average of 1.3 mines on all three withdrawal parcels would be developed per year. Alternative D would result in a reduction in mineral activity from Alternative A and therefore a reduction in employment opportunities. Direct employment associated with Alternative D is an estimated 1,950 employees, or an annual average of 97.5 individuals. Assuming that an estimated 50% of these individuals relocate to the area, this would result in approximately 49 individuals relocating to areas such as Fredonia and Kanab each year. Despite the decrease in employment opportunities (see Section 4.16), no anticipated population changes are expected.

As with the other action alternatives, under Alternative D, no indirect impacts to population near White Mesa Uranium Mill in Blanding, Utah, are anticipated. According to Denison, current employment at the mine would not change if ore is reduced; a certain number of staff are required to run the mill regardless of ore volume delivered or processed there (personal communication, C. Woodward, March 2, 2010).

Indirect and induced employment associated with Alternative D would be 3,812 employees, or an annual average of 190.6 individuals. As under the other action alternatives, indirect employment effects would not be as localized as direct employment (i.e., into Fredonia or Kanab) but would be spread throughout the five-county area.

Mineral exploration and development is not expected to increase the burden on area infrastructure. An estimated 49 employees relocating to area communities each year is not expected to result in increased demand for public services. Current police, fire, medical, and educational facilities should be sufficient to handle direct employment and population changes. Indirect employment and population changes, as previously discussed, would not be localized but would be spread throughout the five-county study area.

The employment estimates under Alternative D would be a reduction from current conditions. However, as noted, decreases in direct and indirect employment opportunities are not expected to result in changes in population. As a result, no direct or indirect impacts to demographics are expected under Alternative D.

STAKEHOLDER VALUES

Impacts discussed under Alternatives B and C would be similar to this discussion of Alternative D. Alternative D includes some mineral activity (concentrated in the North Parcel) but less estimated activity than under Alternative A. Because mineral activity would still occur to some degree, the same groups and individuals who support mineral activity or support mineral withdrawal are likely to be affected. However, individuals and groups who support mineral activity would be more directly and indirectly adversely impacted, while individuals and groups who support mineral withdrawal would also be more (beneficially) impacted.

Thus, Alternative D would result in a moderate long-term impact to stakeholder values.

PUBLIC HEALTH AND SAFETY

Health Risks

Impacts discussed under Alternatives B and C would be similar to this discussion of Alternative D. Less mineral activity than Alternative A is estimated under Alternative D; therefore, less risk of human health impacts is anticipated. Based on the attributes of effect described at the beginning of Section 4.15, no impact to Health Safety is anticipated.

Human Safety Risks

Under Alternative C, direct impacts to public safety would be similar to Alternative A. However, annual heavy-haul trips would be reduced by 14.8%, and the potential for impact on traffic safety within the proposed withdrawal parcels would be lower than under Alternative A. This reduction would minimize the potential for impacts on traffic safety in the proposed withdrawal parcels.

Under Alternative D, indirect impacts to public safety would be similar to Alternative A. However, with the reduction of heavy-haul trips, there is less potential for impact on traffic safety for drivers traveling on the same roads from the proposed withdrawal parcels to Blanding, Utah, than Alternative A.

ENVIRONMENTAL JUSTICE

Under Alternative D, direct and indirect impacts to environmental justice would be the same as under Alternative C.

Cumulative Impacts

Cumulative impacts under Alternative D would be similar in magnitude to Alternative A. For this analysis, there is not enough of a measurable difference in anticipated mineral exploration and development under the RFD scenarios to indicate that cumulative impacts would be substantially different to warrant a separate discussion for Alternative D.

4.16 ECONOMIC CONDITIONS

4.16.1 Impact Assessment Methodology and Assumptions

The impacts analysis for economic conditions will evaluate how the economic effects of the project would be distributed among the communities and counties in the study area. As previously noted, the analysis considers impacts to Coconino and Mohave counties in Arizona and Kane, San Juan, and Washington counties in Utah.

This section contains an analysis of the potential economic impacts associated with the four phases of the 7-year life cycle of a mine: planning and permitting, mine development, mine production, and reclamation. Exploration is included under the planning and permitting phase. This analysis will take into consideration the number of mines to be produced at a time under each alternative.

The phases of the project, durations, and number of employees per phase are defined as follows:

- Planning and Permitting: 2 years, 20 employees
- Mine Development: 1 year, 35 employees

- Mine Production: 3 years, 35 employees
- Reclamation: 1 year, 20 employees

Assumptions for this analysis include the following:

- The total proposed withdrawal would last for 20 years.
- Given limits in industrial capacity, a maximum of six mines for all three parcels with a 7-year life cycle per mine could be in production at any given time.
- Present and future demand for uranium will not change from 2008 demand.
- No changes in state tax schedules are anticipated.
- No federal royalty is assumed in this analysis.
- All uranium from the mines would be extracted.
- No mines would be operating under interim management.
- Growth in tourism-related sectors will be consistent with historic growth trends in Arizona and Utah.
- Average wages by industry are expected to remain constant for all sectors within the study area.

The economic impacts of the project area and alternatives on the economic study area are analyzed using IMPLAN, which is an input/output (I/O) modeling system. I/O modeling is a mathematical accounting of the flow of dollars and commodities through a region's economy. These types of models provide estimates of how a given amount of a particular economic activity translates into jobs and income in a region. The most recent data for these counties and the region provided by IMPLAN are for 2008.

The economic impact analysis for Alternative A, the No Action Alternative, is the first model prepared to provide a baseline for the alternatives analysis. It contains a discussion of impacts used for comparison with other alternatives. Where impacts are the same between alternatives, references are made to the Alternative A analysis so that impact discussions are not repeated. Cumulative impacts for the Proposed Action and each alternative are discussed and include the economic impacts of each action alternative in combination with other proposed, existing, or reasonably foreseeable developments.

In addition to the input/output model (IMPLAN), and an estimate of the market value of economically viable uranium, recreation economics and existence and use value are also discussed (see also Section 3.16). The recreation economics discussion estimates the monetary value of the benefit that local residents and visitors derive from recreational activities (nonconsumptive and hunting), as well as the economic activity that recreation generates in the study area. The existence and use value discussion provides an estimated monetary value for the benefit (or personal value) that people place on the sheer existence of a unique resource, such as air quality or visibility. These values are provided to estimate impacts from the proposed withdrawal.

Tables 4.16-1 and 4.16-2 provide definitions of impact magnitude and duration, respectively, as they relate to economic conditions.

Impacts to economic conditions from implementation of alternatives would be considered significant if one or more of the following occurs:

- Major gains or losses in employment, which could alter economic activity in the study area in the long term.
- Activities or operations altering recreational and employment opportunities in the study area.

Table 4.16-1. Magnitude and Degrees of Effects on Economic Conditions

Attribute of Effect	Description Relative to Economic Conditions
Magnitude	
No Impact	Would not produce obvious changes in existing economic activity, taxes and revenues, employment, recreation economics, existence and use value, road condition and maintenance, or energy resources.
Minor	Project-related impacts on economic conditions that would retain the existing economic conditions, taxes and revenues, employment, recreation economics, existence and use value, road condition and maintenance, or energy resources but create a low level of change which would not alter economic conditions in the study area for residents, employees, and visitors to the area.
Moderate	Impacts on economic conditions that would affect economic conditions for residents, employees, and local and regional economies with tourist-driven economies but that can be mitigated or offset by economic gains from mining activity.
Major	Project-related impacts that would create a high degree of change within economic conditions for current and potential employees, which could alter local and regional economies in the long term.

Table 4.16-2. Duration Definition of Effects on Economic Conditions

Duration	
Short-term	Less than 5 years
Long-term	Greater than 5 years

4.16.2 Impacts of Alternative A: No Action (No Withdrawal)

Direct and Indirect Impacts

ECONOMIC ACTIVITY

Industry Employment

Under Alternative A, the project area would not be withdrawn from entry and location of new mining claims. As mentioned in the RFD scenario (see Appendix B), it is estimated that there would be as many as 26 new mines that might be developed within the proposed withdrawal area, combined with the four existing mines, for a total of 30 mines. According to information provided by Denison (personal communication, C. Woodward, March 2, 2010) approximately 20 employees would be needed for every mine in the planning and permitting phase. Approximately 35 employees would be needed for the mine development and mine production phases. The number of employees needed for the reclamation phase would be 20 employees. Therefore, total employment per mine would be an estimated 75 employees. Indirect impacts are evaluated by indirect and induced effects. Indirect effects include employment created by the demand for supplies by suppliers of the mines. Induced effects include employment resulting from employee spending, which creates a demand for retail and similar jobs. With a maximum of 50% of workers migrating to the area to work for the mines, the industry output could increase in other sectors that would be supplying materials to assist with mine development and production. Other sectors may include construction and the administrative and professional services sector. Impacts on employment are discussed further under Employment, Personal Income, and Unemployment.

Tourism Sectors Employment

As discussed in Section 3.16, industry employment for tourism-related sectors in 2008 represented more than 25% of study area employment. Thus, tourism-related sectors contribute the most in terms of numbers of jobs to study area employment. Under Alternative A, tourists and recreationist activity could

be displaced as mineral activity increases in specific areas; however, overall regional tourist activity and associated employment are unlikely to be affected.

Mining Sector Employment

Total direct employment over the 20-year period under Alternative A would be 2,250 employees, or an annual average of 112. Indirect and induced employment is expected to result in an additional 4,398 jobs in the five-county study area under Alternative A. The direct and indirect increases in employment opportunities would assist in offsetting the relatively high unemployment rates in northern Arizona and southern Utah.

Under Alternative A, direct employment from the mines would result in an annual average increase of 12.43% in employment over 2008 mining employment. The addition of mining employment opportunities to overall employment in the study area would represent a 0.05% increase over 2008 employment in the five-county area. Impacts resulting from Alternative A on mining sector employment is discussed below under Employment, Personal Income, and Unemployment.

Industry Wages

Tourism and Mining Sector Wages

As discussed in the Industry Wages section in Section 3.16, wages for the mining sector are higher than those for tourism-related sectors. While tourism in the area is anticipated to remain constant, wages from the expansion of the mining sector would economically impact the regional economy. Workers at the mine would directly benefit from higher wages that the mining sector provides. As previously stated, under Alternative A, the expansion of employment opportunities in the region's mining sector would result in an increase of workers throughout the area earning higher wages and thus affect regional output as discussed below.

Industry Output

Numbers presented below include estimated value added and industry output for each phase of development, production, and reclamation, over the 20-year period under analysis (Table 4.16-3). Value added is the difference between the sale price of a product and the cost of materials and services to enhance the product.

Direct impacts for all 30 mines over the 20-year period would provide a total of $5.46 billion in value added and output for all phases of mining activity over 20 years. This would be an estimated $182 million per mine, or an annual average impact of $273 million. Labor income is detailed in Table 4.16-3 but discussed in the following section.

Table 4.16-3. Direct Economic Effects under Alternative A

	Labor Income	Value Added	Output
Planning and Permitting	$4,091,898	$13,782,852	$22,619,676
Mine Development	$3,580,410	$12,060,000	$19,792,216
Mine Production	$10,741,230	$36,180,000	$59,376,648
Reclamation	$2,045,949	$6,891,426	$11,309,838
Total Per Mine	$20,459,487	$68,914,278	$113,098,378
Total for Alternative A	**$613,784,610**	**$2,067,428,340**	**$3,392,951,340**

Source: IMPLAN (2008).

Indirect and induced impacts for all 30 mines over the 20-year period would provide $14.16 million in value added and output for the planning and permitting phase, the development phase would provide $12.39 million in value added and output, the production phase would provide $34.76 million in value added and output, and the reclamation phase would provide $7.08 million in value added and output. Total value added and output for all phases of mining activity over 20 years would be $68.9 million. This would be an estimated $2.28 million per mine, or an annual average impact of $3.41 million. Labor income is detailed in Table 4.16-4 but discussed in the following section.

Table 4.16-4. Indirect Economic Effects under Alternative A

	Labor Income Indirect	Labor Income Induced	Value Added Indirect	Value Added Induced	Output Indirect	Output Induced
Planning and Permitting	$1,166,972	$1,160,774	$2,969,698	$2,144,812	$5,368,662	$3,678,288
Mine Development	$1,021,100	$1,015,677	$2,598,487	$1,876,709	$4,697,578	$3,218,501
Mine Production	$3,063,300	$3,047,031	$7,795,461	$3,217,218	$14,092,734	$9,655,503
Reclamation	$583,486	$580,387	$1,484,849	$1,072,406	$2,684,331	$1,839,144
Total Per Mine	$5,834,858	$5,803,869	$14,848,495	$8,311,145	$26,843,305	$18,391,436
Total for Alternative A	**$175,045,740**	**$174,116,070**	**$445,454,850**	**$249,334,350**	**$805,299,150**	**$551,743,080**

Source: IMPLAN (2008).

Given that mining activity would occur over a 20-year period, impacts to economic activity under Alternative A are expected to be beneficial, long-term, and moderate.

Tourism Sectors Output

Regional output from tourism-related sectors in the study area is not expected to change, although output generated from tourism to specific recreational sites could vary as a result of short-term displacement from mining activity. For example, visitation to recreational sites listed in Table 3.16-17 (see Industry Output in Section 3.16) could change as visitors to the area could opt to go to other sites to avoid nearby mining activity. However, mining activities associated with Alternative A are not anticipated to alter regional output, as the overall influx of visitation to tourist areas within the study area is unlikely to change.

Mining Sector Output

In 2008, the mining sector provided $267,506,185 in total output (IMPLAN 2008). As shown above, with increases in employment opportunities, the mining sector output will also increase an annual average of $273 million, or an estimated 102% per year for the 20-year period.

EMPLOYMENT, PERSONAL INCOME, AND UNEMPLOYMENT

Under Alternative A, there would continue to be opportunity for employment as a result of mining activity in all three parcels. Given both project wage levels and local unemployment, the mining jobs would be attractive to local workers. For a period of 20 years, a total direct impact of 2,250 jobs could be created under Alternative A. Labor income would increase an estimated $613.7 million over 20 years, or an annual average of $30.69 million (see Table 4.16-3).

Indirect impacts resulting from the proposed project include the need for support and ancillary services, including mine exploration, which would provide additional employment for residents and generate revenue for local and regional businesses; indirect and induced employment are estimated to produce an additional 4,398 jobs (Table 4.16-5). The addition of 4,398 jobs would result in an estimated $349.16 million in added labor income, or an annual average of $11.64 million.

Table 4.16-5. Indirect Employment Effects per Mine under Alternative A

	Employment Indirect	Employment Induced
Planning and Permitting	9.3	17.4
Mine Development	16.2	30.4
Mine Production	16.2	30.4
Reclamation	9.3	17.4
Total Per Mine	51	95.6
Total for Alternative A	**1,530**	**2,868**

Source: IMPLAN (2008).

Indirect impacts are unlikely to affect the White Mesa uranium mill in Blanding, Utah. According to the Denison website, the mill employs 152 people and is licensed to process an average of 2,000 tons of ore per day and produce approximately 8.0 million pounds of U_3O_8 per year (Denison 2010b). Of those 152 employees, 130 specifically work with uranium ore while the remainder work in vanadium production (personal communication, Harold Roberts, July 15, 2010). Currently, the mill is operating at 50% capacity. Regardless of the amount of uranium ore to be processed, approximately 130 people are needed to operate the mill, so regardless of the alternative, no impacts to the mill are anticipated.

Communities in both southern Utah and northern Arizona that are included in the study area have economies tied to the lands proposed for withdrawal. With an unemployment rates ranging from 7.2% to 9.7% in the counties in the study area, the additional employment opportunities could serve to benefit the overall study area by decreasing unemployment. Additional employment opportunities, increased personal income, and offset unemployment would have beneficial, moderate, and long-term impacts under Alternative A.

Economic Diversity

Changes in employment in the mining sector for the study area are not large enough to create a measurable difference to economic diversity as calculated by the SWDI, discussed in Section 3.16. Thus, no direct or indirect impacts to economic diversity resulting from Alternative A are anticipated.

TAXES AND REVENUES

Numbers presented below include estimated employee compensation tax, household tax, and corporation tax over the 20-year period under analysis. As shown in Table 4.16-6, total state taxes per mine for all mine phases would be $2.27 million, or a total of $68.1 million for all 30 mines. This would result in an estimated annual average of $3.4 million in state taxes.

Federal tax revenue would result in an estimated $7.97 million per mine, or a total of $239.25 million for all 30 mines. This would generate an estimated annual average of $11.96 million in federal tax revenue (Table 4.16-7).

As shown in Table 4.16-8, Alternative A would provide $229.5 million in state and local indirect business and $26.39 million in federal business tax.

Alternative A could result in a beneficial, moderate, long-term impact to residents and local as revenue generated through taxes would be redistributed to counties, which in turn would decide how to best allocate and redistribute revenue to local communities.

Table 4.16-6. State Taxes under Alternative A

	Employee Compensation	Households	Corporation
Planning and Permitting	$18,688	$126,358	$309,020
Mine Development	$16,352	$110,564	$270,393
Mine Production	$49,056	$331,692	$811,179
Reclamation	$9,344	$63,179	$154,510
Total per Mine	$93,440	$631,793	$1,545,102
Total for Alternative A	**$2,803,200**	**$18,953,790**	**$46,353,060**

Source: IMPLAN (2008).

Table 4.16-7. Federal Taxes under Alternative A

	Employee Compensation	Proprietor Income	Households	Corporation
Planning and Permitting	$689,264	$53,840	$334,170	$517,740
Mine Development	$603,105	$47,110	$292,400	$453,022
Mine Production	$1,809,315	$141,330	$877,200	$1,359,066
Reclamation	$344,632	$26,920	$167,085	$258,870
Total per Mine	$3,446,316	$269,200	$1,670,855	$2,588,698
Total for Alternative A	**$103,389,480**	**$8,076,000**	**$50,125,650**	**$77,660,940**

Source: IMPLAN (2008).

Table 4.16-8. State/Local and Federal Indirect Business Taxes under Alternative A

	Indirect Business Tax – State and Local	Indirect Business Tax – Federal
Planning and Permitting	$1,530,070	$175,984
Mine Development	$1,338,812	$153,986
Mine Production	$4,016,436	$461,958
Reclamation	$765,035	$87,992
Total per Mine	$7,650,353	$879,920
Total for Alternative A	**$229,510,590**	**$26,397,600**

Source: IMPLAN (2008).

RECREATION ECONOMICS

Nonconsumptive Recreation

Impacts to recreation in terms of visitor use, recreation opportunities, and recreation settings and experiences are analyzed in Section 4.14. This analysis discusses how changes in visitor use, if any, evaluated in Section 4.14 may result in changes in associated economic benefits. As previously noted (see Section 3.16.1), the total estimated annual benefit of recreation sites in the study area is $450 million (see Table 3.16-17). As stated in Section 4.14, the overall impact to visitor use (through changes in recreation opportunities or desired experiences) would be minor. These minor impacts are not expected to result in any measurable changes in the annual economic benefits of recreation.

Hunting

As previously noted (see Section 3.16), the total estimated annual benefit of hunting activities in the study area is $1.53 million (see Table 3.16-18). The total land area for the four GMUs (9, 12A, 12B, and 13A) considered in the study area cover more than 3.2 million acres. Under Alternative A, if the full RFD scenario is realized, the total estimated ground disturbance is 1,364 acres over a 20-year period for all phases (exploration, mines, roads, and power lines), or an average of 68 acres per year. Thus, in the context of the overall available hunting area, compared with the small amount of ground disturbance, mineral activity is unlikely to result in measurable impacts to hunters, or the associated total estimated annual benefit.

Existence and Use Value

Existence and use values are incredibly difficult to quantify; this difficulty is exacerbated by the absence of a project specific survey or interviews asking respondents to indicate their WTP for the sheer existence of a resource, i.e., its existence or use value. No proposed withdrawal–specific survey was conducted for this project.

The studies discussed in Chapter 3 (see Section 3.16.1) demonstrate what people indicated they would pay (with regard to other projects, not specifically this one) to avoid a reduction in air quality. These studies (see Section 3.16.1) also concluded that 80% of visitors indicated they would shorten their stay at the Grand Canyon if visual quality was reduced. This demonstrates visitor sensitivity to changes in environmental resources in this study area; therefore, it is possible that changes in water, visual, and soundscape quality would have a similar effect.

Section 4.2 states that changes in air quality from mineral activity (exploration and mine development) would result primarily from vehicle/equipment and fugitive dust emissions for access and ore hauling. Additionally, because these emissions would occur at ground level, it is unlikely that emissions would be transported more than a few kilometers, except on windy days and during significant wind events; mitigation measures discussed in Section 4.2 would be expected to reduce these impacts. Thus, no measurable reduction in air quality is expected.

Although no measurable impacts are anticipated, it is possible that mining in the region could impact visitors and tourists to the area as a result of *perceived* impacts to air, water, and visual quality, as well as impacts resulting from increased noise.

Section 4.9 states that impacts on visual resources vary according to the location of the facilities and could range from minor to major impacts. Impacts from noise caused by mining equipment operation are dependent on a variety of factors, including the location of the mining activity to that of the Park boundary, the type of equipment used, the topography of the area, direction of the prevailing wind, and hours of equipment operation (see Section 4.10). Impacts on water resources also range from minor to major and are discussed further in Section 4.4. If people expect impacts to happen and behave based on these expectations (rather than on actual impacts), this could result in a reduction in visitation, although this seems unlikely.

Under Alternative A, in terms of nonconsumptive recreation, hunting, and existence and use value, direct and indirect impacts to recreation economics are expected to be long-term and minor.

ENERGY RESOURCES

In 2008, the worldwide market demand for uranium for the purposes of power generation was 114 million pounds, with annual demand expected to increase to 170 million pounds by 2030 (American Clean

Energies Trust 2009). Under Alternative A, assuming that 2010 demand is the same for 2008, approximately 63.98% of uranium from the proposed withdrawal area could be used to meet this demand in 2010, and 42.91% in 2030.

The current price of uranium per pound is roughly $40. Provided that demands for uranium remain constant, mining under Alternative A would likely produce approximately 33,155 tons, or 72.9 million pounds, of uranium totaling $2.9 billion in estimated value (using the 2008 value of $40 per pound). The forecast of future trends in national and world energy markets is subject to speculation and is subsequently unpredictable.

As previously mentioned in Section 3.16.1, Energy Resources, uranium is considered a fungible commodity where it can be mined in the U.S. and sold to consumers both domestically and abroad based on demand and subsequent market prices. Currently, there are no laws in place that would require domestic uranium to be solely purchased and consumed within the United States. As a result, uranium mined and produced within the parcels would not necessarily move the United States toward energy independence and thus would not represent an impact to national energy resources.

Under Alternative A, direct impacts to energy resources would be long term and beneficial. Given the availability of uranium that could be mined under this alternative, the magnitude of these impacts is likely to be moderate to major. However, impacts are largely dependent on global demand for uranium.

Given the volatility of the market and subsequent demand, it is difficult to speculate about indirect impacts on energy resources resulting from Alternative A. Indirect impacts would largely depend on the demand for uranium both locally, nationally, and globally.

ROAD CONDITION AND MAINTENANCE

Under Alternative A, 22.4 miles of new roads would be constructed and an estimated 300,165 haul trips would occur on area roads over a 20-year time frame (see RFD, Appendix B). Of the 22.4 miles of new roads, 83.9% (18.8 miles) would be constructed on BLM lands within the North and East parcels. The addition of 18.8 miles of new roads would represent an increase of 0.28% of the BLM transportation system of primary, secondary, and tertiary unpaved roads. Construction of 3.6 miles of new roads on Forest Service lands in the South Parcel would represent an increase of 0.49% of the 740 miles of roads open to motorized travel on the Kaibab National Forest.

Of the 300,165 haul trips, an estimated 69.42% (208,385) would occur in the North Parcel, 7.41% (22,240) in the East Parcel, and 23.17% (69,540) in the South Parcel.

Mining companies would be responsible for paying for maintenance of unpaved public roads used to haul ore; thus, no anticipated changes to funding road maintenance are expected. In terms of changes in property and use tax revenue, there could be a decrease in road maintenance funding from tax revenue because of the change in roads constructed; however, tourism sales tax revenue is the primary source of funding for road maintenance. Thus, no discernible effect is expected.

Under Alternative A, there would be no direct or indirect impacts to road condition and maintenance.

Cumulative Impacts

The cumulative effects analysis area for Alternative A includes Coconino and Mohave counties in Arizona and Kane, San Juan, and Washington counties in Utah. All data on economic and fiscal conditions apply to the cumulative effects analysis area analysis. The past and present land uses in the cumulative effects analysis area have had a direct effect on economic conditions of the cumulative effects

analysis area through changes to employment (both types and amount) and revenue generated through various actions within the region. Past and present actions have resulted in the current economic conditions in the cumulative effects analysis area, as described in Section 3.16.

Past projects that have affected economic conditions in the region by increasing recreational use and subsequently visitorship to the area have been the issues of special recreation permits for jeep, hiking, and biking tours on the North and East parcels and commercial and residential development in the area to accommodate population growth. Existing projects and events that are present in the proposed withdrawal area related to economic conditions include mineral development and recreation. Reasonably foreseeable future projects and events for the proposed withdrawal area include adjustments for increased regional and community population growth and land tenure adjustments by both the BLM and Forest Service. As described above, projects in the area include those that would enhance regional transportation systems and recreational areas such as the Four Forest Restoration Initiative, Tusayan's and North Kaibab's Travel Management Projects, and the Greenway Trail and Parking Lot. Projects such as these would impact the region's economy by attracting more visitors.

No further cumulative impacts to economic conditions are anticipated beyond those already described above as direct and indirect impacts.

4.16.3 Impacts of Alternative B: Proposed Action (~1 Million Acres, 20-Year Withdrawal)

Direct and Indirect Impacts

ECONOMIC ACTIVITY

Industry Employment

Under Alternative B, there would be a total of 11 mines, which would decrease mining employment opportunities, compared with Alternative A. Direct employment associated with Alternative B would be 825 employees, or an annual average of 41.25 individuals. Indirect and induced employment associated with Alternative B would be 1,613 employees, or an annual average of 80.65 individuals.

Tourism Sectors Employment

Under Alternative B, tourism employment is expected to remain constant with estimated average annual employment growth rates in Arizona and Utah.

Mining Sector Employment

Under Alternative B, the mining sector employment would not experience tremendous growth as Alternative A. Under this alternative, the mining sector would only increase by a total of 825 jobs over a period of 20 years. As a result of fewer mining employment opportunities, total output as shown below would also be less than that of Alternative A.

The addition of mining employment opportunities to overall employment in the study area would represent a 0.02% increase over 2008 employment in the five-county area. Under Alternative B, direct employment from the mines would result in an annual average increase of 4.58% in employment over 2008 mining employment. Impacts resulting from Alternative B on mining sector employment are discussed below under Employment, Personal Income, and Unemployment.

Industry Wages

Tourism and Mining Sector Wages

Under Alternative B, industry wages from tourism are not anticipated to change. However, compared with Alternative A, the expansion of withdrawal areas would result in fewer mining employment opportunities throughout the area. Alternative B would provide approximately 63.3% fewer mining employment opportunities, which in turn would decrease the number of workers with higher wages and thus affect regional output as discussed below.

Industry Output

Impacts to the local economy would be reduced, compared with Alternative A as a result of the fewer number of mines and less economic activity. Alternative B would provide fewer mining jobs, less taxes to the counties and the state, and less revenue to local and regional businesses than Alternative A. As shown in Table 4.16-9, Alternative B would provide a direct impact of $182 million per mine in value added and output, or a total of $2 billion over the 20-year period. Total output under Alternative B would be 63.3% less than Alternative A.

Indirect and induced effects for each phase are shown in Table 4.16-10. Alternative B would provide a total of $550 million in indirect and induced value added and output. This would be $68.39 million per mine over the 20-year period.

Table 4.16-9. Direct Economic Effects under Alternative B

	Labor Income	Value Added	Output
Planning and Permitting	$4,091,898	$13,782,852	$22,619,676
Mine Development	$3,580,410	$12,060,000	$19,792,216
Mine Production	$10,741,230	$36,180,000	$59,376,648
Reclamation	$2,045,949	$6,891,426	$11,309,838
Total per Mine	$20,459,487	$68,914,278	$113,098,378
Total for Alternative B	**$225,054,357**	**$758,057,058**	**$1,244,082,158**

Source: IMPLAN (2008).

Table 4.16-10. Indirect Economic Effects under Alternative B

	Labor Income Indirect	Labor Income Induced	Value Added Indirect	Value Added Induced	Output Indirect	Output Induced
Planning and Permitting	$1,166,972	$1,160,774	$2,969,698	$2,144,812	$5,368,662	$3,678,288
Mine Development	$1,021,100	$1,015,677	$2,598,487	$1,876,709	$4,697,578	$3,218,501
Mine Production	$3,063,300	$3,047,031	$7,795,461	$3,217,218	$14,092,734	$9,655,503
Reclamation	$583,486	$580,387	$1,484,849	$1,072,406	$2,684,331	$1,839,144
Total per Mine	$5,834,858	$5,803,869	$14,848,495	$8,311,145	$26,843,305	$18,391,436
Total for Alternative B	**$64,183,438**	**$63,842,559**	**$163,333,445**	**$91,422,595**	**$295,276,355**	**$202,305,796**

Source: IMPLAN (2008).

Given that mining activity would occur over a 20-year period, impacts to economic activity under Alternative B are expected to be beneficial, minor, and long term.

Tourism Sectors Output

Under Alternative B, impacts to regional tourism sectors output would be the same as Alternative A, as it is unlikely that the region would see a reduction in visitation. However, under this alternative, there would be less opportunity for short-term displacement with regard to visitor use of specific recreation sites, as there would be less mining activity.

Mining Sector Output

Mining sector output as a result of Alternative B is described above.

Economic Diversity

As with Alternative A, no direct or indirect impacts to economic diversity resulting from Alternative B are anticipated.

EMPLOYMENT, PERSONAL INCOME, AND UNEMPLOYMENT

Employment opportunities would be fewer under this alternative, compared with Alternative A. For a period of 20 years, a total direct impact of 825 jobs would be created under Alternative B, or an annual average of 41.25 jobs. For a period of 20 years, a total direct impact of 825 jobs could be created under Alternative B. Labor income would increase an estimated $225 million over 20 years, or an annual average of $11.25 million.

Indirect and induced employment is estimated to produce an additional 1,612 jobs (Table 4.16-11). The addition of 1,612 jobs would result in an estimated $11.63 million in added labor income, or an annual average of $6.4 million. Workers from the town of Blanding who work at the White Mesa uranium mill would not be affected by the reduction of ore processed at the mill.

Alternative B would result in a beneficial, minor, long-term impact on the residents and communities in the study area, as there would be fewer employment opportunities than would be provided under Alternative A.

Table 4.16-11. Indirect Employment Effects under Alternative B

	Indirect	Induced
Planning and Permitting	9.3	17.4
Mine Development	16.2	30.4
Mine Production	16.2	30.4
Reclamation	9.3	17.4
Total per Mine	51	95.6
Total for Alternative B	**561**	**1,051.6**

Source: IMPLAN (2008).

TAXES AND REVENUES

As shown in Table 4.16-12, state taxes and federal taxes under Alternative B would be less than under Alternative A. Total state taxes per mine for all mine phases would be $ $2.27 million, or a total of $24.9 million for all mines. This would result in an estimated annual average of $1.24 million in state taxes.

Federal tax revenue would result in an estimated $7.97 million per mine, or a total of $87.7 million for all mines. This would generate an estimated annual average of $4.38 million in federal tax revenue (Table 4.16-13).

As shown in Table 4.16-14, Alternative B would provide $84.15 million in state and local indirect business and $9.68 million in federal business tax.

Table 4.16-12. State Taxes per Mine under Alternative B

	Employee Compensation	Households	Corporation
Planning and Permitting	$18,688	$126,358	$309,020
Mine Development	$16,352	$110,564	$270,393
Mine Production	$49,056	$331,692	$811,179
Reclamation	$9,344	$63,179	$154,510
Total per Mine	$93,440	$631,793	$1,545,102
Total for Alternative B	**$1,027,840**	**$6,949,723**	**$16,996,122**

Source: IMPLAN (2008).

Table 4.16-13. Federal Taxes per Mine under Alternative B

	Employee Compensation	Proprietor Income	Households	Corporation
Planning and Permitting	$689,264	$53,840	$334,170	$517,740
Mine Development	$603,105	$47,110	$292,400	$453,022
Mine Production	$1,809,315	$141,330	$877,200	$1,359,066
Reclamation	$344,632	$26,920	$167,085	$258,870
Total per Mine	$3,446,316	$269,200	$1,670,855	$2,588,698
Total for Alternative B	**$37,909,476**	**$2,961,200**	**$18,379,405**	**$28,475,678**

Source: IMPLAN (2008).

Table 4.16-14. State/Local and Federal Indirect Business Taxes under Alternative B

	Indirect Business Tax – State and Local	Indirect Business Tax – Federal
Planning and Permitting	$1,530,070	$175,984
Mine Development	$1,338,812	$153,986
Mine Production	$4,016,436	$461,958
Reclamation	$765,035	$87,992
Total per Mine	$7,650,353	$879,920
Total for Alternative B	**$84,153,883**	**$9,679,120**

Source: IMPLAN (2008).

Alternative B could result in a beneficial, minor, long-term impact to residents in the study area with less revenue generated through taxes that would be redistributed to counties than that provided by Alternative A for a period of 20 years.

RECREATION ECONOMICS

Nonconsumptive Recreation

As with Alternative A, creation of 6.4 miles of temporary new roads for mining under Alternative B is expected to offset any potential impacts associated with impacts to recreationists as a result of mining activity (visual, soundscape, etc.). Alternative B would include less road creation and less mining activity, compared with Alternative A. Thus, no overall impact to visitor use or change in the annual economic benefits of recreation is anticipated; no obvious changes to the recreation setting, opportunity, or available experiences are expected.

Hunting

Under Alternative B, the total estimated ground disturbance is 164 acres over a 20-year period for all phases, or an average of 8 acres per year. Alternative B would result in a surface disturbance that, compared with the overall available hunting area for the four GMUs affected by the proposed withdrawal parcels, would be negligible. Additionally, issuance of hunting tags and other similar limits that affect hunting activity are not expected to change. As a result, mineral activity under Alternative B would result in no impact to the estimated annual benefit of hunting recreation.

Existence and Use Value

Compared with Alternative A, Alternative B would result in fewer fugitive dust emissions and therefore less impact to air quality (see Section 4.2). Thus, actual changes in air quality are not expected to affect recreation and tourist activity. People may also expect that there would be fewer changes to air quality because there is less mineral activity under Alternative B. Consequently, as with Alternative A, future mineral activity under Alternative B is unlikely to affect study area existence and use value.

In terms of nonconsumptive recreation, hunting, and existence value, no impacts to recreation economics are expected under Alternative B.

ENERGY RESOURCES

Under Alternative B, approximately 4,147 tons, or 9.1 million pounds, of uranium could be produced, meeting approximately 8.0% of the U.S. demand in 2009 and 5.3% in 2030. This would total an estimated $364.9 million should prices remain constant at $40/lb. Similar to Alternative A, future demand of uranium is highly speculative and unpredictable.

While direct impacts to energy resources would be long term and beneficial under Alternative B, as a result of less estimated mineral activity, impacts would be minor, compared with Alternative A.

Given the volatility of the market and subsequent demand, it is difficult to speculate about indirect impacts on energy resources resulting from Alternative B. Indirect impacts would largely depend on the demand for uranium both locally, nationally, and globally.

ROAD CONDITION AND MAINTENANCE

Under Alternative B, 6.4 miles of new roads would be constructed, and an estimated 88,885 haul trips would occur on area roads over a 20-year time frame (see RFD, Appendix B).

Most of the new roads would be constructed within the North Parcel (on BLM land). The addition of 6.4 miles of new roads would represent an increase of 0.096% of the BLM transportation system of primary,

secondary, and tertiary unpaved roads. However, construction of 6.4 miles of new roads would be a 71.43% decrease from new road construction anticipated under Alternative A.

One mile of new road would be constructed within the South Parcel (on Forest Service land). An estimated 3.17% (2,820) of haul trips would occur in the South Parcel, and 96.83% (86,065) of haul trips would occur in the North Parcel. In terms of changes in traffic levels as a result of haul trips, total haul traffic for Alternative B would result in a 70.43% decrease in haul traffic from current conditions (as described under Alternative A).

As under all other alternatives, mining companies would be responsible for paying for maintenance of unpaved public roads used to haul ore; thus, no anticipated changes to funding road maintenance are expected. In terms of changes in property and use tax revenue, there could be a decrease in road maintenance funding from tax revenue because of the change in roads constructed; however, tourism sales tax revenue is the primary source of funding for road maintenance. Thus, no discernible effect is expected.

Under Alternative B, there would be no direct or indirect impacts to road condition and maintenance.

Cumulative Impacts

Cumulative impacts under Alternative B would be similar in magnitude to Alternative A, although there would be fewer employment opportunities and subsequently less revenue that would be generated as a result of the reduced number of mines available for development and production. For this analysis, although there is a measurable difference in anticipated mining activity under the RFD scenario, cumulative impacts would not be substantially different to warrant a separate discussion for Alternative B.

4.16.4 Impacts of Alternative C: Partial Withdrawal (~700,000 Acres)

Direct and Indirect Impacts

ECONOMIC ACTIVITY

Industry Employment

Under Alternative C, there would be a total of 18 mines, which would result in fewer mining-related employment opportunities, compared with Alternative A. Direct employment associated with Alternative C would be 1,350 employees, or an annual average of 67.5 individuals. Indirect and induced employment associated with Alternative C would be 2,639 employees, or an annual average of 131.95 individuals.

Tourism Sectors Employment

Under Alternative C, tourism employment is expected to remain constant with estimated average annual employment growth rates in Arizona and Utah.

Mining Sector Employment

Under Alternative C, the mining sector employment would not experience tremendous growth as under Alternative A. Under this alternative, the mining sector would increase by a total of 1,350 jobs over a period of 20 years. As a result of fewer mining employment opportunities, total output as shown below would also be less than that of Alternative A.

The addition of mining employment opportunities to overall employment in the study area would represent a 0.03% increase over 2008 employment in the five-county area. Under Alternative C, direct employment from the mines would result in an annual average increase of 7.49% in employment over 2008 mining employment. Impacts resulting from Alternative C on mining sector employment are discussed below under Employment, Personal Income, and Unemployment.

Industry Wages

Tourism and Mining Sector Wages

Under Alternative C, industry wages from tourism are not anticipated to change. However, compared with Alternative A, the expansion of withdrawal areas would result in fewer mining employment opportunities throughout the area. Alternative C would provide approximately fewer mining employment opportunities than Alternative A, which in turn would decrease the number of workers with higher wages and thus affect regional output as discussed below.

Industry Output

As shown in Table 4.16-15, Alternative C would provide fewer economic benefits than Alternative A. Alternative C would provide a direct impact of $182 million per mine in value added and output, or a total of $3.2 billion over the 20-year period (see Table 4.16-15).

Table 4.16-15. Direct Economic Effects under Alternative C

	Labor Income	Value Added	Output
Planning and Permitting	$4,091,898	$13,782,852	$22,619,676
Mine Development	$3,580,410	$12,060,000	$19,792,216
Mine Production	$10,741,230	$36,180,000	$59,376,648
Reclamation	$2,045,949	$6,891,426	$11,309,838
Total per Mine	$20,459,487	$68,914,278	$113,098,378
Total for Alternative C	**$368,270,766**	**$1,240,457,004**	**$2,035,770,804**

Source: IMPLAN (2008).

Indirect and induced effects for each phase are shown in Table 4.16-16. Alternative C would provide a total of $1.23 billion in indirect and induced value added and output. This would be $68.39 million per mine over the 20-year period.

Given that mining activity would occur over a 20-year period, impacts to economic activity under Alternative C are expected to be beneficial, long term, and moderate.

Tourism Sectors Output

Under Alternative C, impacts to regional tourism sectors output would be the same as under Alternative A.

Mining Sector Output

Mining sector output as a result of Alternative C is described above.

Table 4.16-16. Indirect Economic Effects under Alternative C

	Labor Income Indirect	Labor Income Induced	Value Added Indirect	Value Added Induced	Output Indirect	Output Induced
Planning and Permitting	$1,166,972	$1,160,774	$2,969,698	$2,144,812	$5,368,662	$3,678,288
Mine Development	$1,021,100	$1,015,677	$2,598,487	$1,876,709	$4,697,578	$3,218,501
Mine Production	$3,063,300	$3,047,031	$7,795,461	$3,217,218	$14,092,734	$9,655,503
Reclamation	$583,486	$580,387	$1,484,849	$1,072,406	$2,684,331	$1,839,144
Total per Mine	$5,834,858	$5,803,869	$14,848,495	$8,311,145	$26,843,305	$18,391,436
Total for Alternative C	**$105,027,444**	**$104,469,642**	**$267,272,910**	**$149,600,610**	**$483,179,490**	**$331,045,848**

Source: IMPLAN (2008).

Economic Diversity

As with Alternative A, no direct or indirect impacts to economic diversity resulting from Alternative C are anticipated.

EMPLOYMENT, PERSONAL INCOME, AND UNEMPLOYMENT

For a period of 20 years, a total direct impact of 1,350 jobs, or an annual average of 67.5 jobs, could be created under Alternative C, 40% fewer jobs than Alternative A. Labor income would increase an estimated $368.27 million over 20 years, or an annual average of $18.41 million.

Indirect and induced employment is estimated to produce an additional 2,638 jobs (Table 4.16-17). The addition of 2,638 jobs would result in an estimated $11.63 million in added labor income, or an annual average of $10.47 million. There would be induced economic effects from all of the workers at the mines with the purchase of local goods and services as shown in Table 4.16-17. This would have a moderate and long-term impact on the residents of the study area, as fewer employment opportunities would be provided under this alternative, compared with Alternative A.

Table 4.16-17. Indirect Employment Effects under Alternative C

	Indirect	Induced
Planning and Permitting	9.3	17.4
Mine Development	16.2	30.4
Mine Production	16.2	30.4
Reclamation	9.3	17.4
Total per Mine	51	95.6
Total for Alternative C	**918**	**1,720.8**

Source: IMPLAN (2008).

TAXES AND REVENUES

Under Alternative C, total state taxes per mine for all mine phases would be $2.27 million, or a total of $40.86 million for all mines. This would result in an estimated annual average of $2.0 million in state taxes (Table 4.16-18).

Table 4.16-18. State Taxes under Alternative C

	Employee Compensation	Households	Corporation
Planning and Permitting	$18,688	$126,358	$309,020
Mine Development	$16,352	$110,564	$270,393
Mine Production	$49,056	$331,692	$811,179
Reclamation	$9,344	$63,179	$154,510
Total per Mine	$93,440	$631,793	$1,545,102
Total for Alternative C	**$1,681,920**	**$11,372,274**	**$27,811,836**

Source: IMPLAN (2008).

Federal tax revenue would result in an estimated $7.97 million per mine, or a total of $143.5 million for all mines. This would generate an estimated annual average of $7.17 million in federal tax revenue (Table 4.16-19).

As shown in Table 4.16-20, Alternative C would provide $173.7 million in state and local indirect business and $15.8 million in federal business tax.

Alternative C could result in a beneficial, moderate, long-term impact to residents and communities in the study area, although there would be less revenue to the counties generated through taxes, compared with Alternative A.

Table 4.16-19. Federal Taxes under Alternative C

	Employee Compensation	Proprietor Income	Households	Corporation
Planning and Permitting	$689,264	$53,840	$334,170	$517,740
Mine Development	$603,105	$47,110	$292,400	$453,022
Mine Production	$1,809,315	$141,330	$877,200	$1,359,066
Reclamation	$344,632	$26,920	$167,085	$258,870
Total per Mine	$3,446,316	$269,200	$1,670,855	$2,588,698
Total for Alternative C	**$62,033,688**	**$4,845,600**	**$30,075,390**	**$46,596,564**

Source: IMPLAN (2008).

Table 4.16-20. State/Local and Federal Indirect Business Taxes under Alternative C

	Indirect Business Tax – State and Local	Indirect Business Tax – Federal
Planning and Permitting	$1,530,070	$175,984
Mine Development	$1,338,812	$153,986
Mine Production	$4,016,436	$461,958
Reclamation	$765,035	$87,992
Total per Mine	$7,650,353	$879,920
Total for Alternative C	**$173,706,354**	**$15,838,560**

Source: IMPLAN (2008).

RECREATION ECONOMICS

Impacts to nonconsumptive recreation, hunting, and existence and use value under Alternative C are expected to be very similar to those under Alternative B.

Nonconsumptive Recreation

As with Alternatives A and B, creation of 12.1 miles of temporary new roads for mining under Alternative C is expected to offset any potential impacts associated with impacts to recreationists resulting from mining activity (visual, soundscape, etc.). Alternative C would include less road creation and less mining activity, compared with Alternative A. Thus, no overall impact to visitor use or change in the annual economic benefits of recreation is anticipated.

Hunting

Under Alternative C, the total estimated ground disturbance is 532 acres over a 20-year period for all phases, or an average of 26 acres per year. Alternative C would result in a surface disturbance that, compared with the overall available hunting area for the four GMUs affected by the withdrawal parcels, would be negligible. Additionally, issuance of hunting tags and other similar limits that affect hunting activity are not expected to change. As a result, mineral activity under Alternative C would result in no impact to the estimated annual benefit of hunting recreation.

Existence and use Value

Compared with Alternative A, Alternative C would result in fewer fugitive dust emissions and therefore less impact to air quality (see Section 4.2). Thus, actual changes in air quality are not expected to affect recreation and tourist activity. People may also expect that there would be fewer changes to air quality because there is less mineral activity under Alternative C than under Alternative A. Thus, as with Alternative A, future mineral activity under Alternative C is unlikely to affect study area existence and use value.

In terms of nonconsumptive recreation, hunting, and existence and use value, no impacts to recreation economics are expected under Alternative C.

ENERGY RESOURCES

Under Alternative C, approximately 14,647 tons, or 32.2 million pounds of uranium could be mined, meeting approximately 28.27% of the U.S. demand for 2010 and 18.95% for 2030. Given the amount of uranium that could be mined, the uranium could be worth $1.28 billion should prices remain at $40/lb.

Under Alternative C, direct impacts to energy resources would be long term and beneficial. The magnitude of these impacts is likely to be moderate; however, as previously stated, impacts are largely dependent on global demand for uranium.

Given the volatility of the market and subsequent demand, it is difficult to speculate about indirect impacts on energy resources resulting from Alternative C. Indirect impacts would largely depend on the demand for uranium both locally, nationally, and globally.

ROAD CONDITION AND MAINTENANCE

Under Alternative C, 12.1 miles of new roads would be constructed, and an estimated 166,725 haul trips would occur on area roads over a 20-year time frame (see RFD, Appendix B).

Construction of 12.1 miles of new roads would be a 45.98% decrease from new road construction anticipated under Alternative A. Of the new roads, 85% (10.3 miles) would be constructed on BLM lands within the North and East parcels. The addition of 10.3 miles of new roads would represent an increase of 0.15% of the BLM transportation system of primary, secondary, and tertiary unpaved roads. Construction of 1.8 miles of new roads on Forest Service lands in the South Parcel would represent an increase of 0.24% of the 740 miles of roads open to motorized travel on the Kaibab National Forest.

An estimated 71.63% (119,425) of haul trips would occur in the North Parcel, 6.67% (11,120) in the East Parcel, and 21.7% (36,180) in the South Parcel. In terms of changes in traffic levels as a result of haul trips, total haul traffic for Alternative C would result in a 44.46% decrease in haul traffic from current conditions (as described under Alternative A).

As under all other alternatives, mining companies would be responsible for paying for maintenance of unpaved public roads used to haul ore; thus, no anticipated changes to funding road maintenance are expected. In terms of changes in property and use tax revenue, there could be a decrease in road maintenance funding from tax revenue because of the change in roads constructed; however, tourism sales tax revenue is the primary source of funding for road maintenance. Thus, no discernible effect is expected.

Under Alternative C, there would be no direct or indirect impacts to road condition and maintenance.

Cumulative Impacts

Cumulative impacts under Alternative C would be similar in magnitude to Alternative A. For this analysis, there is no measurable difference in anticipated mining activity under the RFD scenarios to indicate that cumulative impacts would be substantially different to warrant a separate discussion for Alternative C.

4.16.5 Impacts of Alternative D: Partial Withdrawal (~300,000 Acres)

Direct and Indirect Impacts

ECONOMIC ACTIVITY

Industry Employment

Under Alternative D, there would be a total of 26 mines, slightly less than under Alternative A. Direct employment associated with Alternative D would be 1,950 employees, or an annual average of 97.5 individuals. Indirect and induced employment associated with Alternative D would be 3,812 employees, or an annual average of 190.6 individuals.

Tourism Sectors Employment

Under Alternative D, tourism employment is expected to remain constant with estimated average annual employment growth rates in Arizona and Utah.

Mining Sector Employment

Under Alternative D, the mining sector would only increase by a total of 1,950 jobs over a period of 20 years. As a result of fewer mining employment opportunities, total output as shown below would also be less than that of Alternative A.

The addition of mining employment opportunities to overall employment in the study area would represent a 0.04% increase over 2008 employment in the five-county area. Under Alternative D, direct employment from the mines would result in an annual average increase of 10.82% in employment over 2008 mining employment. Impacts resulting from Alternative D on mining sector employment are discussed below under Employment, Personal Income, and Unemployment.

Industry Wages

Tourism and Mining Sector Wages

Impacts to tourism-related sector wages would be the same as those described for Alternative A. Under Alternative D, however, given fewer employment opportunities in the mining sector, there would be fewer employees with high wages relative to mining. This decrease would decrease regional output compared with Alternative A, as described below.

Industry Output

Alternative D would provide fewer mining jobs, fewer taxes to the counties and the state, and less revenue to local and regional businesses than Alternative A. As shown in Table 4.16-21, Alternative D would provide a direct impact of $182 million per mine in value added and output, or a total of $4.7 billion over the 20-year period. Total output for Alternative D would be 13.3% less than under Alternative A.

Table 4.16-21. Direct Economic Effects per Mine under Alternative D

	Labor Income	Value Added	Output
Planning and Permitting	$4,091,898	$13,782,852	$22,619,676
Mine Development	$3,580,410	$12,060,000	$19,792,216
Mine Production	$10,741,230	$36,180,000	$59,376,648
Reclamation	$2,045,949	$6,891,426	$11,309,838
Total per Mine	$20,459,487	$68,914,278	$113,098,378
Total for Alternative D	**$531,946,662**	**$1,791,771,228**	**$2,940,557,828**

Source: IMPLAN (2008).

Indirect and induced effects for each phase are shown in Table 4.16-22. Alternative D would provide a total of $1.77 billion in indirect and induced value added and output. This would be $88.9 million per mine over the 20-year period. Economic activity impacts would be less than under Alternative A.

Table 4.16-22. Indirect Economic Effects per Mine under Alternative D

	Labor Income Indirect	Labor Income Induced	Value Added Indirect	Value Added Induced	Output Indirect	Output Induced
Planning and Permitting	$1,166,972	$1,160,774	$2,969,698	$2,144,812	$5,368,662	$3,678,288
Mine Development	$1,021,100	$1,015,677	$2,598,487	$1,876,709	$4,697,578	$3,218,501
Mine Production	$3,063,300	$3,047,031	$7,795,461	$3,217,218	$14,092,734	$9,655,503
Reclamation	$583,486	$580,387	$1,484,849	$1,072,406	$2,684,331	$1,839,144
Total per Mine	$5,834,858	$5,803,869	$14,848,495	$8,311,145	$26,843,305	$18,391,436
Total for Alternative D	**$151,706,308**	**$150,900,594**	**$386,060,870**	**$216,089,770**	**$697,925,930**	**$478,177,336**

Source: IMPLAN (2008).

Given that mining activity would occur over a 20-year period, impacts to economic activity under Alternative D are expected to be beneficial, long-term, and moderate.

Tourism Sectors Output

Under Alternative D, impacts to regional tourism sectors output would be the same as under Alternative A.

Mining Sector Output

Mining sector output as a result of Alternative D is described above.

Economic Diversity

Under Alternative D, direct and indirect impacts to economic diversity would be the same as under Alternative A.

EMPLOYMENT, PERSONAL INCOME, AND UNEMPLOYMENT

Employment opportunities would be fewer under this alternative, compared with Alternative A. For a period of 20 years, a total direct impact of 1,950 jobs would be created under Alternative D. Labor income would increase an estimated $531.9 million over 20 years, or an annual average of $26.59 million (see Table 4.16-21).

Indirect and induced employment is estimated to produce an additional 3,812 jobs (Table 4.16-23). The addition of 3,812 jobs would result in an estimated $11.63 million per mine in added labor income, or an annual average of $15.13 million (see Table 4.16-22). Workers from the town of Blanding who work at the White Mesa uranium mill would not be affected by the reduction of ore processed at the mill.

This also would have a beneficial, moderate, long-term impact on the residents of the study area, although fewer employment opportunities are anticipated than under Alternative A.

Table 4.16-23. Indirect Employment Effects per Mine under Alternative D

	Indirect	Induced
Planning and Permitting	9.3	17.4
Mine Development	16.2	30.4
Mine Production	16.2	30.4
Reclamation	9.3	17.4
Total per Mine	51	95.6
Total for Alternative D	**1,326**	**2,485.6**

Source: IMPLAN (2008).

TAXES AND REVENUES

As shown in Table 4.16-24, total state taxes per mine for all mine phases would be $2.27 million, or a total of $59 million for all mines. This would result in an estimated annual average of $2.95 million in state taxes.

Federal tax revenue would result in an estimated $7.97 million per mine, or a total of $207.3 million for all mines. This would generate an estimated annual average of $10.36 million in federal tax revenue (Table 4.16-25).

As shown in Table 4.16-26, Alternative D would provide $198.9 million in state and local indirect business and $22.87 million in federal business tax. Both state and federal taxes provided under Alternative D would be less than under Alternative A. Alternative D could result in a beneficial, moderate, long-term impact to residents in the study area by providing less revenue through taxes paid to the region for a period of 20 years.

Table 4.16-24. State Taxes per Mine under Alternative D

	Employee Compensation	Households	Corporation
Planning and Permitting	$18,688	$126,358	$309,020
Mine Development	$16,352	$110,564	$270,393
Mine Production	$49,056	$331,692	$811,179
Reclamation	$9,344	$63,179	$154,510
Total per Mine	$93,440	$631,793	$1,545,102
Total for Alternative D	**$2,429,440**	**$16,426,618**	**$40,172,652**

Source: IMPLAN (2008).

Table 4.16-25. Federal Taxes per Mine under Alternative D

	Employee Compensation	Proprietor Income	Households	Corporation
Planning and Permitting	$689,264	$53,840	$334,170	$517,740
Mine Development	$603,105	$47,110	$292,400	$453,022
Mine Production	$1,809,315	$141,330	$877,200	$1,359,066
Reclamation	$344,632	$26,920	$167,085	$258,870
Total per Mine	$3,446,316	$269,200	$1,670,855	$2,588,698
Total for Alternative D	**$89,604,216**	**$6,999,200**	**$43,442,230**	**$67,306,148**

Source: IMPLAN (2008).

Table 4.16-26. State/Local and Federal Indirect Business Taxes per Mine under Alternative D

	Indirect Business Tax – State and Local	Indirect Business Tax – Federal
Planning and Permitting	$1,530,070	$175,984
Mine Development	$1,338,812	$153,986
Mine Production	$4,016,436	$461,958
Reclamation	$765,035	$87,992
Total per Mine	$7,650,353	$879,920
Total for Alternative D	**$198,909,178**	**$22,877,920**

Source: IMPLAN (2008).

RECREATION ECONOMICS

Impacts to nonconsumptive recreation, hunting, and existence and use value under Alternative D are expected to be very similar to Alternative A.

Nonconsumptive Recreation

As with the other alternatives, the creation of 19.1 miles of temporary, new roads for mining under Alternative D could offset any potential impacts associated with impacts to recreationists resulting from mining activity (visual, soundscape, etc.). Alternative D would include less road creation and less mining activity, compared with Alternative A. Thus, no overall impact to visitor use or change in the annual economic benefits of recreation is anticipated.

Hunting

Under Alternative D, the total estimated ground disturbance is 951 acres over a 20-year period for all phases, or an average of 48 acres per year. Alternative D would result in a surface disturbance that, compared with the overall available hunting area for the four GMUs affected by the withdrawal parcels, would be negligible. Additionally, issuance of hunting tags and other similar limits that affect hunting activity are not expected to change. As a result, mineral activity under Alternative D would result in no impact to the estimated annual benefit of hunting recreation.

Existence and use Value

Compared with Alternative A, Alternative D would result in fewer fugitive dust emissions and therefore less impact to air quality (see Section 4.2). Actual changes in air quality are not expected to affect recreation and touristy activity. People may also expect that there would be fewer changes to air quality because there is less mineral activity under Alternative D than under Alternative A. Thus, as with Alternative A, future mineral activity under Alternative D is unlikely to affect study area existence and use value.

Under Alternative D, in terms of nonconsumptive recreation, hunting, and existence and use value, direct and indirect impacts to recreation economics are expected to be long term and minor.

ENERGY RESOURCES

Under Alternative D, approximately 26,647 tons, or 58.62 million pounds of uranium could be mined, meeting approximately 51.42% of the demand for 2010 and 34.48% for 2030. Given the amount of uranium that could be mined, the uranium would be worth an estimated $2.34 billion.

Under Alternative D, direct impacts to energy resources would be long term and beneficial. Given the availability of uranium that could be mined under this alternative, the magnitude of these impacts is likely to be moderate to major, depending on global demand for uranium.

Given the volatility of the market and subsequent demand, it is difficult to speculate about indirect impacts on energy resources resulting from Alternative D. Indirect impacts would largely depend on the demand for uranium both locally, nationally, and globally.

ROAD CONDITION AND MAINTENANCE

Under Alternative D, 19.1 miles of new roads would be constructed, and an estimated 255,685 haul trips would occur on area roads over a 20-year time frame (see RFD, Appendix B).

Construction of 19.1 miles of new roads would be a 14.73% decrease from new road construction anticipated under Alternative A. Of the new roads, 16.7 miles (87.4%) would be constructed on BLM lands in the North and East parcels. The addition of 16.7 miles of new roads would represent an increase of 0.25% of the BLM transportation system of primary, secondary, and tertiary unpaved roads. Construction of 2.4 miles of new roads on Forest Service lands in the South Parcel would represent an increase of 0.32% of the 740 miles of roads open to motorized travel on the Kaibab National Forest.

An estimated 77.15% (197,265) of haul trips would occur in the North Parcel, 4.35% (11,120) in the East Parcel, and 18.5% (47,300) in the South Parcel. In terms of changes in traffic levels as a result of haul trips, total haul traffic for Alternative D would result in a 14.82% decrease in haul traffic from current conditions (as described under Alternative A).

As under all other alternatives, mining companies would be responsible for paying for maintenance of unpaved public roads used to haul ore; thus, no anticipated changes to funding road maintenance are expected. In terms of changes in property and use tax revenue, there could be a decrease in road maintenance funding from tax revenue because of the change in roads constructed; however, tourism sales tax revenue is the primary source of funding for road maintenance. Thus, no discernible effect is expected.

Under Alternative D, there would be no direct or indirect impacts to road condition and maintenance.

Cumulative Impacts

Cumulative impacts under Alternative D would be similar in magnitude to Alternative A. For this analysis, there is no measurable difference in anticipated mining activity under the RFD scenarios to indicate that cumulative impacts would be substantially different to warrant a separate discussion for Alternative D.

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